

Research Article

Solid Waste Management Application and Its Dilemma in Kano Metropolis-Nigeria

Saleh Muhammad , Azizan Marzuki* 

School of Housing, Building and Planning, Universiti Sains Malaysia, Pulau Pinang, Malaysia

Abstract

Rapid urbanization and population growth with its associated Solid Waste Management issues are at the moment the front burner challenges of the 21st century, more especially in developing countries of the world of which Nigeria is inclusive. However, the majority of past research in Solid Waste Management has mostly concentrated on the institutional capability and resources required to handle the problems associated with solid waste management, with little attention paid to the attitudes of city inhabitants. Therefore, this research article examines the trends and applications of solid waste management (SWM) in the rapidly urbanizing Kano Metropolis, looks at how the attitudes of city dwellers have contributed to the problem of SWM, and then goes on to review new applications that have been used to manage solid waste in the study area. The study report, which draws on secondary and empirical data sources, finds that just 20.5 tons of the 330 tons of solid waste produced every day are properly managed. The results therefore imply that two factors—bad attitudes of city inhabitants and insufficient institutional capacity—influence the city's poor SWM. While these urban citizens' negative views towards solid waste management (SWM) have contributed to the current indiscriminate garbage disposal, weak institutions have also made it difficult to handle solid waste concerns in the city and prevented timely solutions. In order to ensure effective solid waste management in the Kano Metropolis of Nigeria, the research article now suggests public awareness education programs on solid waste management, public-private partnerships, increased stakeholder engagement, and the creation and implementation of new solid waste management plans.

Keywords

Municipal Solid Waste, Developing Countries, Solid Waste Management, Urban Dwellers, Kano Metropolis, Urbanization and Dilemma

1. Introduction

Currently, metropolitan areas are responsible for producing a significant volume of municipal solid waste (MSW), supporting 56% of the world's population. [19]. Whereas, worldwide statistical insight has also reported that due to the alarming rate of urbanization in emerging nations, particularly in Africa, where it is predicted that 63% of people would live in cities by 2030 [12], an average of 3 to 4 million new people

will move into urban areas each month [8]. Malthus referred to this incredible growth as "galloping" and "wild" [4], expressing not only the uncontrollably growing urban population but also the growing problems associated with solid waste management (SWM) and its effects, which are frequently linked to population growth and may have negative effects on the environment, human health, and social welfare

*Corresponding author: chiks72@usm.my (Azizan Marzuki)

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[3]. The tendency of rural population migration to urban areas for better employment, better facilities, and convenience has been seen by developing economies, and it has resulted in a notable increase in the output of municipal solid waste (MSW) [21]. The current study is an extensive analysis that summarizes current SWM practices and identifies the related problems and/or dilemma that prevent viable solutions for MSWM in the Nigerian setting [1].

According to [8], when municipal officials worked to reconcile the geographical, social, and solid waste management features of cities, fairness and sustainability of SWM emerged as essential factors resulting from increased urbanization. While developing-nation / cities have offered significant potential to boost energy efficiency, lessen development inequalities, and enhance the quality of life for urban residents, these African cities are not without some challenges [24]. While there have been numerous reports of problems with pollution, inadequate solid waste management, poverty, disease outbreaks, unemployment, and inadequate shelter, these communities are becoming more and more urbanized. Research has indicated that, in developing country cities, particularly in Nigeria, inadequate solid waste management is the primary cause jeopardizing human health and sustainable environmental management [3, 21].

The 4Rs: Reduce, Reuse, Recycle, and Recover are followed by Sustainable Waste Solid Management (SSWM), together with a prohibition on unlawful dumping and littering. In reality, in any urban society, the 4Rs can assist us in discovering more effective strategies to manage our garbage. Finding new uses for items you would typically discard which is known as REUSE [20]. Additionally, a strategy for enhancing environmental health must include Sustainable Solid Waste Management (SSWM). Uncollected solid waste, however, quickly putrefies in tropical climates, producing offensive odors, giving rise to polluting leachates, and serving as breeding grounds for innumerable flies and, during the wet season, mosquitoes. This is in addition to the evident aesthetic importance of a garbage-free living environment. There are plenty of vermin [21]. Blocking of drains is a particularly indirect outcome of this phenomena, resulting in local floods and the associated threats to the environment's health as well as economic losses. External assistance agencies haven't given solid waste management much thought thus far [8]. Now going back to memory lane, it has also been reported that Solid Waste Management, according to the World Health Organization can be described as all abandoned domestic, commercial, institutional, and industrial garbage; it also includes street sweepings, building debris, agricultural waste, and other non-hazardous/non-toxic [7]. Furthermore, Management of Solid Waste includes the collection, transportation, storage, and disposal of trash produced in homes, businesses, and institutions. As a result, it involves a very intricate set of processes that must be carried out on a massive scale. For instance, it is estimated that Karachi, Pakistan, and certain others Asian countries produce up to 3000 tons every day. It

can account for 20% to 50% of municipal revenues; in India, it employs three to six persons per 1,000 inhabitants. There are 15,000 workers at Karachi Municipal Corporation that work in solid waste management [8]. Although, Solid Waste Management in Nigeria has often been described as a significant environmental and human challenge that affects many state and local government bodies in emerging nations, and even now, SWM is still a problem that is overlooked [18]. Despite the increasing volume of SW in the study area, Over the past 20 years, related research initiatives in Nigeria and other poor nations have shown that SWM is challenging to manage successfully. [26]. [27] stated that every year, hundreds of impoverished people die as a result of inadequate solid waste infrastructure, poor hygiene, and improper handling of liquid and solid wastes [10]. As such there is the need towards emphasizing and as well as promoting solid waste sustainability of cities in Nigeria, The study area presents observable basic challenges related to solid waste management, such as attitudes toward waste disposal, such as littering along urban roads and drainages, lax enforcement of environmental laws, inadequate SW facilities, such as bins and good transport facilities, and unsafe disposal or storage of waste in and around homes, drainage channels, and streets, which later serve as breeding grounds for vectors that spread diseases like typhoid fever, diarrhea, and the most recent and dreaded Covid-19 pandemic in our urban areas. Therefore, increasing urbanization in cities of Nigeria is rapidly diminishing and deteriorating the environment as a result of rural-urban migration, and this is said to have persisted in making solid waste management conditions worse [2, 24]. This is primarily due to the rise in the number of densely populated informal settlements, or "ghettos," which are defined by sub-urban housing and inadequate infrastructure, that include: water supplies, sanitary facilities, and appropriate waste management services. More specifically, the migrant population from rural to urban areas is currently drawn to Nigerian cities by the apparent work and commerce prospects as well as the country's increasing population. As a result, this phenomenon has led to the creation of more solid waste, and certain environmental factors, such as the slum development that has occurred in many Kano metropolis cities, have contributed to the mountainous solid waste that the researcher observed while gathering data for the study. The Millennium Development Goals (MDGs) are a global commitment to reducing poverty, particularly in developing countries, and to ensure sustainable solid waste management [23]. However, efforts to combat the current inadequate solid waste management and to create a functional urban environment in Nigerian cities have been enshrined in the MDGs. Focusing on modern SWM of the 21st millennium, the MDGs seek to reduce by half the proportion of people without Sustainable Solid Waste Management and as well as sanitation. This UN program is expected to significantly improve the lives of at least 100 million slum dwellers in cities and rural areas by 2025 [5].

Nigerian cities continue to face significant challenges in en-

environmental sanitation, particularly in the area of solid waste management, despite efforts made by the international community, national, and municipal governments. Research has also revealed that the low priority that many African nations, including Nigeria, placed on solid waste management (SWM) on their political agendas was the primary cause of these nations' problems in solid waste management practices, even though these same nations also face other pressing issues like unemployment, poverty, hunger, health issues and of recent increasing banditry activities, where urban dwellers are being kidnapped for huge ransom demand from relatives of victims, such ransom monies usually changes the lifestyle of such that are engage in this type bad habits, where they use the proceeds for the purchased of new items that usually increase the existing solid waste in those banditry regions. [9]. These regions, at the moment include Kano (the study area), Zamfara, Kaduna, Katsina, Sokoto and Kebbi state all in the Northern part of Nigeria, and of recent the activities of these bandits has skyrocketed be young the security might and architecture in these states, to the extend whereby most residents of Zamfara, Kaduna, Sokoto Kebbi and Katsina have been migrating to Kano Metropolis as illegal migrants due to the fact that the activity of this bandits is less in Kano Metropolis, this has also increase the population of the study area and this has of course led to increase in solid waste generation and its dilemma across the lurk and crannies of Kano Metropolis [17, 18].

Nevertheless, it was also found that little is known about how the attitudes of urban residents have influenced the deteriorating conditions of solid waste management in emerging nations, especially Nigeria [13]. Therefore, this research study looks at the institutional techniques to manage the solid waste in the study region, the situation of solid waste management in a fast urbanizing Kano metropolis, and the role that city people play with regards to their attitudes toward solid waste management. Kano metropolis, which has eight local government areas at the moment—Kano municipal, Gwale, Dala, Kumbotso, Tarauni, Dawakin Kudu, Nassarawa, and Fagge local government area, respectively is now growing in all directions due to its organic structure., Fagge L.G.A is home abode of the researcher. Fagge has now become the Local Government Area with the highest population and it is reported as the commercial hub of the city from either within and outside the Kano metropolitan area. Kano metropolis, which is the second fastest growing city in the nation after Lagos, the former capital of Nigeria, faces challenges related to inadequate solid waste management, particularly in the area of solid waste treatment and final disposal. Currently, solid waste disposal occurs in open dumpsites and uncontrolled landfills; this is the single biggest issue facing Kano metropolis, and it currently requires a significant overhaul from the state, municipal authorities, and possibly the federal government. In 2020, there were 3,999,560 people living in the Kano Metropolitan area, a 3.38% increase over 2019. The estimated population of the metropolis alone in 2016 was over 3.5 million, but this does

not account for the daily influx of people that migrate into Kano as a result of the recent banditry activities occurring in almost all of the regions of Northwest. This daily migration is estimated to be 15% of the total population of Kano Metropolis. These population increase as result in the piles and piles of solid waste are frequently found along roads, underneath bridges, in alleys, in culverts and drainage channels, and in any other open spaces that are available [20].

Research Study Approach

This research study approach is based on a study undertaken by the author in Kano metropolis from August 2021 to May 2023. With regard to the new approach and the methods that were used in Kano metropolis for SWM, secondary source material was consulted in order to establish a good literature review which focuses on the various and present solid waste management practices in the study area so as to understand and establish the problem associated with management of solid waste and environmental sanitation in Kano Metropolis. Refuse Management and Sanitation Board (REMASAB), Kano State Urban Planning & Development Authority (KNUPDA), State Ministry of Health, water corporation, bureau for land management, National Environmental Standards and Regulations Enforcement Agency (NESREA), KANGIS, Local Government Authorities, formal and informal private waste companies, and State Ministry of Housing Development were among the decentralized institutions in Kano metropolis that were reviewed as part of the study. The documents obtained from these agencies and departments proved to be highly valuable in assessing the current condition of solid waste management in the Kano metropolis. Additionally, they helped identify the primary stakeholders, both institutions and non-institutions, who are focused on managing solid waste management in the Kano Metropolis.

Having identified the key stakeholders, six (6) institutions that comprises these Ministries and Agencies were purposely selected and were involved in the study based on their activities, understanding and involvement in Solid Waste Management across the metropolitan area in the city. These institutions included: Kano State Urban Planning & Development Authority (KNUPDA) responsible for the physical planning and development of Kano Metropolis; Ministry for Land and Physical Planning responsible for all land allocation, Refuse Management And Sanitation Board (REMASAB) an government agency responsible for the collection and disposal of waste; Kano State Geographic and information sector (KANGIS), a private waste management institution responsible for keeping Kano Metropolis clean, green and healthy; State Ministry of Environment who now ensures Sustainable Management of air, land and water; others include the State Ministry of Housing Development (SMHD). They oversee the sub-metropolitan agencies that maintain a healthy environment inside the Sub-Metropolitan areas, as well as clean households and environmental sanitation. whereby representatives of the different institutions conducted institutional surveys over the phone and through semi-structured interviews.

The purposive sampling technique was applied at the community level to choose 8 wards that made up Kano Metropolis from a total of 200 wards that cut across Kano Metropolis as case studies, and they include Kurna-Asabe, Kofar Mata, Bompai, Sheka, Kansakali, Galadima road, Hausawa/Zoo road and Kofar Pampo. These communities are in a growing neighborhood with a central location and varied degrees of Solid Waste Management difficulties (refer to Figure 1). 10 individuals from each neighborhood and the heads (traditional leaders) or ward heads of the 9 different communities were interviewed all in an attempt to get firsthand knowledge of the current situation, difficulties, and conditions surrounding the generation, collection of municip-

pal solid waste and its management in Kano Metropolis.

At the main community town hall located at the Fagge Local Government Area of the study area, participants in a Focus Group Discussion (FGD) were given access to the data earlier collected from both the urban residential areas and the institutional levels. The institutional levels were those that previously mentioned in this study, and these institutions were also presented to the participants. Thus, the Focus Group Discussion (FGD) proved to be quite beneficial in harmonizing, elucidating, and resolving any current concerns regarding Solid Waste Management that might have arisen within the study area.

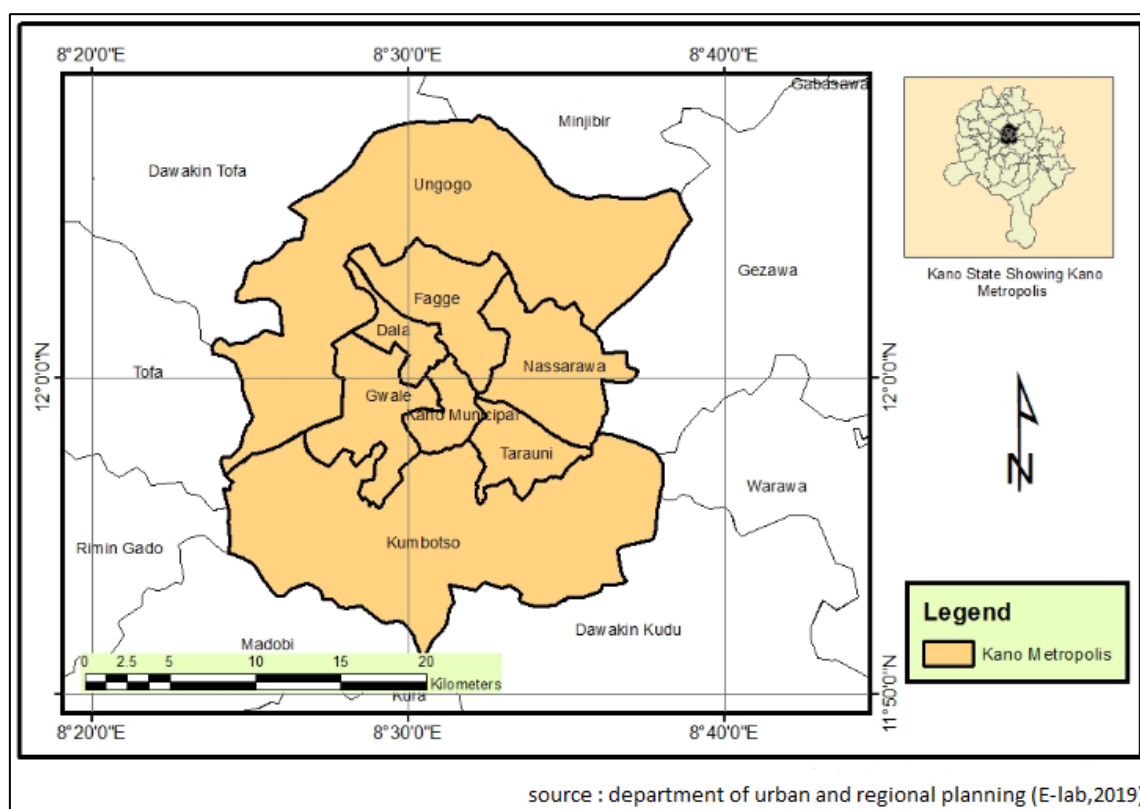


Figure 1. Showing Conurbation of Eight Local Government Areas (LGAs) of Kano Metropolis.

2. Basic Characteristics of the Kano Metropolis

Study Area and Study Context

Kano Metropolis is one of the fastest growing cities in Nigeria, with an annual population growth rate of 3.6%. The second-biggest city in Nigeria and the capital of Northern Western Nigeria. In addition to being the largest city in Nigeria, Kano is a major commercial hub in Northern Nigeria, drawing daily traffic from both neighboring African nations and Nigeria itself., this of course led to the generation of more

waste. In Nigeria, the majority of people live in rural areas, with one-third of them residing in cities. The Solid Waste Management System is rendered ineffectual by factors like population mobility to urban areas, limited financial resources available to the government and citizens, a lack of cutting-edge technologies, a lack of laws forbidding the dumping of waste, and inadequate waste management and oversight. Conditions like these jeopardize human health, the ecology, and cultural heritage [11]. These heaps of trash are frequently dumped in open areas, alleys, and drainage systems near certain homes, highways, incomplete structures, accessible open spaces, etc. This dilemma may be attributed to the high rate of waste generation brought on by population growth and

migration into Kano from neighboring states, as well as inadequate waste management practices in terms of waste handling, storing, collecting, and irresponsible disposal of refuse by private organizations, individuals, and even the Kano state Ministry of Environment and the Refuse Management and Sanitation Board (REMASAB) [6, 5].

Kano State is a historically old settlement in Northern Nigeria that has long relied on its natural resources to support its high population density. This is said to be the case since the state's natural resources and human population are sufficient to support the state's continued growth. The present Metropolitan Kano (sometimes referred as Greater Kano) is the Capital of the Kano State. The Metropolitan area lies between latitude $11^{\circ} 50' N$ to $12^{\circ} 08' N$ and longitude $8^{\circ} 21' E$ to $8^{\circ} 45' E$ (Figure 1 below justify this). For generations, Kano has served as the primary commercial and industrial hub of Northern Nigeria, namely the North Western region, drawing in large numbers of people from all parts of the country, Africa, and beyond. (Refer to Figure 1).

At the moment Kano state is reported as the capital of northern Nigeria (a conurbation of 19 states). And it is currently the fastest growing cities in Nigeria after Lagos the former capital of Nigeria. The state capital was inaugurated in 1967 with its first military governor named as Colonel Audu Bako. Kano has faced significant challenges related to urbanization, such as rapid population growth, overcrowding, the proliferation of slums, rising industrial and vehicular pollution, overuse of urban facilities, and urban poverty. These issues have led to a variety of environmental problems, including MSW, as well as social, economic, and cultural problems [25]. There are hardly any pronounced physical boundaries within this eight (8) local government areas that makes up Kano Metropolis. (Figure 1 above is showing the map of the study area). Kano State Urban Planning and Development Authority (KNUPDA), a government agency in charge of urban planning in 2009 redefined the Metropolitan Kano to cover the whole of Dala, Municipal, Nassarawa, Gwale, Tarauni, Fagge, Kumbotso, Dawakin Kudu, Ungogo and Gezawa local government areas as Kano Metropolis (Kano State Government, 2009). Whereas, the designated dumpsites which are also population sample for the study are spatially distributed in the study area with court road dumpsite located in Tarauni L.G.A, Uba Gam dumpsite in Dala L.G.A, Hajj Camp dumpsite in Fagge L.G.A and Maimalari dumpsite in Nassarawa L.G.A. It is also very significance to note here that all the designated dumpsites are utilizing abandoned burrow pits and they are not technically designed and constructed. Although, there is little control in term of management, more especially with some staffs of (REMASAB) now

(CAPE GATE) being placed there on shift basis to control all solid waste that is been brought to these dumpsites for disposal. However, the actual quantity of MSW deposited daily in these four designated dumpsites cannot be ascertain due to complete absent of measuring equipment (weighing bridge) in all the aforementioned and approved dumpsites located in the study area.

3. Solid Waste Management in Kano Metropolis- Nigeria

Municipal Solid Waste Management by REMASAB in Kano Metropolis is handled centrally by a single agency of the state government, and this is believed to have limit solid management efficiency in the study area. As earlier report in this study, Kano Metropolis itself is spread over eight (8) autonomous Local Government Area, yet the management of waste is still under the responsibility of a single agency. In most parts of the world where waste management has been efficient it has always been a local affair. [19,22] has shown that localization of waste management has serious implications for the disposal, transport and economic of waste management. The following functions are listed in detail in the law that established REMASAB and this include: street sweeping and cleaning; vector control (i.e. mosquito control) through fumigation and other control measures; inspection and education programs on SWM; others include management of refuse, waste collection centers, and dump sites; land reclamation; and street sweeping and disposal. However, of recent solid waste management has taken a new dimension in Kano Metropolis more especially with the introduction of more solid waste stakeholders such as the private registered waste companies, and the German based private waste company known as CAPE GATE

Estimate of Waste Generated in Kano Metropolis

Solid waste generation was obtained after a 14 days SWM activity which now stand at 2.82 kg per each residential household. According to recent report as earlier discussed above, the population of Kano Metropolis is estimated to be 4,206,892. Considering this, the anticipated daily solid waste output per person residing in Kano Metropolis would be 0.88 kg, or 590,640.80 kg for the entire Kano residents. Wastes are categorized into three categories: food waste, recyclables, and non-recyclables. The breakdown of the wastes produced is as follows: 33.30% (2,602.45 kg) are recyclable materials, 30.20% (288.02 kg) are food wastes, and 29.05% (268.99 kg) are non-recyclables.

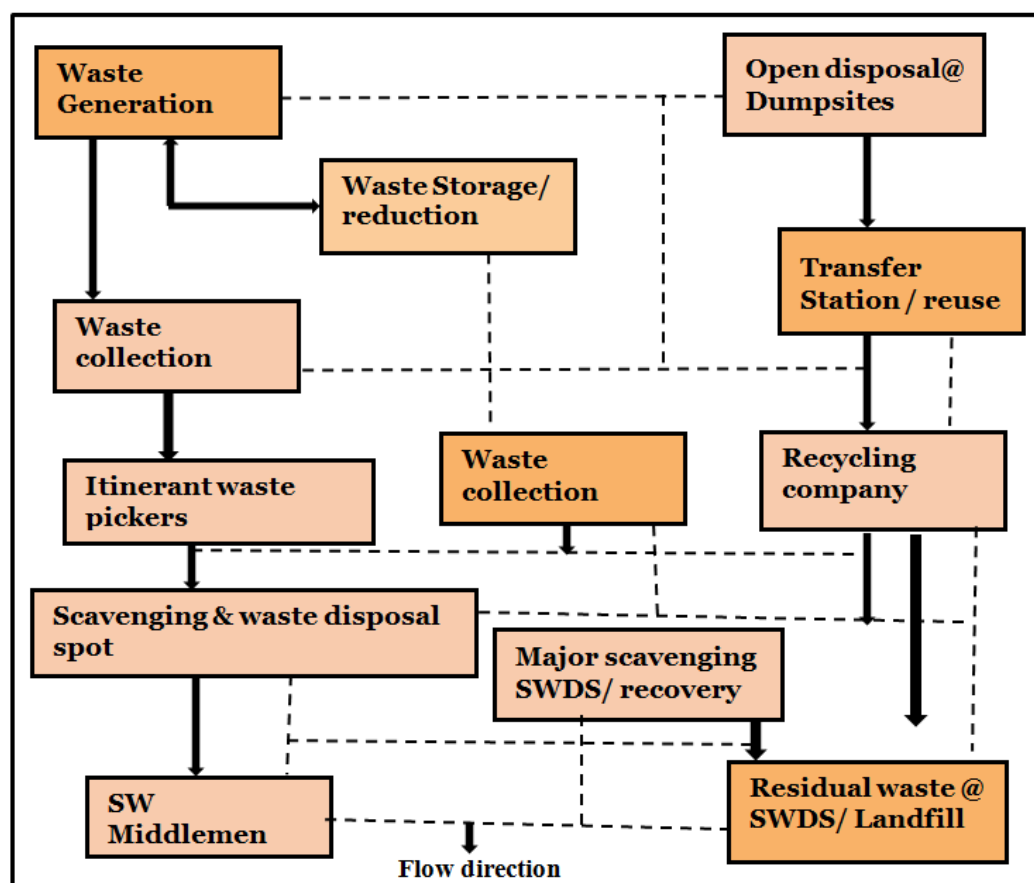


Figure 2. Solid waste management hierarchy system in Nigeria. Source: Authors, (2023).

Note: Solid Waste Dump Site (SWDS)

Orange box: SW Hierarchy concept; Blue box: SWM Process

Table 1. Shows Result of Analysis of MSW Composition (Stream) in Kano - Metropolis.

MSW	Composition (%)	Waste classification	Composition (Kg)	Composition (%)
Paper	16.34	Food waste	288.02kg	37.70%
Glass	3.20	Recyclables	2,602.45 kg	33.30%
Textile	4.80	Non- recyclables	268.99 kg	29.05%
Leather	3.12			
Aluminium	2.21			
Cooking oil	2.06			
Metals	1.02			
Plastic	22.60			
Miscellaneous	18.50			
Hazardous items	0.68			
Total	100	Total	590,640.80 kg	100

Source: Author Field Survey, 2023

When it comes to waste composition, the data indicate that plastic (22.60%) made up the largest portion of the waste stream. This is because recyclable materials are typically followed by non-recyclable materials such as hazardous materials, which made up less than 0.68%, and miscellaneous wastes, which made up approximately 18.50%. Paper (16.34%), glass (3.20%), textile (4.80%), leather (3.12%), aluminums (2.21%), cooking oil (2.06%), and metals (1.02%). The results of the examination of the MSW composition (stream) in the study area are displayed in [Table 1](#). In the above analysis, food waste is about 37.70% of the total waste generated per household in the study area, this shows that food waste has the highest percentage in the waste stream as obtained in the metro area. This is further supplemented by private waste companies / contractors under franchised agreement. REMASAB has a dedicated squad that keeps an eye on these contractors. The study area and different stages of Solid Waste Management (SWM) and Solid Waste Management Hierarchy System (SWMH) in Nigeria are depicted in [Figure 1](#) The SWMHS process comprises reuse, recycle, recover, and recover, whereas the Solid Waste Management System (SWMS) process includes generation, collection, transfer/storage & processing at source, transportation, and final disposal at the landfill. However, in Nigeria, several public sector agencies have the responsibility for SWMS, but the implementation of Solid Waste Management Hierarchy among the general public is reported to be insufficient. As a result, those involved in the Solid Waste Management System ought to emphasize the significance of the Solid Waste Management Hierarchy to local communities, and should create a platform of collaboration among this various SW stakeholder by reducing solid waste through various educational and environmental programs throughout the study area [\[16, 19\]](#). This initiative could possibly attract more public participation and involvement of the urban residents in the task ahead.

4. Results and Discussions

4.1. Understanding Solid Waste Management in Metropolitan Kano

A report by the Kano State Urban Planning and Development Authority (KNUPDA, 2018) and (MUSTAPHA, 2015) indicates that the Kano metropolitan region has a 60% housing shortfall, which has significantly contributed to the city's inadequate solid waste management. This is because the majority of the housing is found in slum or ghetto developments. Roughly 60% of the 80,332 households residing in the city are compound houses, which are the most prevalent kind of housing in Kano and consist of multiple households sharing a single house's rooms as well as common areas like the kitchen, bathroom, and toilet. These compound dwellings are situated

in low-class residential areas near the city center of Kano. They are devoid of the necessary solid waste management amenities, like tiny trash collection containers, communal waste separators or recyclers, and drums for garbage collection. The study's conclusions, given Kano Metropolis's fast urbanization, revealed. Poor waste management that includes: non-existing collection systems to ineffective waste disposal—that causes air and water pollution, and soil contamination. Open and unsanitary landfills for waste disposal also contribute to contamination of drinking water and can also cause infection and transmit diseases. The dispersal of debris pollutes ecosystems and dangerous substances from electronic waste or industrial garbage puts a strain on the health of urban dwellers and the environment. Owners of homes are increasingly converting their bathrooms and loos into residential spaces. This increases the amount of waste produced as well as the number of occupants. Some city dwellers think that this circumstance is what led to the terrible attitudes that urban residents have regarding solid waste management.

About 52% of the working population in Kano Metropolis is employed in agriculture, and the remaining 48% are in the wholesale, service, transportation, and manufacturing sectors (Nabegu, 2010). Kano Metropolis employs 53% public servants. According to the study's findings, immigrants—who typically reside in slums and other unofficial areas—have been drawn to Kano by the city's economic and commercial importance. This phenomenon is known as rural-urban migration. The majority of urban residents think that this circumstance has a role in the poor solid waste management in the city.

The study's conclusions demonstrated that the Kano Metropolis produces 5,150 gallons of liquid waste and 180 tons of solid trash every day from its industrial sectors. Approximately 72% of the solid trash and 78% of the liquid waste produced in the research region are the result of urban residents. 80% and 20%, respectively, of the trash produced in Kano Metropolis is made up of solid and liquid wastes. Solid trash accounts for the majority (70%) of the waste produced in the Kano Metropolis. It is made up of water bags, sachets, polytene materials (45%), plastic (25%), paper (22%), and other materials such broken wood pieces (7%). City dwellers noted that the prevalence of waste from polythene and sachet water bags is due to the growing number of food vendors and hawkers, most of whom are immigrants, who swarmed into the city as early as 7:00 am to sell their wares, creating an increased amount of waste in the process. But the state of solid waste management in the areas around central business districts (CBD) is especially terrible. (e.g. Bello road, Murtala Muhammad way, BUK road, Bompai, Nassarawa G. R. A etc.). [\[19\]](#)

But according to the study's conclusions, only 25% of all solid waste produced is handled well. According to REMASAB, some of the issues causing poor solid waste management in the research area include an inadequate per-

sonnel, budgetary constraints, technological choices, resources (like cars), and waste management logistics (like garbage collecting containers). For instance, the Kano Metropolis as a whole only has 310 neighborhoods, is serviced by 103 REMASAB employees rather than 280, and has only 102 communal waste containers for waste collection, even though the Metropolis actually needs at least 1500 containers to ensure effective solid waste management. This condition actually supports the literary thesis that city municipal authorities, who are supposed to be in charge of solid waste in the urban center, give solid waste management in developing nations minimal priority [14]. Furthermore, the research findings indicate that inadequate institutional capability, including waste laws and regulations, has contributed to substandard management of land fill sites for appropriate waste disposal. Because of the state government's ongoing financial difficulties, the court road dumpsite located along court road in Kano

metropolis depicted in Figure 3 has been neglected over time.

The REMASAB claims that in order to manage one of Kano Metropolis' four dump sites, at least N12, 500,000 (US\$88,600) is required per week. The city officials assert that this financial promise cannot be fulfilled at this time because of insufficient resources. In an ideal world, the land fill site would be treated once a week to prevent or reduce environmental hazards like disease outbreaks, particularly the recent and much-dreaded Covid-19 pandemic. However, the study's findings show that none of the four designated land-filled sites have been treated in a very long time. Residents who live adjacent to these landfills have so bemoaned the terrible conditions of rotting, growing mounds of solid garbage from the disposal site. And such this is not good for both public environmental health condition of the people residing close to this facility.



Figure 3. Plate A & B Shows the State of the Court Road, Kano Metropolis Waste Dumpsite (Source: Author field survey 2023).

The interviews with urban dwellers also revealed that, despite the apparent weak institutional capacity to manage solid waste and other environmental issues in Kano Metropolis, some urban dwellers' poor attitudes seem to be the main cause of poor Solid Waste Management in the study area. However, the majority of urban residents surveyed for the study acknowledged that they had really disposed of solid garbage in an indiscriminate manner. As seen in Figure 3, the indiscriminate disposal of solid waste, primarily made up of plastics, sachet materials, papers, carton material, manufactured wrappings, and other poly-thane materials, has spread throughout the metropolitan areas of Kano, this is believed to be contributing to urban blight. While some urban residents

blamed the indiscriminate waste disposal on the absence of a continuous waste collection and disposal infrastructure, the study's conclusions indicate that most of them intentionally left waste on the streets. Even while a city residents expressed disapproval of the private firms handling waste management in the city, he also pointed out that since these corporations pay employees to clean the city, they won't have any work to do if we stop littering the streets. This statement highlights the coldness of some city dwellers who live in the city but treat Kano Metropolitan Solid Waste Management poorly, and this situation according to the urban dwellers has resulted in the continues littering of wastes on the road sides, gutters and any other available open space.



Figure 4. Plate a, b, c, d, e, & f Shows the Dilemma of Indiscriminate Dumping & Littering of Refuse in Kano Metropolis.

Another aspect of city residents' attitudes towards solid waste management that is worth taking note of is the indiscriminate littering and defecation by local residents who might have migrated from the rural area and without any awareness of the environmental consequences of this action [22]. Some residents attributed the indiscriminate littering and or defecation mostly on access road that led to the open dumpsites to inadequate public toilet facilities in the metropolis. One resident explained the situation: "... the whole of this neighborhood has just four (4) public toilets, meanwhile most of the houses here don't have toilet facilities in them. And as such this warrants most people to defecate in the bushes around and uncompleted buildings because they can't walk long distances to or queue at the public toilets ...". The study findings showed that indiscriminate littering and or defecating by some urban dwellers residing in the study area in available open spaces, drainage sides, access parts, uncompleted buildings and surrounding bushes has contributed significantly to the cases of water borne diseases causing cholera and diarrhea in the city as shown in Figure 3. Areas designated for public uses such as public open spaces, access way and schools have been converted into places of convenience and waste littering by some urban dwellers residing in the Kano Metropolis.

4.2. Impact of Poor Solid Waste Management in the Development of Kano Metropolis

The study findings indicated that the impact of poor Solid

Waste Management in the development of Kano Metropolis is mostly caused by poor attitudes of city urban dwellers towards solid waste management coupled with weak institutional capacity that involves SWM rule and regulation has really affected the sustainable solid waste management in Kano Metropolis in some number of ways. In fact, the recent flooding of 2022 was so devastating that it destroyed many lives and properties within the study area. The city authorities stated that the main cause of choking in the sewerage and drainage system—which the author observed to be filled with refuse is poor attitudes of the urban residents towards solid waste management. As a result, flooding has now become a normal phenomenon that accompanies rainfall in the metropolis. This situation not only worsens the conditions surrounding solid waste management but also puts the lives of urban residents in danger, particularly during heavy downpours. Table 1 shows how the Metropolis's inadequate solid waste management has exacerbated a number of infectious diseases, including diarrhea, cholera, yellow fever, malaria, and typhoid fever. To put it another way, Table 2 is a list of vector-borne illnesses arranged by the vector that spreads them. The type of infection responsible for the disease in humans is also depicted in the list.

Additionally, city dwellers reported high rates of premature death in the metropolis, which they attribute to inadequate solid waste management as the main contributing reason. The urban residents' perception, regarding mortality rates and solid waste management, was confirmed by an official government's report which showed that mortality rates among

children below the age of five are significantly higher in the inner and inaccessible routes of the neighborhood in which there are many room in the compound with shared solid waste

facilities since they generate more waste than other residents [15].

Table 2. Five commonly reported illnesses in Kano Metropolis Source: from the REMASAB Report, 2022.

Vector	Disease caused	Type of pathogen	Percentage attack
Mosquitoes	Malaria	Virus	62.40
Flies	Cholera	Virus	11.30
Mosquitoes	Yellow fever	Virus	15.60
Flies	Typhoid fever	Bacteria	4.50
Flies / Dirty Environment	Diarrhoea	Virus	6.25
Total	5	5	100

Another effect of poor Solid Waste Management which was strongly expressed by the urban dwellers is the infrequent collection of refuse by REMASAB in the study area, sometimes it takes months. According to them, infrequent collection services of accumulated solid waste has become an accepted practice in the Kano Metropolis. Inadequate solid waste facilities and poor attitudes coupled with poor management of the landfill site appeared to have posed a considerable public health risk to urban residents of the metropolis more especially those living close to the landfill site. This is supported by research conducted by the United Nations Environment Program (UNEP), which found that city dwellers in urban areas living close to solid waste landfills and refuse disposal sites, especially in developing nations like Nigeria, are severely exposed to serious health risks from contaminated drinking water and soil [2]. As was previously indicated, the government's financial limitations have prevented any treatment for a number of years at the four designated Kano dump site. Residents claim that this has led to the flow of wastewater into ground water, particularly during periods of intense rainfall from the site, thereby endangering the health of those who live in the study area. The study's conclusions showed that the Metropolis's prevalent practice of uncontrolled defecation in open areas and bushes has exacerbates the pollution issue, which has been linked to potential health risks for people [3, 21].

5. New Approaches for Managing Solid Waste in Kano Metropolis

For the past five years a new method of waste disposal by the informal sector has been introduced in Kano metropolis in which waste is locally collected from house to house for disposal by waste vendor using locally fabricated wheel barrow after payment of some stipends from the urban dwellers, as this waste is been collected for disposal the waste vendor

inform the urban dwellers whether they want their waste to be collected for onward disposal, interested urban dwellers now ask the waste vendor to collect their waste for disposal, and while pouring the waste into the locally fabricated wheel barrow they will at the same time carry out a separation activity in which some waste resource material are return as reuse items or recycling item that will now be sold to recycling companies. Similarly, waste materials such as papers cardboard, metals, aluminum, unused spoiled television, and refrigerators, compressors, bottles of finished items are also bought by the waste iterant from the urban dwellers at a stipend, this is fully illustrated at above in Figure 4: Plate a, b, c, & d, e & f. However, this situation may be similar in other developing countries. Whereas, the unseparated solid waste at source that the residential homes in most developing countries of the world are reported to have been linked to social taboo, citizen's attitude, poor assessment, inadequate potential strategies, un-organized informal sector of waste, unplanned fiscal, and poor implementation of government policies [1].

Moreover, the Kano State Environmental Protection Authority Solid Waste Management Regulation No. 1 of 1997 and the Kano State Local Government Environmental Sanitation Edict, No. 2 of 1991, which repeals Edicts 5 of 1984, serve as the foundation for the Solid Waste Management efforts in the Kano Metropolis, despite the fact that they are still insufficient. In this legislation it states that Kano state government regulation on solid waste gives considerable responsibility to the local government authorities 'to carry out solid waste collection and disposal. It also requires the Local Government among other things to evacuate refuse and junks from any public or private places and to provide and maintain public dustbins and receptacles for temporary deposit and collection of refuse. Regulation rule No 2 also imposes and as well as empowers the Authority to issue permits to any person(s) to deposit waste on designated refuse disposal sites and may be charge fees as deemed necessary for that permit. In

other words, these Local Government Act provides a new but supporting framework for safeguarding a clean and healthy environment in Kano Metropolis. The Act also mandates the REMASAB to regulate the implementation of government policies on the environment in the Metropolis.

Although the research findings revealed that there are indications of legislation enforcement in Kano metropolis including the use of hierarchy system such as reduction, reusing, recovery and recycling but poor coordination among the solid waste managers (e.g. REMASAB, Housing Development, Ministry of environment and KNUPDA) has become a daunting challenge. As a result, there is no better Solid Waste Management Policy or Plan. And since Kano is one of the fastest growing cities in Nigeria, the lack of comprehensive Solid Waste Management Plan/Policy to guide effective management of Municipal Solid Waste in the city was attributed according to the waste personnel that were interviewee to poor coordination, scientific SWM efforts and collaboration between the various institutions in managing

solid waste as it was enumerated above.

Furthermore, the research findings showed that poor attitudes of the city residents have also been reflected in the Management of Solid Waste in the Metropolis. According to some urban dwellers, individuals, groups of persons and even the institutions themselves contravene the Solid Waste Management legislations with impunity as a result of their political affiliations. In fact, poor attitudes of politicians and traditional authorities were mentioned by the urban dwellers as the major challenge impeding the actual implementation of real and modern Solid Waste Management legislations. For example, the residents in Fagge local government area, which is also the Author's home abode were dissatisfied with their community leader, who due to bad leadership and corruption had sold out a piece of land demarcated for a temporary dumpsite facility to a private developer. The residents explained that all efforts towards retaining the said piece of land back to its original use proved futile as a political party chairman intervened and got the case withdrawn from court.



Figure 5. Plate I & II Shows a Recycling Efforts by an Urban Dweller in Kano Metropolis-Nigeria.

These poor attitudes of some traditional leaders and politicians in the city have been contributing to poor Solid Waste Management in the study area, as they appear to render the enforcement of the legislations (e.g. Act No5 of 1991 & that of 1997) ineffective, and since waste cannot be avoided in Kano metropolis, recovery of materials and energy from waste as well as remanufacturing and recycling waste into usable products should be the second new option and or ap-

plication. Furthermore, the world best solid waste management technique is the recycling and reusing this method are considered to be the world best waste management method, for obvious reasons because recycling not only allows us to get rid of waste material that we no longer need but effectively converts it into something that is useful and is required as raw materials for industries





Figure 6. Plates a b c & d shows solid waste separation, reuse, recovery and recycling in Kano Metropolis.

6. Improving Solid Waste Management in Kano Metropolis

New Future Directions Central (NFDC) to this research article is the understanding of the state of Solid Waste Management in Kano Metropolis and the contribution of poor attitudes of city residents to Solid Waste Management and environmental waste management challenges. From the ongoing discussion, this research article has now established the actual trend of Solid Waste Management in the Kano Metropolis, which also reflects the same situation in many cities of developing countries. The poor solid waste management condition in the Kano Metropolis is also well characterized by poor attitudes of urban dwellers and as well as the weak capacity of Solid Waste Management institutions, which has also resulted in the indiscriminate disposal/littering of solid wastes, inadequate Solid Waste Management facilities, and the low priority accorded to Solid Waste Management by city municipal authorities. Regarding the new approaches to Solid Waste Management, the chapter has identified lack of Solid Waste Management Plan/Policy and weak enforcement of legislations due to the poor attitudes of traditional leaders and politicians, as the basic underlying challenges/problems impeding upon the effective implementation of solid waste legislations and regulations in Kano Metropolis.

With the continuous poor and apathetic attitudes of these urban dwellers, the research article now recognizes the need for solid waste management education / awareness in Kano metropolis. City municipal authorities should capitalize on the availability of mass media to enlighten, give awareness programs on SWM hierarchy and as well as engage and involve the urban dwellers (public participation) in Solid Waste Management and other related issues [22]. Urban dwellers should have easy access to solid waste management information, more especially on ways of ensuring Sustainable Solid Waste Management (SSWM) in the study area, as well as its associated benefits. If actually undertaken, such has the potential of reducing the high level of apathy among residents and as well as to minimize the indiscriminate disposal of solid wastes and as well as reducing the number of human health

and environmental related cases in the study area.

As an effort to ensure effective enforcement of Solid Waste Management legislations, the research article advocates for a more collaboration and coordination between all solid waste stakeholders earlier mentioned above from each neighborhood within Kano Metropolis and the city authorities. Furthermore, solid waste management institutions should make conscious efforts to build cordial relations with all the solid waste stakeholders through regular visits and engagement of these stakeholders. In other words the study recommends a close collaboration and engagement of the private sector in Solid Waste Management.

The city authorities through the REMASAB should engage more private Solid Waste Management companies to ensure effective management of wastes. Given the huge sums of money needed in managing solid waste especially in the treatment of landfill site and the low priority accorded to Solid Waste Management, the study proposes that a 'special fund' be created and set aside and solely used for Solid Waste Management in the cities of developing countries, particularly Kano Metropolis. This fund should be created by the city municipal authorities from their internally generated fund and they should be targeted at procuring basic Solid Waste Management facilities such as waste collection bins, rake, shovel, wheelbarrow, and providing support to the Solid Waste Management personnel. Moreover, the study finally proposes that the City Municipal Authorities in consultation with the various key solid waste stakeholders involved in Solid Waste Management should prepare a Solid Waste Plan for the city. As earlier mentioned, the lack of environmental sanitation plan in Kano Metropolis has contributed to the low priority accorded to Solid Waste Management by city authorities. The formulation of a solid waste plan for Solid Waste Management in the Kano Metropolis would contribute towards improving the Solid Waste Management conditions in the city.

7. Conclusion

This research article has discussed the solid waste existing trends and or conditions and practices in the Kano Metropolis amidst population growth with increasing urbanization. The

study has revealed that the underlying causes of the appalling state of Solid Waste Management conditions and the weak approaches used in managing it are largely attitudinal. Consequently, the study article now distinguished between two degrees of solid waste management challenges: inadequate institutional capability and unsatisfactory resident attitudes. The mentality of city dwellers was shown to be the primary factor contributing to subpar solid waste management in the paper. On the other hand, problems with the careless disposal of solid waste and open defecation at dump sites were found to be linked to the negative opinions of city people. The literature [15, 8] indicates that the city municipal authorities are unable to properly manage the daily generation of solid trash in the metropolis due to insufficient institutional capability. Weak institutional capability in the study area has led to issues such a lack of a solid waste management strategy and lax enforcement of solid waste management laws.

The research article now suggests solid waste awareness and education in response to these difficult circumstances in the Kano Metropolis. It also suggests creating a solid waste management plan that includes the 4Rs SWM Hierarchy and financial stability, collaborating with and involving stakeholders in solid waste management, and making a deliberate effort to fund solid waste management in the Metropolis. It is thought that consciously adhering to and implementing all of the study's recommendations would help improve the city's and other developing nations' solid waste management conditions, better positioning Kano Metropolis to fulfill its role as the commercial and industrial center of North-Western Nigeria. It would further create a sustainable, livable and socially inclusive urban city for urban dwellers for living, working and recreating in the city.

Abbreviations

REMASAB	Refuse Management and Sanitation Board
KNUPDA	Kano State Urban Planning and Development Authority
SME	State Ministry of Environment
SMHD	State Ministry of Housing Development
KANGIS	Kano State Geographic Information System
NFDC	New Future Directions Central
SWMHS	Solid Waste Management Hierarchy System
SWMS	Solid Waste Management System
MSWM	Municipal Solid Waste Management

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Conflicts of Interest

The authors declare no conflicts of interest.

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Biography



Saleh Muhammad is a third year PhD student at School of Housing, Building & Planning, Universiti of Sains Malaysia, Pulau Penang, 11700. He got a Bachelor's degree in Urban & Regional Planning from Ahmadu Bello University Zaria - Nigeria. A master Degree from the same University,

His researches are based on urban planning, transportation planning, urban management, Solid waste management & Urban design.



Prof Azizan Marzuki is a Professor at Department of Urban Planning & Regional Planning, School of Housing, Building & Planning, Universiti Sains Malaysia, Pulau Penang 11700. He got his Master's and PhD degrees in Tourism Planning from Department of Cultural Tourism School of

Humanities, Faculty of Education, Humanities, Law & Theology, Flinders University, and Adelaide. His research focuses on Tourism Planning, Tourism Development, Regional Tourism and Sustainable Development.