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Integrated Municipal Solid Waste Management: A Panacea to Waste Management Problems in Kano Metropolis, Nigeria

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ABSTRACT
The study examined integrated municipal solid waste management and hierarchy: thepanacea to solid waste issues in Kano metropolis which was anchored on the concept of sustainable development to meet the 2015 Sustainable Development Goals (SDGs) 3; 6 and 11 by 2030. Primary data were obtained through administration of 160 structured and semi structured questionnaires and field interview questions to randomly, systematically and purposefully sampled population. Secondary data were obtained from desk review of other literatures, journals, seminars, conference papers and REMASAB's records. Descriptive statistic and model were employed for analyses of the data. Findings revealed that 75.6% are of the view that REMASAB and Private Waste Management Institutions majored in waste collection and disposal at dumpsites, 10.6% reported that the waste management agencies practice Integrated Municipal Solid Waste (IMSWM) and 5.8% opined to waste management hierarchy (WMH). The public clamoured for the IMSWM and WMH in the metropolis. REMASAB performance was measured 31.6% using IMSWM scored board. The study also reveals that 77% of the REMASAB and private waste institutions do not have biological treatment facility and suggested the adaption of USEPA models of IMSWM and WMH. The study further recommends paradigm shift from municipal solid waste collections and disposals to an integrated waste management, provision of sufficient fund, supervision and incorporation of all management factors for sustainable environment.

KEYWORDS: Integrated, Hierarchy, Sustainable development, Combustion and Landfill.

I. INTRODUCTION

Cities over the years have been experiencing high increase in population growth, urbanisation and industrialization, especially the developing countries. These have resulted to continuous generation of enormous municipal solid waste in virtually almost all the parts of the urban centres. According to Hoornweg and Bhada-Tata (2012) in World Bank report, opined that most cities of the world generate about 1.3 tons of municipal solid waste annually which is about 1.2kg per capita per day and likely to get to about 2.2 billion tons and also rising to 1.42kg per capita per day by the year 2025. Small, medium to large open dumps are often visible at the backyard, fronts and beside of most homes. They are also visible at road sides, offices and market areas in most developing nation.

According to Aina (1994), the then Director General of defunct Federal Environmental Protection Agency (FEPA) in Nigeria, is of the view that of all the environmental problems such as flooding, drought, desert encouragement, erosion and landslide among others that are bedeviling the nation; the most obvious, prominent, persistent, feasible and most embracing as well the one which has consistently portrayed the government and the environmentalists in a bad light is the municipal solid waste.

Kano the commercial nerve of the north and the second largest commercial centre after Lagos in Nigeria is characterized by enormous volume of municipal solid waste. It has been estimated that about 3,085 tons of known wastes are generated every day and only about 800 tons are being evacuated at full capacity each day, giving an individual generation rate of 0.56kg per capita per day (Nabegu, 2010 and 2017; Abila, 2014). This implies that 2,285 tons are left uncollected and have resulted to the littered and heaps of waste, overflowed skips or dustbins with waste in the metropolis especially in the low class residential and sub-urban areas. Similarly, about 156,676 tonnes of solid waste are being generated every month in Kano metropolis (Nabegu and Mustapha, 2014). The issue of municipal solid waste has been in existence for over two decades and seems to defy possible solutions postulated in

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the developing countries such as Nigeria and particularly in Kano city, centre of commerce and industry.

Several studies over the years have been conducted on municipal solid waste in Kano metropolis and most of the studies revealed that MSWM has defied possible solutions. In the same vein, Butu and Mshelia, (2014; 2017); Nabegu, (2008; 2010; 2015); Mshelia, *et al*, (2020a) pointed out that street sweeping, collection and disposal at dumpsites are the major management practices being carried out in the metropolis by all the stakeholders which made the practices ineffective as reported by Butu and Mshelia (2017). This constitutes environmental nuisance and health issues therefore, the urgent need for paradigm shift from the traditionalcollection and disposal to integrated municipal solid waste management system and waste management hierarchyby Refuse Management and Sanitation Board (REMASAB), waste management hierarchy and other contemporary methods in order to mitigate environmental effects of solid waste management (SWM).

It on the basis that enormous volume of solid wastes are being generated every day in Kano metropolis and dot major streets, roads, pavements, open spaces, alleys and gutters or drainage channels as well as the issue thatmunicipal solid waste (MSW) seems to have defied every solution proffered in Kano metropolis despite the establishment of (REMASAB) in 2003. The board also incorporated private waste management agencies to manage the wastes in the metropolis but yet little result has been achieved and this necessitates the study in order to seek alternative methods or ways of waste management in the metropolis. The study furthermore attempts to take into cognizance Integrated Municipal Solid Waste Management (IMSWM) and Waste Management Hierarchy (WMH) in order to: wholly modified the rudimentary methods of municipal solid waste management (MSWM) of sweeping streets, collection and disposal of waste at dumpsites (Butu and Mshelia, 2017 ; Mshelia, *et al* 2020b)and also suggest contemporary ways of MSW in the metropolis with the view to provide useful information and ways towards achieving the 2015 Sustainable Development Goals (SDGs) 3; Good Health and Well-being for People 6; Clean Water and Sanitation, and 11; Sustainable Cities and Communities by the year 2030.

1.1 Integrated Municipal Solid Waste Management

Integrated solid waste management (IMSWM) systems varies from one geographic location to another (one region to region) and are internationally recognized at national, state, local government, institutional as well as community levels depending on the local conditions. It takes into consideration all the policies, programmes, and technologies that are necessary to manage the waste stream from waste generation to disposal (UNEP, 2005;Latifah. *et al.,* 2008). Muchangos, *et al*(2015) is of the view that MSWM planning requires three steps namely: development, implementation, and review and update. The integrated approach is an important segment of development phase; this is because the different types or classes of waste cannot be treated with a single method if one wants to really sustain the environment devoid of hazards (McDoughall, 2001). Memon (2019) refers to IMSWM as ‘‘the strategic approach to sustainable management of solid wastes covering all sources and all aspects, from generation, segregation, transfer, sorting, treatment, recovery to disposal in an integrated manner, with an emphasis on maximizing resource use efficiency’’.

EPA (2002) viewed IMSWM approach as a total, complete, holistic and comprehensive management system that involves waste prevention and waste stream right at the point of generation to end point of disposal. Human health and environmental protection are the focal point of concern in IMSWM. In this regard, it examines contemporary waste management system and applies the most appropriate (environmental friendly) for a particular city. According to McDoughall (2001) IMSWM goes far beyond only safe disposal of waste but also proffers ways forward to problems of waste by emphasizing life cycle thinking based on the cradle to the grave principle. Three advantages of IMSWM are: it effectively handle MSW, achieve environmental benefits and optimize economic cost.

1.2Concept of Sustainable Development

Development brings it effects along and must be addressed, including management of municipal solid wastes. Sustainable development centres on finding the right balance, the use of resources in the environment and its maintenance or sustenance. The United Nations defines it as: *‘‘Development that meets the needs of the present, without compromising the ability of future generations to meet their needs”*. This makes it our duty to ensure that: all uses of renewable resources

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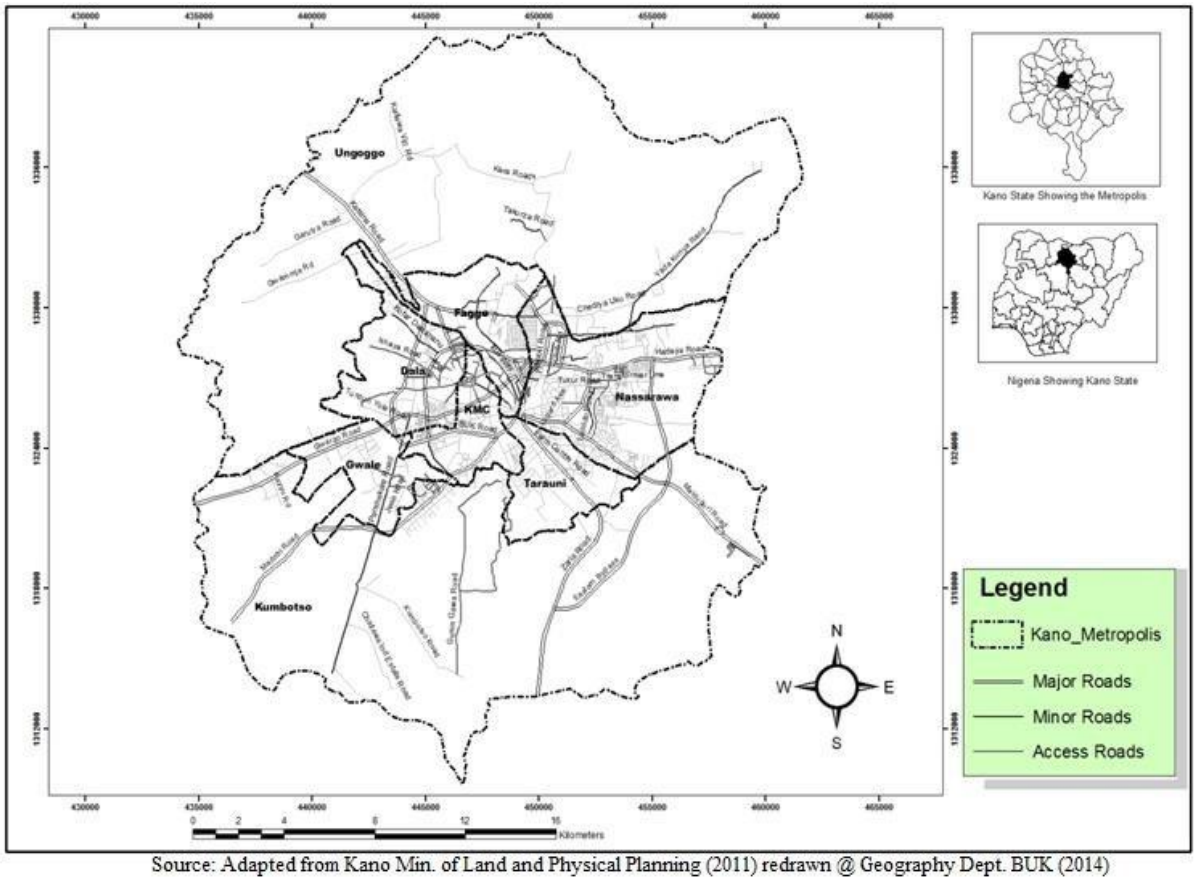
are sustainable; the diversity of life is conserved and damage to natural environmental systems is minimized. Symptoms of environmental issues such as indiscriminate dumping of wastes can create environmental damage or instability (Peter, 1996). It is therefore pertinent to apply the concept of sustainable development in order to protect and keep the environment from the clutches of waste management. The principles of sustainable development involve integrating the environment into the decision making process, reorienting technology and management of risks, conserving and enhancing the resource base, and strengthening international cooperation. These principles were the focus of discussions at the United Nations Conference on Trade and the Environment (or Earth Summit), that was held in Rio de Janeiro in 1992.

II. MATERIALS AND METHODS

2.1 Study Area

Kano Metropolis is located between latitudes $11^0 40'$N and $12^0 25'$N of the equator and $8^0 30'$E and 8^0 45'E of the Greenwich meridian (Figure 1:1). The boundary of Kano Metropolis keeps on changing with time due to rapid urbanization processes (Muhammad, Buba and Abdulmusawwir, 2017). Kano metropolis which consists of eight Local Government Areas (Kano Municipal, Fagge, Dala, Gwale, Taurani, Nasarawa, Ungogo and Kumbotso) is the capital of Kano state in Northern Nigeria, located in the Sahelien geographic region, south of the Sahara as shown on Figure 1.1. The metropolis has a 2019 projected population of 4,194,635 and covers land mass of 499Km^2 (Un-habitat, 2012; NPC, 2012).



Source: Adapted from Kano Min. of Land and Physical Planning (2011) redrawn @ Geography Dept. BUK (2014)

2.2 Climate and Weather

The metropolis falls within the tropical climate characterized by divergent seasons of dry and wet. The mean annual temperature is 27 °C but sometimes reaches 38–42 ^{0}C in the months of March to April and often marked by high humidity and high temperature (Abdullaziz, 2014). This kind of climate and weather is good for waste composting. The climate is influenced by the movement of the two air masses; the maritime air masses originating over Atlantic Ocean and the dry air masses from the Sahara desert. The wet season usually begins May/June – September and the dry period starts October and ends April/May. Annual

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rainfall ranges from 700mm to 1,000mm, averagely about 690 mm of precipitation per year which usually last for three to five months. (Ahmed *et al* (2012).

2.3 Socio-economic Activities

The major socio-economic activities in Kano metropolis is commerce and industries. Perhaps this is the reason why Kano is regarded as the commercial nerve of northern Nigeria (Ahmed, 2012). The commercial and industrial activities have contributed immensely to urban and population growth. One of the resultant effects is enormous generation of MSW and its environmental and health problems. The industrialized parts of Kano are located in Sharada, Bompai and Challawa. Aside, the large commercial activities, street hawking and petty trading are also largely practiced. The used sachets of water, cartoons and other wastes products are indiscriminately littered by the hawkers and traders in the LGA.

2.4 Methods of Data Collection and Sampling Procedures

Types of data used for the study includes socioeconomic and demographic characteristics of the respondents, MSWM methods, IMWSM, waste to energy, institutions/agencies or stakeholders involve in the management practices in Kano metropolis Other data are on the problems or constraints of municipal solid waste management practices by households and the waste management agencies.

Reconnaissance survey was first carryout on the study area to get first-hand information on the littered and heaps of MSW in the metropolis as well as the various management practices to ascertain if such practices are in agreement with contemporary or IMSWM**.** Primary data were obtained from structured and semi structured survey questionnaires on the practices of IMSWM in Kano metropolis by REMASAB and stakeholders. One hundred and sixty (160) questionnaires were randomly, systematically and purposefully administered in the selected wards of the metropolis.

Four multi-stage sampling techniques was employed and selected two wards each from the eight LGAs (Gwale, Kwombotso, Kano Municipal, Tarauni, Nasarawa, Fagge, Ungogo and Dala) that made up of the Kano metropolis to give sixteen wards. This method was employed based on Gordon (2005) assertion who stated that it is practically not possible to study a whole population of interest, hence, a given sample or portion of the population was drawn as sample size for feasibility, practicability and convenience of the study. Formal and informal actors were given preference and interviewed ahead of the general populous. Therefore, only 160 residents were administered questionnaires and the bulks of the data were obtained from the interview method and review of relevant literatures. The formal actor surveys are: REMASAB and Private waste management institutions. The informal actor surveys are the Households and Community Based Organisations (CBOs). The actors were consulted, interviewed and studied and gathered data on MSW management practices in line with the existing policies and sustainable management practices to meet the 2015 SDGs Number 3; 6 and 11by 2030.
Other sources of data were obtained from documents or materials such as journals, textbooks, the proceedings of seminars and other research works. Descriptive statistics was employed to analyze the data using tables and charts in simple arithmetic mean and frequency. In addition, a criterion called Integrated Waste Management Scoreboard developed by UNEP (2005) was adapted and used to measure the contemporary practices by REMASAB. The researchers are at liberty to score a maximum of 100 points for the itemized framework.

III. RESULT AND DISCUSSION

The section, result and discussion deals with the data got from the field on the municipal solid waste management and the integrated municipal solid waste management that are being observed in Kano metropolis. Observations and views of various actor groups and individuals were presented in models and descriptive statistics in form of tables, charts and figures.

3.1Socio-Demographicand Economic Characteristics of Respondents

Demographic characteristics as age, educational status and occupations, family size have effects on the perception, views and opinions of individuals, ways of life and the environment with regards to generation and disposal of MSW (Mshelia, *et al* 2020a; Butu and Mshelia, 2017). Table 3.1 shows the demographic and economic characteristics of the respondents.Out of the 160 respondents; 61.3% males and 38.7% females of the sampled population were administered questionnaires and interviewed. Even though, women seem to be involved greatly in waste generation and disposal, preference was accorded to males because of their cultural right over women and ease to access. Residents within the age group

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40 - 49 were also given consideration as 64.4% of the respondents were interviewed. 63.1% and 60.6% of civil/public servants and respondents with tertiary education were considered because of the belief that they are better informed. Mustapha (2011) reported that population contributes immensely to the volume of waste being generated in cities. Therefore, family size as well determines the generation of waste at a particular location.

Table 3.1: Socio-Economic Characteristics of Respondents

Characteristics	Frequency	Percentage
Age		
21 – 30	11	6.9
31 – 40	18	11.2
41 – 50	103	64.4
51 – 60	21	13.1
61 and above	7	4.4
Gender		
Male	98	61.3
Female	62	38.7
Family Size		
2- 6	13	8.1
7-11	38	27.8
12-16	73	45.6
17- 21	25	15.6
21 and above	11	6.9
Educational Status		
No Formal Education	12	7.5
Primary Education	22	13.8
Secondary Education	29	18.1
Tertiary Education	97	60.6
Occupation		
Traders/Business men/women	36	22.5
Civil/Public Servants	101	63.1
Labourers (Mason, Carpenters)	14	8.8
House Wives	05	3.1
Others	04	2.5

Source: Field Survey, (2020)

3.2 MSWM Practices by REMASAB and Private Waste Management Institutions

Figure 3.1 shows the views of the respondents administered questionnaires. The highest percentage of 75.6% are of the view that REMASAB and Private Waste Management Institutions major in waste collection and disposal at dumpsites, 10.6% reported that the waste management agencies practice Integrated Municipal Solid Waste (IMSWM). Respondents of 5.8% and 5% are of the opinion that they also practice waste management hierarchy (WMH) and incineration respectively while combustion practice which leads to waste to energy (WTE) recorded nil. This clearly reveals that Kano government and other stakeholders still practice the traditional collection and disposal as also revealed by Mshelia, *et al* (2020) and Nabegu (2010). The state isyet to key into contemporary practices such as the IMSWM, WMH, combustion (Waste to Energy) and anaerobic digestion among others.

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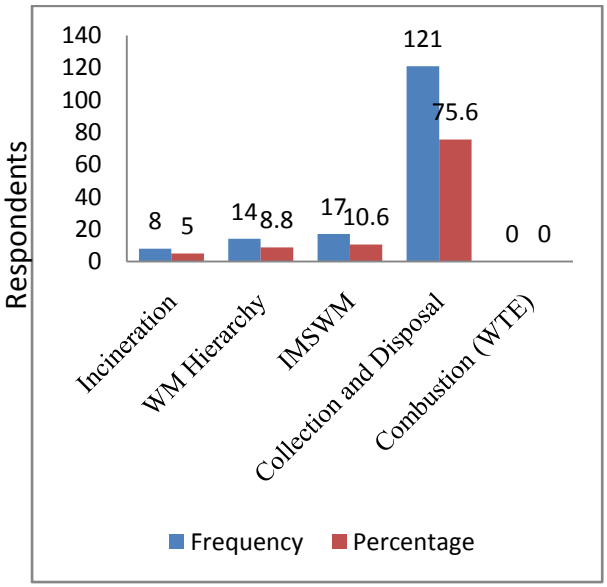

Figure 3.1: MSWM Practices by REMASAB and Private Waste management Institutions
Source: Field Survey, (2020)

Based on the study on Figure 3.1 and the interviews conducted to staff of REMASAB and private waste management institutions, it is evidently clear that they are incapacitated to effectively practice IMSWM, WMH and other contemporary methods in the metropolis as indicated in the law that establishes REMASAB, contained in the Kano State Gazette No.7 Vol. 35 of November 2003; where No.7. Section 4(1) of the law specifies the structure of the agency in terms of departments, mode of operation and sources of finance as well its functions. Notable of the functions are: refuse collection and disposal, management of refuse collection centres and dump sites, street sweeping and cleaning and land reclamation among others (Nabegu and Mustapha, 2015). The responsibility of waste management in Kano metropolis rest on the shoulder of REMASAB but the issue is that the board has not been empowered financially or otherwise to practice IMWSM and WMH which in turn could lead to the practices of the combustion, anaerobic digestion, biogasification and waste to energy despite the potentials since high percentage of 43% of all the waste generated in Kano is organic waste.

3.3 Management of Solid Waste at Dumpsites

Figure 3.2 shows that solid waste management such as composting, segregation, anaerobic digestion are poorly observed at the dumpsites with reportsof13.8%, 17.5% and 1.3% respectively of the responses recorded. The respondents of 67.5% reported that the management of waste at the dumpsites is purely burning of the solid waste of all kinds.

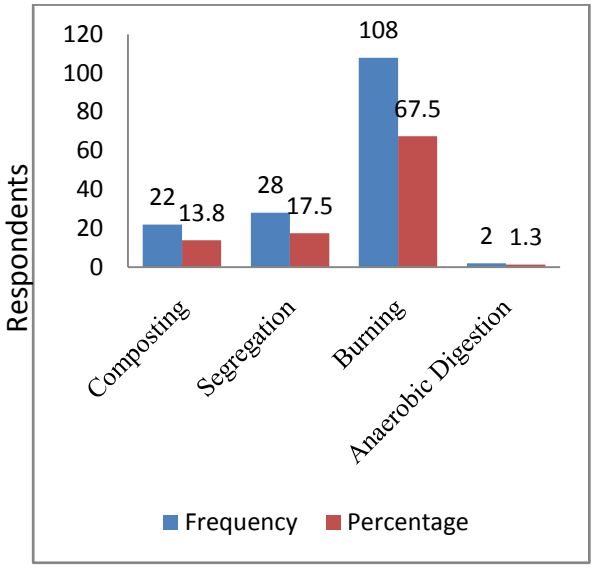

Figure 3.2: Management of Solid Wasteat Dumpsites
Source: Field Survey, (2020)

It is also pertinent to note that observations and interviews revealed that there is no single engineered or sanitary landfill of any kind in the whole of Kano metropolis. MSW are being disposed at open excavated lands without buffers.

3.4 Biological Treatment Facility at REMASAB

Biological treatments which can either be in the form of composting or biogasification are often used to treat both the organic part and the paper part of an MSW stream are not available as opined by 77% of the respondents,17% did not respond while only 6% reported that the facility is available as shown on Figure 3.3

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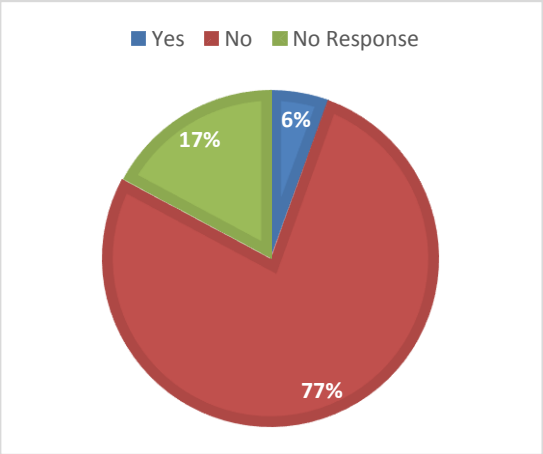

Figure 3.3: Biological Treatment Facility by REMASAB
Source: Field Survey, (2020)

3.5 Integrated Municipal Solid Waste Management (IMSWM in Kano Metropolis using Scoreboard

Visvanathan*et al.* (2004) keyed into the views of some scholars, researchers and academics and reported IMSWM as the right and appropriate introduction or application of technologies, techniques, procedures, modalities and specific programmes or planning aimed at achieving defined municipal solid waste management objectives and goals which centred on having a sustainable city devoid of environmental pollution or hazards. It is pertinent to note that there is no single or sole method that can be an island on itself and achieve result. Interrelationships among various factors and procedures are instrumental to clean and waste free environment. Therefore, the study discovered that REMASAB solely depends on collection of generated waste and disposal of the wastes at unprotected dumpsites. The interview with residents and staff of the board ascertained that contemporary practice will no doubt give good result and also opined that integrated waste management should be genuinely and holistically embraced without further delay in the metropolis.

Further investigations revealed that the residents as well as the staff of the REMASAB clamour for sanitary or engineered landfill, composting, combustion and incineration where energy can be generated, biological treatment facility, natural anaerobic digestion in the landfill, recycling and for a sustainable MSWM as on Figure 3.4 in Kano metropolis.

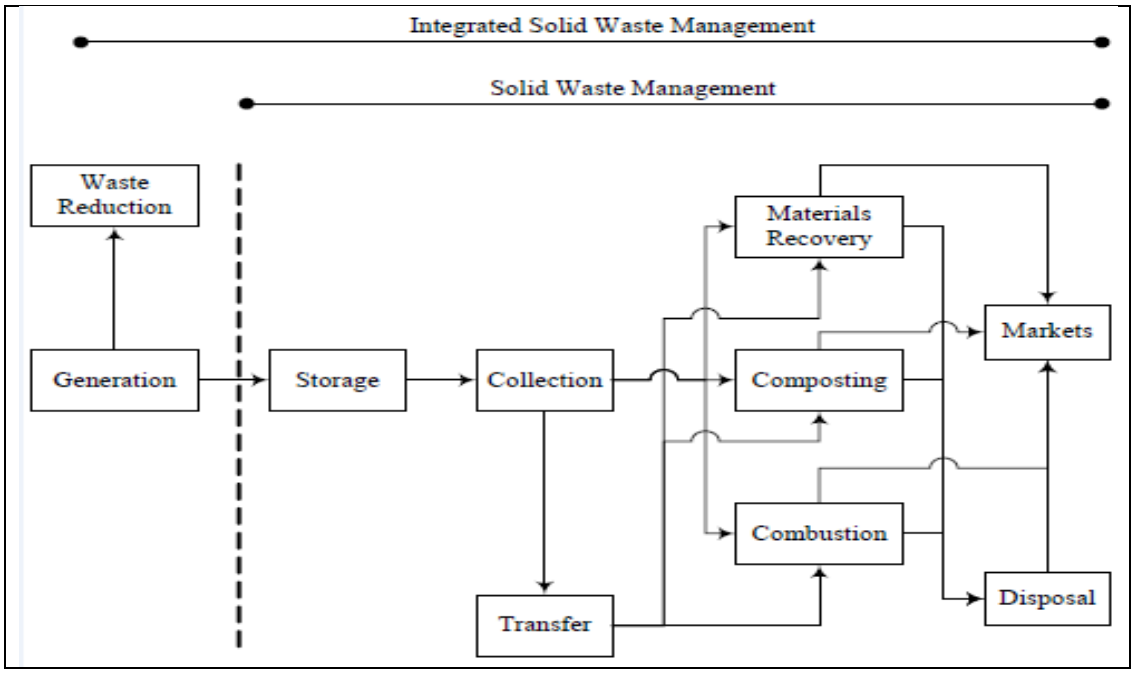

Figure 3.4: Model of Integrated Solid Waste Management (IMSWM)
Source: UNEP (2005)

Integrated solid Waste Management Scoreboard is a criterion developed by UNEP (2005) which is a planning tool to measure performance in municipal solid waste management programmes and systems at the national, State/Provincial/Regional, municipal, community,

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and institutional levels. The study therefore, measured the performance of municipal solid waste management in Kano metropolis as shown on Table 3.1. The result of the assessment conducted by the researchers concur with the interviews conducted which indicates that IMSWM and other contemporary methods such as conversion of waste to energy and fuel are not being practiced in the metropolis. REMASAB collects and transports municipal solid waste to open fields and excavated lands within the state capital and on the outskirts of the metropolis. These places where wastes are disposed are the dumpsites since the study reveals that there is no sanitary or engineered landfill in the metropolis.

Table 3.2: Integrated Waste Management Scoreboard of Kano Metropolis

Item	Category	State/Municipal level Goals	Description	Points Allocation	Score
A	Role	To develop and enact legislation and policies that promotes and ensures environmental protection. To establish an agency or department to implement these programmes. To be directly involved in planning and approvals for solid waste management programmes and facilities. Support research and development and pilot projects Responsible for implementation of municipal solid waste programmes and facilities		Not applicable Not applicable Not applicable Not applicable Not applicable	Not applicable Not applicable Not applicable Not applicable Not applicable
B	**Institutional Framework**				
	Legislation and policies	Environmental protection Solid waste management Waste reduction/avoidance Resource recovery (recycling, composting and combustion). Landfill disposal Financial sustainability Other relevant legislation and policies Environmental protection agency or department	There is a body; Refuse Management and Sanitation Board (REMASAB) under the supervision of the Ministry of Environment. It is responsible for SWM in the metropolis. The study observed that resource recovery (recycling, composting and combustion) are not being practice by REMASAB. There is no landfill but excavated land as serving as dumpsites The board is inadequately funded. The legislation is conflicting between State and LGAs as to who is responsibility for MSWN	Up to 100 points maximum if all the items are addressed	20
	Environmental Agency	Maintain database on solid waste indicators Establish a funding programme. Providing training and capacity building	There is a body; Refuse Management and Sanitation Board (REMASAB) under the supervision of the Ministry of Environment. There are other private waste management agencies being regulated by REMASAB.	Up to 100 points maximum	100
	Research and development	Other relevant initiatives.	The board maintains partial database on solid waste indicators but funding of programmes such as training and capacity building are not conducted.	Up to 100 points maximum	30

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C	**Waste Reduction and Avoidance**	Adoption of waste reduction/Avoidance initiatives	Waste reduction in form of either recycling is only practice by scavengers and reduction by Aminu Kano Teaching Hospital who have incinerator. REMASAB do not practice waste reduction and avoidance.	Up to 100 points maximum	20
D	**Storage and collection**	% of state/municipal population or households that receive frequent collection service	Households rate the services of REMASAB as poor and very poor (Nabbegu, 2010; 2015; Mshelia*et al*, 2020). Do not get frequent collection services. Some areas have never been visited by REMASAB	Up to 100 points maximum	25
E	**Resource Recovery**	% of state/municipal waste stream that is managed by resource recovery programme and facilities	Some parts of land along court road Gyadigyadihas been reclaimed by the board and converted it playground. Apart from the recovery of the Gyadigyadi land there is no any other area recovered.	Up to 200 points maximum	50
F	**Disposal**	The residual waste stream that is currently managed at landfills that are designed operated and closed according to national standards guidelines Disposal sites (nationally that have been properly closed and/or rehabilitated.	There is no single landfill that is designed, operated and closed according to national standards guidelines. However, there are dumpsites used for dumping waste. Nil	Up to 100 points maximum Up to 100 points maximum	20 10
G	**Public awareness /Education**	Adoption of public awareness/education initiative at the state/municipal level	REMASAB periodically use other means such as radio, television aimed at educating the people on proper MSWM.	Up to 100 points maximum	50
				Maximum 1,000 points	Total =325 **36.1%**

Blow average score
Source: Field Survey, (2020)

3.6 Waste Management Hierarchy

The waste management hierarchy is often referred to as one of the important roots or foots of contemporary municipal solid waste management systems which have been popularly and fully adopted for the development of policies, practices and programmes related to waste management at regional, state, local and national levels, especially in developed countries (UNEP, 2005). Same cannot be said in the developing countries because it is capital intensive and also as result of inadequate human and material resources (UNEP 2009).

Waste management hierarchy is an internationally accepted or recognised strategy for municipal solid wastes management that considers significance emphasis on strategies, tactics,and techniques as well as programmes to avoid waste generation or encourage source reduction of waste and reuse of materials termed as waste. It also recognises recycling/composting as biological decomposition of organic matter or materials such as grass, leftover food, leaves, and vegetables waste into a soil improvement; energy recovery which involves processing waste to produce energy and fuel; treatment and disposal being the least favoured options in a sustainable way as shown on Figure 3.5 (USEPA, 2019).

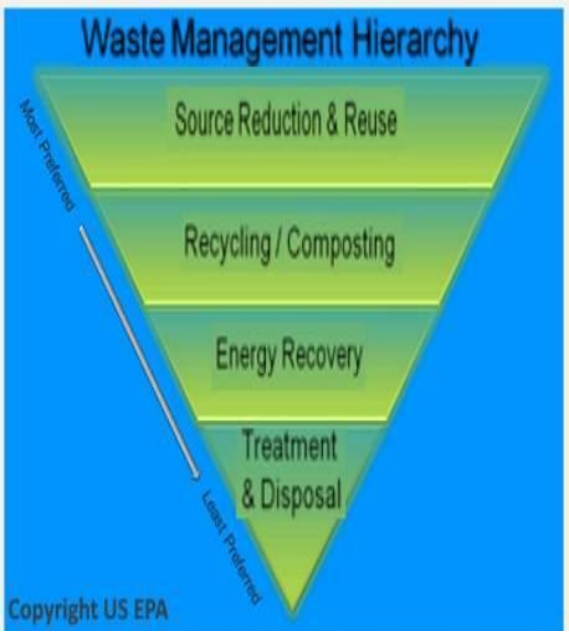

Figure 3.5: Waste Management Hierarchy
Source: USEPA (2019)

IV. CONCLUSION AND RECOMMENDATIONS

The study examined contemporary waste management practices such as integrated municipal solid waste management in Kano metropolis which involves recycling, combustions, incineration and the use of bioreactor waste treatment technology which converts degradable organic matter into consumable fuels and mitigates the effects of wastes that are organic in nature. The care of organic waste is fundamental to sustainable environmental development. Therefore, modern practices of waste management should be embraced wholly and religiously carried out in the metropolis if the issues of waste which seems to have defied solutions in the developing economy, especially in Kano metropolis are to be curtailed. It is on record as well as practical that Kano metropolis is the populous and largest city in Northern Nigeria (NPC, 2012). This perhaps has contributed to the high volume of waste generated in the metropolis on daily basis and have resulted to littered and heaps of waste which has overwhelmed REMASAB and private waste management institutions. The agencies dwell mostly on collection and disposal of waste at dumpsites as there is no sanitary landfill in the metropolis and then set the dumpsites on fire to get burn. The study conducted revealed that the residents and the stakeholder support the adoption of integrated municipal solid waste management and waste management hierarchy.

To key into the 2015 Sustainable Development Goals (SDGs) 3; Good Health and Well-being for People 6; Clean Water and Sanitation, and 11; Sustainable Cities and Communities in Kano metropolis by 2030, the study recommends that:

i. There is the need for paradigm shift from municipal solid waste collections and disposals to an integrated waste management.

ii. IMSWM is capital intensive, therefore Government should provide sufficient fund for bioreactor technology or biological treatment facilities and other waste management equipment and machines.

iii. There should be interrelationship among all the processes and procedures of solid waste management for sustainable environment.

iv. The demographic, economic and cultural characteristics of Kano indigenes requires intensive and consistent education and enlightenment on integrated and hierarchy approaches to municipal solid waste management for better result.

v. There should be specific and specified designed programmes of implementations from every part of the city.

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