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PUBLIC AWARENESS OF THE CHALLENGES OF SUSTAINABLE SOLID WASTE MANAGEMENT IN NIGERIA: A META-REVIEW

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Abstract

The accumulation of solid waste in Nigeria's urban areas has become a pressing environmental concern, exacerbated by rapid population growth and inadequate waste management practices. This study employs an exploratory research methodology, drawing on conceptual framework and existing literature to analyze the complexities of municipal solid waste (MSW) management in Nigeria. It highlights the lack of public awareness campaign high lighting the adverse effects of improper waste disposal and the deficiencies in current waste management strategies. The research identifies systemic issues, such as bureaucratic approaches that neglect the informal waste sector, insufficient coordination among government agencies, and a general lack of expertise. The paper emphasizes the urgent need for tailored waste management solutions that consider Nigeria's unique socio-political and economic landscape. Recommendations include enhancing public education through public awareness-campaigns on sustainable waste practices, integrating advanced waste management technologies, and fostering collaborations between government, communities, and private sectors. It advocates for comprehensive policy development and the implementation of innovative strategies, such as recycling and composting, to improve waste management efficiency. The study concludes

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that effective waste management is vital for environmental sustainability and public health, urging a collaborative effort among all stakeholders to address the multifaceted challenges posed by municipal solid waste in Nigeria.

Keywords: Environmental Quality, Solid Waste Management, Municipal Solid Waste (MSW), Urban Areas, Environmental Problems, Public Awareness

INTRODUCTION

In Nigeria urban areas, solid waste accumulation has become a major problem. Omuta, (1998) observed that as the city grows and expands in population and aerial extent, so its land use becomes more complex, consequently, solid waste is generated in volume and in variety. Due to waste management laxity, solid waste generated in Nigerian cities are never adequately collected and disposed of, which has summed up as "aesthetic disaster" (Alabi, 2006).

Solid waste disposal is one of Nigeria's most pressing environmental challenges. As noted by Aina (1994) and referenced in Okoye and Okoye (2008), the disposal and management of municipal solid waste (MSW) is frequently highlighted as a critical environmental issue. Population growth has exacerbated waste generation, intensifying the need for proactive government or agency intervention in waste management (Olu-Olu and Omotosho, 2007; Schwarz-Herion et al., 2008; Adejobi and Olorunnimbe, 2012; Ekanem et al., 2013; Elenwo, 2015). Achieving a sustainable built environment alongside improved waste management practices can yield multiple benefits, including income generation, enhanced public health, and reduced susceptibility to environmental health issues (Adetunji et al., 2015).

Managing land pollution from improper solid waste disposal remains a significant challenge in Nigeria. Public awareness regarding sustainable waste practices is limited, and efforts by relevant agencies to increase this awareness are insufficient. Many urban residents, particularly those in low-income areas, are not well informed about the negative impacts of indiscriminate waste disposal (Abila and Kantola, 2013). Fafioye and John-Dewole (2013) indicate that community members generally lack sufficient knowledge about environmental care, waste disposal practices, and management, is contributing to the poor environmental quality observed in numerous Nigerian cities.

Solid waste presents significant health and environmental challenges globally, including Nigeria. Without timely and effective management and disposal solutions, these challenges

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could escalate, posing even more severe risks to society due to the continuous nature of waste generation and disposal cycles. As long as human activity persists, waste generation will remain an unavoidable aspect of daily life.

Nigerian cities, ranked among the world's fastest-growing urban areas, grapple with significant challenges in solid waste generation and management. Rapid urbanization, along with the swift expansion of urban and peri-urban areas, exacerbates the situation, especially when waste management practices lag behind. Additionally, issues related to land tenure and the rising demand for urban land for development complicate the search for suitable sites for sanitary landfills. Waste generation in Nigeria has raised considerable concern at both the national and local levels. Given the diverse categories of waste produced, solid waste poses a complex, multifaceted problem that often exceeds the capacity of existing waste management systems.

Waste management presents a fundamental challenge in developing African nations, particularly in Nigeria, where it poses significant threats. Numerous researchers have examined patterns of solid waste generation in Nigeria; however, most studies tend to focus on specific states or local areas. Additionally, awareness around solid waste generation, disposal, and management remains limited in many urban areas. To address these issues, this study uses an exploratory approach, gathering data from existing literature, including journals, reports, and books on related topics. Waste reduction and minimization are proposed as sustainable strategies for solid waste management in Nigeria and, by extension, sub-Saharan Africa.

Waste can be divided into several categories. Classification and sorting of waste into categories is the first stage in waste management. Waste can be classified as either hazardous or non-hazardous. Broadly classified, we have solid, semi-solid, liquid and gaseous waste based on the hardness of waste texture.

Solid waste can be placed into several categories, based on the sector of the economy responsible for generating waste, such as domestic, commercial, industrial, institutional, hospital, agricultural, *etc*. Solid waste is waste that has definite geometrical shapes and may need high temperature and pressure to change their shapes and forms. According to Ohwofasa and Biose (2023), solid waste refers to any useless, unwanted or discarded materials which include metallic materials, junks from abandoned vehicles, old drums and leftover junks from blacksmiths/mechanics workshops, wooden furniture, wood shavings/sawn dusts, plastic materials, husk/shafts from maize, organic leftover of fruits, vegetables/crops, bones, broken

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glasses, pet/cans of mineral/fruit drinks. Uchegbu and Obani, (2024) defined solid waste as any substance that the holder discards or intends to discard and its disposal is important to ensure the well-being of the general public and the protection of the environment. Unlike solid waste, semi-solid waste is waste that has no definite geometrical shapes and often forms a paste, as seen from organic materials, ground food material such as cassava, maize, flour, which forms a potential breeding ground for bacteria, fungi and insects.

These are wastes that can easily flow out either through pipes or flushed out, of water and flushes from brewery drains/chemical industrial plants. They mostly originate from residential areas, sewage storm, drains and effluents from industries. They include nitrogenous waste from farm animals and effluent from broken pipes in sewages/soak-away pits and leachates from dumpsites/landfills. While gaseous wasteare waste emanating from industry, domestic smoke, and automobile.All the category of waste, except those of calcium carbonate and Sulphur deposits, that are not easily degradable belong to non-hazardous waste, while semi solid and gaseous waste are regarded are hazardous (Okoye and Okoye 2008).

Characterization of solid waste

Municipal solid waste (MSW), the focus of this study, includes various types of discarded materials from human activities that are deemed unusable within their originating processes or systems. In Nigeria, however, waste collection, disposal, and management agencies have yet to fully leverage the substantial potential of the large volumes of accumulated waste across the country. With sustainable and effective management practices, these waste resources could provide significant benefits to the nation.

Solid waste can be categorized based on various criteria, such as origin, environmental impact, utility, and physical characteristics (Aguoru and Alu, 2015; Amukali, 2019). By origin, solid waste types include municipal, industrial, agricultural, mining and mineral, construction and demolition, healthcare, radioactive (nuclear), as well as human and animal wastes (Amukali et al., 2018). Municipal solid waste, however, tends to receive the most attention, as it is both highly prevalent and challenging to manage in daily life (Zurbrugg, 2003).

Waste and Waste Management

Waste is commonly referred to as trash, garbage, or rubbish, and the composition of solid waste varies across different municipalities (Adewole, 2009; Amukali, 2019). Solid waste

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encompasses non-liquid, non-gaseous by-products of human activities, often considered useless and taking forms such as refuse, garbage, and sludge (Leon and Omotosho, 2004).

Solid waste management involves controlling the generation, storage, collection, transfer, transport, processing, and disposal of waste in line with public health standards, economic feasibility, engineering practices, conservation, aesthetics, and environmental protection principles, while also being responsive to public attitudes (Amukali, 2019).

Generally, materials deemed unusable or unwanted are labeled as waste, making it an unavoidable by-product of daily human activity (Nhlanhla, 2014; Oroye, 2020). Waste management is a comprehensive process that spans from waste production to disposal, including collection, storage, transport, treatment, recycling, recovery, and disposal, aiming to render waste harmless to humans, animals, ecosystems, and the environment as a whole (Fafioye and John-Dewole, 2013; Odiana and Olorunfemi, 2021).

There are various methods and strategies employed to manage waste from its source to the final disposal point, which can promote a clean, healthy, and cost-effective environment (Igbinomwanhia, 2011). If waste is left unchecked, it can lead to unsightly conditions and pose significant health risks, particularly when hazardous materials are present in the waste stream. Therefore, efficient waste collection from the point of generation and proper disposal in regulated facilities are essential (CSIR, 2000). According to Ndubuisi-Okolo et al. (2016), waste management encompasses the processes of collection, transportation, storage, treatment, recovery, and disposal. Furthermore, waste management involves the characterization and classification of waste, as well as its selection, treatment, storage, transportation, and final disposal. Adewole (2009) adds that waste management refers to the processes of collecting, accumulating, treating, and disposing of waste in a manner that is safe for both humans and the ecological system.

Unfortunately, in Nigeria, waste is often dumped along roadsides, in nearby bushes, and in drainage channels. In rural areas, waste is typically managed through burning, composting, occasional open-field dumping, or by feeding it to animals (Ndubuisi-Okolo et al., 2016). These authors emphasize that effective and timely waste management is vital for the sustainable development of cities, ensuring that current needs are met without compromising those of future generations. However, waste management practices in Nigeria have yet to embrace sustainable approaches; instead, they often involve merely accumulating, storing, collecting,

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and transporting waste to dumpsites. Indiscriminate waste dumping has led to clogged drainage systems and rivers, resulting in flooding and creating breeding grounds for disease-carrying pests, particularly in stagnant water, which increases the spread of malaria, Lassa fever, Zika virus, and other contagious diseases, including COVID-19 (Oroye, 2020).

Most local government authorities in Nigeria, responsible for waste disposal, continue to struggle with collection and disposal issues, especially when compared to the sustainable best practices observed in developed countries. It has been reported that approximately 87% of Nigerians resort to unsanitary methods of solid waste disposal (Amukali, 2019). These practices create nuisances, unsightly conditions, unpleasant odors, and serve as breeding grounds for pests and diseases (Agunwamba, Egbuniwe, Ogwueleka, 2003). Indiscriminate solid waste disposal has become a significant issue and embarrassment in a nation where heaps of refuse litter many urban areas (Amukali, 2019).

In light of the above, solid waste management is recognized as a crucial environmental health service and an essential component of urban infrastructure. According to Sandra (1982), effective solid waste management is fundamental to environmental hygiene and should be integrated into comprehensive environmental planning. Poor waste management can have serious implications, posing health hazards to individuals exposed to unsanitary conditions. Diseases such as cholera, dysentery, and malaria are linked to inadequate waste management practices, resulting in a loss of human resources essential for development. Therefore, effective and sustainable solid waste management should focus on strategies aimed at minimizing waste to its lowest possible levels. Techniques should prioritize waste minimization, reuse, and recycling (Sridhar and Hammed, 2014). Furthermore, waste can be disposed of at the point of generation through methods such as "home incinerators" and "garbage grinders." Emphasizing these approaches is expected to enhance environmental sanitation standards while improving the quality and visual appeal of the environment (Amukali, 2019).

Waste generated by human activities has long posed a significant and escalating challenge, becoming a major concern for nations worldwide (Oyelola and Babatunde, 2008). The rapid growth in the volume and types of solid and hazardous waste due to economic development, urbanization, and industrialization presents a mounting challenge for governments striving to implement effective and sustainable waste management practices (Ogu, 2000; Igoni et al., 2007). In Nigeria, pressing environmental and public health issues include the challenges of

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solid waste generation, control, and disposal. While the issue of solid waste disposal has existed since the dawn of humanity, it has become so complex in many cities that it overwhelms government efforts (Momodu et al., 2011). The volume of solid waste continues to rise at a rate that outpaces the ability of waste management agencies to enhance the financial and technical resources necessary to manage this growth effectively (Olukanni and Mnenga, 2015; Nnaji, 2015). Solid waste management is s global problem. Statistics shows that among the industrialized nations, USA is the world biggest waste generator. Ike *et al.*, (2018) posited that the scenario is not different in the developing nation's cities. According to him, Ibadan city in Nigeria is identified to producing the highest garbage in tonnes/year. Table 1 gives an insight to urban waste generation rates in various Nigeria cities.

Table 1: Volume of Municipal Solid Waste Produced in Selected Cities Throughout Nigeria.

Cities	Population Estimation	Estimated kg/ capita/day	Tonne/ day	Tonne/ year
Minna	346,524	0.68	235	86007
Enugu	817,757	0.74	605	220876
Birnin kebbi	128,403	0.65	83	30463
Lagos	21,000,000	0.92	119320	7051800
PortHarcort	1,363,596	0.85	1159	423055
Bauchi	493, 730	0.68	336	122543
Abuja	1,857,298	0.95	1764	644018
Ibadan	3,565,108	0.72	2566	936910
Kaduna	1,582,102	0.70	1107	404227
Onitsha	561,066	0.69	387	141304
Sokoto	563,861	0.68	383	139950
Jos	816,824	0.73	596	217642
Benin City	1,125,058	0.78	877	320304

Source: Ike *et al.*, (2018)

STRATEGIES FOR SOLID WASTE MANAGEMENT

Various waste management techniques exist, and they differ significantly between countries based on several factors. Key considerations include economic factors, the types of waste produced, the availability of land for disposal, the accessibility of appropriate management technologies, and psychological and political influences (Ezechi et al., 2017; Beatrice and Jussi, 2013).

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Solid waste management technique veries from country to country depending upon physical, demographics and level of economic development/technological knowhow, (Corrales and Horton, 1995).

Studies reveals that on an annual basis huge amount of solid waste is generated by residential, commercial, institutional land uses, construction and demolition, municipal services, processing and agricultural sources, which presented a current MSW generation per capital per day of low, medium and countries, (UDSU 1999)

Pre-History Urban Domestic Solid Waste-Disposal

Before the mid-1850s, as noted by Okoye (2008), the disposal of municipal solid waste (MSW) received little public attention from prehistory to the present. A common method of disposal involved simply dumping solid waste outside urban or peri-urban areas, often in sites near wetlands adjacent to rivers or streams. The waste was typically buried or burned. Unfortunately, these practices continue to be prevalent in many developing countries today. Amukh (2019) found that approximately 78% of Nigerians still rely on these unsanitary waste disposal methods.

Public and Private Solid Waste Managers

In Nigeria, there are two major approaches or techniques to solid waste management. Namely, “Public” “Private”. The collection, disposal and treatment is done by the government or the private sector agency or a collaboration of both. The public solid waste management system is more conventional and traditional and its waste disposal unit have been the most common management system (Onokrohrarye, 1997, Omuta, 1985). The public waste disposal unit is usually established at the local government areas level of the state, with the operation section domiciled at the Health Department, whose responsibility is to locate public garbage collection deport/dumpsites in the different parts of the city and the enforcement of disposal of collected waste. As for waste collection, households are expected to dispose of their waste at designated dumps or sanitary landfills for final collection, disposal, and treatment. Alternatively, the agency organizes yard-by-yard collection.

The emergence of private system of solid waste management, though very similar to the public system, was a product of the failure of public organization and arrangement. The private system is a contractual arrangement between a private establishment and the individual beneficiary, with a user-charges paid by the beneficiary.

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Hybrid Public-Private System

The hybrid arrangement is a system whereby a public organization works in collaboration with a private company on a contractual basis. This system makes amends for the inadequacies of the public-private solid management strategy. It is a public partnership system which ensures easy implementation of the waste management objectives, (FMHE, 1983).

Despite the above management techniques, Owangu, (2003), Omuta (1985) and Okpala (1986), solid waste disposal still remains a major urban environmental problem in Nigeria. To address these problems, Nkwocha and Okeoma, (2009); Otioju, (2014), Bellamy, (2007); Ladan, (2014) and Ogwueleka, (2003) suggests integrated waste solid waste management techniques. The integrated 4Rs Strategy and Composting should be considered before thinking of disposal of collected wastes because of the resourceful benefits of these techniques.

Hog/Animal Feed

This waste management technique, a form of resource recovery, involves feeding animals processed or unprocessed edible waste from garbage heaps. It serves as a reduction or minimization strategy in waste management. In agro-based industries and large farms, this method contributes to waste reduction and is economically beneficial for agro-businesses. In the developed world, it is recognized as a sustainable waste management strategy.

Incineration

Another method of solid waste management is incineration. In this method, combustible waste are reduce through burning. Commercial solid waste such as cow bones, used tyres, industrial wastes (paper) from print media and domestic refuse can be subjected to incineration. To minimize pollution, such waste should be moved to cities outskirt to burn. In most developed countries, a better process of incineration has been adopted.

SOLID TRASH ADMINISTRATION STRATEGY

Municipal Solid Trash Administration (MSTA) encompasses the processes of collecting, storing, treating, and disposing of solid waste to ensure it remains safe for humans, plants, animals, ecosystems, and the environment as a whole (Ezerie et al., 2017; Oyije et al., 2020). In Nigeria, efforts to implement MSTA as a waste management strategy have primarily focused on solid waste collection and disposal, often neglecting the complete range of functional components necessary for effective waste management. Ideally, MSTA includes waste generation, on-site storage and sorting, recycling of materials, collection, transfer, transportation, processing, recovery, and disposal (Tchobanoglous et al., 1993). Practicing

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these elements holistically promotes sanitation. According to the American Academy of Science, this strategy is sustainable, environmentally friendly, and resource-efficient; however, this comprehensive approach to sustainable solid waste management remains uncommon in many developing countries, including Nigeria.

Integrated waste management strategy

Integrated waste management strategy entails the waste management process, using the 4Rs. We can manage waste by Refusing, Reducing, Reusing and Recycling. To manage solid waste, we can refuse to buy items that we really do not need. By reducing waste, we can consume less and leave a simpler lifestyle or minimize generated waste. In reusing waste, we rely more on items that can be used repeatedly instead of throwing away wasted items. In recycling waste, we separate, sort and recycle papers, glasses/bottles, cans, plastics, nylon/polythene, metals, clothes and other items and buy products made from recycled materials. Recycling involves reprocessing discarded solid materials into new, useful products. The relevance of integrated strategy reduces waste generated, pollution and save money, material resources.

Waste management strategies prioritize minimizing waste, reusing items, and recycling before resorting to disposal. Sridhar and Hammed (2014) noted a creative example where a school in Abeokuta used old tires as playground fencing. Individuals in urban settings are encouraged to sort and identify items for potential reuse, reducing the overall volume of waste. For waste that cannot be reused, sorting and directing recyclable materials to industries is advised, with aluminum repurposed into cooking pots, plastics into household items, and glass into new industrial bottles. Scavengers also play a role by recovering valuable metals, which blacksmiths and artisans transform into gates, tools, and other functional items (Nzeadibe and Eziuzor, 2006).

Amid rising waste production and depleting resources, reuse and recycling efforts are crucial. Local residents or informal waste collectors, known as cart pushers, often gather recyclable items, creating informal employment opportunities. Though informal, cart pushers are essential in under served areas, despite being viewed as illegal by formal waste-management authorities (Afon, 2007). Unfortunately, public perception is often negative toward these workers, especially cart pushers and landfill scavengers, who typically operate outside the official waste collection framework (Medina, 2005; Afon, 2007).

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In many towns, however, recyclable waste is often discarded indiscriminately. Otitoju (2014) observed that waste in Nigerian urban centers is frequently dumped without sorting at the source. A study in Awka by Modebe and Ezeama (2011) indicated that most households did not engage in recycling, and Ogwueleka (2003) reported that less than 60% of municipal solid waste (MSW) is collected in developing countries. Effective recycling systems could make a difference, as Nkwocha and Okeoma (2009) highlighted that up to 60% of household waste could be recycled if proper systems were in place.

Composting

Composting as an option or strategy, is the biodegradation of the organic constituent of solid waste through aerobic microbial activities resulting in stable humus-like soil amendment called composite, (FHME, 1983) Composting offers a viable solution to managing solid waste in Nigeria. It is a natural process where organic waste—such as food scraps, manure, leaves, grass clippings, paper, and household waste is broken down by microorganisms like bacteria and fungi in an oxygen-rich environment, transforming it into a nutrient-rich humus-like material (Bellamy, 2007). Ladan (2014) highlighted composting as a sustainable waste management approach in Katsina metropolis, noting its potential to significantly reduce waste while providing valuable resources for the agricultural sector. This process not only mitigates waste accumulation but also supports agro-businesses by enriching soil and improving crop yields.

Waste Reduction and Minimization

Waste reduction and minimization are crucial strategies in effective waste management aimed at decreasing the volume of waste generated at the source. These approaches focus on altering consumption patterns, encouraging the use of sustainable materials, and promoting practices that lead to less waste production. These strategies as commonly practice in the advanced countries, not only contribute to environmental sustainability but also promote a culture of responsible waste management within communities.

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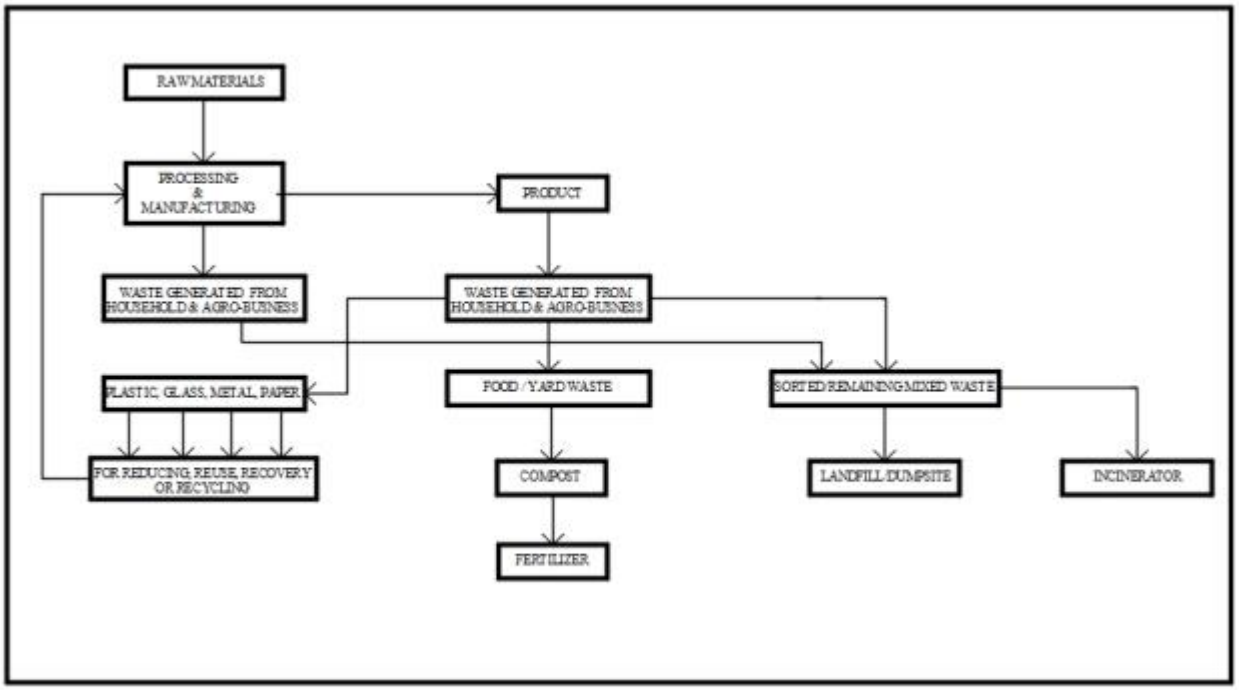

Figure 1. Waste minimization and reduction Source: Tyler and Spoolman, (2008)

Figure 1 above provides a detailed summary of how waste can be managed, from the point of generation to collection. It further highlights the importance of characterizing and sorting various types of waste at the point of generation, which aids in the implementation of the R's of waste management techniques.

CHALLENGES TO EFFECTIVE WASTE MANAGEMENT AND PUBLIC AWARENESS CAMPAIGN

Public awareness refers to a coordinated effort to educate and inform the public about the importance of proper practices, the effects, and the role individuals or group persons can play in disseminating information that can benefit the generality of the public . Borawska , (2017) , defines public awareness campaign as“ a set of different activities planned for a specific time , addressed to a specific target group , whose aim is to increase knowledge leading to a change in thinking and behaviour , towards a specific social problem “ . This concept is crucial in addressing social issues , promoting health , and protecting the environment . A well structured theoretical framework is essential for designing an effective public awareness campaign on solid waste management (SWM). Such a framework draws upon key behavioral and communication theories to guide the campaign's objectives, strategies, and evaluation methods.

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When individuals understand the environmental and health consequences of poor waste disposal, they are more likely to develop positive attitudes and take responsibility for their actions. Additionally, sustainable practices like recycling and composting tend to spread more effectively when they are perceived as simple, useful, and compatible with daily life. Public awareness efforts that combine education, social engagement, and accessible solutions are more likely to inspire long-term behavioral change. In doing so, they help foster a shared culture of environmental responsibility and active public participation in sustainable waste management.

With a global population nearing seven billion, generating over ten million metric tons of waste daily (Lacoste and Chalmin, 2007), the challenges of waste management and the consequences of improper disposal on health and the environment become increasingly significant (Odiana and Olorunfemi, 2021). In Nigeria, the indiscriminate disposal of waste, particularly in urban areas, not only detracts from the environment's aesthetic appeal but also contributes to the spread of infectious diseases such as cholera, malaria, dysentery, and diarrhea. This issue is exacerbated during the rainy season when drainage systems become blocked or stagnant water collects, creating breeding grounds for mosquitoes and vector-borne diseases like malaria (Coker et al., 1998). In contrast, rural communities generate less solid waste per ton, which is often managed through backyard burning, composting, feeding to animals, or occasionally disposed of at the outskirts of these areas (Abila and Kantola, 2013).

The ineffective management and disposal of solid waste in Nigeria cost the nation approximately US$5 billion each year (Babatola, 2008). Inadequate waste disposal practices significantly hinder Nigeria's efforts to achieve a clean and healthy environment conducive to sustainable development. The situation has deteriorated to the point where a practical approach was implemented, mandating residents to dedicate the last Saturday morning of each month to cleaning their properties. The waste collected during these clean-up efforts is to be placed on the streets for collection and disposal. Additionally, every Thursday morning is designated for traders in commercial centers and markets to clean their surroundings. However, these initiatives do not always occur consistently, resulting in the accumulation of rubbish (Sangodoyin, 1995).

According to Abila and Kantola (2013), waste management processes in Nigeria include storage, collection, transportation, and disposal at dumpsites, with the most commonly utilized

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methods being open dumping, landfilling, and open burning. Igbinadolor et al. (2019) noted that the lack of formal recycling sectors in Nigeria forces valuable resources from generated waste to be recycled informally by scavengers, who either collect materials from waste sites or purchase reusable items from individuals visiting both legal and illegal dumpsites.

A major issue that calls for concern in waste management is the nature and quantity of waste generated. The quantity of waste generated depends on the geographical location of the area, the season of the year, indices of income level, education status, and other population characteristics of location. More waste seems to be generated in most urban area than the rural settings. A common feature that attests to this is the huge refuse dumps that adorn urban marketplace, and this constitutes a major environmental challenge in most nation's cities, Nigerian cities inclusive.

Nigeria faces numerous challenges in managing municipal solid waste, encompassing economic, technological, psychological, and political factors. Key issues include inadequate legislation and weak enforcement of policies, insufficient public awareness on environmental sanitation, and limited infrastructure and professional resources available to waste management services. Additionally, environmental agencies often struggle with insufficient funding, and there is a lack of incentives for waste minimization and recycling initiatives. This results in reliance on sub-optimal disposal techniques, which mirrors similar obstacles in other developing nations.

Poor Legislation and Policy Enforcement

Nigeria's solid waste management policy suffers from weak constitutional backing and ineffective enforcement. Implementation lacks sufficient monitoring, which has hampered efforts by state and local environmental protection agencies to rid streets and neighborhoods of indiscriminate waste disposal (Kofoworola, 2007). The Federal Government of Nigeria enacted Decree No. 58 on December 30, 1988, establishing the Federal Environmental Protection Agency (FEPA) to curb and manage waste disposal issues. However, despite the goal of controlling indiscriminate refuse disposal, this decree has not met its objectives, largely due to the weak constitutional framework and ineffective policy implementation (Beatrice and Jussi, 2013; Oroye, 2020).

Public Awareness on Environmental Sanitation

The awareness level regarding sustainable waste management in Nigeria is notably low, with minimal efforts from waste management agencies to educate municipalities about the negative

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impacts of indiscriminate waste disposal and the advantages of sustainable waste practices. According to Oroye (2020) and Imam et al. (2008), public awareness and attitudes significantly influence the solid waste management processes within a nation.

Lack of Professional/Practitioners and Infrastructures

In Nigeria, the lack of appropriate technology presents a significant challenge to effective waste management. Inadequate waste collection equipment and poor maintenance have led to the accumulation of refuse at illegal dumping sites. Additionally, there is a shortage of qualified personnel to operate this equipment (Ezerie et al., 2017). Many environmental protection agencies and waste management staff lack sufficient training to meet international waste management standards, primarily due to the limited number of institutions in Nigeria that offer specialized waste management courses. Furthermore, the absence of collaboration between local waste management agencies and international solid waste management organizations exacerbates the shortage of skilled labor, hindering progress in the waste management sector.

Inadequate Funding of Environmental Agencies

Insufficient funding is another significant barrier to effective solid waste management in Nigeria. Achieving sustainable waste management goals requires consistent financial support, similar to the practices seen in many developed nations (Ezerie et al., 2017; Beatrice and Jussi, 2013).

Culture of Waste Reduction and Minimization

There is a lack of formal government recycling programs or policies aimed at promoting effective waste minimization and reduction techniques, including composting, as practiced in developed countries. In many urban areas, the only recycling efforts come from informal activities carried out by scavengers who actively search for and purchase recyclable materials from their surroundings (Oguntoyinbo, 2012).

Urbanization and unplanned development

Sangodoyin (1995) argues that rapid urbanization complicates the acquisition of land necessary for locating landfill and dump sites to accommodate the growing amounts of solid waste. Due to urbanization and rapid population growth in the country, waste is generated more quickly than it can be collected, transported, and disposed of. This challenge further exacerbates waste management issues, as rapid development leads to land scarcity and encroachment on existing landfill and dump sites.

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Conclusion

Solid waste generated in many cities poses significant health and environmental challenges worldwide, and Nigeria is no exception. Common strategies for municipal solid waste management (MSWM) employed by development agencies and private sector organizations often fall short in many developing countries, including Nigeria. Waste management in the country has deteriorated markedly, as the strategies implemented to address these challenges have seen minimal success. This is largely due to bureaucratic approaches that focus solely on the formal sector while neglecting the informal sector. Furthermore, a lack of coordination and expertise in waste management issues among environmental agencies and government bodies contributes to inefficiency.

The study identifies that the solid waste management problems faced by developing countries, including Nigeria, differ from those found in the developed world, necessitating distinct strategies. According to Omuta (1985), achieving sustainable and effective solid waste management requires consideration of political, institutional, social, financial, economic, and technical aspects of MSWM. The study also emphasizes that disciplines such as engineering, urban planning, geography, public health, and law should be integrated under a cohesive policy framework to create an effective waste management system. Amasuomo and Baird (2017) assert that the establishment of clear policies, along with the adequate adoption and enforcement of management strategies, will be crucial in driving sustainability in waste management in Nigeria.

RECOMMENDATION

Effective waste management and disposal in Nigeria require collaboration among households, institutions, manufacturing companies, and government entities. There is an urgent need for state governments to enhance awareness programs about the negative impacts of indiscriminate waste disposal and to promote sustainable waste management practices through incentive programs that encourage waste minimization and reduction across the country. Additionally, the government should incorporate sustainable technologies for resource recovery, such as bio-gasification, which could enhance national energy production and transform organic waste into compost for agriculture, thus providing an additional revenue source for the government (Ezerie et al., 2017).

To support these initiatives, waste management policies need to be reviewed, restructured, and effectively implemented and monitored. Each state government should focus on equipping

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their waste management agencies with skilled professionals who possess the technical expertise necessary for effective waste management. Regular training sessions and workshops, in partnership with international solid waste management organizations, should be organized for stakeholders to keep waste managers updated on best practices. Furthermore, the federal government should provide financial support and oversight to ensure that each state progresses towards sustainable waste management. Private partnerships should also be encouraged to enhance waste management strategies. The existing waste management processes in Nigeria, including storage, collection, transportation, and disposal at dumpsites, must continue to be strengthened. To address these challenges, the proposed waste management flowchart, illustrated in Figure 1, of this paper, should be adopted.

Effective waste management is critical for fostering sustainable and healthy living conditions worldwide, including Nigeria. To enhance proper waste management practices among residents, it is essential to promote public awareness through health education, ensure consistent refuse collection services, and provide designated disposal sites. It is recommended that both government and private waste management entities ensure adequate financial resources, implement robust waste legislation, and conduct public awareness campaigns. Additionally, ongoing training for staff, investment in sustainable equipment, regular maintenance of existing facilities, and active community participation are vital for achieving sustainable solid waste management. Establishing composting and recycling facilities should also be prioritized to enhance overall waste management efforts at both urban neighborhood and at institutional levels.

Community Mobilization and Public Education

A robust plan for community mobilization should be established by all stakeholders, including all tiers of Government waste managers and private waste managers /NGOs,to regularly disseminate health education messages through public awareness campaign media outlets, such as radio and television. This initiative aims to raise awareness about the negative impacts of improper solid waste disposal and can significantly alter community attitudes and behaviors toward waste generation and management.

Promoting Recycling and Waste Minimization

The importance of recycling and its benefits should be emphasized by the three - tiers of Government , both at Federal, State and the waste management agencies, most especially at the grass root levels (LGAs)within communities, as this practice can substantially reduce the

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volume of waste generated. Efforts to cultivate a recycling culture should extend to tertiary institutions, secondary schools, and primary schools throughout the country.

Fostering International Partnerships and Technological Advancement

The three - tiers of Government at Federal , State and Local Government Areas (LGAs) , should pursue partnership opportunities with international agencies and non-governmental organizations (NGOs) to address waste management challenges through research, community engagement, and the promotion of modern technologies for safe solid waste disposal.

Strategic Urban Planning and Land Use Management

Ministries and agencies responsible for urban development, land management, and physical planning should prioritize effective planning and appropriate siting of solid waste disposal sites in the context of urban renewal and the development of new towns and cities.

Environmental Monitoring and Groundwater Protection

The ministries of health and environment should conduct regular environmental monitoring, including physicochemical analyses of groundwater near solid waste disposal sites. This monitoring is essential to detect any contamination resulting from leachate, allowing for timely intervention and mitigation measures.

Strengthening Legal Frameworks and Policy Enforcement

To effectively tackle the problem of poor legislation and policy enforcement in solid waste management, the government must undertake a comprehensive reform of existing environmental laws across all levels. Clear and enforceable legislation should be introduced, outlining specific responsibilities and penalties for violations. Environmental protection agencies must be equipped with adequate legal authority, resources, and training to enforce these regulations. Additionally, a dedicated judicial mechanism should be established to handle environmental cases swiftly, ensuring that offenders are prosecuted and penalties are enforced. Strengthening legal structures will significantly improve compliance and accountability in waste management practices nationwide.

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