IMPEDIMENTS TO SOLID WASTE MANAGEMENT IN BENIN METROPOLIS

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CERTIFICATION

We, the undersigned, hereby certify that this research was conducted by Ogbeide Aghatotikolo of the Department of Health, Safety and Environmental Education, Faculty of Education, University of Benin, Benin City, Nigeria.

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DEDICATION

This research is dedicated to God Almighty for His guidance and grace throughout this journey. I also dedicate it to my beloved wife, Mrs. A.T. Ogbeide, whose unwavering support and encouragement have been invaluable, and to our cherished children; Eghosasere, Oghosasere, Uyioghosasere, and Eleghosarumwen Ogbeide, whose love and inspiration continue to motivate me.

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ABSTRACT

This study investigated impediments to solid waste management in Benin Metropolis. Impediments are those factors that hinder solid waste management, it was aimed at ascertaining the relationship between segregation, storage, collection, transportation, and disposal stage of solid waste as it affects solid waste management. Seven (7) research questions guided the study, alongside one hypothesis and tested at a 0.05 level of significance.

The descriptive survey research design was used in the study. The study population comprised one hundred and sixteen (116) registered solid waste management companies operating within the three Local Government Areas that constitute Benin Metropolis. Sample sizes of seventy (70) registered solid waste management companies, representing sixty percent (60%) of the population, were selected using the multi-stage sampling technique (stratified, proportional and simple random sampling techniques). Data were collected using two research instruments: a structure questionnaire and a checklist. The structured questionnaire and the checklist were validated by the researcher's chief and co supervisor ant three others. The questionnaire reliability was determined through the test-retest method and analyzed using the Pearson Product Moment Correlation, yielding a reliability coefficient of 0.73. However, the checklist was not subjected to reliability test. Descriptive statistics (frequency counts, percentages, means, and standard deviations) were employed to analyze the research questions, while inferential statistics (ANOVA) was used to test the hypothesis.

The findings revealed among others that lack of segregation of solid waste at household level, insufficient storage equipment, irregular and non-payment of solid waste collection bills by some residents, the use of vehicles that were not roadworthy and dumpsites not being regularly maintained were the impediments inherent in segregation, storage, collection, transportation and

disposal, respectively to solid waste management in Benin metropolis. However, there was a significant difference in the impediments inherent in the various stages of solid waste management in Benin metropolis. It was concluded that segregation of solid waste at household level, improvement in storage equipment, regular payment for solid waste collection bills by residents, the use of vehicles that are roadworthy and regularly maintenance of dumpsites are crucial to enhancing solid waste management in Benin metropolis. Based on these findings, the following recommendations were made, Solid waste management companies should be supported and encouraged to procure and maintain durable trucks to ensure proper waste packaging and minimize spillage. The government should collaborate with these companies to acquire modern equipment that enhances service delivery. Regular road maintenance should be undertaken to facilitate efficient solid w aste transportation. Funding for solid waste management should be increased, especially in view of the public-private partnership model. A comprehensive policy framework promoting waste reduction and recycling should be developed and implemented to ensure effective and sustainable solid waste management in Benin Metropolis.

CHAPTER ONE

INTRODUCTION

Background to the Study

The environment serves as the foundation for human existence and development. It not only supports life but also supplies essential resources required for socio-economic advancement. Historically, natural resources and environmental conditions have played a vital role in shaping social, political, and economic transformations. However, the relentless pursuit of development has pushed human activities beyond environmentally sustainable limits, resulting in ecological degradation. In particular, modern human activities such as consumption habits, industrial production, agricultural intensification, transportation, and urban expansion have contributed substantially to environmental deterioration through the excessive generation of waste, particularly solid waste. The accumulation of this waste imposes a heavy burden on the environment, which becomes overwhelmed by the sheer volume and impact of human activities. These discarded remnants of daily life are collectively referred to as waste, representing the negative externalities of development.

The environment comprises a complex interaction of physical, chemical, and biological (biotic) factors, which collectively sustain life on Earth. Waste is a byproduct of these interactions when resources are consumed and rendered unusable. Waste materials, often considered worthless or defective, can exist in solid, liquid, or gaseous forms. Among these, solid waste is particularly concerning due to its volume, persistence, and potential hazards. Solid waste refers to any discarded or unwanted materials that are non-liquid or gas, typically generated from human activities. Its non-liquid, non-soluble materials that are discarded rejected or abandoned including materials that are worthless, useless or in excess. It encompasses a broad range of

items such as household trash, industrial waste, construction debris, agricultural waste, municipal waste and hazardous waste.

These materials can be categorized into organic waste (biodegradable) such as food waste, yard trims, paper, and wood. Inorganic waste (non-biodegradable) such as plastics, metals, glass, ceramics, hazardous waste such as toxic, chemical, batteries and electronic waste. Solid waste are materials that are no longer considered useful and are discarded as a result of human activities. These include household refuse; industrial waste, agricultural residues, and commercial debris, Therefore, solid wastes are masses of refuse resulting from the various human activities in the environment. As defined by the World Health Organization (WHO, 2023), solid waste consists of useless, unwanted, or discarded materials arising from routine community operations. Daily human activities, carried out to achieve individual or collective objectives, often degrade the environment and generate waste in the process which need to be managed.

Solid Waste Management is the comprehensive process of handling solid waste from the moment it is generated to its final disposal. It entails, solid waste processing and treatment that incorporate various techniques such as recycling, composting, incineration, or mechanical- It encompasses a sequence of interrelated stages designed to protect human health and the environment. These stages include; solid waste generation, segregation, storage, collection, transportation and disposal.

Waste Generation is the initial phase where solid waste is produced at households, industries, commercial establishments, institutions, and other sources (UN-Habitat, 2022). Waste Segregations involves sorting waste at the point of generation into specific categories such as recyclables, organic waste, hazardous materials, and non-recyclables. Effective segregation enhances recycling efficiency and reduces the burden on landfills (Dennis & Ejovo, 2011). Also,

Waste Storag is the temporarily storeage of waste either at its point of generation or in designated containers and facilities, ensuring safety, sanitation, and the prevention of pest infestations (WHO, 2025).

Solid waste collection is the collection of solid waste from storage points by solid waste management company (Ukala & Ifeanyi, 2020) to the point of transportation. Solid waste transportation is when wastes are moved using specially equipped vehicles to recycling centers, transfer stations, or dumpsites (Adekola, 2021). Solid waste disposal is the final stage in solid waste management cycle, typically involving solid waste disposal in sanitary landfills or other environmentally approved dumpsites to prevent contamination of soil, water, and air (Ogwueleka, 2019). These stages of solid waste management may be interrupted as a result of some impediment.

Impediment to solid waste management\ are those obstacles that is preventing effective solid waste management, ranging from inadequate segregation, storage, collection, transportation and disposal equipment, funding, of solid waste. Solid waste segregation is a crucial step in effective solid waste management, enabling efficient recycling, composting, and disposal of solid waste.

However, several impediments inherent in the segregation process hinder its effectiveness, poor solid waste segregation, failure to segregate solid waste at source, leading to mixed waste streams and increased risks of environmental pollution. Limited understanding of segregation benefits and practices among the public and waste generators hinders effective segregation (Wilson et al., 2015).

The storage stage of solid waste management can face several impediments, including, inadequate storage equipment, insufficient or poorly designed storage containers, leading to waste spillage, leakage, or overflow, insufficient capacity, storage equipment that are too small

or inadequate to handle the volume of waste generated can lead to overflow, litter, and other environmental issues. Lack of maintenance: failure to regularly clean and maintain storage equipment, leading to pest infestations, odors, and other issues. Inadequate protection from pests and animals: storage equipment that is not designed or maintained to prevent pest and animal infestations. Environmental hazards, storage equipment that are not designed to prevent environmental hazards such as leachate or gas emissions. Aesthetic issues: storage equipment that are unsightly or create unpleasant odors, affecting the surrounding environment and community (Vinary & Vavneet 2018).

These impediments to the storage stage of solid waste management can lead to: Environmental pollution, health risks, aesthetic issues, increased waste management costs. Addressing these impediments requires: Proper design and maintenance of storage equipment, adequate capacity planning, effective waste segregation practices regular cleaning and maintenance storage equipment, pest control measures, environmental protection measures which can be improved upon to reducing environmental and health risks. The collection stage of solid waste management is an important component of the solid waste management. Adienbo, Njoku, & Asara, (2013)

However, several impediments inherent in this stage can compromise solid waste management systems. They are inadequate equipment, insufficient or poorly maintained collection vehicles, containers, and can lead to inefficient solid waste collection, increased costs, and environmental pollution, Inadequate funding, personnel, and equipment can hinder effective solid waste collection, leading to reduced service quality and increased environmental risks. Inefficient collection routes, poorly planned collection routes can lead to increased collection times, fuel

consumption, and emissions, compromising the efficiency and sustainability of waste collection systems, (Kamila, 2020).

Transportation Stage is categorized with inadequate vehicles and equipment, traffic congestion and route inefficiencies, safety and health risks, environmental impacts, and regulatory challenges: Efficient transportation requires adequate equipment optimized routes, and safety measures Disposal Stag: Environmental Pollution, Landfills and other disposal facilities can lead to environmental pollution, including leachate and gas emissions, and groundwater contamination. Health Risks poorly managed disposal equipment can pose health risks to nearby communities, including the spread of diseases and exposure to toxic substances (WHO, 2018). Insufficient disposal capacity can lead to waste accumulation, increased costs, and environmental pollution.

Neglect of informal sector, process of registration of solid waste managers, application for registration, licensing process, power to cancel or suspend license, not allowing unregister private solid waste managers, designation of solid waste dumpsites, penalties for unregistering private solid waste managers, waste managers to be treated as contractors are some of the impediments to solid waste management in Benin metropolis. The degree to which uncontrolled dump sites, the dumpsite become breeding grounds for insects, rodents, and other disease vectors, and gathering places for dogs, wild animals, and poisonous reptiles depends largely on Government policy and programs to limit negative environmental consequences, (law No.5 of, 2010).

When Government policies and programs are too hard or difficult to meet it becomes a problem to get more hands in solid waste management, this is in line with Sommerville, Jones, Rahajaharison & Milner, (2010), which state that there is typically a lack of human resource at

both state and local Government levels with the technical expertise necessary for solid waste management, planning and operations. It is important therefore for the Government to reduce or relieve some of its policy on the processes of registration. In Benin metropolis, solid waste management is given a very low priority except perhaps in some parts of the metropolis, as a result very limited funds are provided to the solid waste managers by the Government, and the levels of services required for the protection of public health and the environment are not attained. The situation has also been compounded by the reluctance of some residential households to pay for solid waste collection and disposal services, for reasons of poverty, low monthly income, and not willing to pay, (Abdullahim, 2019).

One of the reasons for not being willing to pay lies in the fact that the Waste Management Board was established as a nonprofit-oriented sector and their services as being a public good that attracts little or no charge, also inefficiency on the side of accredited waste managers. According to Obirih - Opareh & Post, (2002), the promotion of environmental quality depends on how individuals and communities see themselves about their environment. It is the ways people perceive the environment that they will treat it. And it is the way the environment is treated that will in turn support life. He believes that illiteracy, ignorance, poverty, and greed are some of the major contributors to environmental degradation because each influences people's behavior and attitudes towards the environment, a person who is ignorance of his actions on the environment will likely have wrong perception about the effect of his action on his health. A community that understands the link between a healthy environment and good health can save time, money, and avoidable agonies.

In Nigeria for example, there is no national law on urban solid waste management as the role of urban waste management is constitutionally vested in local governments, (the Nigeria

Constitution 1999 as amended). The existing relationship between local and state governments, the form and extent to which citizens participate in the public processes of policymaking, and the role of the political party in local government administration, all affect the character of effective solid waste management, governance, and the type of solid waste management strategies which is possible and appropriate for the citizens (Ashok, 2019). The effective functioning of solid waste managers in the Benin metropolis may be influenced by waste storage, waste collection, waste transportation, waste segregation, and waste disposal; hence there is a need for communities to take ownership of effective solid waste management in their various communities.

Ekere, Mugisha and Drake, (2019), opined that the effectiveness and sustainability of municipal solid waste management depend on the degree to which the served population identifies with, and takes "ownership" of the process. Therefore, they must be fully involved in the planning of solid waste management. A typical solid waste management style in Benin Metropolis displays an array of problems, it includes; inadequate containers or equipment for storing and transporting the solid waste, few accredited solid waste managers, covering large areas or routes in the metropolis, indiscriminate and irresponsible dumping of solid waste in street corners; in between houses; in gutters/drains, poor management of landfill sites and refuse dumps, Obirih - Opareh & Post, (2002).

Government policies as it affects effective solid waste management, weak and slow enforcement of environmental laws/regulation, as it stipulated in Edo State sanitation and pollution management law, little or no supervision by concerned authorities to ensure proper solid waste management, inadequate solid waste laborers or workers for solid waste collection as they are not well paid and regarded as the low-class income earner, improper handling and control of

informal solid waste picking (scavenging) activities), high cost/maintenance of solid waste management equipment's and vehicles, unavailability of properly engineered disposal sites and waste treatment plants, inadequate haulage equipment's and lack of expertise, lack of financial assistance and support from the government; (Cointreau, 2016).

According to Adebayo, Lancheros, Ezinma, and Nuruden, (2018), some of the problems facing effective urban solid waste management in Nigeria and other developing countries are; a lack of waste data, poor waste disposal options, inefficient solid waste collection system, neglect of the informal sector, lack of waste management technology, lack of unified rules and regulation and lack of awareness. Lack of waste data records, waste generation, collection, and characterization records in Benin Metropolis are generally poor and in most cases not available, poor waste disposal options there are no specific waste disposal options in Nigeria and Benin Metropolis in particular which may lead to indiscriminate dumping of solid waste.

Indiscriminate dumping of solid wastes even into the gutter/drains is the order of the day, inefficient solid waste collection system; refuse collection is a process of transferring solid waste from the storage receptacle either directly to the designated dumpsites or nearby authorized or non-authorized sites. In Nigeria, there are problems of inappropriate designation of solid waste collection centers, and hence wastes are dumped at street junctions and corners, the case is not different in Benin metropolis, Olufayo & Omotosho, (2017). Solid waste management is a growing global challenge, especially in urban areas in developing countries where rapid population growth and urbanization have outpaced the capacity of solid waste management systems (Vinary & Vavneet, 2018).

In Nigeria, and particularly in Benin Metropolis, ineffective solid waste management practices may have led to widespread environmental degradation, health risks, and diminished quality of life (Ukala & Ifeanyi, 2020; Adekola, 2021).

Consequently, there is an urgent need to examine impediments to solid waste management in Benin Metropolis. Understanding the factors responsible for the inefficiencies in current solid waste management system is essential for formulating effective interventions and policies aimed at improving public health, environmental sustainability, and urban governance.

Despite the government approach to Solid Waste Management in Benin metropolis, Benin Metropolis faces challenges in solid waste management. A considerable portion of solid waste generated within the city ends up on the streets, in open spaces, and in public areas due to ineffective solid waste management systems (Ukala & Ifeanyi, 2020). This issue is not unique to Benin metropolis; it reflects a broader trend across many urban centers in developing countries, where indiscriminate waste disposal persists due to poor public attitudes, insufficient solid waste management equipment, and weak enforcement of environmental sanitation law and regulations (Vinary & Vavneet, 2018).

In Nigeria, inadequate waste collection and disposal services have led to widespread dumping of solid waste in unauthorized areas such as vacant lots, gutters, roadways, and waterways. This occurs largely due to the absence of clearly designated sites for solid waste segregation, storage, collection, transportation and final disposal. In Benin Metropolis, the most prevalent method of waste disposal is through open dumping in drains, markets, and street corners, often without regard for environmental consequences (Adekola, 2021). This poor practice of solid waste management has been linked to serious public health and environmental hazards, including:, contamination of surface and underground water sources, Outbreaks of waterborne diseases such as cholera and dysentery, respiratory and skin infections from decaying waste, air pollution and foul odors from decomposing organic materials (WHO, 2025; Adekola, 2021)

Solid waste management companies play a pivotal role in maintaining environmental health within urban areas. These companies are responsible for providing public guidance on effective Solid waste management practices, preparing operational and compliance reports, investigating public complaints, and managing media communications when required (Jamieson, 2017). Additionally, they formulate and enforce policies governing Solid waste management operations and safety standards, supervise staff to ensure adherence to government regulations, and intervene to resolve operational challenges. Moreover, Solid Waste Management companies contribute to policy implementation by attending stakeholder meetings and offering technical expertise on solid waste management initiatives. Their duties also encompass long-term strategic planning, which includes workforce organization, financial forecasting, and project performance evaluations (Wilson, Whiteman, & Tormin, 2021). At the organizational level, they are tasked with human resource functions such as recruiting, training, appraising, rewarding, and disciplining employees, thereby ensuring a competent and motivated workforce. The responsibilities of solid waste management companies also extend to the maintenance and repair of waste collection vehicles, financial administration, route planning, scheduling, record-keeping, personnel management, and long-term strategic planning for urban waste systems (Ogwueleka, 2019).

Efficient and cost-effective solid waste management remains one of the most pressing urban challenges of the 21st century and is a core responsibility of government authorities. As Wilson, Whiteman, and Tormin (2021) asserted that, a city incapable of managing its solid waste is often equally incapable of delivering more complex services such as public health, education, or transportation. In Benin Metropolis, rapid urbanization has intensified these challenges of solid waste management, contributing to overcrowding, slum proliferation, and poor solid waste

management (Ochuko, 2014). Urban residents typically consume more resources and generate greater quantities of solid waste than their rural counterparts, which in turn amplify the pressure on solid waste management equipment. Unfortunately, this waste is rarely segregated, stored, collected, transported, or disposed of according to best practices, leading to widespread indiscriminate dumping and environmental degradation (UN-Habitat, 2022).

The Nigerian Constitution delegates the responsibility for urban sanitation, including solid waste management, to local governments the third tier of government (Federal Republic of Nigeria, 1999). However, in Edo State and particularly within Benin Metropolis, local authorities have been largely ineffective in addressing this responsibility. As a response to these shortcomings, the Edo State Government established the Edo State Waste Management Board (EDSWMB) in 2010 to oversee and improve solid waste management systems across Benin metropolis. To enhance the efficiency of solid waste management operations, the Edo State Waste Management Board [EDSWMB] introduced a public-private partnership model by accrediting private solid waste management companies. The Board functions as the regulatory authority supervising both residential waste management and the operations of accredited private companies. While these private companies are responsible for the actual service delivery of solid waste collection, transportation, and disposal, Edo State Waste Management Board retains authority over service regulation, including the setting of bills for residents and businesses (EDSWMB, 2010).

Importantly, the fees charged for solid waste services are not based on the volume of solid waste generated but rather on the location and classification of households or establishments. Under the Edo State Sanitation and Pollution Management Law (2010), these services are compulsory for all residents of Benin Metropolis as part of a broader effort to ensure effective solid waste management and environmental sanitation to improve public health. Despite structural

interventions, the implementation of solid waste management in Benin Metropolis has been hindered by the residents' reluctance to pay for solid waste collection and disposal services. This reluctance is often attributed to widespread poverty or the belief that such services should be provided by the government at little or no cost (Edo State Sanitation and Pollution Management Law, 2010).

Although government agencies, community organizations, private companies, and concerned individuals have made various efforts to address the solid waste management crisis in Benin metropolis, these measures have largely proven inadequate in the face of the city's rapid population growth and the corresponding increase in solid waste generation (Edo State Sanitation and Pollution Management Law, 2010; UN-Habitat, 2022). The upsurge in solid waste production has overwhelmed the capacity of the limited number of registered or accredited waste management companies. As a result, these companies struggle to meet the necessary standards for public hygiene and environmental sustainability. One visible manifestation of this systemic failure is the accumulation of solid waste at road junctions and markets across the metropolis, where refuse piles emit offensive odors and degrade the aesthetic quality of the urban environment. This failure is closely linked to the inadequacy of the current zoning system for solid waste management companies, which has rendered Benin metropolis increasingly uninhabitable from a public health standpoint.

Urban waste in Nigeria is often viewed as a "non-resource" devoid of economic or functional value and thus, has been historically treated with neglect. Consequently, a similar attitude prevails in the management of solid waste within Nigerian cities (Asikhia, 2011). This mindset has further perpetuated poor solid waste disposal practices. According to Ogwueleka (2019), the major cause of solid waste management problems in Nigerian cities is the failure to ensure

proper environmental sanitation. This stems from both ineffective solid waste management systems and weak enforcement of environmental sanitation laws. In Benin Metropolis, this is particularly evident in the lax enforcement of existing solid waste disposal regulations. Over the years, successive governments at the federal, state, and local government levels have expressed concern for environmental and public health, instituting various laws and decrees aimed at encouraging proper hygiene and environmental sanitation. Historically, sanitary inspectors, also known as public health officers, played a critical role in educating citizens and ensuring community-wide compliance with environmental health standards. In 1984, the Nigerian government introduced monthly environmental sanitation exercises to encourage residents to clean their surroundings at least once a month a practice still maintained in some states in Nigeria till date (Asikhia, 2011).

The implications of poor solid waste management go beyond aesthetic concerns. Inadequate Solid Waste Management poses severe environmental and health risks, creating ideal breeding conditions for disease-carrying organisms and degrading both human health and natural ecosystems (Agboje, Adeoti, & Irhivben, 2014). Heaps of uncollected refuse serve as breeding grounds for pathogens, contributing to the spread of infectious diseases and environmental pollution. To curb indiscriminate solid waste disposal, it is imperative for the government to implement effective, enforceable policies and programs tailored to the unique challenges of solid waste management in Benin Metropolis. A coordinated approach involving regulatory enforcement, community participation, and sustainable funding mechanisms is essential. In light of these pressing issues, this study seeks to explore the impediments to solid waste management in Benin Metropolis.

Statement of the Problem

Edo State is one of Nigeria's fastest-growing regions in terms of urban development and it continues to grapple with the challenges of solid waste management in Benin Metropolis, its capital city. The city's expanding population driven largely by urbanization has led to an increase in solid waste generation. Unfortunately, this increase has not been met with a corresponding improvement in solid waste management. As a result, a large proportion of solid waste ends up in drains and channel, clogging the free flow of water and contributing to recurring regional erosion and flooding during the rainy season in some part of Benin metropolis (Dennis & Ejovo, 2011).

The aesthetic and sanitary quality of an urban environment is a direct reflection of its solid waste management. In Benin Metropolis, nevertheless, many residents continue to dispose of solid waste indiscriminately, often without awareness of the adverse effects on the environment and public health (Dennis & Ejovo, 2011). This behaviour has contributed to a widespread culture of environmental neglect; with heaps of uncollected refuse lining in major streets in Benin metropolis thisf is an alarming situation for a state capital. The core objective of solid waste management is to maintain a clean, safe, and healthy environment. Yet, this objective has not been achieved in Benin Metropolis due to numerous impediments. Despite government efforts and initiatives to promote a clear and safe environment for inhabitants which include the establishment of the Edo State Waste Management Board (EDSWMB), the enactment of environmental sanitation and pollution control laws, the creation of a dedicated enforcement unit, and the distribution of solid waste receptacles in strategic places across parts of Benin metropolis the problem persists (EDSWMB, 2023).

In many cases, solid waste management companies fail to adhere to effective collection schedules. Instead, refuse is often left unattended for prolonged periods, or only collected at times that suit the convenience of the contractors. This ineffective service delivery undermines public confidence and contributes to continued environmental degradation. Moreover, despite the presence of relevant laws and equipment, residents continue to engage in unsanitary solid waste disposal practices, further complicating the task of maintaining a healthy urban environment. These challenges have contributed to an alarming rise in environmental health issues, including the spread of diseases such as malaria, typhoid fever, cholera, and dysentery particularly in densely populated or poorly serviced neighborhoods (EDSWMB, 2023; WHO], 2023).

While several studies by Abdulrasaq, (2021) and Burns, (2016), have acknowledged the challenges of waste management in Nigerian cities, there is a lack of comprehensive research specifically focusing on the interlinked components of solid waste management such as solid waste segregation, storage, collection, transportation, and final waste disposal in Benin Metropolis. Limited attention has been paid to the systemic disconnection between solid waste management, and these stages and how such disjointed operations contribute to overall failure in solid waste management. This study seeks to fill this critical gap by investigating the impediments to solid waste management in Benin Metropolis. It aims to answer the fundamental research question: What are the impediments to solid waste management in Benin Metropolis? Addressing this question will offer valuable insights into the root causes of solid waste management crisis in Benin metropolis and propose practical strategies for reform. The ultimate goal is to contribute to the development of a cleaner, healthier, safe and more sustainable urban environment for the residents of Benin Metropolis.

Research Questions

Seven research questions were raised to direct course of the study

1. What are the impediments inherent in the segregation stage of solid waste management in Benin metropolis?
2. What are the impediments inherent in the storage stage of solid waste management in Benin metropolis?
3. What are the impediments inherent in the collection stage of solid waste management in Benin metropolis?
4. What are the impediments inherent in the transportation stage of solid waste management in Benin metropolis?
5. What are the impediments inherent in the disposal stage of solid waste management in Benin metropolis?
6. What is the availability of solid waste management equipment in Benin metropolis?
7. Are there differences in the impediments inherent in the various stages of solid waste management in Benin Metropolis?

Hypothesis

One hypothesis was formulated and tested at 0.05 level of significance.

1. There are no significant differences in the impediments inherent in the various stages of solid waste management in Benin metropolis.

Purpose of the Study

The purpose of the study is to investigate the impediments to solid waste management in Benin Metropolis, Edo State. Specifically, the study seeks to:

1. identify the impediments inherent in the segregation stage of solid waste management in Benin Metropolis,
2. examine the impediments inherent in the storage stage of solid waste management in Benin metropolis,
3. investigate the impediments inherent in the collection stage of solid waste management in Benin Metropolis,
4. explore the impediments inherent in the transportation stage of solid waste handling in Benin Metropolis,
5. assess the impediments inherent in the disposal stage of solid waste management in Benin Metropolis,
6. determine the availability of solid waste management equipment within the metropolis, and
7. examine whether there are significant differences in the impediments across the various stages of solid waste management.

Significance of the Study

To the solid waste management companies, this study will be of great importance if published. It will promote a better understanding of solid waste management principles and best practices, enabling the development of effective strategies for solid waste handling. The findings will help enhance operational efficiency in optimizing processes such as solid waste generation, segregation, storage, collection, transportation, and disposal. This, in turn, will reduce the overall cost of solid waste management and improve service delivery. Through insights from this study, solid waste managers will be able to develop evidence based policies and regulations that align with national environmental and health standards, thereby ensuring more effective waste

management in Benin Metropolis. The study will also enhance the capacity of solid waste management companies to design, implement, and monitor solid waste management processes. Moreover, an improved understanding of these processes will help them identify opportunities for innovation, such as waste-to-energy initiatives and recycling programs, which will further strengthen their effectiveness.

To the Ministry of Environment, the study will be of great value in supporting informed policy development. By deepening the Ministry understands of solid waste management, it will facilitate the creation of evidence-based policies and regulations for effective waste management. This will promote environmental protection by reducing pollution, conserving natural resources, and safeguarding ecosystems. Furthermore, the study will contribute to sustainable development by supporting national environmental goals and reducing the environmental impact of solid waste. It will also encourage the principles of reduction, reuse, and recycling (the 3Rs) by helping the Ministry design and implement initiatives that minimize waste generation, improve recycling rates, and promote resource efficiency. Additionally, it will strengthen the Ministry's ability to monitor waste management activities and enforce environmental regulations, thereby contributing to the conservation of natural resources and the protection of public health.

The study will also benefit the Ministry of Education by promoting environmental awareness among students and teachers. It will provide an opportunity for educational institutions to integrate topics related to proper waste disposal, recycling, and environmental conservation into their learning activities. Furthermore, it will encourage students to participate in solid waste management initiatives and community programs, thereby fostering social responsibility and civic engagement in environmental matters.

For the Ministry of Information, the study will be highly beneficial in guiding the development of public awareness campaigns on proper waste disposal practices and the importance of recycling. It will support the Ministry in collaborating with communities to promote waste management initiatives, encourage public participation, and disseminate accurate information on waste management policies, regulations, and best practices. The findings will also help in developing communication strategies that encourage behavioral change toward sustainable waste management. Through collaboration with other government agencies and stakeholders, the Ministry of Information will play a crucial role in promoting environmental conservation and sustainability.

Finally, the study will be of great benefit to the Ministry of Health by contributing to disease prevention and the promotion of public health. Proper solid waste management reduces the spread of diseases and minimizes health risks associated with poor waste disposal. By providing a cleaner and safer environment, it helps reduce pollution and its associated health impacts. The study will further enable the Ministry of Health to develop policies and guidelines aimed at protecting public health and preventing environmental hazards related to improper waste management.

Scope and Delimitation of the Study

The scope of this study was to find out the impediments to solid waste management in Benin Metropolis. It identified the barriers affecting effective solid waste management in Benin metropolis. However, the study was delimited to accredited solid waste management companies duly registered and operating under the Edo State Waste Management Board. At the time of conducting this research, only these accredited companies were authorized to operate within Benin Metropolis, as other zones and Local Government Areas had not yet been accredited non

integrated into the Edo State Waste Management Board system. The study focused particularly on identifying impediments across the major stages of solid waste management, solid waste segregation, storage, collection, transportation, and disposal stages within Benin Metropolis.

Definition of Terms

The following terms are operationally defined as used in this study:

Behavioural Change: The process of modifying human attitudes and practices, particularly as it relates to improving household and community solid waste management behaviors.

Impediments: The structural, behavioral, logistical, and policy related challenges, obstacles, barriers that hinder solid waste management operations in Benin Metropolis.

Inherent: This refers to the internal or intrinsic obstacles, challenges, or limitations that are embedded within the various stages of solid waste management.

Solid Waste Management Company Managers: Authorized representatives of solid waste management companies accredited by the Edo State Waste Management Board to operate as part of the public-private partnership in solid waste handling and service delivery.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter reviewed related literature and was discussed under the following subheadings:

- Theoretical Framework
- Conceptual Framework
- Concept of Solid Waste
- Concept of Solid Waste Management
- Stages of Solid Waste Management
- Impediments to Solid Waste Management
    - Impediments Inherent in Segregation Stage of Solid Waste Management
    - Impediments Inherent in storage stage of solid waste management
    - Impediments Inherent in Collection Stage of Solid Waste Management
    - Impediments Inherent in Transportation Stage of Solid Waste Management
    - Impediments Inherent in Disposal Stage of Solid Waste Management
    - Availability of Solid Waste Management Infrastructure
- Empirical Studies on Impediments to Solid Waste Management Process
- Summary of Reviewed Literature

Theoretical Framework

This study is anchored on General System Theory, originally developed by an Austrian biologist Ludwig von Bertalanffy in 1928. System Theory is a transdisciplinary scientific framework that investigates the structure and behavior of complex systems across disciplines. It emphasizes how interconnected components of a system interact to achieve a shared goal (Ofomata, 2018; Burns, 2016; Abimbola & Stephen, 2020). According to System Theory, a system is comprised of

multiple interrelated parts or subsystems that must work collaboratively and efficiently to maintain system integrity and functionality. When each component operates effectively, the entire system functions optimally. Conversely, dysfunction in any component can impede the performance of the whole (Harris, 2013).

This theoretical lens is particularly relevant to solid waste management, which involves various interconnected components such as waste segregation, storage, collection, transportation, and disposal. Each of these subsystems must operate in harmony for the entire waste management system to be effective. System Theory provides a conceptual basis for understanding the complex interdependencies and interactive challenges that may obstruct waste management operations (Thompson, 2013; Daniel, 2020). Impediments to solid waste management that can be analyzed through System Theory include:, Insufficient Funding: Financial constraints that hinder the implementation of waste management programs and procurement of necessary equipment. Inadequate Infrastructure: Deficits in waste collection, transport systems, and disposal facilities. Poor Governance: Weak regulatory frameworks, poor enforcement of policies, and corruption in the waste management sector. Lack of Environmental Education: Limited public awareness and participation in sustainable solid waste management.

System Theory thus allows for a holistic examination of the solid waste management ecosystem, illustrating how failures in one subsystem such as policy enforcement or infrastructure can cascade into inefficiencies throughout the entire system (Adebayo, Lancheros, Ezinma, & Nuruden, 2018). Furthermore, System Theory is widely recognized for its applicability in the analysis of social organizations, offering a universal framework for explaining behaviour within complex human systems (Thompson, 2013; Daniel, 2020). It facilitates the establishment of

objectives, allocation of resources, formulation of action plans, and continual system evaluation and adjustment an approach essential for sustainable solid waste management practices.

In essence, by applying System Theory, this study seeks to deepen understanding of the interactions and interdependencies that characterize solid waste management in Benin Metropolis. Such an approach can yield practical insights for systemic reforms, thereby contributing to sustainable urban development and improved environmental health outcomes (Dennis & Ejovo, 2011; Ofomata, 2018; Abimbola & Stephen, 2020). A system comprises a set of interconnected and interdependent components that work collaboratively to achieve a shared objective. The proper functioning of each component is essential, as the failure of one part can compromise the effectiveness of the entire system. To fully understand a system, it is crucial to examine it holistically rather than focusing on its isolated elements (Agboje, Adeoti, & Irhivben, 2014).

In the context of solid waste management in Benin Metropolis, System Theory offers a useful lens through which the roles and interrelations of various stakeholders can be analyzed. These stakeholders include the Edo State Waste Management Board (EDSWMB), which is responsible for supervising, regulating, and enforcing sanitation and pollution control laws; private waste management companies, who provide operational support; and community members such as landlords, market vendors, and the general public, who are essential for proper waste disposal behaviour (Agboje et al., 2014). System Theory emphasizes that inefficiencies or failures should not be attributed to a single group. Rather, it calls for a systemic investigation of how and where breakdowns occur within subsystems, identifying opportunities for correction and improvement. For example, if the solid Waste Management Board and private companies fulfill their respective responsibilities effectively, and the public is adequately sensitized about the consequences of

poor solid waste management supported by consistent enforcement of the Edo State Sanitation and Pollution Management Law then many of the impediments to solid waste management in the metropolis can be reduced, if not eliminated (Agboje et al., 2014).

By acknowledging the interdependencies among all actors within the waste management system, System Theory promotes a collaborative and integrative approach. This theoretical framework facilitates the identification of weaknesses, fosters adaptive learning, and enables the development of sustainable solutions to the challenges facing solid waste management in Benin Metropolis. Ultimately, its application can support improved environmental health outcomes and sustainable urban development (Burns, 2016; Harris, 2013).

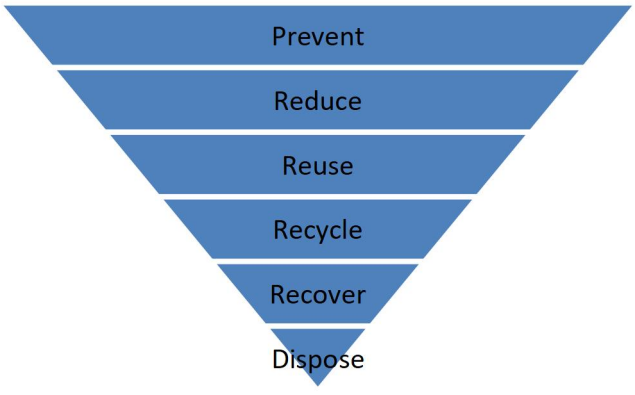
Conceptual Framework

The evolving concept of solid waste management is centered on the principles of waste reduction, reuse, and recycling, with the primary aim of preventing harm to human health and the environment (Ahmed & Ali, 2004). Solid waste management plays a crucial role in achieving a circular economy, which has become a priority in many developed countries, particularly in Europe. The circular economy aims to conserve resources and promote their circularity, leading to more sustainable development and an economically viable future. This concept is built on the idea of reducing solid waste and promoting the efficient use of resources. The idea of solid waste management has its roots in the Waste Hierarchy concept, also referred to as the "3 Rs" - Reduce, Reuse, and Recycle. This concept was first introduced by Abraham Maslow in 1943 and classifies solid waste management strategies according to their desirability in terms of waste minimization.

The waste management hierarchy is a conceptual framework designed to guide and rank waste management decisions at both individual and organizational levels. It prioritizes waste

prevention, followed by reuse, recycling, recovery, and finally disposal. The hierarchy helps to rethink our relationship with waste based on five priorities, ranked in terms of what is best for the environment, often illustrated as a five-tier inverted pyramid. Waste Prevention: Reducing waste generation through sustainable practices and consumption. Reuse: Finding alternative uses for products to extend their lifespan. Recycling: Converting waste materials into new products to conserve resources. Recovery: Recovering energy or materials from waste through various technologies. Disposal: Disposing of waste in a responsible and environmentally friendly manner viable (Wilson et al., 2012).

By adopting this hierarchy, both individuals and institutions can engage in informed, environmentally sound waste management decisions that align with global goals for environmental sustainability and pollution reduction (UNEP, 2016). The waste hierarchy framework supports a transition toward a more resilient, resource-efficient economy, and serves as a vital guide in understanding the conceptual underpinnings of waste management policies and practices relevant to Benin Metropolis.



Waste Management Hierarchy Ranking, (UNEP, 2016).

Fig.1. Inverted pyramid

The hierarchy concept has been widely applied in the analysis of social organization and behaviour, offering a systems-oriented approach that views a structure as a whole composed of interconnected components working collaboratively to accomplish shared objectives (Okpei, 2013). This approach entails setting goals, analyzing available resources, developing actionable strategies, and engaging in continuous monitoring and evaluation to improve outcomes (Okpei, 2013). Within the context of municipal solid waste management, the core functional elements include waste generation, handling, separation, storage, collection, transportation, and final disposal (Hiriya, 2013; Ogwueleka, 2013). Waste generation encompasses activities wherein materials are identified as no longer useful and are consequently discarded or earmarked for disposal (Hiriya, 2013). In Benin Metropolis, solid waste management involves various stakeholders with distinct but complementary responsibilities:

Edo State Waste Management Board is mandated to supervise and regulate waste management activities, accredit private waste managers, enforce environmental sanitation and pollution control laws, and promote environmental education (EDSWMB, 2023). Accredited Private Waste Management Companies are responsible for the operational aspects of solid waste handling, including timely collection, transportation, and safe disposal of solid waste across assigned zones (Agboje, Adeoti, & Irhivben, 2014). Landlords and Landladies play a vital role in managing waste generated within their properties, ensuring tenants comply with proper disposal practices (Asikhia, 2011). Market Traders (Men and Women) are responsible for ensuring that solid waste generated in marketplaces is appropriately managed and not dumped indiscriminately (Ogwueleka, 2019). The General Public holds a collective responsibility to dispose of waste responsibly, following segregation and storage protocols to maintain environmental hygiene (Dennis & Ejovo, 2011).

If all stakeholders perform their respective roles efficiently, many of the impediments to effective solid waste management in Benin Metropolis can be reduced. Specifically: Enforcement of Sanitation and Pollution Management Laws remains critical to curbing indiscriminate solid waste disposal and ensuring compliance with best practices (EDSWMB, 2023). Public Environmental Education is essential for changing behaviour and improving awareness of the adverse impacts of mismanaged solid waste on public health and environmental sustainability (Asikhia, 2011; Ogwueleka, 2019). Collaboration and Coordination among stakeholders including public agencies, private operators, community leaders, and residents are indispensable for ensuring a holistic and effective solid waste management system (Agboje et al., 2014; Harris, 2013). By integrating these strategic efforts under the waste management hierarchy and system theory frameworks, stakeholders can jointly enhance the environmental quality and public health of Benin Metropolis.

Concept of Solid Waste

Solid waste refers to any material that is unwanted or discarded, including refuse, garbage, and sludge originating from treatment plants, water supply facilities, and air pollution control systems. These wastes can exist in solid, liquid, semi-solid, or contained gaseous forms and arise from a variety of sources such as industrial, commercial, mining, agricultural, and residential activities (Subramanian, 2015). Essentially, solid waste includes all materials not discharged as wastewater or atmospheric emissions. Waste is generally considered a material without value to the person discarding it, although it may still hold value for others (Subramanian, 2015). Solid waste is often a reflection of inefficiencies in the use of raw materials, energy, and water, resulting in economic losses for individuals and operational challenges for waste management agencies across various stages of solid waste management which involves solid waste

segregation, storage, collection, transportation, and disposal (Karen, 2018). Beyond its economic implications, solid waste is a major contributor to environmental pollution and poses long-term threats to human and ecological health (Karen, 2018).

The composition and quantity of solid waste are influenced by several factors, notably: Income Level: Higher-income populations typically generate more packaging waste, including paper, plastic, glass, cans, and bottles (Ram & Pankaj, 2022). Level of Industrialization: Highly industrialized regions tend to produce more complex and hazardous waste due to the nature of manufacturing processes and chemical use (Ram & Pankaj, 2022). Solid waste can be broadly categorized based on its source: Household waste: Includes food waste, paper, plastics, glass, and general domestic refuse. Industrial waste: Comprises hazardous substances, chemicals, and manufacturing by-products. Commercial waste: Arises from business activities, such as offices, shops, and restaurants. Construction and demolition waste: Includes debris like concrete, timber, and other construction materials (Urban Development Bank of Nigeria [UDBN], 2020).

According to the Urban Development Bank of Nigeria (2020), solid waste in Nigerian cities such as Benin Metropolis is often classified into: Vegetable matter: Organic residues like food scraps and fruit peels. Food remnants: Leftovers and edible discards. Ashes and dust: Residues from cooking and cleaning. Metal and tins: Cans, scrap metal, and related items. Plastics and polythene: Bags, containers, and synthetic packaging. Glass: Bottles, jars, and broken glass items. Textiles: Clothing and fabric waste. Bones: Animal remains and other biodegradable solids. Wood: Furniture, tree branches, and carpentry waste. Paper: Office paper, newspapers, and cardboard. Miscellaneous waste: Includes electronics, batteries, and hazardous materials (UDBN, 2020).

Improper disposal of solid waste leads to severe environmental consequences, including: Air pollution: Emissions of greenhouse gases such as methane and other volatile organic compounds. Water pollution: Leachate and runoffs contaminating surface and groundwater resources. Land degradation: Soil contamination and reduced land usability due to indiscriminate dumping (Kamila, 2020). Given growing public concern over sustainability and ecological safety, waste management companies are increasingly pressured to adopt environmentally responsible practices. This includes implementing waste reduction strategies, recycling systems, and community awareness programs to align with both environmental goals and societal expectations (Kamila, 2020).

Sources of Solid Wastes

Solid waste is generated from various sources, including households, commercial establishments, institutions, streets, construction and demolition sites, and industrial activities. Understanding the sources of solid waste is crucial for developing effective waste management strategies, (Silpa & Lisa, 2018).

Household Trash and Debris

Household trash and debris are commonly referred to as residential waste or domestic refuse. It comprises all solid waste that is the consequence of household activities, including: Food preparation, food waste, fruit peels, and other organic waste. Sweeping and clearing; dust, dirt, and other debris. Fuel burning; ash and other combustion by-products. Gardening: yard trimmings, branches, and other plant material. Old clothing and furnishings: discarded clothing, furniture, and other household items. Retired appliances: old appliances, such as refrigerators, washing machines, and televisions. Packaging materials: paper, plastic, cardboard, and other packaging waste, Ashok, (2019).

Commercial Refuse

Commercial refuse is the waste generated by any business organization, including: Stores: packaging materials, containers, and other retail waste. Offices: paper waste, office supplies, and other administrative waste. Fuel service stations: oil, grease, and other petroleum-based waste Warehouses: packaging materials, storage containers, and other warehouse waste.. Restaurants: food waste, packaging materials, and other food service waste. Hostels: household waste, food waste, and other residential waste. In developing countries, markets often generate a significant share of commercial waste. According to Syeda and Bhupathi (2021), most commercial refuse in developing countries is handled by the municipality, while large hotels and commercial office buildings may hire private waste hauling services.

Institutional Refuse

Institutional refuse is the waste generated by educational settings, primary health care centers, governmental offices, police/army barracks, motor parks, markets and, religious buildings. This type of waste typically contains a higher proportion of paper compared to food waste. Solid waste from primary health care services in developing countries may be handled privately by the hospital or its contractor (Dave, 2018).

Street Sweeping

Street sweeping consists of dirt and litter, including: Dirt and dust: soil, dust, and other particulate matter. Litter: trash, garbage, and other discarded materials. Household refuse: household waste, including food waste and other organic materials. Drain cleanings: waste and debris from storm drains and sewers. Human fecal matter: human waste, including feces and urine. Animal manure: animal waste, including feces and other organic materials. In developing

countries, street sweeping waste may also contain appreciable amounts of household refuse, drain cleanings, and human fecal matter, (Majeti, Methika & Atya, 2019).

Construction and Demolition Refuse

Construction and demolition refuse vary from one country to another, but typically includes: Building materials: concrete, asphalt, bricks, blocks, and other masonry materials. Packing and rubble: packaging materials, debris, and other waste generated during construction and demolition activities. Tree parts and stumps: tree branches, stumps, and other plant material Roofing materials: shingles, tiles, and other roofing materials. Corrugated cardboard and paper: packaging materials and other paper products. According to Giulia, Claudio and Maria, (2021), developing countries have no problems in major multistory building construction and demolition debris. He however, maintains that activities involving small buildings, especially those using clay soils as construction materials can impact the composition of solid waste in municipal refuse. Large heaps of soil and stones are often dumped on our streets with the assumption that the municipal council must evacuate them. The other materials that may be found in construction and demolition wastes are: treated and untreated wood scrap; tree parts, tree stumps, and branches, concrete, asphalt, bricks, blocks and other masonry, plasters and wallboards, roofing materials, corrugated cardboards and miscellaneous papers, ferrous and nonferrous metal, non-asbestos building insulation, plastic scrap, dirt carpets and padding, glass (windows and doors); and other miscellaneous materials; (Erik, 2018).

Industrial Waste

Gabriella and Bentham, (2021) are of the view that Industrial waste encompasses a wide range of by-products generated from various industrial activities. This type of waste can include packaging materials such as paper, plastic, and cardboard that is discarded during the manufacturing process. Food waste is another component, particularly in industries involved in food processing and manufacturing, where surplus or spoiled food products are generated. Additionally, damaged metals and plastics are common in industrial settings, where materials may be rendered unusable due to defects or damage during production.

Residuals from fuel combustion, such as ash and slag, are also prevalent in industries that rely on fossil fuels for energy. Moreover, processing chemicals and hazardous materials are often generated as waste in industrial processes. These can include a variety of substances used in manufacturing, cleaning, or other industrial applications, which require careful handling and disposal to prevent environmental contamination and health risks, (Fulekar and Wana, 2020). Overall, industrial waste is diverse and can have environmental and health implications if not managed properly. Effective waste management strategies are essential to mitigate these impacts and promote sustainability in industrial operations.

Concept of Solid Waste Management

Solid waste management encompasses the entire process of handling solid waste, beginning from its generation to its final disposal. The stages in this process include segregation, storage, collection, transportation, and disposal. Effective solid waste management is critical for maintaining public health and environmental quality, yet it remains a persistent challenge in many urban centers, particularly in developing countries such as Nigeria (Gabriella, Carla, &

Bentham, 2021). Contributing factors include poor waste collection and disposal equipment, limited public awareness, and insufficient funding (Ghosh, 2020).

In Nigeria, the challenges are exacerbated by rapid urbanization, population growth, and weak institutional frameworks for managing waste (Ghosh, 2020). Despite numerous interventions, including the establishment of sanitation authorities and waste management boards, the problem persists across several cities (Salami & Oderinwale, 2015). The country is increasingly plagued by indiscriminate dumping of both domestic and imported toxic waste, leading to unsanitary conditions in cities like Lagos, Port Harcourt, Benin, and Kaduna, among others (Akpofure, 2019). Although waste presents major environmental challenges, it can also serve as a potential source of energy, underscoring the importance of exploring sustainable solid waste management practices (Abdulrasaq, 2021).

Open Dumps Method

The open dumps method remains a common waste disposal practice in many developing countries, including Nigeria. It involves unregulated solid waste disposal in open spaces, such as roadsides, markets, and drainage systems (Dave, 2018; Andrew & Gery, 2017). In nations like Liberia, Afghanistan, and Guinea, the majority of solid waste ends up in open dumps due to weak infrastructure (Mohammad & Tobia, 2017). According to Italo (2019), open dumps are often located in pits, street corners, or markets, and pose numerous health risks. These include the proliferation of disease vectors like flies and rats, which can spread illnesses such as cholera, typhoid, and tuberculosis. The practice also leads to air pollution due to the burning of waste, which releases toxic pollutants (Gabriella, Carla, & Bentham, 2020).

Additionally, open dumps contribute to groundwater contamination through leachate formation a toxic liquid that percolates through waste layers (Jerry & Richard, 2023). Waste collectors in

such environments face direct exposure to hazardous substances due to the lack of proper waste segregation (Ana, Graca, Susana, & Maria, 2018). The continued use of open dumps is environmentally and socially unsustainable, necessitating a transition to safer alternatives like sanitary landfills and recycling (Kevin, 2019).

Ocean, Sea, and River Dumping Method

This method involves discharging waste into bodies of water, a practice common in coastal regions such as Lagos, though the sea has a natural capacity to degrade waste, indiscriminate dumping results in the accumulation of harmful substances like heavy metals in marine sediments, threatening marine life and human health (Sridhar, 2016; Okpei, 2013). Some developed countries have implemented stringent regulations to manage marine dumping. For example, the North Sea limits the discharge of specific wastes like sewage sludge and drilling muds (Omole, 2016). However, Nigeria's marine environment continues to suffer from pollution caused by solid waste, sewage, and oil (Rachael, 2019). Historically, cities in the United States engaged in marine dumping until environmental concerns led to a shift in policy (Cunningham, 2003). While one school of thought argues that the ocean can absorb waste indefinitely, others caution against long-term ecological damage (Encyclopedia Americana, 2021). Overall, ocean dumping is an unsustainable practice that requires urgent mitigation.

Landfills Method

Landfills involve burying waste in designated sites and covering it with soil to minimize pest infestation (Ghosh, 2020). In high-income countries, sanitary landfills are engineered with environmental safeguards to control emissions and leachate (Calif, 2014). In contrast, most landfills in Nigeria are poorly designed, increasing the risks of landslides and groundwater contamination (UDBN, 2020). Moreover, landfill gases can contain volatile organic compounds,

such as dichloromethane, linked to health issues like kidney disease and leukemia (Olise, 2013). In Europe, some countries maximize the amount of waste recycling and composting possible before landfilling materials that are suitable for resource recovery (Mohammad et al., 2017). Despite the benefits of recycling and composting, landfill remains the primary method of disposal used by most high-income countries, due to its relatively low cost compared to other disposal options (Joe, 2013). However, in countries like Nigeria and Edo State, most existing landfills are not properly designed and regulated. According to the Urban Development Bank of Nigeria (UDBN, 2020), poor landfill design and management can lead to environmental and health problems, such as landslides and groundwater contamination.

Additionally, landfill gas contains several trace volatile organic compounds, such as dichloromethane, which is toxic and may increase the risk of kidney disease and leukemia (Olise, 2013). While landfills can be a viable method of waste disposal, it is essential to ensure that they are properly designed, managed, and regulated to minimize the risks associated with waste disposal. This includes implementing strict environmental protection standards, maximizing waste recycling and composting, and ensuring that landfill sites are properly selected and managed. Despite these drawbacks, landfilling remains popular due to its cost-effectiveness, especially where recycling is limited (Joe, 2013). Countries in Europe now emphasize recycling and composting prior to landfilling; a model Nigeria could emulate (Mohammed et al., 2017).

Incineration Method

Incineration utilizes high-temperature oxidation to treat waste, converting it into gases and inert solids. This method is particularly useful for non-recyclable waste (Akpofure, 2019; Ezeudu, 2022). It reduces waste volume significantly and enables energy recovery through heat-to electricity conversion (Cunningham, 2015). Still, incineration has environmental drawbacks,

such as the release of heavy metals in smoke and ash, contributing to air and soil pollution (Karen, 2018). Still, when managed using best available equipment, it remains a viable waste management option. Incineration is a complex waste management method that offers both benefits and challenges. While it can be an effective way to reduce waste volume and recover energy, it also poses environmental risks if not done properly. As with any waste management method, careful consideration must be given to the potential impacts and benefits of incineration, and efforts must be made to minimize its negative effects on the environment.

Composting Method

Composting involves the aerobic decomposition of organic waste by microorganisms. It requires the separation of organic and inorganic waste, often enhanced by the addition of bulking agents like sawdust or shredded paper (Berry & Bove, 2017). Composting not only reduces waste volume but also produces nutrient-rich soil conditioners (Cointreau, 2014). Though, large-scale composting requires economic feasibility studies and market integration. Decentralized composting may be more appropriate in countries like Nigeria (Coffey, 2010). Source separation improves the effectiveness of composting systems. According to Cointreau (2014), composting is a solid waste disposal technology where the organic fraction of the waste is aerobically decomposed by the natural microorganisms within the waste. This process involves enhancing the conditions necessary for decomposition, including nutrients, oxygen, and moisture levels. Composting is an effective method for reclaiming organic materials and reducing the volume of solid waste that needs to be transferred and disposed of (Mohammed et al., 2017).

Additionally, composting generates a valuable soil conditioner for agricultural and horticultural use. However, decisions to introduce composting must be market-oriented and based on careful economic and financial analysis (Wilson, 2000). Large-scale sector composting operations are

often not financially viable, and alternative small-scale, decentralized composting plants may be worth considering (Christian, Hellweg, & Stucki, 2003). Implementing waste separation at the source can greatly enhance the economic feasibility of composting, regardless of the scale of operation.

Conservation of Matter Method

The conservation of matter principle emphasizes that waste cannot be eliminated only transformed. This supports waste minimization strategies such as the 3Rs: Reduce, Reuse, and Recycle (Vasudevan, Faisal, Sanjeev, & Mohammad, 2016; Daniel, 2020). Effective application of this principle leads to sustainable consumption and waste management.

Solid Waste Reduction Method

Waste reduction involves minimizing waste generation at the source through cleaner production methods. One major contributor to waste is the over-packaging of goods, with materials like glass and plastic forming a large portion of household waste (Aparcana, 2017).

Reuse of Solid Waste Method

Reusing waste extends the lifecycle of products. Common examples include the reuse of plastic bags, which could be enhanced by making them more durable (Sivaku, 2018). Industrial by-products such as fly ash can be repurposed in construction, reducing the demand for raw materials (Marc, 2013).

Recycling Method

Recycling converts waste into reusable materials. It plays a critical role in reducing landfill dependency and conserving natural resources (Ramesha & Diganta, 2012; Subramanian, 2017). For instance, paper waste can be recycled into toilet rolls and cartons, while metallic waste supports the steel industry.

Salami et al. (2015) suggest that switching from organic food wraps to recyclable materials could ease sanitation issues. Promoting recycling among food vendors and manufacturers could further reduce waste and improve public hygiene. Implementing a combination of these methods particularly recycling, composting, incineration (with controls), and sanitary landfills Nigeria and similar developing countries can improve their solid waste management systems and promote sustainable development.

Overview of Environmental Sanitation

Environmental sanitation encompasses a range of activities aimed at improving and maintaining essential environmental conditions that directly influence human health and well-being. These conditions include the provision of clean and safe water, clean air, efficient solid waste disposal systems, protection of food from contaminants, and adequate housing within hygienic surroundings (Sanoop, 2023). As emphasized by Abdullahim (2019), the phrase "cleanliness is next to godliness" underscores the importance of daily efforts to maintain clean homes and environments.

Okpei (2012), posits that environmental sanitation has become important in that a dirty and filthy environment can lead to an outbreak of an epidemic, which can in no small measure lead to loss of lives and properties. A dirty environment provides a breeding ground for secondary hosts and pathogens to thrive multiply and easily transmit diseases like wildfire with its attendant deadly consequences. Environmental pollutants can be broadly categorized into two main types; biodegradable and non-biodegradable. A pollutant is any substance or form of energy introduced into the environment that results in harmful or undesirable effects. These pollutants can cause both short-term and long-term damage to ecosystems and living organisms. All forms of life rely

on a balanced environment for proper growth, development, and reproduction; any disruption caused by pollutants can impact ecological stability.

Biodegradable pollutants are substances that can be broken down by natural processes, particularly through the action of microorganisms such as bacteria and fungi. These pollutants decompose into simpler, harmless compounds over time and are generally less threatening to the environment. Common examples include domestic wastes such as garbage, urine, fecal matter, and sewages, agriculture residues, paper, wool, vegetable scraps, and plants remains. Since these materials can eventually be eliminated from the environment, they pose a real lower risk when managed properly. On the other hand non-biodegradable pollutants are substances that do not broken down easily in nature and can persist in the environment for an extended period.

These materials accumulate over time, leading to serious environmental and health hazards. Examples of non-biodegradable pollutants include plastics, polythene bags, insecticides, pesticides, heavy metals like mercury, lead, and arsenic as well as materials such as aluminum cans, synthetic fibers, glass objects, iron products, and silver foils. Because they cannot be decomposed natural agents, non-biodegradable pollutants require careful management and disposal to prevent long-term ecological damage. However, understanding the distinction between biodegradable and non-biodegradable pollutants is essential for effective environmental protection and sustainable living. Reducing the use of non-biodegradable materials and promoting responsible disposal of solid waste are critical steps toward maintaining ecological balance. However, non-biodegradable pollutants cannot be removed and are therefore potentially more dangerous to man's health (Abimbola & Stephen, 2010).

Sanitation stands as a cornerstone in the realm of effective solid waste management. It involve the systematic collection, transportation, and disposal of solid waste, aiming to mitigate

environmental pollution and safeguard public health. Proper sanitation practices are instrumental in preventing the proliferation of diseases, enhancing the quality of life, and fostering sustainable environment. Inadequate sanitation can lead to severe health risks, including the spread of infectious diseases such as cholera, typhoid, and dysentery. These conditions often arise from improper solid waste management. Moreover, effective sanitation contributes to environmental conservation by reducing pollution and promoting the recycling of waste materials. Sanitation is not merely a matter of cleanliness but a vital component of public health. Its role in disease prevention, environmental protection, and community well-being highlights its significance in solid waste management.

In developing countries where sewerage is not the major means of managing human excreta and sullage, there will be sanitation residues from privies and latrines says, the World Health Organization (WHO, 2023). Oftentimes, a substantial portion of garbage collected from the household finds its way into drains through illegal dumping and at times on the streets due to the overloading of trucks and the bad state of some of the dumping trucks. These constitute street sweeping and environmental sanitation problems as the drains would require cleaning. It is important to institute comprehensive environmental hygiene monitoring programs that will verify their activities.

The fact is that the Edo State Waste Management Board is not well funded, environmental hygiene monitoring and verification is not only important to ensure that cleaning activities are effective, but also provide valuable data for their operations and cleaning schedules to facilitate adequate environmental sanitation and promote effective solid waste management system, retrieved from Edo State Waste Management Board (ESWMB, 2023). The physical environment encompasses the totality of eternal conditions and factors that surround and influence an

organism or group of organisms, this includes both abiotic elements, such as temperature, light, water, and soil, and biotic components, like other living organisms and their interactions. These environmental factors collectively determine the growth, development and survival of organism by providing essential resources and influencing biological processes.

In essence, the physical environment serves as the backdrop against which organisms live and interact, shaping their behaviour and adaptations. Understanding the intricate relationships between organisms and their physical surroundings is crucial for comprehending ecological dynamics and the sustainability of life on Earth. Environment is the circumstances or conditions that surround an organism or group of organisms as well as the complex social or cultural conditions that affect an individual or community (Hiriya, 2013).

The environment is the complete set of conditions and factors that surround and affect an organism or group of organism. This includes both living (biotic) elements, such as other organisms, and non-living (abiotic) factors, like climate, soil, water and sunlight.. The natural environment consist of all living and non-living things occurring naturally on earth, the development at any level of a general nature of the surrounding ecosystem, its foundational relationship to human life, and the need to preserve its integrity. Intuitively, the nature of the environment refers to the relatively enduring and sable set of circumstances that surround some given individual (Blandine & Sammy, 2020).

While our environments may share certain similarities, they are ultimately distinct due to the unique combinations of external conditions and influences that surround each organism. The term environment is commonly defined as the aggregate of all external conditions and influences affecting the life and development of an organism. This comprises both living (biotic) and non-living things (abiotic) components, which collectively determine the growth and survival of

organisms. The physical environment includes all elements, factors, and conditions that have the same impact on the growth and development of certain organisms, (Vinary & Warneet, 2018).

Humans have always inhabited two interconnected realms: the natural world and the constructed world. The natural world are the plants, animals, soils air, and water that existed long before us and with which share a deep interconnection. The environment composed of both living (biotic) and non-living (abiotic) elements, has been fundamental to our survival and development. It provides essential resources and regulates processes that sustain life, (Omole, 2016). In contrast, the constructed world is the domain of manmade systems and structures. It includes the social institutions, technologies, and political organizations that we have developed to organize our societies and manage our interactions with natural world.

Importance of Environmental Sanitation

Environmental sanitation is fundamental to disease prevention and the promotion of public health. Poor sanitation practices elevate the risk of infectious diseases such as cholera, typhoid, and dysentery (Okpei, 2013). Additionally, proper sanitation contributes to environmental sustainability by minimizing pollution and encouraging the reuse and recycling of waste materials (World Health Organization [WHO], 2023).

Types of Environmental Pollutants

Environmental pollutants are generally classified into biodegradable and non-biodegradable categories: Biodegradable pollutants are materials that microorganisms like bacteria and fungi can naturally decompose. Examples include domestic waste, agricultural residues, vegetable scraps, wool, paper, and plant remains (Abimbola & Stephen, 2020). Non-biodegradable pollutants, in contrast, are resistant to decomposition and can persist in ecosystems for extended periods, often accumulating and causing serious environmental and health problems. Such

pollutants include plastics, polythene bags, synthetic fibers, glass objects, heavy metals like mercury, lead, arsenic, aluminum cans, pesticides, insecticides, and iron products (Swamy, 2013).

Role of Environmental Sanitation in Solid Waste Management

Environmental sanitation plays a central role in the efficient management of solid waste by facilitating the systematic collection, transportation, and disposal of solid waste materials. Effective environmental sanitation practices dose not only prevent disease outbreaks but also promote cleaner environments and higher living standards of people, especially in densely populated urban areas (WHO, 2023). In many developing nations, where centralized sewer systems are lacking, human excreta from latrines and privies contribute to environmental burdens. Moreover, the physical environment comprising both abiotic elements such as soil, water, light, temperature and biotic components of organisms and their interactions in the ecosystem plays a vital role in sustaining life. Understanding the interconnectedness of these components is essential for analyzing ecological patterns and achieving sustainable waste and sanitation practices (Vinay & Warneet, 2018).

Environmental Issues

The unrestrained exploitation of natural resources has caused widespread environmental degradation. While science and technology have brought many benefits, they have also contributed to the deterioration of urban and natural environments (Paul, 2014). Presently, three pressing global issues global warming, ozone layer depletion, and acid rain continue to exacerbate the crisis in environmental management (Beatrice, Abila, & Jussi, 2013). Global warming refers to the long-term increase in Earth's average temperature, primarily driven by greenhouse gas emissions from industrial and agricultural activities (American Heritage Dictionary of Science, 2025). The consequences include more frequent extreme weather events,

loss of biodiversity, and damage to coral reefs (Phillip, 2021). Ozone layer depletion is largely caused by the emission of chlorofluorocarbons (CFCs), halons, and other ozone-depleting substances. This thinning of the ozone layer allows increased ultraviolet radiation to reach the Earth's surface, contributing to skin cancer, eye damage, and immune system disorders (Salami, Patinvoh, & Ola, 2011). Acid rain, resulting from the release of sulfur dioxide and nitrogen oxides into the atmosphere, has damaging effects on aquatic systems, soil fertility, forests, and human-made structures (Jerry & Richar, 2023). These challenges require integrating environmental sanitation with broader sustainability goals. Through improved solid waste reduction practices, efficient resource use, and environmentally responsible sanitation practices, societies can mitigate these issues and work toward long-term ecological balance (Marc, 2013).

Stages of Solid Waste Management

Solid waste management is essential for promoting a healthy and sustainable environment, encompassing several interconnected stages (Medina, 2013). These stages generally include waste generation, segregation, storage, collection, transportation, processing and treatment, and final disposal.

Solid Waste Generation

The generation of solid waste marks the initial stage of the management process and arises from diverse human activities. Waste is produced across residential, commercial, industrial, and institutional sectors. A comprehensive understanding of the types and quantities of waste generated at each source is fundamental for the planning and implementation of effective management strategies (Medina, 2020).

Solid Waste Segregation and Sorting

Segregation and sorting involve the classification of waste into specific categories such as recyclables, organics, hazardous materials, and non-recyclables (Kathryn & Mirian, 2015). This process can be executed at the point of generation such as households or at centralized facilities. Based on the nature of the waste, different treatment methods such as recycling, composting, incineration, or mechanical-biological treatment are employed (Kathryn & Mirian, 2015).

Solid Waste Storage

Waste storage refers to the temporary containment of solid waste at or near the point of generation until it is collected. To minimize environmental and health hazards such as odors, infestations, and unsightliness, waste must be stored in a hygienic and secure manner. The World Health Organization (WHO, 2023) recommends that storage equipment have impermeable, hard standing floors with effective drainage systems, provide ease of access for waste handlers, and offer protection from direct sunlight (Cherry, 2016).

Solid Waste Collection

Collection involves the organized retrieval of solid waste from residential, commercial, or industrial areas by designated waste management personnel. Efficient collection systems are characterized by scheduled pickups, door to door services, and careful handling practices to prevent accumulation at the source. According to WHO (2025), waste bags should be tightly sealed or closed once they are approximately three-quarters full to ensure hygienic handling and safety in healthcare and related settings.

Solid Waste Transportation

Transportation refers to the transfer of collected waste to designated facilities such as transfer stations, recycling centers, or disposal sites. Vehicles used for transporting waste should be well-

covered and designed to facilitate easy loading and unloading. They must also be easy to clean and free of sharp edges that could tear waste bags or containers (Castillo & Victor, 2023).

Solid Waste Processing and Treatment

Processing and treatment involve the application of various techniques tailored to the type of waste. Common methods include recycling, composting, incineration, and mechanical-biological treatment. These processes aim to reduce the volume and toxicity of waste, thereby preparing it for final disposal or potential resource recovery (Abila, & Jussi, 2013).

Waste Disposal

Disposal constitutes the final phase in the solid waste management cycle. Ideally, waste is deposited in engineered sanitary landfills designed to minimize adverse environmental and public health impacts. However, in many developing regions, open dumping remains prevalent, contributing to environmental degradation and health hazards. Disposal methods include sanitary landfilling, open dumping, incineration, and, in some cases, open burning (Johnson, 2020).

Impediments to Solid Waste Management

Municipal solid waste management is influenced by a range of interconnected factors, including personnel, equipment, funding, at the various stages of the waste management cycle namely waste generation, segregation, storage, collection, transportation, and disposal. Additionally, regulatory processes such as licensing, registration of waste managers, designation of dumpsites, and penalties for noncompliance to solid waste management affect the efficiency of solid waste management operations (Law No. 5 of 2010). The neglect of the informal sector and bureaucratic hurdles in the licensing and registration process often discourage wider participation. Uncontrolled dumpsites, which are prevalent in many areas, become breeding grounds for disease vectors like insects and rodents, and attract wild animals and reptiles. The extent of this

threat largely depends on the strength and effectiveness of government policies and environmental protection programs (Dennis & Ejovo, 2011). When policies are overly stringent or difficult to implement, they serve as deterrents to the engagement of new actors in the sector. Sommerville, Jones, Rahajaharison, and Milner (2010) highlight that many local and state governments lack the human resources and technical expertise required for proper planning and execution of solid waste management operations. Thus, there is a need for governments to streamline and simplify registration processes to encourage broader participation.

In Benin Metropolis, solid waste management is given low priority by authorities, leading to inadequate government funding. This underfunding hampers the ability of waste management authorities to provide services that protect public health and the environment. Compounding the problem is the reluctance of many households to pay for solid waste collection services, primarily due to poverty, low income levels, and the perception that solid waste management is a public good that should be free of charge (Abdullahi, 2019). Moreover, inefficiencies among some accredited solid waste companies further degrade service delivery. Public perception and environmental awareness are vital to achieving sustainable solid waste management. Christian, Stefanie, and Samuel (2021) argue that individuals' and communities' environmental behavior is shaped by how they perceive their surroundings. Dagnew, Alemu, and Zenebe (2023) emphasize that ignorance, poverty, and greed are contributors to environmental degradation, as they negatively affect people's understanding and attitudes toward sustainable practices. A community that recognizes the link between a healthy environment and public health is more likely to support and engage in sound waste management practices.

In Nigeria, urban solid waste management lacks a comprehensive national legal framework, as the responsibility is constitutionally assigned to local governments. The effectiveness of local

government solid waste management is influenced by intergovernmental relationships, citizen participation in policymaking, and the political dynamics at the local level (Ashok, 2019). In Benin Metropolis, these institutional gaps manifest in challenges such as inadequate storage and transport equipment, limited numbers of accredited solid waste managers, indiscriminate dumping, poor landfill management, and insufficient oversight by regulatory authorities (Obirih-Opareh & Post, 2002). Ekere, Mugisha, and Drake (2019) assert that the effectiveness and sustainability of municipal solid waste systems depend heavily on the extent to which the local population identifies with and takes ownership of the process. However, in Benin Metropolis, the system is fraught with issues, including the limited number of operators covering vast routes, the frequent use of informal and unsafe dumping grounds, and poor landfill site management (Omole, 2016).

Furthermore, weak enforcement of environmental regulations, as outlined in the Edo State Sanitation and Pollution Management Law, exacerbates inefficiencies. Solid waste workers often receive low wages and are undervalued, which undermines workforce morale and productivity. Scavenging by informal actors is also poorly regulated. High operational and maintenance costs of solid waste management vehicles and equipment, absence of properly engineered disposal and treatment equipment, and a lack of technical expertise further complicate the situation (Cointreau, 2014). Adebayo, Lancheros, Ezinma, and Nuruden (2018) identify several hallenges affecting solid waste management in Nigeria and similar developing countries. These include the absence of reliable waste data, poor disposal options, inefficient collection systems, neglect of the informal sector, inadequate equipment, and the lack of harmonized regulations. In Benin Metropolis, these challenges are pronounced, with poor documentation of solid waste generation

and characterization, absence of designated disposal sites, and widespread dumping in unauthorized areas such as drains and street corners (Olufayo & Omotosho, 2017).

Solid waste management remains a critical public health and environmental concern. However, in Benin Metropolis, several impediments persist, including ineffective policy frameworks, insufficient funding, limited public awareness, weak institutional support, and lack of data for planning and monitoring. As Sommerville et al. (2010) and Calif (2014) observe, a shortage of technically skilled personnel further constrains local capacity. Burns (2016), notes that limited government investment also affects service delivery, while Abdullahi (2019) emphasizes the impact of poverty and public unwillingness to pay for solid collection waste services. Blandine and Sammy (2020) stress the importance of public awareness, suggesting that environmental quality can only improve when communities understand their role in sustainable practices. Therefore, for solid waste management to improve in Benin Metropolis and similar urban centers, a comprehensive strategy involving institutional reform, public engagement, adequate funding, and effective data systems is essential.

Impediments Inherent in the Segregation Stage of Solid Waste Management

The segregation of solid waste is sorting it into organic and inorganic fractions, it is a fundamental stage in the solid waste management process. This can occur at the source, through separate collection of biodegradable (organic) and non-biodegradable (inorganic) waste, or at designated facilities using mechanical methods such as magnetic separation to extract ferrous metals, plastics, glass, and aluminum. Despite its significance, the segregation of solid waste in Benin Metropolis faces several critical impediments. One major challenge is the lack of waste separation at the household level. Many households do not engage in basic waste segregation, which undermines efforts to recover reusable or recyclable materials from the waste stream. This

limits resource recovery and places additional pressure on landfill capacity. In addition, there is a shortage of recycling equipment within communities and households, further hindering the effective processing and reuse of waste materials. Without adequate equipment, even segregated waste often ends up in mixed disposal systems.

Another issue is the insufficient promotion of reuse practices. The failure to encourage or adopt sustainable consumption and material reuse contributes to the unnecessary generation of solid waste. Salami and Oderinwale (2015), advocate for the adoption of the "cleaner production" concept, which involves the continual use and reintegration of materials into the consumption cycle, thereby reducing overall waste volumes. Daniel (2020) emphasizes the importance of the "three R's" reduce, reuse, and recycle as a foundational principle of modern solid waste management. Segregation plays a pivotal role in enabling this hierarchy by facilitating the recovery of materials that would otherwise be discarded. Similarly, Salami, Olorunfemi, and Oderinwale (2015) explain that waste segregation contributes to reducing the volume and toxicity of waste generated at the source, supporting more efficient use of raw materials during production processes.

A driver of unnecessary waste is excess packaging**,** particularly of food and consumer goods. Materials such as paper, plastic, metal, and glass packaging account for a significant proportion of household waste. Promoting sustainable consumption patterns and minimizing packaging are therefore essential strategies in addressing segregation-related challenges (Salami et al., 2015). In summary, the segregation stage of solid waste management in Benin Metropolis is constrained by several factors: low levels of household level participation in segregation, lack of recycling equipment, minimal adoption of reuse practices, and excessive packaging of consumer goods. Addressing these challenges requires a multi-pronged approach public education, community-

level investment in recycling technologies, and the promotion of sustainable production and consumption patterns.

Impediments Inherent in the Storage Stage of Solid Waste Management

The storage stage is a critical component of the solid waste management chain, influencing the efficiency of subsequent stages such as collection, transportation, and disposal. Proper waste storage ensures that solid waste is temporarily contained in a manner that is sanitary and environmentally safe until it is collected for further handling. According to Lee and Paul (2015), waste storage plays a pivotal role in determining the overall success of solid waste management, as the method of storage directly affects public behavior. Individuals who lack access to adequate storage equipment are more likely to engage in indiscriminate disposal. In the study conducted in Palembang City, Lee and Paul (2015) found that inadequate or improper storage methods were factor hindering effective solid waste management in the city. This aligns with broader research findings that identify improper storage as impediment in many developing urban areas.

Storage involves the interim holding of solid waste after its generation and before its collection and final disposal. It is the responsibility of both the government and waste management companies to ensure the provision of adequate storage equipment. Recommended solid waste receptacle bins should be durable, watertight, and resistant to corrosion, rodent and insect proof, equipped with handles, and fitted with secure lids. These containers must also be easy to clean and maintained in a sanitary condition. However, in Benin Metropolis, the availability and adequacy of such storage containers remain critically insufficient.

Among the impediments observed in Benin Metropolis are the shortage of proper waste receptacle bins**,** limited number of storage and collection points**,** inadequate accessibility to

storage equipment as a result of bad roads**,** and the prevalent use of plastic bags (nylons) for storage. These challenges has not only lead to indiscriminate dumping of refuse but also cause delays in collection and inefficiencies in transportation of solid waste due to the scattered and uncoordinated nature of stored waste. Storage related challenges in Benin Metropolis reflect broader patterns observed in many developing countries, where urban dwellers often lack awareness, motivation, or resources to engage in appropriate waste storage practices. In contrast, residents in developed countries are increasingly adopting improved storage methods, driven by growing environmental consciousness and government support.

Factor contributing to the poor state of solid waste storage in Benin Metropolis is the limited involvement of government authorities in the provision and supervision of storage equipment. When government commitment is weak or inconsistent, the effectiveness of solid waste management systems is compromised. Additionally, there is often a shortage of technical expertise and storage equipment at both local and state government levels, making it difficult to plan and implement efficient solid waste storage systems (Sommerville, Jones, Rahajaharison, & Milner, 2010). To address these impediments, there is a need for strategic investment in appropriate storage equipment, public education on proper solid waste containment, and increased government participation in solid waste planning and management

Impediments Inherent in the Collection Stage of Solid Waste Management

Solid waste collection is a vital stage in the waste management process, involving the removal of waste from designated storage receptacles and its subsequent transfer to authorized disposal sites or processing equipment. Despite its critical importance, the collection stage is often constrained by numerous challenges, particularly in urban areas of developing countries. A major impediment in cities like Benin Metropolis is the inadequate provision of waste collection points.

The limited availability of refuse bins leads to the indiscriminate disposal of waste in unauthorized areas such as street corners, uncompleted building fronts, and abandoned structures. This contributes to environmental degradation, including air pollution, odor, and visual blight (Hancock & Alan, 2023).

Another challenge is the lack of modern waste collection vehicles. The use of outdated or poorly maintained vehicles impairs the efficiency of solid waste collection services. In addition, many areas suffer from the inappropriate designation of collection centers, which results in residents dumping waste at unofficial and unsanitary locations such as road junctions and gutters (Olufayo & Omotosho, 2017). These deficiencies emphasize the urgent need for investment in collection infrastructure and equipment to support reliable and efficient operations.

The health and safety of solid waste collection workers also remain a serious concern in developing countries like Nigeria. Workers often come into direct contact with unsorted and potentially hazardous waste, unlike their counterparts in high-income countries who typically handle sealed, hygienically packaged refuse. This exposes them to toxic substances, harmful gases, and pathogenic microorganisms**,** increasing the risk of occupational illness and injury (Salami, Olorunfemi, & Oderinwale, 2015; Hancock & Alan, 2023). Proper training and the provision of personal protective equipment (PPE) are necessary to safeguard their well-being.

Legislative frameworks such as the Edo State Sanitation and Pollution Management Law (Law No. 5 of 2010) mandate that private waste collection outfits must be registered and licensed by the appropriate authorities. The law also requires residents to patronize approved solid waste service providers and mandates penalties for non-compliance. However, poor enforcement of this legislation in Benin Metropolis has resulted in widespread nonpayment for waste collection

services by residents. This noncompliance undermines the financial viability of waste management operations and reduces the quality and consistency of services delivered.

The collection stage of solid waste management in Benin Metropolis is hampered by several interrelated issues: insufficient collection points, inadequate waste transport vehicles, inefficient waste retrieval systems, health risks to collection workers, and weak enforcement of regulatory policies. Addressing these challenges demands a coordinated approach that includes increased government commitment, capacity building among waste handlers, enhanced regulation enforcement, and active participation from residents in complying with waste management norms.

Impediments Inherent in the Transportation Stage of Solid Waste Management

Transportation plays a pivotal role in the solid waste management chain, serving as the link between solid waste collection points and final disposal or treatment sites. For this process to be effective, waste must be transported in a manner that is environmentally safe and compliant with legal and technical standards. According to Olufayo and Omotosho (2017), the transportation of solid waste should only be carried out using covered, watertight, and dripproof vehicles equipped with metal containers that have welded seams**,** to prevent leakage and environmental contamination. However, in Benin Metropolis, the transportation stage is undermined by multiple systemic issues. One major impediment is the use of inadequate and not roadworthy vehicles. Many of the vehicles used in Benin Metropolis are uncovered and poorly maintained, leading to the spillage of waste along transport routes**,** contributing to environmental pollution and visual blight (Olufayo & Omotosho, 2007). These vehicles often lack the required specifications outlined in regulatory frameworks and pose risks not only to public health but also to road safety.

Additionally, long distances to government-approved dumpsites hinder the efficiency of waste transport. Haulers must often travel considerable distances to reach designated disposal equipment, resulting in increased operational costs**,** time delays, and reduced collection frequency. This challenge is compounded by fuel costs and vehicle wear and tear, making it economically unsustainable for many waste operators. The lack of skilled labor further exacerbates transportation inefficiencies. Poor handling, route planning, and vehicle operation due to untrained or undertrained personnel can severely compromise the effectiveness of waste transport systems (Salami, Olorunfemi, & Oderinwale, 2015). Without proper training, staff are ill-equipped to manage logistics, perform maintenance, or respond to emergencies such as vehicle breakdowns or spills.

Closely tied to this is the poor working condition of waste transportation vehicles, which contributes to frequent mechanical failures and even road accidents (Hancock & Alan, 2023). These breakdowns not only delay waste transport but also expose the public to unsanitary conditions when waste remains uncollected or improperly disposed. Despite regulatory provisions such as those in the Edo State Sanitation and Pollution Management Law (Law No. 5 of 2010) which mandates that all waste management vehicles must be designed to prevent spillage during transportation compliance and enforcement are weak. Waste continues to litter roads during transit due to uncovered vehicles and the absence of secure containment systems, thereby increasing environmental and public health risks (Edo State Sanitation and Pollution Management Law, 2010).

To enhance the transportation stage of SWM in Benin Metropolis, targeted interventions are required. These include the provision of adequately constructed vehicles, shortening the distance to official dumpsites through satellite stations or transfer centers, training skilled personnel, and

ensuring regular maintenance of transportation equipment. Moreover, enforcement of existing legal frameworks is necessary to promote compliance and deter substandard practices. Addressing these impediments will lead to more efficient, hygienic, and sustainable solid waste management in the metropolis.

Impediments Inherent in the Disposal Stage of Solid Waste Management

The disposal stage is the terminal phase of the solid waste management (SWM) process, involving the safe, sanitary, and environmentally sound deposition of waste materials. In an ideal system, disposal should minimize risks to human health and the ecosystem. However, in Benin Metropolis, as in many developing urban centers, this stage is beset by significant challenges that undermine the effectiveness of the entire waste management cycle. In most developing countries, unregulated open dumping remains the most common method of waste disposal. Cunningham (2015), notes that this practice is prevalent across low- and middle-income nations, contributing to widespread environmental degradation.

In Nigeria, less than 25% of collected solid waste is deposited in controlled landfills, and only about 15% is disposed of in modern sanitary landfills**,** while the majority is discharged into open, unmanaged dumpsites (Ossai, 2006). This poses severe health and ecological risks, particularly in densely populated areas like Benin Metropolis. A central impediment to effective disposal in Benin Metropolis is the absence of well-defined and regulated waste disposal options**.** Many of the disposal sites currently in use are unofficial and poorly managed, allowing indiscriminate dumping of waste with little or no oversight (Hantoko, 2021). Furthermore, existing dumpsites are not regularly maintained, leading to the accumulation of hazardous substances, leachate generation, and air pollution through the uncontrolled burning of waste (Helsinki, 2011).

Another critical issue is the lack of solid waste treatment facilities in the metropolis. Without appropriate treatment infrastructure—such as composting units, incinerators, or recycling plants—most of the waste ends up in open dumps, untreated and unsegregated, exacerbating environmental contamination and making resource recovery impossible (Adebayo et al, 2018). The topographical features of dumpsites also present a major challenge. Many sites are located in unsuitable terrains, including flood-prone or ecologically sensitive areas. Such placements increase the risk of soil, groundwater, and surface water contamination, especially in the absence of engineered containment measures (Adebayo et al., 2018).

Despite government efforts to improve solid waste management in Nigeria, progress remains limited. Salami and Oderinwale (2015) describe Nigeria's waste management sector as still being in its "infancy stage," with limited coordination, weak enforcement of environmental laws, and inadequate investment. In Benin Metropolis specifically**,** indiscriminate dumping has become rampant, with open spaces, drainage channels, and even residential zones increasingly used as makeshift dumping grounds (Drain, Raliavao, & Carnell, 2011). Ekere et al. (2019) reaffirm that unregulated dumps continue to dominate waste disposal practices in Benin Metropolis. According to their findings, less than 25% of collected waste is disposed of in government approved dumpsite, and **l**ess than 15% in sanitary landfills, while the remainder ends up in uncontrolled dumps, heightening environmental and health risks.

Addressing the challenges at the disposal stage of solid waste management in Benin Metropolis requires a multifaceted strategy. This should include the establishment of regulated, engineered landfills**,** routine maintenance of existing dumpsites**,** and investment in waste treatment technologies**.** Moreover, public education and stricter enforcement of waste disposal regulations

will be essential to reversing the current trend of unregulated dumping and ensuring sustainable urban sanitation.

Availability of Solid Waste Management Equipment

Effective solid waste management is heavily dependent on the availability and functionality of appropriate equipment at every stage of solid waste management. In Nigeria, particularly in Benin Metropolis, impediment to proper waste management is the inadequate supply and poor condition of essential solid waste management equipment. According to Andrews, Lord, O'Toole, & Requena, (2013), solid waste management encompasses processes such as segregation, storage, collection, transportation, treatment, and disposal, each of which requires specialized equipment. The severe lack of these resources in Benin Metropolis hampers the effectiveness and efficiency of waste management operations. Dagnew, Alemu, and Zenebe (2023) emphasize that the absence of basic equipment including waste segregation equipment, storage equipment, and reliable collection vehicles is a major constraint in ensuring efficient solid waste management in urban areas of developing countries. In Benin Metropolis, the situation is particularly critical, with outdated or non-existent equipment at virtually all stages of the waste management process.

Several categories of essential equipment are either insufficient or completely lacking in Benin Metropolis: Waste Segregation Equipment: Advanced tools such as wrapping machines, sorting plants, waste balers**,** conveyor belts, shredders, and reel splitters are rarely available. This makes it nearly impossible to sort recyclable from non-recyclable materials effectively, leading to mixed waste disposal and loss of potentially recoverable resources (Agamuthu, 2019). Storage Equipment: Proper storage equipment including storage buildings, fencing, and drainage systems is grossly inadequate. The lack of these equipment contributes to indiscriminate dumping of

refuse, leachate pollution, and increased health risks in urban neighborhoods (Achankeng, 2013). Collection Equipment: Basic tools such as brooms, shovels, hand scrapers, and wheelbarrows are either in short supply or completely unavailable to sanitation workers, severely impeding street cleaning and household waste collection efforts (Olufayo & Omotosho, 2017).

Transportation Vehicles: The few available compactor trucks, garbage trucks, tipping trucks, and dump trucks are often old, poorly maintained, and prone to frequent mechanical breakdowns, resulting in irregular waste collection and prolonged accumulation of refuse in residential and commercial areas (Ekere et al., 2019). Treatment and Disposal Equipment: Critical equipment such as incinerators, motor graders, compacting tractors, and bulldozers are largely unavailable. This gap restricts the treatment and environmentally sound disposal of solid waste, particularly for hazardous or bulky waste types (Hancock & Alan, 2023). The chronic shortage of modern solid waste management equipment in Benin Metropolis has profound implications for public health, environmental quality, and urban sanitation. Inadequate tools not only reduce the operational capacity of waste management agencies but also expose sanitation workers and the general public to increased risks of pollution and disease. As such, concerted efforts by government agencies, private sector operators, and community stakeholders are urgently needed to invest in and upgrade waste management infrastructure across all stages of the waste lifecycle.

Empirical Studies on Impediments to Solid Waste Management

Several studies have investigated the factors that influence effective solid waste management. Onazi, Gaiya, Ola-Adisa, and Mangden (2018) conducted a study on waste management practices in selected pre-urban communities in North Central Nigeria to explore key variables that influence overall solid waste management. The study found that perceived consumer effectiveness (PCE) was the most influential variable in predicting zero waste behavior (ZWB)

intention (B = 0.380, p < 0.001), even surpassing perceived behavioral control (PBC) (B = 0.232, p < 0.001). PBC also directly influenced ZWB (B = 0.321, p < 0.001), and injunctive norms (B = 0.171, p < 0.05) exerted a slightly greater influence than attitudes (B = 0.122, p < 0.001). Furthermore, environmental concern was a meaningful antecedent to all belief variables (control belief: B = 0.367, p < 0.001), exerting an indirect effect on ZWB (B = 0.474), especially through attitude and PBC. Although perceived facility limitations negatively impacted intention (B = -0.073, p < 0.05), they positively related to ZWB (B = 0.189, p < 0.001), potentially worsening the effect of intention on ZWB (B = -0.033, CI [-0.102, 0.036]). These results provide crucial insights for devising impactful strategies and formulating sound policies to encourage consumer ZWB.

Another study was embarked on with three distinctive objectives on domestic solid waste collection and management systems in selected public housing estate in Lagos metropolis to identify the existing waste collection systems (methods) in a public housing estate, examine the types of domestic solid waste collection and to evaluate the relationship between frequency of waste collection and waste disposal in the study area. 55 household respondents were received and analyzed, from the demographic characteristics of the respondents' age category 31-40 and 41-50 forms the majority with frequency 28 and 19 representing 50.9% and 34.5% of the entire population respectively. Respondents between age 21-30 were 6 in number representing 10.9% of the population while below 20 (between18-20) years and 51-Above had 1 respondent each representing 1.8%. Measuring the level of education, 53 respondents out of 55 had tertiary education qualification representing 96.4% of the study population while the remaining 2 respondents were shared between primary and secondary school qualification equally. The income level characteristics shows that 1 respondent have an income that is below 50,000naira

and another respondent with income range between 51,000-100,000 naira both shared 3.6% of the study population whereas 70.9% have income range between 101,000- 150,000 and the remaining 25.5% are for respondents with 151,000-200,000 naira income range. It shows that the income level with a standard deviation .47 and mean of 3.24 for a population 55 respondents. Identified waste collection systems (methods) in a public housing estate in the Lagos metropolis. The waste collection operation system in the study area shows that 1.8% engage in burying of their waste, 10.9% dump their waste by themselves to the dump site, while 50.9% of the waste are collected from door to door leave 34.5% to waste operators and finally 1.8% are left to the informal sectors. In other words about 14.5% of the total wastes are not collected by organized sector therefore issues of uncollected waste can be envisaged.

It was observed that about two third of all the domestic solid waste generated in the study area are mainly organic wastes in nature, while one third of the domestic solid waste generated are from paper, plastic, metal and textile wastes. This means that a very large percentage of the domestic solid wastes generated in the study area are biodegradable (about 96%) compared to the non-biodegradable wastes generated in the study area (about 4%), this also implies that the biodegradable wastes can be decomposed and used for other purposes. Abila, and Jussi (2013), in the same vein reported that majority of the wastes generated are biodegradable waste compared to non-biodegradable waste which when decomposed can be harmful to human health.

Domestic Solid Waste Management Strategies Employed in the Study Area, it was showed that the major domestic solid waste management strategies employed in the study area is open dumping, burning and burying. About 62% of the respondents dump their wastes openly; about 22% bury their wastes while about 16% burn their wastes. Marianna, Susanna, and Francesco (2021)

in the same vein reported that there were no well-maintained dumpsites in Benin metropolis and the major method of waste disposal are open dumping, land filling and dig and bury..

Global municipal solid waste (MSW) generation rose from 1.3 billion tons in 2012 to 2.1 billion tons (0.74 kg/capita/day) as of 2016, which by 2050 is expected to increase by 70% to reach a total of 3.40 billion tons or 1.42 kg/capita/day. The per capita MSW generation varies among regions and countries. In the EU (European Union), it ranges from 0.3–1.4 kg/capita/day [20], and in some African cities, the average is 0.78 kg/capita/day. In Asia, urban areas generate about 760,000 tons of MSW per day, which is expected to increase to 1.8 million tons per day or 26% of the world's total by 2025, despite the continent housing 53% of the world's population. In China, the total MSW generation was around 212 million tons (0.98 kg/capita/day) in 2006, out of which 91.4%, 6.4%, and 2.2% were disposed of via landfilling, incineration, and composting.

In 2010, only 660 Chinese cities produced about 190 million tons of MSW, accounting for 29% of the world's total, while the total amount of solid waste in China could reach at least 480 million tons in 2030. In China, industrial waste (more than one billion tons) was five times the amount of MSW generated in 2002, which is expected to generate approximately twice as much MSW as the USA, while India will overtake the USA in MSW generation by 2030.

In Malaysia, while the average rate of MSW generation was about 0.5–0.8 kg/person/day, Kuala Lumpur's daily per capita generation rate was 1.62 kg in 2008, which is expected to reach 2.23 kg in 2024. About 64% of Malaysia's waste consists of household and office waste, 25% industrial waste, 8% commercial waste, and 3% construction waste. In Sri Lanka, the assessed mean waste generation in 1999 was 6500 tons/day or 0.89 kg/cap/day, which is estimated to reach 1.0 kg/cap/day by 2025. With a 1.2% population growth rate, the total MSW generation in 2009 was approximately 7250 tons/day. In Ghana, the solid waste generation rate was 0.47

kg/person/day, or about 12,710 tons per annum, consisting of biodegradable waste (0.318), non-biodegradable (0.096), and inert and miscellaneous waste (0.055) kg/person/day, respectively. Moreover, global SWM costs are anticipated to increase to about $375.5 billion in 2025, with more than four-fold increases in lower- to middle-income countries and five-fold increases in low-income countries. Globally, garbage collection, transportation, and disposal pose a major cost component in SWM systems. Inadequate funding militates against the optimization of MSW disposal services. Comprise of everyday SWM practices in low-, middle- and high-income countries according to major waste management steps. The literature indicates that waste generation rates and practices depend on the culture, socioeconomic status, population density, and level of commercial and industrial activities of a city or region.

Other studies have highlighted the importance of proper waste collection, transfer, and transportation systems in solid waste management. Al-Khatib, Monou, Abdul, and Hafez (2010) reported that improper collection, transfer, and/or transportation systems affect solid waste management. Issues such as poor route planning, lack of information regarding collection schedules, insufficient vehicles, poor road conditions, and inadequate equipment further complicate the process. Marianna, Susanna, and Francesco (2021) analyzed the factors influencing household solid waste disposal and found that the availability of solid waste storage equipment affects disposal choices.

Inadequate provision of containers and long distances to disposal points increase the likelihood of illegal dumping in open spaces and along roadsides. The role of informal waste workers has also been widely acknowledged. Emmanuel, Eric, & Sampson, (2018) noted that informal waste workers engage in storage, collection, transportation, segregation, and disposal of waste,

providing economically valuable services. However, the precarious and marginalized socio-economic conditions of these workers make integrating them into formal systems a challenge.

A study conducted in Indonesia by Novriandhy, Komalasari, Hatta, and Oktarina (2020) on earth and environmental science revealed that waste generation is influenced by demographic factors. Older individuals and the unemployed tend to generate less waste. The study also suggested that household waste generation correlates strongly with storage practices. Furthermore, an enhanced economy fosters greater participation in waste collection, supporting a more sustainable workforce.

In contrast, Benin Metropolis has a weak economic base, leading to minimal formal waste collection efforts. As a result, individuals engage in scavenging or waste picking, which is unsustainable for long-term waste management (Ogwueleka, 2019). Adelegan (2010) asserted that informal waste workers provide economically valuable services, often operating as self-employed individuals or informally organized groups. In some cases, they are directly engaged by households or community associations. However, their exclusion due to socio-economic marginalization hinders effective integration into the waste management system. The informal sector plays a crucial role in urban solid waste management through segregation at the point of collection. These individuals recover recyclable materials, removing over 37% of municipal solid waste. Despite this contribution, they remain largely neglected by federal, state, and local governments (Sampson, 2012). Although recycling and reuse offer tangible benefits, recycling rates remain low. For instance, Malaysia recycles only about 5% of its waste (Dede, 2016). The potential for growth in the recycling industry is vast, and integrating the informal sector could enhance waste diversion rates.

Government involvement in solid waste management in Benin Metropolis has been widely questioned. Concerns revolve around the roles, responsibilities, and effectiveness of government institutions, especially regarding the contracting of services to private enterprises. The success of municipal solid waste management systems depends heavily on community involvement and ownership (Ekere, Mugisha, & Drake, 2019). The typical waste management system in Benin Metropolis suffers from numerous challenges, including inadequate storage containers and equipment, a limited number of collection vehicles, lack of waste segregation, insufficient accredited waste managers, and indiscriminate dumping in streets, between houses, and in drainage systems (Asije, 2023).

Moreover, enforcement of environmental laws, such as those outlined in the Edo State Sanitation and Pollution Management Law, is often weak or slow. Supervision by relevant authorities is minimal, leading to ineffective solid waste management. Other challenges include the inadequate number of waste laborers often poorly paid and perceived as low-status workers poor regulation of scavenging activities, high maintenance costs for waste equipment and vehicles, lack of engineered disposal sites, insufficient treatment plants, inadequate haulage equipment, lack of technical expertise, and minimal financial support from government (Cointreau, 2014).

Vasudevan, Faisal, Sanjeev, and Mohammed (2016) explored household waste management behavior in Nigeria and found that waste management attitudes significantly affect disposal behavior. These attitudes may be influenced by lifestyle, consumption habits, and personal waste management practices. Cornelius and Cover (2018) also reported that many individuals regardless of gender engage in open dumping, using unregulated and unsafe dumpsites. This method remains prevalent in most developing countries. In middle-income countries such as Nigeria, China, Egypt, Kenya, Latvia, and Bosnia and Herzegovina, less than 25% of waste is

deposited in controlled landfills, and less than 15% in modern sanitary landfills, with the rest being discarded in open dumps, many of which are hazardous (Ossai, 2006).

Summary of Related Literature Reviewed

Existing literature reveals that solid waste management in Benin Metropolis faces impediment across all stages, that is solid waste generation, segregation, storage, collection, transportation, and final disposal. These challenges stem from inadequate funding, poor infrastructure, insufficient technical capacity, and limited public cooperation. Government agencies are often under-resourced, lacking both the manpower and equipment necessary for effective waste handling. Poor enforcement of regulations, lack of political will, and weak institutional frameworks contribute to inefficient service delivery. At the household level, many residents are unwilling or unable to pay for waste collection services. Waste is rarely segregated at source due to limited awareness and lack of access to recycling or reuse options. Instead, excessive packaging and poor environmental education contribute to increased waste volumes. Storage equipments are inadequate, with many residents relying on plastic bags instead of proper bins.

The shortage of suitable containers and collection points leads to indiscriminate dumping and delays in waste removal. Collection is hampered by outdated and insufficient vehicles, lack of protective equipment for workers, and inefficient routing systems. Many communities are underserved, resulting in open dumping in streets and drains. Transportation of solid waste is equally problematic due to long distances to disposal sites, high fuel costs, vehicle breakdowns, and the use of uncovered, leaking trucks that pose health and safety risks. Disposal practices are largely unregulated, with open dumping being the most common method. Most dumpsites lack proper management, and are often located in environmentally sensitive or flood-prone areas. There is a critical shortage of sanitary landfills, composting centers, recycling plants, and

incineration equipment, making resource recovery almost nonexistent. The absence of such infrastructure increases environmental pollution and public health risks.

Furthermore, the solid waste sector in Benin Metropolis suffers from a severe shortage of modern equipment at every stage. Basic tools such as bins, compactors, wheelbarrows, and incinerators are either outdated, insufficient, or completely unavailable. These constraints reduce operational efficiency and endanger the health and safety of workers and residents alike.

Empirical studies emphasize the importance of public behavior, attitudes, and awareness in achieving effective waste management. Factors such as environmental concern, access to equipment, and social influence impact waste reduction practices. The informal sector also plays a vital, though undervalued, role in waste collection and recycling, yet remains marginalized due to lack of integration and support. Overall, the literature highlights that effective solid waste management in Benin Metropolis is impeded by a combination of technical, financial, institutional, and social factors. Without strong policy implementation, public participation, investment in infrastructure, and integration of informal actors, sustainable waste management remains out of reach.

CHAPTER THREE

METHODOLOGY

In this chapter details of the method and procedure that was used in the study. They were discussed under the following subheading:

- Design of the Study
- Population of the Study
- Sample and Sampling Technique
- Research Instrument
- Validity of the Instrument
- Reliability of the Instrument
- Method of Data Collection
- Method of Data Analysis

Design of the Study

This study adopted the descriptive survey research design**,** which is deemed most appropriate because it enables the collection of data from respondents without manipulating any variables. This design allows the gathering of factual information, analyze relationships between variables, and draw conclusions that reflect the existing conditions among the target population (Owie, 2016). It also facilitates the representation of a diverse population, thereby providing a comprehensive understanding of the issues under investigation.

Population of the Study

The populations for this study comprise all the one hundred and sixteen (116) accredited solid waste management companies operating in Benin Metropolis. This includes the managers of Edo State Waste Management Board.

Sample and Sampling Techniques

The sample for the study was seventy (70) solid waste management company managers in Benin metropolis. The sample was determined using multistage sampling techniques. Firstly, the stratified sampling technique was used to divide the waste management company into different local government area according to their various zones and operational localities in Benin Metropolis. Secondly, proportional sampling technique was used to select sixty percent (60%) of the entire population.

Thirdly, following the stratification and proportional sampling, simple random sampling techniques was used to select the actual participants. This involved listing the names of all solid waste management companies in each local government area, placing each name on a slip of paper, and mixing them thoroughly in separate containers according to their local government area. Slips were drawn one at a time, with replacement, until the desired sample size was achieved. This method ensured that every solid waste management company manager had an equal chance of being selected

Table 1: Sampling Breakdown by Local Government Area (LGA)

LGA	Solid Waste Management company	Solid Managers sampled in L.G.A. (60%)
Oredo	40	24
Egor	43	26
Ikpoba Okha	33	20
Total	**116**	**70**

Note: Adapted from Edo State Waste Management Board, (2023).

Research Instrument

This study employed two instruments for data collection, a structured questionnaire and checklist. The checklist was used to check the availability of solid waste management equipment in Benin metropolis, it was adapted from a previously submitted thesis to the Department of Health, Safety, and Environmental Education, University of Benin (Abdulrasaq, 2021). The questionnaire was divided into two sections. Section A and Section B. Section A focused on eliciting demographic information from respondents, while Section B addressed items on impediments to solid waste management in Benin metropolis.

A four-point modify Likert scale was used for scoring responses: Strongly Agree (4 points), Agree (3 points), Disagree (2 points), and Strongly Disagree *(*1 point). For negatively worded items, reverse scoring was applied. A benchmark mean score of 2.5 was established; hence, any item with a mean score of 2.5 or above was considered an impediment to solid waste management in Benin Metropolis.

Validity of the Instrument

The content validity of the instrument (questionnaire) was ensured through expert review. The instrument was validated by five experts. The instrument underwent critical review, and all suggested modifications were integrated into the final draft. The checklists were not validated.

Reliability of the Instrument

The reliability of instrument (questionnaire) was established using the test-retest method. The instrument was initially administered to twenty (20) respondents outside the study sample. After a two-week interval, the same questionnaire was re-administered to the same group. Responses from both administrations were analyzed using the Pearson Product Moment Correlation Coefficient, yielding a reliability index of 0.73, indicating acceptable consistency.

Method of Data Collection

The data was collected with the help of two research assistants. The assistants were instructed on the study's objectives, administration procedures, and ethical considerations related to both the questionnaire and the checklist. They were guided on interpreting questionnaire items for respondents who encountered comprehension challenges and instructed to ensure that instruments were handled carefully to improve the response rate.

Prior to the administration of the instrument, ethical clearance and permission were obtained. An introductory letter from the Department of Health, Safety, and Environmental Education, University of Benin, was presented to the manager of the Edo State Waste Management Board. In response, the manager convened a meeting of all managers of solid waste management companies, during which the researcher and assistants were formally introduced.

Method Data Analysis

Data collected were analyzed using both descriptive and inferential statistics. Descriptive statistics of frequency counts, percentages, mean scores, and standard deviations were used to address the research questions. To test the hypothesis formulated, Analysis of Variance (ANOVA) was employed at a 0.05 level of significance.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

Presentation of results

This chapter presents the analysis of data collected for this study. The presentation and analysis was based on a separate consideration of each research question and hypothesis tested. The following are the results which are shown in tabular forms and discussed.

Research Question One: What are the impediments inherent in the segregation stage of solid waste management in Benin metropolis?

Table 2: Mean and Standard Deviation Distribution of Impediments inherent in Segregation Stage of Solid Waste Management in Benin Metropolis

S/N	Segregation Stage as Impediments to Solid Waste Management	Mean	S.D	Remark
1.	Lack of segregation of solid waste at household level affects solid waste management in Benin metropolis.	3.44	.50	Agree
2.	Lack of recycling equipment in households affects solid waste management in Benin metropolis.	3.30	.46	Agree
3.	Solid waste may sometimes include excreta, making segregation difficult.	3.58	.50	Agree
4.	Lack of proper reuse of materials affects solid waste management in Benin metropolis.	3.58	.50	Agree
5.	Lack of segregation equipment affects solid waste management in Benin metropolis.	3.58	.50	Agree
	Grand mean	**3.49**	**0.49**	**Agree**

- **Benchmark mean=2.50**

Table 2 above reveals the impediments inherent in the segregation stage of solid waste management in Benin metropolis. The lack of segregation of solid waste at the household level (Mean = 3.44) is one of the impediments. Many residents do not separate their waste into recyclables, non-recyclables, or organic waste. This lack of segregation at the source complicates solid waste management, as it becomes more difficult to recycle and reuse materials. The absence of recycling equipment within households (Mean = 3.30) exacerbates the problem.

Without the necessary equipment to recycle materials, residents are less likely to engage in the practice of recycling, which could reduce the amount of solid waste sent to landfills. The lack of proper equipment to manage recyclable solid waste at the household level reduces the effectiveness of the entire waste management system in Benin metropolis.

Solid waste may sometimes include excreta, making segregation difficult (Mean = 3.58). The presence of organic waste, such as human waste, complicates the segregation process. This kind of waste requires special handling and cannot easily be segregated from other materials. It creates hygiene challenges and could hinder solid waste segregation. The lack of proper reuse of materials (Mean = 3.58) further compounds the issue of solid waste segregation. In many cases, reusable materials are not being effectively managed. If households or solid waste management companies were better equipped to identify and repurpose materials like plastics, metals, and paper, less solid waste would need to be disposed of, contributing to a more sustainable waste management system.

The lack of proper segregation equipment (Mean = 3.58) is another major barrier. If adequate equipment, such as separate bins for recyclables and non-recyclables waste, were provided at both household and community levels, it would encourage better solid waste segregation. The absence of such equipment makes it difficult for residents to engage in solid waste segregation. The grand mean for segregation stage is 3.49, which indicates that the impediments in the segregation stage are visible. The high values across the various items suggest that segregation is one of the most challenging aspects of solid waste management in Benin Metropolis. The segregation stage of solid waste management in Benin Metropolis is hindered by several impediments, including the lack of segregation of solid waste at the household level, lack of

recycling equipment, the presence of excreta in waste, inadequate reuse of materials, and the absence of proper segregation equipment.

Research Question Two: What are the impediments inherent in the storage stage of solid waste management process in Benin metropolis?

Table 3: Mean and Standard Deviation Distribution of Impediments inherent in Storage Stage of Solid Waste Management in Benin Metropolis

S/N	Storage Stage as Impediments to Solid Waste Management	Mean	S.D	Remark
6.	Insufficient storage bins in most part of Benin metropolis affects solid waste management.	2.86	.99	Agree
7.	Few storage points affect solid waste management in Benin metropolis.	2.58	.73	Agree
8.	Poor storage option adopted by some residents affects solid waste management.	3.44	.50	Agree
9.	Inadequate access to storage points due to bad roads affects solid waste management.	3.00	.53	Agree
10.	The use of nylons affects solid waste management in Benin metropolis as most time gets scatted easily.	3.42	.50	Agree
	Grand mean	**3.06**	**0.65**	**Agree**

- **Benchmark mean=2.50**

Table 3 above reveals the impediments inherent in the storage stage of solid waste management in Benin metropolis. These include insufficient storage bins in most parts of Benin metropolis,

with respondents agreeing that this limitation delays solid waste collection efforts (Mean = 2.86). The scarcity of designated storage and collection points (Mean = 2.58) also hinders smooth operations, leading to solid waste buildup in certain areas.

Poor storage options of some residents in Benin metropolis present an additional impediment, as indicated by a high mean score (Mean = 3.44). Inadequate storage points contribute to environmental pollution and further complicating solid waste management efforts. Additionally, the widespread use of lightweight storage materials like nylons (Mean = 3.42), which can easily scatter, exacerbates the problem, leading to littering and further obstructing solid waste management. The storage stage of solid waste management in Benin Metropolis faces substantial impediments, primarily due to insufficient storage bins, few storage points, poor storage options of some residents, inadequate access to storage points due to bad roads, the use of nylons. The grand mean score of 3.06 indicates that these issues are consistently recognized as significant impediments.

Research Question Three: What are the impediments inherent in the collections stage of solid waste management in Benin metropolis?

Table 4: Mean and Standard Deviation Distribution of Impediments inherent in Collection Stage of Solid Waste Management in Benin Metropolis

S/N	Collection Stage as Impediments to Solid Waste Management	Mean	S.D	Remark
11.	Irregular and nonpayment of solid waste collection bills by some residents affect solid waste management.	3.15	.65	Agree
12.	The zoning system does not permit regular collection of solid waste thereby affecting solid waste management.	3.30	.46	Agree
13.	Lack of modern vehicles for solid waste collection affects timely collection.	3.30	.46	Agree
14.	Inadequate solid waste collection points hinder effective solid waste management.	2.87	1.13	Agree
15.	Poor solid waste disposal pattern affect ease of collection..	3.14	.64	Agree
	Grand mean	**3.15**	**0.67**	**Agree**

- **Benchmark mean=2.50**

Table 4 above reveals the impediments inherent in the collection stage of solid waste management in Benin metropolis. The impediments in this stage include lack of payment for solid waste collection services by some residents, with respondents agreeing on its negative impact on solid waste management (Mean = 3.15). When payments are irregular or absent, it becomes challenging for waste managers to sustain and improve solid waste collection services.

The current zoning system in Benin Metropolis was reported as a barrier to regular solid waste collection, with a high mean score (Mean = 3.30). The zoning arrangement appears to restrict the frequency and reliability of solid waste collections, leading to waste accumulation in certain areas and reducing overall efficiency in solid waste management.

Another barrier is the scarcity of modern vehicles for solid waste collection, as highlighted by respondents (Mean = 3.30). Without good working vehicles, solid waste collection is often delayed, and the capacity to handle waste across the metropolis is reduced. Limited solid waste collection points (Mean = 2.87) and poor solid waste disposal pattern in Benin metropolis affect collection of waste (Mean = 3.14) further complicate waste management. The collection stage of solid waste management in Benin Metropolis encounters challenges stemming from irregular and non-payment of solid waste collection bills by some residents, the zoning system not permitting regular collection of solid waste, lack of modern vehicles for solid waste collection, inadequate solid waste collection points, and poor solid waste disposal patterns. The grand mean of 3.15 reflects a consensus on the impact of these impediments.

Research Question Four: What are the impediments inherent in the transportation stage of solid waste management in Benin metropolis?

Table 5: Mean and Standard Deviation Distribution of Impediments inherent in Transportation Stage of Solid Waste Management in Benin Metropolis

S/N	Transportation Stage as Impediments to Solid Waste Management	Mean	S.D	Remark
16.	The use of vehicles that are not roadworthy constitutes a problem for solid waste management.	3.58	.73	Agree
17.	Long distance to government approved dump sites affect timely transportation of solid waste.	3.30	.46	Agree
18.	Lack of skilled labourers in solid waste transportation affects solid waste management.	3.28	.45	Agree
19.	Not covering vehicles during transportation affects solid waste management.	3.30	.46	Agree
20.	Poor road condition delays timely transportation of solid waste.	3.58	.50	Agree
	Grand mean	**3.41**	**0.52**	**Agree**

- **Benchmark mean=2.50**

The data from Table 5 above reveals the impediments inherent in the transportation stage of solid waste management in Benin metropolis. The use of vehicles that are not roadworthy (Mean = 3.58) is one of the most prominent impediments. This issue creates delays in solid waste management due to frequent breakdowns, which hinder timely waste transportation. Poorly maintained vehicles lead to inefficiencies and increased costs for repairs, as well as a failure to meet scheduled solid waste collection routines.

The long distances to government-approved dump sites (Mean = 3.30) present another impediment. This increases the time it takes to dispose of solid waste and adds to transportation costs. Delays in reaching dumpsites can lead to piles of uncollected solid waste in residential areas, causing environmental and health problems. The absence of skilled laborers in solid waste collection (Mean = 3.28) also hampers the effectiveness of solid waste transportation. Without adequate labor, there is a lack of personnel to manage solid waste transport operations efficiently. Skilled laborers are essential for the proper handling and transportation of solid waste, and their absence can disrupt operations. The practice of not covering solid waste vehicles (Mean = 3.30) has been identified as a problem. Uncovered solid waste vehicles pose environmental and aesthetic impediments, as waste can spill out onto the streets, causing littering and contamination of the natural environment. This also contributes to the spread of diseases and worsens the overall appearance of the metropolis.

The poor conditions of roads delay timely transportation of solid waste in Benin metropolis (Mean = 3.58) is another issue. Poorly maintained roads delay the transportation and disposal of solid waste, resulting in the accumulation of solid waste on the streets, creating environmental health hazards and undermining the efficiency of the entire waste management system. The grand mean for the transportation stage is 3.41, which suggests that, overall, the impediments in the transportation stage are considered barrier by the respondents. The transportation stage of solid waste management in Benin Metropolis is hindered by multiple impediments, including the use of vehicles that are not roadworthy, long distances to government-approved dump sites, lack of skilled laborers, not covering vehicles when transporting solid waste, and poor roads.

Research Question Five: What are the impediments inherent in the disposal stage of solid waste management in Benin metropolis?

Table 6: Mean and Standard Deviation Distribution of Impediments inherent in Disposal Stage of Solid Waste Management in Benin Metropolis

S/N	Disposal Stage as Impediments to Solid Waste Management	Mean	S.D	Remark
21.	Dumpsites not being regularly maintain affect solid waste management.	3.28	.45	Agree
22.	The location of government approved dumpsites does not favour efficient waste disposal.	3.44	.50	Agree
23.	Lack of solid waste treatment at dumpsites affects proper disposal.	3.28	.45	Agree
24.	Failure to compact solid waste at dumpsites affects waste management.	3.30	.46	Agree
25.	The topographical nature of dumpsites hinders vehicle access, affecting waste management.	3.58	.50	Agree
	Grand mean	**3.37**	**0.47**	**Agree**

- **Benchmark mean=2.50**

The data from Table 6 above highlights the impediments inherent in the disposal stage of solid waste management in Benin metropolis. These challenges include: The lack of regular maintenance of dumpsites (Mean = 3.28) negatively affects the disposal of solid waste. When dumpsites are not maintained, solid waste accumulates, leading to sanitation and environmental concerns. Unkempt dumpsites can also contribute to the spread of diseases and attract pests, making it difficult to manage solid waste effectively.

The location of government-approved dumpsites is not ideal for solid waste management (Mean = 3.44). When dumpsites are located in areas that are far from the main residential zones or are difficult to access, it complicates the solid waste disposal process. Poorly located dumpsites can lead to inefficiencies in solid waste disposal and may increase the environmental impact, such as air and land pollution, leading to health risks in nearby communities. The absence of treatment equipment at dumpsites (Mean = 3.28) affects waste disposal. Without treatment processes like waste-to-energy programs, waste accumulates in its raw form, leading to the proliferation of harmful substances in the environment. This also discourages people from using the dumpsites, as untreated solid waste may emit unpleasant odors and pose health risks.

The failure to compact solid waste at dumpsites (Mean = 3.30) further complicates waste management. Solid wastes that are not compacted takes up more space, leading to overcrowding of dumpsites and reducing the available space. Compaction helps maximize space at dumpsites, reduces littering, and allows for more organized and efficient waste disposal. The topographical nature of some dumpsites (Mean = 3.58) impedes the movement of vehicles in and out of these sites. If the terrain is uneven or poorly structured, it can make it difficult for vehicles to access the site easily.

The grand mean for the disposal stage is 3.37, which indicates that the challenges faced in the disposal stage are visible. The high ratings across the various items suggest that impediments like poor dumpsite maintenance, difficult locations, lack of waste treatment, failure to compact waste, and topographical challenges are key barriers to effective solid waste disposal in Benin Metropolis.

Research Question Six: What is the availability of solid waste management equipment in Benin Metropolis?

Table 7: Descriptive Statistics of Frequency Counts and Percentages Distribution of Availability of Solid Waste Segregation Equipment

S/N	Segregation Equipment	Available	(%)	Not Available	(%)
1.	Wrapping Machines	30	42.9%	40	57.1%
2.	Sorting Plants	35	50.0%	35	50.0%
3.	Separators	38	54.3%	32	45.7%
4.	Waste Balers	32	45.7%	38	54.3%
5.	Conveyor Belts	25	35.7%	45	64.3%
6.	Shredders	0	0%	70	100%
7.	Reel Splitters	0	0%	70	100%

Segregation equipment is limited, with separators showing a slightly higher presence at 54.3%. However, conveyor belts (35.7%) and waste balers (45.7%) have relatively low availability, and equipment such as shredders and reel splitters is completely unavailable.

Table 8: Descriptive Statistics of Frequency Counts and Percentages Distribution of Availability of Solid Waste Storage Equipment

S/N	Storage Equipment	Available	(%)	Not Available	(%)
8	Storage and Treatment Tanks	0	0.0%	70	100%
9	Storage and Treatment Buildings	0	0.0%	70	100%
10	Storage Fencing with Gates	0	0.0%	70	100%
11	Covers, Drainage, and Runoff Control	0	0.0%	70	100%
12	Seepage Detection and Control	0	0.0%	70	100%
13	Interior Accessing	0	0.0%	70	100%
14	Exterior Accessing	0	0.0%	70	100%

Table 8 shows that all examined solid waste storage equipment are entirely unavailable in Benin Metropolis. This includes critical equipment such as treatment tanks, fencing, and drainage systems, indicating a major gap in waste storage capability.

Table 9: Descriptive Statistics of Frequency Counts and Percentages Distribution of Availability of Solid Waste Collection Equipment

S/N	Waste Collection Equipment	Available	(%)	Not Available	(%)
15	Brooms	55	78.6%	15	21.4%
16	Shovels	60	85.7%	10	14.3%
17	Hand Scrapers	45	64.3%	25	35.7%
18	Tractor Scraper Blades	40	57.1%	30	42.9%
19	Elevating Type Box Scrapers	30	42.9%	40	57.1%
20	Garden Size Tractor Scraping Tools	25	35.7%	45	64.3%
21	Mechanical Scrapers for Gutters	20	28.6%	50	71.4%
22	Tractor Front End Loaders	55	78.6%	15	21.4%
23	Skid Steer and Articulated Loaders	45	64.3%	25	35.7%
24	Head Pans	60	85.7%	10	14.3%
25	Wheelbarrows	65	92.9%	5	7.1%
26	Roweling Waste Bins	58	82.9%	12	17.1%

Table 9 shows the most commonly available solid waste collection tools are wheelbarrows (92.9%) and head pans (85.7%). Other widely used equipment includes shovels (85.7%), roweling bins (82.9%), and tractor front-end loaders (78.6%). Conversely, mechanical scrapers and garden-size tractors are less available

Table 10: Descriptive Statistics of Frequency Counts and Percentages Distribution of Availability of Solid Waste Transportation Equipment

S/N	Transportation Equipment	Available	(%)	Not Available	(%)
27	Compactor Trucks	5	7.1%	65	92.9%
28	Landfill Tippers	4	5.7%	66	94.3%
29	Garbage Trucks	60	85.7%	10	14.3%
30	Tipping Trucks	40	57.1%	30	42.9%
31	Dump Trucks	55	78.6%	15Q	21.4%

Table 10 shows the transportation equipment such as garbage trucks (85.7%) and dump trucks (78.6%) are relatively available. However, essential tools like compactor trucks (7.1%) and landfill tippers (5.7%) are severely lacking.

Table 11: Descriptive Statistics of Frequency Counts and Percentages Distribution of Availability of Solid Waste Disposal Equipment

S/N	Disposal Equipment	Available	(%)	Not Available	(%)
32	Incinerators	0	0.0%	70	100%
33	Motor Graders	0	0.0%	70	100%
34	Compacting Tractors	45	64.3%	25	35.7%
35	Designated Dumpsites	65	92.9%	5	7.1%
36	Recyclers	0	0.0%	70	100%
37	Dispensers	30	42.9%	40	57.1%
38	Tanks	50	71.4%	20	28.6%
39	Crushers	48	68.6%	22	31.4%
40	Pumps	35	50.0%	35	50.0%

Table 11 shows among disposal equipment that, designated dumpsites have the highest availability (92.9%), followed by compacting tractors (64.3%) and crushers (68.6%). On the other hand, incinerators, motor graders, and recyclers are completely unavailable, indicating a major gap in disposal infrastructure.

Hypothesis Testing

Hypothesis:

There is no significant difference in the impediments inherent in the various stages of solid waste management in Benin Metropolis.

Table 12: ANOVA on difference in the impediments inherent in the various stages of solid waste management in Benin metropolis

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	.581	23.187[b]	4.000	67.000	.000
	Wilks' Lambda	.419	23.187[b]	4.000	67.000	.000
	Hotelling's Trace	1.384	23.187[b]	4.000	67.000	.000
	Roy's Largest Root	1.384	23.187[b]	4.000	67.000	.000

a. Design: Intercept

Within Subjects Design: factor1

b. Exact statistic

The multivariate tests (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Large/st Root) all yield significant results ($p < .001$), indicating that there is a statistically significant difference in impediments across the stages. This rejects the null hypothesis, suggesting that some stages of solid waste management in Benin metropolis face higher impediments than others.

Table 13: Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	96467.335	1	96467.335	19323.015	.000
Error	349.465	70	4.992		

The grand mean of the impediments is 16.49, but variability across stages is significant, with an F-statistic of 19323.015 ($p < .001$), confirming significant differences between stages. This further supports the idea that each stage of solid waste management experiences different levels of impediment. The analysis provides evidence against the null hypothesis, indicating significant differences in the impediments at different stages of solid waste management in the Benin metropolis.

The analysis from table 12 reveals a grand mean of 16.49 across all stages of solid waste management. However, the results of the analysis of variance (ANOVA) show a statistically significant difference in the levels of impediments among the different stages, as indicated by an F-statistic of 19,323.015 ($p < .001$). Therefore, the null hypothesis is rejected. This suggests that each stage of solid waste management segregation, storage, collection, transportation, and disposal experiences unique challenges and varying levels of operational difficulty in Benin Metropolis.

Discussion of Findings

The purpose of the study was to investigate impediments to solid waste management in Benin metropolis. Specifically, the study aimed to identify impediments inherent in segregation, storage, collection, transportation, and disposal stages of solid waste management in Benin metropolis. The finding indicates that the segregation stage of solid waste management in Benin Metropolis is hindered by several impediments, including the lack of segregation of solid waste at the household level, lack of recycling equipment, the presence of excreta in waste, inadequate reuse of materials, and the absence of proper segregation equipment.

This practice reflects low public awareness among the residents in Benin metropolis, weak enforcement of solid waste management regulations, and the absence of incentives to encourage source separation. When solid waste is not segregated at the household level, opportunities for recycling and composting are largely lost. Lack of recycling equipment, the finding also highlights the scarcity of recycling equipment in Benin Metropolis. Without sorting centers, recycling plants, or material recovery equipment, even potentially recyclable materials end up being disposed of as general waste. This reinforces a linear collect and dump system rather than

a circular waste management approach. The lack of recycling equipment discourages both households and private operators from investing effort in segregation.

Presence of Excreta in Solid Waste, the mixing of human excreta with solid waste poses serious public health and environmental risks. This situation may arise from inadequate sanitation equipment, the use of waste bins for fecal disposal. The presence of excreta contaminates recyclable materials, exposes waste handlers to pathogens, and makes manual sorting unsafe. It also reflects broader sanitation challenges that intersect with solid waste management. Inadequate reuse of materials, the finding suggests that reusable materials such as plastics, bottles, metal containers, and paper are not adequately recovered. This may be due to limited awareness of reuse practices, lack of organized reuse systems, and insufficient market linkages for reusable materials. As a result, valuable resources are discarded, increasing solid waste volumes and pressure on solid disposal equipment.

Absence of proper segregation equipment, the unavailability of proper segregation equipment such as colour coded bins, labeled containers, and household level sorting receptacles further hinders effective solid waste segregation in Benin metropolis. Without appropriate equipment for solid waste segregation, even households willing to separate solid waste lack the means to do so. This equipment gap also affects public institutions and commercial premises, reinforcing the persistence of mixed solid waste streams. These impediments collectively weaken the segregation stage, which is critical for enabling efficient solid waste collection, safe transportation, effective recycling, and environmentally sound disposal. Poor segregation increases the cost of solid waste management, reduces the efficiency of recycling initiatives, and exacerbates environmental pollution and public health risks.

Encouraging household dwellers in Benin metropolis to segregate solid waste could improve solid waste management in Benin metropolis. The absence of recycling equipment within households exacerbates the problem. Without the necessary equipment to recycle materials, residents in Benin metropolis are less likely to engage in the practice of recycling, which could reduce the amount of solid waste sent to landfills. The lack of proper equipment to manage recyclable solid waste at the household level reduces the effectiveness of the entire waste management system in Benin metropolis. This align with Salami et al. (2005) who states that solid waste segregation help in the reduction in waste volume or quality generated at source or otherwise. It is a waste management strategy that advocates for the minimization of raw materials in the production process. Excess packaging of food and consumer products is one of the greatest sources of unnecessary waste, with paper, plastic, glass, and metal packaging materials constituting more than half of domestic trash.

The presence of organic waste, such as human waste, complicates the segregation process. This kind of waste requires special handling and cannot easily be segregated from other materials. It creates hygiene challenges and could hinder the smooth functioning of the solid waste segregation process. The lack of proper reuse of materials further compounds the issue of solid waste segregation. In many cases, reusable materials are not being effectively managed. If households or solid waste management manager were better equipped to identify and repurpose materials like plastics, metals, and paper, less waste would need to be disposed of, contributing to a more sustainable waste management system.

This in line with Salami and Oderinwale (2005) suggestion that the adoption of the "cleaner" production concept, which would reduce the volume of domestic waste. This concept involves the continuous use of materials already used in the past, thereby reducing waste generation and

promoting sustainable consumption patterns. The lack of proper segregation facilities is another major barrier. If adequate infrastructure, such as separate bins for recyclables and non-recyclables, were provided at both household and community levels, it would encourage better waste sorting. The absence of such equipment makes it difficult for residents to engage in solid waste segregation.

The high values across the various items suggest that segregation is one of the most challenging aspects of solid waste management in Benin Metropolis. This is in line with Daniel (2020), who posits that modern solid waste management stresses in their hierarchical order, the "three R's" of reduction, reuse, and recycling before destruction or, finally secure storage of wastes. Addressing these impediments will require integrated interventions, including public awareness campaigns, provision of segregation and recycling equipment, improved sanitation equipment, policy enforcement, and the promotion of reuse and recycling practices. Strengthening solid segregation at the source is essential for improving the overall effectiveness and sustainability of solid waste management in the metropolis. This shortfall leads residents to store waste in inappropriate containers or dispose of it indiscriminately, thereby increasing environmental pollution and public health risks.

The finding reveals that the storage stage of solid waste management in Benin Metropolis faces substantial impediments, primarily due to insufficient storage bins, few storage points, poor storage options of some residents, inadequate access to storage points due to bad roads, the use of nylons. The shortage of adequate storage bins at household, street, and community levels is a major impediment to effective solid waste storage in Benin metropolis. Many residents lack access to standardized storage bins, forcing them to store solid waste in makeshift containers and dump it in open spaces. Insufficient solid waste bins lead to waste overflow, indiscriminate

dumping, and the exposure of waste to scavengers, animals, and weather elements. This situation reflects inadequate investment by solid waste management authorities and limited private sector participation in storage infrastructure provision.

Few designated storage points, the finding indicates that there are few designated storage points across Benin metropolis. Where solid waste storage points are scarce, residents may travel long distances to dispose of their waste, which discourages proper solid waste storage. As a result, some residents resort to dumping of solid waste along roadsides, drains, and vacant plots. The limited number of storage points also creates pressure on existing ones, leading to rapid accumulation and unsanitary conditions. Poor solid waste storage practices by residents, poor storage options adopted by some resident's further compound the problem. These practices include storing waste in open containers, sacks, or uncovered heaps within residential premises. Such methods are often driven by lack of awareness, poverty, or the absence of proper storage equipment. Poor storage practices result in offensive odors, attraction of pests and disease vectors, and increased risk of environmental contamination.

Inadequate access to storage points due to bad roads, the finding also highlights that poor road conditions limit access to storage points, both for residents and waste collection vehicles. Bad roads characterized by potholes, erosion, and flooding make it difficult to transport solid waste to designated storage locations. In some areas, solid waste trucks cannot reach storage points regularly, leading to delayed evacuation and waste accumulation. This equipment challenge discourages compliance with proper storage practices and undermines collection efficiency. The use of Nylons for Waste Storage, the widespread use of nylon bags for waste storage is another significant impediment. Nylons are easily torn, especially when filled with mixed or sharp waste materials, leading to spillage and littering. They are also non-biodegradable and contribute to

plastic pollution when improperly disposed of. The reliance on nylons reflects the lack of affordable, durable alternatives and insufficient regulation of appropriate waste storage materials. Combined effects on solid waste management, collectively, these impediments weaken the storage stage and create a chain reaction of inefficiencies throughout solid waste management process. Poor storage complicates solid waste collection, increases handling risks for solid waste workers, accelerates environmental degradation, and poses public health threats. It also undermines residents' confidence in waste management services, further reducing compliance.

Additionally, the widespread uses of lightweight storage materials like nylons, which can easily scatter, exacerbates the problem, leading to littering and further obstructing solid waste collection. This is in line with Sommerville, Jones, Rahajaharison and Milner, (2010), which state that there is typically a lack of storage facilities at both state and local Government levels with the technical expertise necessary for solid waste management, planning, and operations. It is important therefore for the Government to be fully involved in solid waste management.

The finding shows that the collection stage of solid waste management in Benin Metropolis encounters challenges stemming from irregular and non-payment of solid waste collection bills by some residents, the zoning system not permitting regular collection of solid waste, lack of modern vehicles for solid waste collection, inadequate solid waste collection points, and poor solid waste disposal patterns.

Non-payment of solid waste collection Bills, one of the most critical impediments to effective solid waste collection is the irregular and complete non-payment of solid waste collection fees by some residents. This undermines the financial sustainability of solid waste management agencies and private operators, limiting their ability to pay workers, fuel vehicles, maintain equipment, and expand services. Non-payment often results from low income levels, poor service delivery,

lack of trust in waste management authorities, or weak enforcement mechanisms. Consequently, collection services become irregular, reinforcing a cycle of poor performance and public dissatisfaction.

Zoning system limiting regular waste collection, the zoning system adopted for waste collection, while intended to enhance efficiency, appears to restrict regular service delivery in some areas of Benin Metropolis. Some zones may be underserved due to poor planning, uneven population distribution, or limited operational capacity of assigned contractors. These result infrequent solid waste collection schedules, especially in densely populated or low income neighborhoods, leading to waste accumulation and indiscriminate dumping. Lack of modern solid waste collection vehicles, the absence of modern waste collection vehicles, such as compactors and mechanized trucks, affects collection efficiency. Instead, waste collection often relies on outdated or improvised vehicles and manual handling. This limits the volume of waste that can be collected per trip, increases turnaround time, and exposes workers to health and safety risks. The lack of modern vehicles also contributes to frequent breakdowns and inconsistent service coverage.

Inadequate solid waste collection points, the finding further indicates that there are insufficient designated solid waste collection points within Benin metropolis. Where collections points are few and poorly located, residents are discouraged from using them and may dump solid waste in unauthorized areas such as drains, road verges, and open spaces. Inadequate collection points also lead to overcrowding of existing sites, resulting in spillage, foul odors, and unsanitary conditions. Poor solid waste disposal patterns by residents, poor disposal behaviour among some residents in Benin metropolis compounds the challenges of solid waste collection. This includes dumping of solid waste outside designated collection area, disposing of solid waste at

unauthorized locations, and mixing waste types indiscriminately. Such patterns make systematic collection difficult and increase the workload of collection crews. Poor disposal practices are often linked to low awareness, inadequate infrastructure, and irregular collection services.

Interrelated nature of the challenges, these impediments are closely interconnected. For example, irregular payment reduces service efficiency, which in turn discourages residents from paying collection fees. Similarly, inadequate vehicles and collection points worsen service irregularity, encouraging poor disposal practices. This interdependence highlights the complexity of challenges facing the collection stage.

Improving the collection stage is essential for ensuring a more efficient and sustainable solid waste management system in the metropolis. This align with Olufayo and Omotosho, (2017) who says that in Nigeria, there are problems of inappropriate designation of solid waste collection centers, and hence wastes are dumped at street junctions and corners, the case is not different in Benin metropolis. Additionally, insufficient governmental support, in terms of providing adequate working trucks and motivation, was seen as a critical gap, underscoring the need for stronger resource allocation to waste management.

The finding indicates that the transportation stage of solid waste management in Benin Metropolis is hindered by multiple impediments, including the use of vehicles that are not roadworthy, long distances to government-approved dump sites, lack of skilled laborers, not covering vehicles when transporting solid waste, and poor roads. Since transportation links solid waste collection points to final disposal sites, inefficiencies at this stage compromise the effectiveness of the entire solid waste management stages. The use of vehicles that are not roadworthy, the reliance on non-roadworthy and poorly maintained vehicles is a critical constraint in solid waste transportation. Such vehicles are prone to frequent mechanical

breakdowns, which disrupt solid waste collection schedules and increase downtime. Breakdowns often result in solid waste remaining at collection points for extended periods, causing overflow, foul odors, and public health concerns. Additionally, constant repairs raise operational costs and reflect inadequate funding, weak maintenance culture, and limited investment in modern waste transportation fleets.

Long distances to government approved dump sites, the long distances between solid waste collection points and officially approved dump sites reduce solid transportation efficiency. Extended haulage distances increase fuel consumption, vehicle wear and tear, and travel time, thereby limiting the number of trips that solid waste trucks can make daily. This reduces the volume of waste transported and encourages irregular disposal schedules. In some cases, operators may resort to illegal dumping along roadsides or vacant lands to minimize cost and time, further exacerbating environmental degradation.

Lack of skilled laborers, the transportation stage also suffers from a shortage of skilled personnel, including trained drivers, mechanics, and waste handling supervisors. Skilled labour is essential for safe vehicle operation, efficient route planning, routine maintenance, and compliance with environmental and safety standards. The absence of adequately trained workers increases accident risks, accelerates vehicle deterioration, and reduces overall system efficiency. It also highlights gaps in capacity building and workforce development within the waste management sector.

Failure to cover vehicles during waste transportation, transporting solid waste in uncovered vehicles poses serious environmental, health, and aesthetic problems. Uncovered waste often spills onto roads, creating litter, unpleasant odors, and traffic hazards. It also exposes residents and road users to airborne pollutants and pathogens. This practice indicates inadequate

enforcement of regulations, lack of appropriate vehicle designs (such as covered trucks or compactors), and poor operational oversight. Poor road infrastructure, poor road conditions within Benin metropolis significantly hinder waste transportation operations. Roads characterized by potholes, erosion, flooding, and narrow access routes slow down vehicle movement and increase the likelihood of breakdowns. In some neighborhoods, waste trucks are unable to access collection points at all, leading to irregular evacuation of waste. Poor roads also discourage private sector participation due to high vehicle maintenance costs and operational risks.

Combined effects on waste transportation efficiency, these impediments are closely interrelated and collectively reduce the effectiveness of the transportation stage. Poor vehicles perform even worse on bad roads, long distances magnify fuel and maintenance challenges, and unskilled labor exacerbates operational inefficiencies. As a result, transportation becomes a major constraint, causing backlogs at collection points and undermining public confidence in waste management services. The cumulative impact of these transportation challenges includes delayed waste evacuation, increased indiscriminate dumping, environmental pollution, and heightened public health risks. Inefficiencies at the transportation stage also negate improvements made at earlier stages such as storage and collection.

The practice of not covering solid waste vehicles has been identified as a problem. Uncovered vehicles pose environmental and aesthetic issues as waste can spill out onto the streets, causing littering and contamination. This is in line with Olufayo and Omotosho (2017), states that it's unlawful for any solid waste collector to transport solid waste except in a covered watertight and drip proof, vehicle equipped with a metal box welded seams. This also contributes to the spread of diseases and worsens the overall appearance of the metropolis. The poor working conditions

of vehicles are another significant issue. Inefficient or poorly maintained vehicles delay the transportation process. This results in the accumulation of waste in the streets, creating health hazards and undermining the entire waste management system. The transportation stage is hindered by the use of vehicles that are not roadworthy, long distances to government-approved dump sites, lack of skilled laborers, and poor working conditions of vehicles. The segregation stage is crucial for effective solid waste management, but it is hindered by several impediments, including lack of segregation of solid waste at the household level, lack of recycling facilities, presence of excreta in waste, and lack of proper segregation equipment. This is consistent with Daniel (2020), who emphasized the importance of the "three R's" of reduction, reuse, and recycling in modern solid waste management.

The finding highlights that solid waste disposal in Benin Metropolis suggest that impediments like poor dumpsite maintenance, difficult locations, lack of waste treatment, failure to compact waste, and topographical challenges are key barriers to effective solid waste disposal in Benin Metropolis Poor dumpsite maintenance, poorly maintained dumpsites emerge as a major barrier to effective solid waste disposal. Inadequate maintenance practices such as the absence of regular covering of solid waste, lack of fencing, poor access control, and ineffective leachate management can lead to environmental pollution and public health risks. Poor maintenance also reduces the lifespan of dumpsites and makes them unattractive and unsafe for waste handlers and nearby communities.

Difficult dumpsite locations, the finding indicates that the locations of dumpsites pose serious challenges. Dumpsites situated far from waste generation centers, in hard-to-reach areas, or within environmentally sensitive zones increase transportation difficulties and operational costs. Difficult access discourages consistent disposal, delays waste offloading, and in some cases

promotes indiscriminate dumping at unauthorized locations within the metropolis. This align with Adebayo, Lancheros, Ezinma, and Nuruden, (2018), who noted that some of the problems facing effective urban solid waste management in Nigeria and other developing countries are a result of poor waste disposal options, dumpsites not well maintained regularly, lack of treatment equipment and topographical nature of dumpsite are some of the impediment to solid waste management in Benin metropolis.

Lack of waste treatment equipment, the absence of solid waste treatment options such as recycling, composting, or incineration significantly undermines effective solid waste disposal. Without treatment, all collected waste is deposited directly at dumpsites, accelerating site saturation and increasing environmental hazards. This practice reflects a disposal oriented rather than an integrated waste management approach, limiting opportunities for waste recovery, resource conservation, and reduction of landfill pressure. Failure to compact waste, failure to compact waste at disposal sites is another major constraint. Without compaction, waste occupies excessive space, reducing dumpsite capacity and shortening its operational lifespan.

Poor compaction also contributes to unstable waste heaps, increased fire risk, and the proliferation of pests. This issue often results from the absence of appropriate machinery and trained personnel at disposal sites. Topographical challenges, topographical factors such as uneven terrain, poor soil conditions, flooding, and erosion further complicate waste disposal operations. Challenging terrain can hinder vehicle movement, damage equipment, and increase operational risks. In flood prone areas, waste can be washed into nearby water bodies, exacerbating environmental pollution and undermining public health.

The high ratings across these items collectively suggest that the disposal stage represents a critical weakness in the solid waste management system of Benin Metropolis. Inefficiencies at

this stage negate efforts made during waste collection and transportation, resulting in persistent environmental degradation, unsanitary conditions, and reduced quality of urban life. Solid waste generation, segregation, storage, collection, transportation and disposal in Benin Metropolis are generally poor and in most cases, poor solid waste disposal options as there are no specific solid waste disposal options in Nigeria and Benin metropolis in particular. The absence of treatment equipment at dumpsites affects proper waste disposal. Without treatment processes like composting or waste-to-energy programs, waste accumulates in its raw form, leading to the proliferation of harmful substances.

This also discourages people from using the dumpsites, as untreated waste may emit unpleasant odors or pose health risks. The failure to compact waste at dumpsites further complicates waste management. Solid waste that is not compacted takes up more space, leading to overcrowded and inefficient dumpsites. Compaction helps maximize space at dumpsites, reduces littering, and allows for more organized and effective waste disposal. This is line with Cunningham (2015), who reported that for many people the way to dispose of waste is to simply drop it in any place of their choice school premises or any place open not minding their actions, unregulated dumps are still the predominant method of waste disposal in most developing countries

The finding reveals that storage and segregation equipment are largely unavailable, whereas basic collection tools are relatively available. This has important operational and environmental implications. Limited availability of storage equipment, the lack of adequate storage equipment such as standardized solid waste bins, containers, skips, and covered communal receptacles poses a major challenge at the point of waste generation. Without proper storage, waste is often heaped on open ground, roadsides, or drains before collection. This practice encourages littering,

emits offensive odors, attracts pests, and increases the risk of disease transmission. Inadequate storage also makes waste handling more labour intensive and inefficient for collection crews.

Absence of segregation equipment, the finding further indicates that equipment needed for waste segregation such as color-coded bins and separate containers for biodegradable, recyclable, and hazardous waste is largely unavailable. As a result, waste is mixed at source, making downstream processes like recycling, composting, or safe disposal of hazardous materials extremely difficult. The absence of segregation reflects limited public awareness, weak policy enforcement, and insufficient investment in modern waste management practices. Availability of basic collection tools, in contrast, the availability of basic collection tools such as shovels, rakes, wheelbarrows, and handcarts suggests that waste collection activities are primarily manual and focused on removing waste after it has already accumulated. While these tools enable day to day waste evacuation, they are inefficient for handling large volumes of waste and do not support hygienic or environmentally sound waste management.

The imbalance between solid waste collection equipment and storage/segregation equipment indicates a reactive rather than preventive approach to solid waste management in Benin Metropolis. Emphasis is placed on clearing waste from the environment, rather than managing it systematically from the point of generation. This undermines efforts toward waste minimization, recycling, and sustainable disposal. These findings are consistent with Cointreau (2014), who noted that high costs and maintenance of solid waste equipment and vehicles, unavailability of properly engineered disposal sites and solid waste treatment plants, inadequate haulage equipment, and lack of financial assistance and support from the government are challenges to solid waste management.

The finding revealed that there were significant differences in the impediments inherent in the various stages of solid waste management in Benin Metropolis. Suggesting that challenges are not uniform across the various stages but vary in nature, intensity, and impact from one stage to another. This has important analytical and policy implications. Variability of challenges across the various stages of solid waste management in Benin metropolis, solid waste management typically involves several interconnected stages, including storage, segregation, collection, transportation, and disposal. The finding indicates that each of these solid waste stages in Benin Metropolis is affected by distinct sets of impediments, rather than a single overarching problem. For instance, while storage and segregation may be constrained by lack of equipment and public awareness, transportation may be hindered by poor vehicles and road conditions, and disposal by inadequate dumpsite management and lack of treatment facilities.

The significant differences observed imply that impediments are stage-specific. At the storage and segregation stage, challenges are largely infrastructural and behavioral, such as absence of bins and failure to separate waste at source. During collection, limitations may include inadequate manpower, reliance on manual tools, and irregular service coverage. At the transportation stage, mechanical and logistical issues such as non-roadworthy vehicles, long haul distances, and poor road networks are more pronounced. At the disposal stage, technical and environmental constraints such as poor dumpsite maintenance, lack of compaction and treatment, and topographical difficulties dominate. This variation underscores the complexity of the waste management system and the need for targeted solutions.

Because the solid waste management stages operate as an integrated system, weaknesses at any single stage can compromise overall performance. However, the finding shows that some stages may be more severely constrained than others, creating bottlenecks that undermine the

effectiveness of the entire chain. For example, even if waste is efficiently collected, poor transportation or disposal facilities can result in waste accumulation and environmental degradation. The presence of significant differences in impediments suggests that a one size fits all intervention approach is inappropriate. Instead, policies and investments should be tailored to address the specific challenges at each stage of the solid waste management stages. This allows for more efficient allocation of limited resources and improves the likelihood of meaningful improvements in overall system performance.

This finding also reflects gaps in coordination among institutions responsible for different stages of waste management. Uneven development across stages may result from fragmented planning, inconsistent funding, and weak enforcement of regulations. Strengthening institutional integration and adopting a holistic, chain-based management approach are therefore essential. In summary, the finding demonstrates that solid waste management challenges in Benin Metropolis are heterogeneous and stage-dependent. Recognizing and addressing these differences is crucial for designing effective, sustainable, and context-specific waste management strategies. Targeted interventions that address the unique impediments at each stage of the waste management chain would enhance the efficiency and environmental performance of the system in Benin Metropolis

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

This study investigated the impediments to solid waste management in Benin Metropolis. Impediments are those factors that hinder solid waste management, it was aimed at ascertaining the relationship between segregation, storage, collection, transportation, and disposal stage of solid waste as it affects solid waste management. Seven (7) research questions guided the study, alongside one (1) hypothesis and tested at a 0.05 level of significance.

The descriptive survey research design was used in the study. The study population comprised one hundred and sixteen (116) registered solid waste management companies operating within the three local government areas that constitute Benin Metropolis. A sample size of seventy (70) registered solid waste management companies, representing sixty percent (60%) of the population, was selected using the multi-stage sampling technique (stratified, proportional and simple random sampling techniques). Data were collected using two research instruments: a structure questionnaire and a checklist. The structure questionnaire and the checklist were validated by the researcher's chief and co-supervisors, and three other experts, two from the Department of Health, Safety, and Environmental Education, Faculty of Education, University of Benin, and one from the Edo State Waste Management Board, Government House, Benin City. The questionnaire reliability was determined through the test-retest method and analyzed using the Pearson Product Moment Correlation, yielding a reliability coefficient of 0.73. However, the checklist was not suggested to reliability test. Descriptive statistics (frequency counts, percentages, means, and standard deviations) were employed to analyze the structure research questions, while inferential statistics (ANOVA) was used to test the hypothesis.

The findings from this study are as follows:

1. The segregation stage of solid waste management in Benin Metropolis is hindered by several impediments, including the lack of segregation of solid waste at the household level, lack of recycling equipment, the presence of excreta in waste, inadequate reuse of materials, and the absence of proper segregation equipment.
2. The storage stage of solid waste management in Benin Metropolis faces substantial impediments, primarily due to insufficient storage bins, few storage points, poor storage options of some residents, inadequate access to storage points due to bad roads, the use of nylons.
3. The collection stage of solid waste management in Benin Metropolis encounters challenges stemming from irregular and non-payment of solid waste collection bills by some residents, the zoning system not permitting regular collection of solid waste, lack of modern vehicles for solid waste collection, inadequate solid waste collection points, and poor solid waste disposal patterns.
4. The transportation stage of solid waste management in Benin Metropolis is hindered by multiple impediments, including the use of vehicles that are not roadworthy, long distances to government-approved dump sites, lack of skilled laborers, not covering vehicles when transporting solid waste, and poor roads.
5. The high ratings across the various items suggest that impediments like poor dumpsite maintenance, difficult locations, lack of waste treatment, failure to compact waste, and topographical challenges are key barriers to effective solid waste disposal in Benin Metropolis.

6. Storage and segregation equipment were largely unavailable, while basic collection tools are available.
7. There were significant differences in the impediments inherent in various stages of solid waste management chain in Benin Metropolis.

Conclusion

This study critically explored the multifaceted impediments to solid waste management in Benin Metropolis, with a particular focus on the challenges associated with segregation, storage, collection, transportation, and disposal stages. The findings revealed systemic deficiencies in equipment, equipment availability, and institutional support, which collectively undermine the efficiency of solid waste management in Benin metropolis. At the household level, the absence of proper segregation practices and recycling equipment impedes solid waste minimization efforts. Storage systems are characterized by inadequate waste bin distribution, poor maintenance of solid waste equipment, and informal disposal practices, while solid waste collection suffers from inefficient logistics, outdated billing practices, and a lack of enforcement mechanisms. Transportation is constrained by the use of obsolete vehicles, inaccessible roads, and long travel distances to dumpsites. Furthermore, disposal practices are largely ineffective due to the absence of solid waste treatment and compaction equipment.

Despite some availability of basic solid waste collection equipment, the complete lack of advanced solid waste equipment underscores the resource limitations affecting solid waste management companies. The absence of statistically variation across stages suggests that these impediments are pervasive and systemic in nature. These findings highlight the urgent need for comprehensive reforms to enhance the effectiveness, sustainability, and environmental integrity of solid waste management in Benin Metropolis.

Recommendations

Based on the findings drawn from this study, the following recommendations are proposed:

1. To strengthen solid waste Segregation, the government should implement household level segregation programs that will promote household segregation for effective solid waste management. Provide accessible recycling equipment for household. Promote reuse and recycling practices in household. Develop and enforce solid waste management policies and guidelines in household level**.** Public awareness campaigns should be launched to educate residents on the importance of separating solid waste at the point of generation. Households should be provided with colour coded waste bins, and pilot programs for source-level recycling and composting should be initiated. Additionally, investments should be made in essential segregation equipment such as shredders, reel splitters, and sorting tables.

The finding underscores the need for Public education and awareness campaigns on household-level waste segregation, provision of segregation equipment at household and community levels, development of recycling infrastructure and markets, integration of sanitation improvements with solid waste management, enforcement of regulations promoting reuse and source separation

2. This finding underscores the need for provision of adequate and standardized storage bins at household and community levels, expansion and equitable distribution of storage/collection points, public sensitization on proper waste storage practices, and improvement of road infrastructure to enhance accessibility, regulation and gradual replacement of nylon bags with safer storage options. In summary, the finding demonstrates that inefficiencies at the storage stage represent a critical weakness in solid waste management in Benin Metropolis, and addressing these impediments is essential for achieving a cleaner, healthier, and more sustainable urban environment.

3. To enhance solid waste collection efficiency, the billing and zoning systems should be reviewed and reformed to promote equitable access and increased participation. The fleet of modern solid waste collection vehicles should be expanded, and workforce capacity should be strengthened. Additionally, accessible solid waste collection points should be established with input from the community to encourage better compliance. The finding suggests the need for strengthening billing and enforcement mechanisms to improve fee collection, reviewing and restructuring the zoning system to ensure equitable and regular service delivery, investing in modern waste collection vehicles and equipment, expanding and strategically locating waste collection points, enhancing public education on proper waste disposal practices

In conclusion, the finding demonstrates that the collection stage is a major weak link in the solid waste management chain in Benin Metropolis, and addressing its financial, infrastructural, and behavioral challenges is essential for achieving an effective and sustainable waste management system.

4. To upgrade solid \waste transportation systems, obsolete trucks should be replaced with roadworthy, sealed vehicles designed to minimize spillage and control odors. Personnel should be trained in safe and efficient waste handling practices. Additionally, access roads should be improved to ensure timely and uninterrupted transportation of waste. This finding underscores the need for: investment in modern, roadworthy waste transportation vehicles, establishment of transfer stations to reduce haulage distances, training and capacity building for waste transportation personnel, strict enforcement of regulations requiring covered waste transportation, improvement of urban road infrastructure, particularly in underserved areas. In summary, the finding demonstrates that addressing transportation-related impediments is critical to improving

the overall efficiency, reliability, and sustainability of solid waste management in Benin Metropolis.

5. To modernize solid waste disposal, **e**stablish engineered landfill sites equipped with compaction systems, leachate control measures, and recycling equipment. Where feasible, introduce incineration, composting, and material recovery systems. Additionally, conduct environmental impact assessments prior to siting new dumpsites to ensure environmental suitability and compliance. This finding underscores the need for: improved maintenance and management of existing dumpsites, strategic siting of new disposal facilities based on accessibility and environmental suitability, investment in waste treatment and recovery technologies, provision of compaction equipment and trained personnel, consideration of topographical factors in dumpsite planning and design Addressing these barriers holistically would enhance the effectiveness, safety, and sustainability of solid waste disposal in Benin Metropolis.

6. To invest in solid waste management equipment, **s**ubsidies should be offered solid to waste management companies for the acquisition of advanced tools and machinery. Provide training for local government personnel and solid waste management staff on modern solid waste management equipment and best practices. Promote public-private partnerships to support the development of sustainable solid waste management equipment. This finding underscores the need for: provision of adequate storage facilities at household and community levels, introduction of segregation equipment to encourage source separation, public education on waste sorting and storage practices, segregation of storage and segregation into solid waste management policies. The finding suggests that improving the availability of storage and

segregation equipment is essential for transitioning Benin Metropolis toward a more efficient, hygienic, and sustainable solid waste management system.

7. To strengthen institutional frameworks, **e**nhance coordination among agencies responsible for sanitation, urban planning, and environmental health. Ensure strict enforcement of waste management regulations through regular monitoring and appropriate penalties. Allocate adequate budgetary support to facilitate continuous improvements in solid waste management systems.

By implementing these recommendations, stakeholders will enhance the efficiency, environmental sustainability, and social responsibility of solid waste management in Benin Metropolis.

Contribution To Knowledge

The study has contributed to knowledge in the following ways:

1. Established that impediments to solid waste management differed across the five critical stages segregation, storage, collection, transportation, and disposal. This stage based analysis provides a clearer understanding of where specific problems occur, allowing policymakers and waste management companies to design more targeted interventions rather than general waste management reforms.
2. Provided concrete data on the nature and extent of challenges faced by solid waste management companies in Benin Metropolis. It revealed that the most critical impediments were associated with inadequate segregation practices, insufficient storage infrastructure, not roadworthy transportation vehicles, poor road networks, and poorly maintained dumpsites. This empirical evidence contributes to local environmental management research and can serve as a benchmark for other cities in Nigeria and similar contexts in developing countries.

3. Highlighted the importance of aligning solid waste management with national environmental and health standards, thereby assisting the Ministry of Environment and other agencies in formulating policies that are data driven and contextually relevant.
4. Provided insights that can help solid waste management companies improve operational efficiency. It emphasized the need for investment in modern solid waste collection vehicles, segregation equipment, recycling technologies, and workforce training thus contributing to the literature on institutional strengthening for sustainable waste management.
5. Emphasized that effective environmental education, through schools and mass communication, was vital in fostering behavioural change, encouraging solid waste segregation at the source, and enhancing community participation in solid waste reduction and recycling initiatives.
6. Demonstrated how quantitative data can be effectively applied to environmental management studies, offering a replicable model for future researchers investigating solid waste management challenges in other urban settings.
7. Demonstrated that inefficiency at one stage such as segregation or transportation could disrupt the entire solid waste management process.
8. Provided actionable insights for advancing sustainable waste management in Nigerian Cities.

Suggestion for further studies

This research focused on the impediments to solid waste management in Benin Metropolis. Therefore, future studies should examine solid waste collection techniques in the Benin

metropolis and explore additional variables that could help enhance the environmental and health conditions of residents in Benin Metropolis.

Implication for Environmental Education

Poor solid waste management in Benin Metropolis has led to the indiscriminate disposal of waste and unsanitary environmental conditions, posing serious threats to public health and the ecosystem. Inefficient solid waste handling is a primary contributor to environmental pollution, creating breeding grounds for pathogenic organisms and facilitating the spread of infectious diseases. Due to limitations in both human and material resources, a large portion of solid waste is not collected or transported to designated dumpsites. When not properly managed, particularly at the household level solid waste can result in severe environmental and health hazards. Unattended solid waste in streets and marketplaces attracts vectors such as flies, rats, and other disease carrying organisms. For example, in Benin Metropolis, the presence of houseflies in kitchens has been linked to cases of childhood diarrhea. Similarly, studies have shown a correlation between the open burning of solid waste and the occurrence of respiratory symptoms in both adults and children.

Ensuring that solid waste generated in homes, communities, and institutions is properly stored and promptly collected for safe disposal is essential in reducing the prevalence of communicable diseases in the metropolis. Identifying existing gaps in solid waste management system and implementing strategic solutions is vital for improving environmental health outcomes. The increasing volume of waste is closely tied to population growth. As the population expands, so does the demand for food and other consumables, thereby generating more waste. To address these challenges, environmental education must be prioritized. Educating both solid waste managers, and the general public about the importance of effective solid waste management

serves as a critical control measure. Waste management personnel should be adequately trained to ensure the implementation of environmentally safe practices. Public enlightenment campaigns should be conducted to promote household-level solid waste segregation, emphasizing the principles of reduction, reuse, and recycling. Organic waste should be separated and composted, as composting remains one of the most sustainable methods of waste management.

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APPENDICES

Appendix A

TEST OF RELIABILITY FOR IMPEDIMENTS TO SOLID WASTE MANAGEMENT IN BENIN METROPOLIS.

Respondents	X	Y	X^2	Y^2	XY
1	41	31	1681	961	1271
2	37	26	1369	676	962
3	43	32	1849	1024	1376
4	43	28	1849	784	1204
5	29	30	841	900	870
6	41	29	1681	841	1189
7	25	22	625	484	550
8	37	28	1369	784	1036
9	27	25	729	625	675
10	42	33	1764	1089	1386
11	29	30	841	900	870
12	27	25	729	625	675
13	42	33	1764	1089	1386
14	43	32	1849	1024	1376
15	41	31	1681	961	1271
16	37	28	1369	784	1036
17	41	29	1681	841	1189
18	37	26	1369	676	962
19	25	22	625	484	550
20	43	28	1849	784	1204
	$\sum x=730$	$\sum y=568$	$\sum x^2=27514$	$\sum y^2=16336$	$\sum xy=21038$

$$\frac{r = \sum xy - \frac{\left((\sum x)(\sum y)\right)}{N}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{N}\ \sum y^2 - \frac{(\sum y)^2}{N}\right)}}$$

$when\ \sum x = 730, \sum y = 568, \sum x^2 = 27514, \sum y^2 = 16336, \sum xy = 21038, N = 20$

$$\frac{r = 21038 - \frac{\left((730)\ (568)\right)}{20}}{\sqrt{\left((27514 - \frac{(730)^2}{20}\ (16336 - \frac{(568)^2}{20}\right)}}$$

$$\frac{r = 21038 - \frac{414640}{20}}{\sqrt{\left((27514 - \frac{(532900)}{20}\ (16336 - \frac{(322624)}{20}\right)}}$$

$$\frac{r = 21038 - 20732}{\sqrt{(27514 - 26645)(16336 - 16131.2)}}$$

$$\frac{r = 306}{\sqrt{(869)(204.8)}}$$

$$\frac{r = 306}{\sqrt{177971.2}}$$

$$\frac{r = 306}{421.87}$$

$r = 0.725$

$r = 0.73$

Appendix B

Cross Section pictures of solid waste management equipment in Benin metropolis

Appendix C

Cross Section pictures of transportation of solid waste with the use of vehicles that are not road worthy in Benin metropolis

Appendix D

Cross Section pictures of indiscriminate dumping of solid waste in Benin metropolis

Appendix E

Questionnaire

Department of Health, Safety & Environmental Education

Faculty of Education

University of Benin

Benin City

To Whom It May Concern

Dear Respondent,

I am a postgraduate student of the above-named institution conducting a research study on *Impediments to Solid Waste Management in Benin Metropolis*. Your cooperation in responding to the attached questionnaire is kindly requested to help me obtain relevant and accurate information for this study.

Please be assured that all information provided will be treated with the utmost confidentiality.

Thank you in anticipation of your kind support.

Yours faithfully,

Aghatotikolo Ogbeide

Please provide your candid responses to the following questions.

Kindly tick (√) the option that best represents your opinion on each statement.

KEY: SA = Strongly Agree | A = Agree | D = Disagree | SD = Strongly Disagree

	Segregation stage as impediments to solid waste management	**SA**	**A**	**D**	**SD**

1.	Lack of separation of waste at household affects solid waste management in Benin metropolis.				
2.	Lack of recycling equipment in household affects solid waste management in Benin metropolis				
3.	Solid waste may sometimes include excreta and as such segregation becomes difficult.				
4.	Lack of proper reuse of materials affects solid waste management in Benin metropolis.				
5.	Lack of segregation equipment affects solid waste management in Benin metropolis.				
	Storage stage as impediments to solid waste management	**SA**	**A**	**D**	**SD**
6.	Insufficient storage bins in most part of Benin metropolis delay solid waste collection.				
7.	Few storage and collection points affect solid waste management in Benin metropolis.				
8.	Poor storage option of some residents in Benin metropolis affects solid waste collections.				
9.	Inadequate access to storage and collection points as a result of bad roads affects solid waste management in Benin metropolis.				
10.	The use of nylons affects solid waste management in Benin metropolis as most time get scatted easily.				
	Collection stage as impediments to solid waste management	**SA**	**A**	**D**	**SD**

11.	Irregular and nonpayment for solid waste collection services by some residents in Benin metropolis solid waste management.				
12.	The zoning system does not permit regular collection of solid waste and it affects solid waste management in Benin metropolis.				
13.	Lack of modern vehicles for solid waste evacuation affects timely collection of solid waste in Benin metropolis.				
14.	Inadequate collection points affect solid waste management in Benin metropolis				
15.	Poor solid waste disposal pattern in Benin metropolis affect easy collection of solid waste.				
	Transportation stage as impediments to solid waste management	**SA**	**A**	**D**	**SD**
16.	The use of vehicles that are not road worthy constitutes problem to solid waste management in Benin metropolis.				
17.	Long distance to government approved dump sit affect timely transportation of solid waste in Benin metropolis.				
18.	Lack of unskilled labourers in regular solid waste transportation affects solid waste management in Benin metropolis.				
19.	Not covering the vehicle when solid waste is being transported affects solid waste management in Benin metropolis.				
20.	Poor condition of roads delay timely transportation of solid waste in Benin metropolis.				
	Disposal stage as impediments to solid waste management	**SA**	**A**	**D**	**SD**

21.	Dumpsite not well maintained regularly affect solid waste management in Benin metropolis.				
22.	Location of government approved dumpsite doesn't favour solid waste management in Benin metropolis.				
23.	Lack of treatment of solid waste at the dumpsite affects proper solid waste disposal.				
24.	Not compacting solid waste at the dumpsite affects solid waste management in Benin metropolis.				
25.	Topographical nature of dumpsite doesn't allow vehicles to drive in and out freely into the dumpsite affect solid waste management in Benin metropolis.				

Appendix F

OBSERVATION SCHEDULE FOR SOLID WASTE MANAGEMENT EQUIPMENT

Solid Waste Segregation Equipment

S/N		YES	NO
1.	Wrapping machines		
2,	Sorting plants		
3.	Separators		
4.	Waste balers		
5.	Conveyor belts		
6.	Refuse recycle bins		
7.	Reel splitters		

Others ……

Solid Waste Storage Equipment

S/N		YES	NO
8.	Storage and Treatment Tanks		
9.	Storage and Treatment buildings		
10.	Storage fencing with gates		
11.	Covers, drainage and runoff control		
12.	Storage seepage detection and control		
13.	Storage interior accessing		
14.	Storage exterior accessing		

Others ……

Waste Collection Equipment

S/N		YES	NO
15.	Brooms		
16.	Shovels		
17.	Hand scrapers		
18.	Tractor scraper blades		
19.	Garden size tractor scraping		
20.	Mechanical scrapers for gutters		
21.	Tractor front end loaders		
22.	Skid steer and articulated loaders		
23.	Head pans		
24.	Wheelbarrow		
25.	Rowling waste bins		

Others ……

Transportation Equipment

S/N		YES	NO
26.	Compactors Trucks		
27.	Garbage Trucks		
28.	Tipping Trucks		
29.	Dump Trucks		
30.	Bulldozers		
31.	Dino Truck		
32.	Pay loader		

Others ……

Solid Waste Disposal Equipment

S/N		YES	NO
33.	Incinerators		
34.	Motor grader		
35,	Compacting tractor		
36.	Designated dumpsite		
37.	Recyclers		
38.	Dispensers		
39.	Tanks		
40.	Crushers		
41.	Pumps		

Others ……

Appendix G

```
DESCRIPTIVES VARIABLES=q1 q2 q3 q4 q5 q6 q7 q8 q9 q10 q11 q12 q13 q14 q15 q16 q17
q18 q19 q20
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

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	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=q1 q2 q3 q4 q5 q6 q7 q8 q9 q10 q11 q12 q13 q14 q15 q16 q17 q18 q19 q20 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.04

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
q1	70	1.00	4.00	3.3662	.72189
q2	70	1.00	4.00	3.0704	.91533
q3	70	1.00	4.00	3.0000	.86189
q4	70	2.00	4.00	3.1549	.85604
q5	70	1.00	4.00	3.2535	.73131
q6	70	1.00	4.00	3.1408	.94560
q7	70	1.00	4.00	2.7324	.86119
q8	70	1.00	4.00	3.4648	.69346
q9	70	1.00	4.00	3.0141	.81928
q10	70	1.00	4.00	2.8451	.95091
q11	70	1.00	4.00	3.3944	.66502
q12	70	1.00	4.00	3.2394	.96310
q13	70	1.00	4.00	2.8451	.98049
q14	70	1.00	4.00	2.2254	1.00281
q15	70	1.00	4.00	2.2535	.87372
q16	70	1.00	4.00	2.2113	.86049
q17	70	1.00	4.00	2.7606	.86956
q18	70	1.00	4.00	2.8169	.91511
q19	70	2.00	4.00	3.1408	.79814
q20	70	1.00	4.00	3.4648	.75273
Valid N (listwise)	70				

```
GET
  FILE='C:\Users\hp\Documents\Mr Atas Ogbeide new.sav'.
DATASET NAME DataSet4 WINDOW=FRONT.
DESCRIPTIVES VARIABLES=i1 i2 i3 i4 i5 i6 i7 i8 i9 i10 i11 i12 i13 i14 i15 i16 i17 i18 i19
i20
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	70
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	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=i1 i2 i3 i4 i5 i6 i7 i8 i9 i10 i11 i12 i13 i14 i15 i16 i17 i18 i19 i20 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.05

[DataSet4] C:\Users\hp\Documents\Mr Atas Ogbeide new.sav

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
i1	70	1.00	3.00	2.2676	.89375
i2	70	2.00	4.00	2.8451	.83918
i3	70	1.00	4.00	2.8310	1.01399
i4	70	3.00	4.00	3.2817	.45302
i5	70	3.00	4.00	3.2817	.45302
i6	70	3.00	4.00	3.7183	.45302
i7	70	3.00	4.00	3.4225	.49748
i8	70	3.00	4.00	3.1408	.35034
i9	70	3.00	4.00	3.5775	.49748
i10	70	3.00	4.00	3.1408	.35034
i11	70	3.00	4.00	3.1408	.35034
i12	70	3.00	4.00	3.4225	.49748
i13	70	2.00	4.00	3.4366	.73158
i14	70	3.00	4.00	3.5775	.49748
i15	70	3.00	4.00	3.1408	.35034
i16	70	2.00	4.00	2.7042	.70497
i17	70	1.00	4.00	2.8592	.83317
i18	70	3.00	4.00	3.8592	.35034
i19	70	1.00	4.00	2.9718	.95576
i20	70	2.00	3.00	2.8592	.35034
Valid N (listwise)	70				

```
DESCRIPTIVES VARIABLES=s21 s22 s23 s24 s25
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

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Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=s21 s22 s23 s24 s25 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.05

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
s21	70	1.00	4.00	2.8592	.98989
s22	70	1.00	3.00	2.5775	.73020
s23	70	3.00	4.00	3.4366	.49950
s24	70	2.00	4.00	3.0000	.53452
s25	70	3.00	4.00	3.4225	.49748
Valid N (listwise)	70				

0

```
DESCRIPTIVES VARIABLES=c26 c27 c28 c29 c30
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

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	Active Dataset	DataSet4
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	70
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=c26 c27 c28 c29 c30 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.02

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
c26	70	2.00	4.00	3.1549	.64692
c27	70	3.00	4.00	3.2958	.45964
c28	70	3.00	4.00	3.2958	.45964
c29	70	1.00	4.00	2.8732	1.13301
c30	70	2.00	4.00	3.1408	.63910
Valid N (listwise)	70				

```
DESCRIPTIVES VARIABLES=t31 t32 t33 t34 t35
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

Output Created		17-OCT-2024 22:54:01
Comments		
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	Active Dataset	DataSet4
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	70
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=t31 t32 t33 t34 t35 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.02

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
t31	70	2.00	4.00	3.5775	.73020
t32	70	3.00	4.00	3.2958	.45964
t33	70	3.00	4.00	3.2817	.45302
t34	70	3.00	4.00	3.2958	.45964
t35	70	3.00	4.00	3.5775	.49748
Valid N (listwise)	70				

```
DESCRIPTIVES VARIABLES=st36 st37 st38 st39 st40
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

Output Created		17-OCT-2024 22:54:21
Comments		
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	70
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=st36 st37 st38 st39 st40 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.04

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
st36	70	3.00	4.00	3.4366	.49950
st37	70	3.00	4.00	3.2958	.45964
st38	70	3.00	4.00	3.5775	.49748
st39	70	3.00	4.00	3.5775	.49748
st40	70	3.00	4.00	3.5775	.49748
Valid N (listwise)	70				

```
DESCRIPTIVES VARIABLES=d41 d42 d43 d44 d45
  /STATISTICS=MEAN STDDEV MIN MAX.
```

Descriptives

Notes

Output Created		17-OCT-2024 22:54:38
Comments		
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	Active Dataset	DataSet4
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	70
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=d41 d42 d43 d44 d45 /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.05

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
d41	70	3.00	4.00	3.2817	.45302
d42	70	3.00	4.00	3.4366	.49950
d43	70	3.00	4.00	3.2817	.45302
d44	70	3.00	4.00	3.2958	.45964
d45	70	3.00	4.00	3.5775	.49748
Valid N (listwise)	70				

```
COMPUTE s=SUM(s21 to s25).
EXECUTE.
COMPUTE c=SUM(c26 to c30).
EXECUTE.
COMPUTE t=SUM(t31 to t35).
EXECUTE.
COMPUTE st=SUM(st36 to st40).
```

```
EXECUTE.
COMPUTE d=SUM(d41 to d45).
EXECUTE.
GLM s c t st d
  /WSFACTOR=factor1 5 Polynomial
  /METHOD=SSTYPE(3)
  /EMMEANS=TABLES(OVERALL)
  /PRINT=DESCRIPTIVE
  /CRITERIA=ALPHA(.05)
  /WSDESIGN=factor1.
```

General Linear Model

Notes

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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	70
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the model.
Syntax		GLM s c t st d /WSFACTOR=factor1 5 Polynomial /METHOD=SSTYPE(3) /EMMEANS=TABLES(OVERALL) /PRINT=DESCRIPTIVE /CRITERIA=ALPHA(.05) /WSDESIGN=factor1.
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.23

Within-Subjects Factors

Measure: MEASURE_1

factor1	Dependent Variable
1	S
2	C
3	T
4	St
5	D

Descriptive Statistics

	Mean	Std. Deviation	N
s	15.2958	2.18694	70
c	15.7606	1.94543	70
T	17.0282	1.21857	70
st	17.4648	1.43259	70
d	16.8732	1.25276	70

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	.581	23.187[b]	4.000	67.000	.000
	Wilks' Lambda	.419	23.187[b]	4.000	67.000	.000
	Hotelling's Trace	1.384	23.187[b]	4.000	67.000	.000
	Roy's Largest Root	1.384	23.187[b]	4.000	67.000	.000

a. Design: Intercept
Within Subjects Design: factor1

b. Exact statistic

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	Df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor1	.355	70.790	9	.000	.696	.727	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: factor1

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Sphericity Assumed	237.482	4	59.370	27.354	.000
	Greenhouse-Geisser	237.482	2.783	85.343	27.354	.000
	Huynh-Feldt	237.482	2.910	81.623	27.354	.000
	Lower-bound	237.482	1.000	237.482	27.354	.000
Error(factor1)	Sphericity Assumed	607.718	280	2.170		
	Greenhouse-Geisser	607.718	194.787	3.120		
	Huynh-Feldt	607.718	203.666	2.984		
	Lower-bound	607.718	70.000	8.682		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	factor1	Type III Sum of Squares	df	Mean Square	F	Sig.
factor1	Linear	167.641	1	167.641	72.055	.000
	Quadratic	43.945	1	43.945	13.027	.001
	Cubic	23.803	1	23.803	10.876	.002
	Order 4	2.093	1	2.093	2.639	.109
Error(factor1)	Linear	162.859	70	2.327		
	Quadratic	236.127	70	3.373		
	Cubic	153.197	70	2.189		
	Order 4	55.535	70	.793		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	96467.335	1	96467.335	19323.015	.000
Error	349.465	70	4.992		

Estimated Marginal Means

Grand Mean

Measure: MEASURE_1

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
16.485	.119	16.248	16.721