



Conversion Of Municipal Solid Wastes To Energy, Its Effects On The Environment- A Case Study Of Kosofe, Ikorodu, Ikeja And Agege Local Government Areas Of Lagos State

Lucky Oderhohwo

(Department of Environmental Management & Technology)
(Ph.D. Student, Azteca University, Mexico)

ABSTRACT: The generation and management of Municipal Solid Waste (MSW) is a global challenge today and it requires immediate and concerted efforts. This research study ascertained the challenges of solid waste management in Lagos and the various ways the solid waste can be converted to useful products. Waste to wealth technologies were evaluated such as the Plasma Arc gasification, composting, pyrolysis, and biochemical process of waste to energy conversion. To enable the research study, achieve its objectives the researcher created three research questions and three Null hypotheses which were tested at 0.05 level of significance. Semi-or quasi- experiment and survey methods were adopted to collect data. A sample size of 400 was drawn from a population of 6,000. The Chi- square was used to test the null hypotheses. The findings from the research study show that there is economic value to be derived from solid waste conversion. Such economic values are the conversion of waste to energy, biodiesel. The research study showed that for efficient solid waste management Public and Private Partnership is a spring bond for economic development. The Government has a great deal of roles to play such as promulgation of legislations, creating conducive environment for investors to invest in the business of waste to wealth programs. The provision of waste management facilities within sources of waste generation to easy waste collection and storage. The following recommendations were made, create intensive and unified waste management awareness programmes to the grassroots, to encourage people collect, segregate and store wastes for recycling and Public & private partnership should be encouraged and ensure that there is government sponsored waste conversion capacity building programmes & budget and resources for integrated waste conversion technology and practice.

KEYWORDS: Municipal Solid Wastes, Energy, Environment, Pollution

Received 02 Apr., 2024; Revised 09 Apr., 2024; Accepted 11 Apr., 2024 © The author(s) 2024.

Published with open access at www.questjournals.org

I. INTRODUCTION

The size of the world remains static while the population of people increases on daily basis thereby causing overexploitation of the environmental components [1]. The Environment has been plagued by the nonchalant anthropogenic activities, poor solid wastes management hence the need to protect the environment. Man has always had need to create products for its existence by relying on the natural resources and as such several of the environmental components have invariably been jeopardized. Global warming, soil contamination, ozone depletion, hazardous wastes, acid rain, radioactive hazards, climate change, desertification, deforestation, noise, and diminishing biodiversity are illustrations of current environmental problems that are common to nations worldwide.

According to Boyle [2], the growth in human population and rising or deteriorating living standards due to use or misuse of technology are intensifying these problems. If the existing human–environment interaction continues and if the human population increases with the current trends, the evidence shows that irreversible environmental damage may be inflicted on this fragile planet. Ecologically sensitive areas have also been impoverished leading to the extinction of ecologically sensitive species. Wastes are generated in any human and industrial activities in the quest to satisfy a curiosity or need.

[3], in his study opined that the scope of human intervention in the environment and how it is managed bear particular importance, in that humans are now the main causes of environmental changes and man eventually is subjected to the adverse effects of environmental pollution.

However, in recent times there has been a dramatic development and technological advancement leading to the production of less environment-friendly products with adverse negative effects on the environment. The release of toxic substances arising from the production of household items and poor solid waste management arising from burning of municipal solid wastes releasing air pollutants into the atmosphere has hitherto negatively destabilized the equilibrium existing within the natural ecosystem and hence the untold environmental consequences that have reared their devastating effects on the climate.

From the forgoing, it is therefore a matter of urgency to ensure that the environment is protected. Man must watch what he does and evaluates the negative impact of his activities on the environment.

[4] emphasized that one of the major causes of environmental problems is technology and how humans use it and the resultant wastes. He went further to state that technology can be both source and remedy to environmental problems and that it plays a critical role as an instrument for observing and monitoring the environment on global and local scales. The wastes generated must be managed to ensure that the environment is protected.

Waste is anything that does not have economic value to the originator and therefore should be managed from cradle to grave to ensure environment- friendly operation. Due to the dumping of nuclear waste at Koko in Warri North in 1988, the Federal Government of Nigeria promulgated the Federal Environmental Protection Act (FEPA Act 1988) giving rise to establishment of Federal Environmental Protection Agency (FEPA) and the states were mandated to establish the State environmental protection Agency (SEPA) such as the Lagos State Environmental Protection Agency (LASEPA).

Subsequently, the Federal Ministry of Environment and other State Ministries of Environment were created to make Environmental Policies, regulations, administer and enforce environmental laws in Nigeria. It took over this function in 1999 from the Federal Environmental Protection Agency (FEPA), which was created under the FEPA Act. Pursuant to the FEPA Act, each state and local government in the country set up its own environmental protection body for the protection and improvement of the environment within its jurisdiction.

Municipal solid waste management is a major responsibility of state and local government environmental agencies. The agencies are charged with the responsibility of handling, employing, and disposing of solid waste generated. The state agencies generate fund from subvention from state governments and internally generated revenue through sanitary levy and stringent regulations with heavy penalties for offenders of illegal dumping and littering of refuse along streets [5].

II. STATEMENT OF PROBLEM

The generation and management of solid wastes in Nigeria is a major challenge in environmental protection just as it is globally. The first environmental problems experienced in Nigeria was the dumping of toxic solid wastes in Koko, Warri North Local Government Area in Delta State. This aroused the environmental protection consciousness of the Federal Government. As important as it is, not much has been achieved in this regard. Municipal solid wastes are all over the streets in Nigeria posing serious environmental and health challenges to the inhabitants. This therefore calls for a concerted effort as to proffering solutions to the management and utilization of the solid wastes. The creation of wealth from wastes is a major consideration for the effective waste management in Nigeria.

Urbanization, overpopulation, industrial revolution has become a major cause of waste generation and inappropriate disposal method especially in urban areas of Nigeria. Human exposure to this unlawful act has triggered more health risks to the populace which advertently affects the entire livelihood and their major landscape. Lack of appropriate storage facilities, inadequate waste management and planning, wrong perceptions by residents and non-challant attitudes towards environmental cleaning and sanitation might be a cause of this problem.

[6] stated that dirty environment poses a lot of harmful effects and negative impacts on human especially outdoor personnel, workers producing infectious materials while young children get easily contacted and are most vulnerable to this act of ignorance and dirtiness.

This research study is being conducted to evaluate possible ways that municipal solid waste in ways that it can be put into use or create useful products and ensure safe environment for all. The main objective of this study is to ascertain possible ways that solid wastes can be converted to useful products. Other specific objectives are:

1. To evaluate the impacts of municipal solid waste conversion on the economy.
2. Ascertain the role of public private partnership in solid waste management.
3. To ascertain the role of awareness creation in solid waste management.

III. SIGNIFICANCE OF THE STUDY

The significance of this study will be discussed under academic & economic or industrial significance. Economically & industrially, the outcome and information accruing from this study will be of great benefits to the nation and the industrial sector. The solid wastes generated and disposed-off in an unkempt manner will be put into useful products, like recycling tyre to other house hold products or reuse bottles many times that will boost the economy of Lagos State and the national at large.

Academically, when this work is published, or donated to library, the findings of this study will add to the body of knowledge on how solid wastes can be converted into valuable products and create employment opportunities. The study will assist solid waste managers, collectors, and facilities engaged in solid waste recycling.

Furthermore, the findings of this study will add to the existing literature, and on solid waste management.

IV. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

i. THE CONCEPT OF SOLID WASTES

The concept of waste revolves round human activities. Wastes are generated once anthropogenic activities take place and the wastes generated are in the form of solid, liquid & gas. The research study focusses on municipal solid wastes and so solid wastes could be defined as wastes that are not in the liquid and gaseous forms resulting from anthropogenic activities, which often is regarded as being useless. It could take the forms of refuse, garbage, and sludge [7].

Cities in Nigeria, being among the fast-growing cities in the world are faced with the problem of solid waste generation, handling, and disposal [8]. The implication is serious when a country is growing rapidly, and the wastes are not efficiently managed. Waste generation scenario in Nigeria has been of great concern both globally and locally [9].

[10] pointed out that solid wastes have posed the most serious urban environmental problem in Nigeria, as the streets experience continual presence of solid waste from various commercial activities. [11]; [3] identified age, rising population, educational status, collection facilities and amount charged for waste collection services as major factors influencing challenges of solid waste management.

The increase in the quantities of wastes generated is because of urbanization and the high rate of developmental activities in any economy. As nations and cities become more populated and prosperous, there is an unavoidable quest to create products and services to meet the demands of the populace and hence generation of wastes.

According to [13] in 1900, almost 14 percent were urban dwellers, although only 12 cities had one million or more dwellers and in 1950, 30percent of the world population resided in urban centres and the number of cities with over1 million people grew to 83 cities. The world has experienced unprecedented urban growth in recent decades.

In the works of [14] they stated that in 2008, in the history of urban & rural population growth, the world population was evenly split between urban and rural areas, more developed nations were about 74 percent urban, while 44 percent of residents of less developed countries lived in urban areas.

In another research study, [15] stated that, urbanization in so many less developed nations of the world are occurring in a rapid and quick succession and that it is however anticipated that about 70 percent of the world population will be urbanized by 2050 and most urban growth will occur in less developed countries.

[16] projected that about 50% of the Nigeria's population will reside in urban areas by 2025, and this will lead to more municipal solid wastes to be generated. Since the beginning of history, humans have generated solid waste and disposed of them in a variety of ways, such as makeshift waste dumps or incineration. After the Industrial Revolution in the eighteenth century, the quantity of goods and items used and disposed by the populace increased so dramatically that it became necessary for cities to provide landfills and old-style incinerators for disposing wastes. The management of urban waste became problematic during the mid-twentieth century as the consumption of goods and the corresponding generation of Municipal Solid Waste saw a manifold increase [17].

Undoubtedly, civilization and urbanization has seen human race generating waste such as bones and other parts of animals they slaughter for their food or the wood they cut to make their shelters, tools, carts etc. The advancement of civilization and industrialization witnessed the waste generation getting enhanced and becoming more complex in nature. The beginning of industrial era has had enormous effect on the lifestyles of people which have started changing with the availability of many consumer products and services in the market. The manufacturing and usage of vast range of products as well as management of the resulting waste give rise to emission of greenhouse gases. This has led not only to the pollution of air and water but has affected the planet earth through global warming [18].

Waste generation is a natural product of urbanization, economic development and population growth. As nations and cities become more populated and prosperous, offer more products and services to citizens, and participate in global trade and exchange, they face corresponding amounts of waste to manage through treatment and disposal. Effective solid waste management is achieved if they are segregated, sorted/categorized, and disposed in approved dumpsites or recycled.

ii. WASTE & CATEGORIZATION

Waste is relative in nature as it hinges on what an individual would regard to be a waste and what another individual will assume it to be. The definition of wastes is relative and depends on individual's perception of what waste is; because what is a waste to an individual is a resource to another individual. So, waste can be defined as, anything that does not have an economic value to the originator(s) and must be managed from 'cradle to grave'.

Waste is defined as unwanted and unusable materials and is regarded as a substance which is of no use. Waste that we see in our surroundings is also known as garbage. Garbage is mainly considered as a solid waste that includes wastes from our houses (domestic waste), wastes from schools, offices, etc. (municipal wastes) and wastes from industries and factories (industrial wastes).

iii. MUNICIPAL SOLID WASTE GENERATION

Urbanization and the quest to satisfy a particular need calls for creating an avenue through which such needs are met and in the process such activities create wastes. Waste generation is both domestic/municipal and industrial. Every anthropogenic activity leads to waste generation. Waste generation increases with increase in developmental activities and population growth; when the population is increasing, there is the tendency to create products that will meet the needs of the growing population, hence increase in the rate of waste generation. Waste generation is a global concern as there is no country that is immune from solid waste generation. The rate of municipal waste generation in Nigeria is alarming just as other countries of the world.

According to a recent survey conducted by World Bank, the world generates about 2.01 billion tonnes of municipal solid waste annually, with at least 33% of the solid wastes not managed in an environmentally friendly manner. A global Snapshot of Solid Waste Management to 2050 conducted by World Bank stated that global waste is expected to grow from 2.01 billion tonnes to 3.40 billion tonnes by 2050, more than double population growth over the same period. Waste generation is a natural product of urbanization, economic development, and population growth. As nations and cities become more populated and prosperous, offer more products and services to citizens, and participate in global trade and exchange, they face corresponding amounts of waste to manage through treatment and disposal. Municipal solid waste (MSW) encompasses decomposable wastes such as food and vegetable wastes (cooking waste), and non-decomposable wastes such as metallic, glass, paper, polymers (synthetic rubbers, polyethylene terephthalate, polyvinyl chloride etc.), industrial waste is made up of a wide variety of nonhazardous materials that result from the production of goods and products. Commercial and institutional, or industrial waste is often a significant portion of municipal solid waste, even in small cities and suburbs [18].

City	Population	Agencies	Tonnage /month	Density(kg /m ³)	Kg/capita/day
Lagos	8,029,200	Lagos State waste management authority (LAWMA)	255,556	294	1.06
Kano	3,248,700	Kano State Environmental Protection Agency	98,440	245	1.01
Ibadan	1,835,307	Oyo State Environmental Protection Commission	53,960	286	0.98
Kaduna	1,458,900	Kaduna State Environmental Protection Agency	44,640	303	1.02
Port Harcourt	5,700,000	Rivers State Environmental Protection Agency	179,600	325	1.05
Makurdi	259,500	Urban Development Board	7,863	270	1.01
Onitsha	509,500	Anambra State Environmental Protection Agency	15,440	234	1.01
Nsukka	100,700	Enugu State Environmental Protection Agency	3,051	257	1.01
Abuja	778,567	Abuja Environmental Protection Agency	24,290	298	1.04

iv. ELECTRONIC WASTE(E-WASTE)

The advent of Information and Telecommunications Technology (ICT) and computer Internet networking has penetrated nearly every aspect of modern life and is positively affecting human life even in the most remote areas of developing countries such as Nigeria [19].

Electronic waste(e-waste) is referred to the end-of-life electronic and telecommunication equipment and consumer electronics, such as, the computers, laptops, television sets, DVD players, mobile phones etc., which are to be disposed. It is one of the fastest growing segments of the Municipal Solid Waste stream in Nigeria. The (United Nations-Electronic Waste Recovery Business) estimated that on yearly basis between 20

and 50 million tons of e-waste is generated globally, an amount growing at a rate nearly three times faster than the overall municipal solid waste stream [20].

v. THE CONCEPT OF WASTE MANAGEMENT

Waste management has different concepts, approaches, and hierarchy. Waste management involves scientific, artistic, and technological approaches to waste control, disposal, and conversion to other useful materials which are beneficial to man and the environment. The principle of waste management revolves around the "3Rs", namely, reducing, re-use, and recycling. This classification is according to their desirability in terms of waste minimization. The waste hierarchy aims to extract the maximum practical benefits from products and generate the minimum amount of end waste (Reduce). Reuse seeks alternative uses for the wastes. The third stage is to recycle, which refers to recovery of wastes or waste-to-energy strategy. The waste hierarchy represents the progression of a product or materials through the sequential stages of the pyramid of waste management. It represents the latter parts of the life-cycle for each product. Waste recycling can be done by converting solid waste products through various technological processes into usable products [21].

[22] went further to confirmed that studies in the laboratory were shown that the discarded pseudostem and fiber of Musa species could be utilized or converted into papermaking and bio-alcoholic. He opined that following a systematic approach to waste management, waste materials can be transformed to wealth. Wealth created through the conversion of waste has to do with harnessing and sensibly packaging waste resources at one's disposal. In other words, discarded waste could be as well be utilized to produce more useable items.

vi. PLASTIC WASTES MANAGEMENT

Just like other municipal solid wastes, E-waste, plastic waste is a global menace that requires urgent industrial and technological intervention. Since the late 19th century, globally man has always depended on plastic as an affordable and durable material and its affordability. The generation of plastics waste just like other municipal solid wastes is stimulated by increase production coupled with an increasing population, and it is responsible for the world's present environmental crisis.

According to [5] management of plastic wastes has some complications such as the increasing number of additives used in the production of plastic products alter the strength, texture, flexibility, colour, resistance to microbes, and other characteristics of plastics, and this make plastics less recyclable. To worsen it there is little market value in some plastics, leading municipalities to landfill or incinerate plastics as waste. Based on figures from the EPA (2011 data) only 8% of plastic materials are recovered through recycling.

vii. MUNICIPAL SOLID WASTE MANAGEMENT

It is extremely difficult to avoid the generation of waste however small it would be, anthropogenic activities create wastes, but the crucial aspect of waste generation and management is about its reduction and recycling protocol. The act of using recyclable paper bags/carriers or cloth shopping bags and taking adequate procedures to buy reusable products whenever possible are some of the necessary practices. These basic procedures will reduce the volume of municipal solid waste generated.

[3] defined waste management as purposeful, systematic control of the generation, storage, collection, transportation, separation, processing, recycling, recovery, and disposal of solid waste in a sanitary, aesthetically acceptable, and economical manner. It is the practice of protecting the environment from the polluting effects of waste materials in order to protect public health and the natural environment. Thus, the priority of a waste management practice is to ensure maintenance of the health and safety of citizens and their environment. He went further to state that waste management involves preparing policies, determining the environmental standards, fixing emission rates, enforcing regulations, monitoring air, water and soil quality and offering advice to government, industry and land developers, planners and the public.

V. LITERATURE REVIEW

a. SOLID WASTES GENERATION AND MANAGEMENT IN LAGOS STATE

Lagos State is one of the commercial hubs of Nigeria and it is the second fastest and largest growing city in Africa and seventh in the world (<http://www.lagosglobal.org>). Lagos State has a population of about 21 million with a per capita waste generation of 0.5 kg per day with about 10,000 tons of solid waste per day. There have been different strategies to manage the volume of municipal solid wastes generated in the city. Lagos State Waste Management Authority (LAWMA) was created to oversee waste collection, sorting, recovery, recycling, and disposal. One fundamental challenge of waste management in the State just like any other states in Nigeria is the delayed collection of household solid wastes. Worst still, in some cases, the wastes are not collected until after a week or two, as a result, the waste bin overflows and litters the surroundings. These wastes are then feasted on by rodents and breeze carry them all over the stretch of the streets thereby aggravating the current environmental state. The drive by the Lagos State government and its Agency (LAWMA) to integrate private

partnership into solid waste management has also bedeviled the situation. The Private trucks engaged to cart away these wastes to the dumpsite are often seen overloading the trucks with the wastes dropping on the street as they move the wastes to the various dumpsites. Lagos state hosts the largest landfill sites in Nigeria.

i. OLUSOSUN DUMPSITE

Olusosun is the largest dumpsite located on 43 hectares and 18m deep in Nigeria with capacity of about 2.1 million tonnes of waste annually comprising mostly municipal solid waste, construction waste, and electronic waste (e-waste). It was constructed in 1992 and has housed about 24.5 million tonnes of waste since then.

ii. SOLOUS 2 DUMPSITE

Solous 2 dumpsite is in Lagos and constructed in 2006 and occupies around 8 hectares of land along LASU-IBA road with an installed capacity of about 820,000 tonnes of waste annually and has since its existence received about 5.8 million tonnes of Municipal Solid Wastes. The dumpsite is located 200 meters away from the nearest dwellings and almost 4 million people live within 10km radius from the site. Due to the vulnerable sand formation of the area, leachate produced at the dumpsite flows into groundwater causing its contamination.

iii. EPE DUMPSITE

Epe dumpsite was sited in 2010 on about 80 hectares of land with an annual capacity of 12,000 tonnes of MSW. The dumpsite which the Lagos State government is planning to upgrade to an engineered landfill and set to replace Olusosun dumpsite after its closure. Since its existence, it has received about 47,000 tonnes of waste and it is just 500 meters away from the nearest settlement. The dumpsite is also just 2km away from Osogbo River and 7km away from Lekki Lagoon.

VI. METHODS OF SOLID WASTES HANDLING AND PRINCIPLES OF WASTE MANAGEMENT

Generation of waste is unavoidable and not the challenge in any nation but rather the methods and technologies available for its handling. There are different methods that have been adopted from the medieval times till date such as composting. Latest methods and techniques have also been heralded into waste management globally. There are some basic principles in waste management when adopted proffer solution to the global problems of waste management. These are waste inventorization, waste characterization, waste segregation, waste minimization and all waste must be treated to a form that it can conveniently be handled. This paper shall attempt to explain some of the principles and the various methods used in waste handling globally and Nigeria in particular.

i. WASTE MINIMIZATION

[24] stated that waste minimization is an important element of waste management and sustainable development because it allows improvements to business performance to be created concomitantly with improvements to environmental performance. Elimination of waste followed by reduction at source and then recycling form the preferred hierarchy of options. Reduction at source techniques includes good practice as well as changes to raw materials, processes, and products.

Waste minimization is a conscientious effort to reduce the volume of wastes generated. It is a good principle in waste management that every industrial establishment should adopt. To efficiently minimize waste, waste inventorization is another key principle in waste management.

ii. WASTE INVENTORIZIZATION

[25] stated that the challenge of managing solid waste generally in developed countries has shifted from ensuring minimum damage to public health and environment to the way discarded resources are to be handled such that future generations are not deprived of its value. Developing countries like Nigeria on the other hand are still battling with the protection of human health and well-being while attempting to conserve resources [26].

Waste inventorization is the principle of waste management whereby the amount/quantities of all the categories of wastes generated are weighed and recorded. This will enable an individual, state, or nation to know the quantities of all the categories of waste generated within a time frame and thereby assisting in future budgeting for waste management facilities. Once you cannot quantify the quantity of solid wastes generated you cannot develop strategies for reduction and to adequately budget for facilities for the management.

iii. WASTE CHARACTERIZATION

Solid waste characterization is another type of the principle of waste management which is imperative in waste handling; this is because the characteristics of waste depend mainly on the various sources. It was emphasized in this paper the various sources of solid waste generation in a municipal area, mainly from

domestic, markets, industrial, agricultural, institutional, commercial, healthcare etc. The characteristics of solid waste from each of these sources vary widely and as such the handling methods is dependent on these characteristics.

In line with UNEP, for any Waste to Energy (WTE) technology to be used in handling waste stream, waste characterization data is very useful in achieving the following:

- determination of the best management methods for different materials;
- planning recycling and composting programmes by identifying the amounts of recyclables and organic materials generated by different sources;
- sizing WTE facilities based on the number of wastes remaining in the waste stream after recycling and composting; and
- estimating waste transportation and separation costs using local estimates of total municipal waste volume and weight.

The design of WTE is dependent on the chemical characteristics of the solid waste streams. In the works of [18] stated that in the design of the furnace/boiler portion of WTE facilities, the Municipal Solid Waste (MSW) characteristics that are critical are the calorific value, moisture content, proportion of non-combustibles, and other components (such as heavy metals, chlorine, and sulfur) whose presence during combustion will result in the need for flue gas cleanup. The capacity of a WTE furnace/boiler is roughly inversely proportional to the calorific or heating value of the waste.

iv. WASTE SEGREGATION

Waste segregation is the separating and sorting of waste to facilitate recycling. And, when sorted, waste is more easily recycled thereby saving you money (www.wastenetwork.com). Waste characterization improves greatly the waste segregation principle of waste management. Waste segregation is simply sorting the various categories of waste into their types and are stored in different containers. This principle also aids in WTE technology and easy of waste conversion to energy. Segregation of solid waste is carried out at: source of generation, the collection point, transportation, and disposal point. It is worthy to note that waste segregation done at a collection point often generates additional income for waste collectors wherein the collectors usually keep papers, undamaged bottles metal, and plastic items separately for selling to scrap dealers.

In the research work of [27], they commented that segregation of waste can be done by hand sorting, screening process, air classifier (Air classifiers are used to separate the less dense material from denser fraction using air), Sink/Float Separators, Inclined Tables/ shaking tables, optical sorting, magnetic, by differential in melting temperature, electrostatic separators.

According to WHO, waste segregation is essential for waste minimization; indispensable for effective waste management, improves public health protection; should be done according to specific treatment and disposal requirements; it should be carried out by waste producer; harmonize all over the country and same segregation from production until disposal.

v. WASTE MINIMIZATION

Waste minimization is a waste management principle that seems to assist to reduce the quantities of wastes generated. There are 5Rs of waste minimization; viz; reduce, recycle, reuse, recover/residue. Waste recycling is an embodiment of the subject known as waste-to-energy. Recycling is defined as recovery of material resources usually in form of paper, glass, metals, and plastics, sometimes wood and food waste from the waste stream [28]. It is the process of reclaiming of waste into a usable raw material or product consequently allowing materials to have a protracted life in addition to reducing resource consumption and avoiding disposal costs [18].

b. WASTE DISPOSAL METHODS

The collection of Waste is germane in the chain of municipal solid waste management practice right from the point of generation to ultimate disposal. In any initiative to strengthen or upgrade waste management service, sustainable, contextually appropriate collection should be a major focus of attention. The main disposal methods for municipal solid waste (MSW) are open dumping and sanitary landfill. Uncontrolled dump sites are smoky with a lot of leachate generation with severe environmental pollution. On open dumping grounds generate foul odors and habitat for vectors and rodents. There are various methods used in handling wastes in Nigeria in particular and globally in general, which border on waste burning, ocean dump, composting, landfill and incineration methods.

The open burning is largely abhorred and the environmental regulatory bodies frown at burning of refuse because of the deleterious safety risks, health risks to the public and the greenhouse effect. There are some remote/rural areas in Nigeria where dumping of solid wastes into rivers have still been practiced till today; and this can be traced to rural factors where such waste disposal options are not readily available. The waste

streams are mainly domestic, food and agricultural products. This practice leads to odour, high turbidity and salinity in such open water sources. Composting of waste is at the local/rural level where the farmers resort to digging some of the agricultural wastes into the ground to form manure.

Sanitary landfills are the last option stockpile for solid waste after all other waste management options have been considered. Consideration of sanitary landfill should be made so that they are not close to residential areas to avoid transmission of germs, fire incidents, and leachate that can contaminate surface water. Landfills can be categorized according to open dumps, controlled dumps, or sanitary landfills (or secured landfill or engineered landfill [29]. Sanitary landfill facilities should be located where the quality of air will not be affected by the offensive odour from it and consideration should be made so that it is far away from airport due to birds that can cause accident to aircrafts.

Incineration is another method used for waste disposal and it is one of the most widely used methods to dispose all combustible waste. Incineration is a solid waste thermal treatment process which encompasses the burning of organic substances contained in waste materials. Incineration of waste materials converts the waste into ash, flue gas and heat. Combustion process results in air pollutants and needs to be controlled. Incineration is less practiced in the developing countries for economic reasons. The role of regulatory requirement in effective waste management and disposal is key to ensure environmental sustainability. There are existing environmental protection and waste management regulations in place in Nigeria, but enforcement is so very essential to ensure compliance. Waste is the greatest danger facing mankind in the world today therefore measures must be nationally and internationally taken to control disposal of such waste to save humanity from total extermination from the surface of the earth [30].

VII. METHODOLOGY

The descriptive survey research design was used for this study. There will be assessment of the opinion of the selected respondents. Survey research generally collects information from a defined sample in order to describe condition of the population using variables under the study [31]. The area of the research study is in four Local Government Areas (Kosofe, Ikorodu, Agege and Ikeja) in Lagos State. Lagos State is one of the fastest growing cities in Nigeria. It has an area of about 3,577km² created 27th May 1967 (State Creation and Transitional Provisions Decree No. 14 of 1967) within the Western Region of Nigeria.

Kosofe Local Government Area has an area of 81 km² (31 sq mi) and a population of 665,393 at the 2006 census. Ikorodu Local Government Area is located to the north-east of Lagos City, along the Lagos Lagoon and shares a boundary with Ogun State with a population of 535,619 according to the Census 2006. Agege Local Government Area has a population of 459,939 according to 2006 census. While Ikeja Local Government Area has a population of 313,196 according to 2006 Census. The target population for this study was 6000 occupational health & safety professionals, waste vendors and waste Managers.

A sample size of 400 occupational health & safety professionals, waste vendors and waste Managers. The 400 persons responded to the questionnaire. There are various ways propounded to determine the sample size of a population but for this research study, the Taro Yamani formula was adopted because it is very suitable for academic works. The Taro Yamani formula is represented as below

$$n = \frac{N}{1+N(e)^2}$$

Where n= sample size, N= Population

E= Sampling of error or level of precision, which is 5%.

From this formula, the sample size can be calculated.

$$n = \frac{6000}{1+6000(0.05)^2} \qquad n = \frac{6000}{1+6000(0.0025)}, \qquad n = 375$$

A self-constructed researcher questionnaire was used for the study. The questionnaire was in two sections, section A and B, section A consist of personal data of the respondents while section B, are questions constructed to contain the content of the study on waste management.

Validity of an instrument is to ascertain whether an instrument measured what it tends to measure. Therefore, to ascertain the validity of the constructed instrument, the researcher used the face, content of the work and construct techniques to construct the instrument and gave it to experts in measurement and evaluation department of University of Lagos to access its face, content and construct validity. The instrument was found to be valid for this study

The test-retest method of reliability was used to ascertain the reliability of the instrument. 20 copies of the instrument were administered on 20 experts of waste management who are going to be part of the study to answer, after two weeks the same instrument was readministered to the same group of the sample, the Pearson's

Product Moment Correlation Coefficient was used to measure the reliability and strength of the two sets of scores it was found that the instrument was reliable.

Primary and Secondary type of data collection methods were employed. The primary source of data collection is from results of questionnaires and interview conducted while the secondary source is from data sourced from journals, textbooks, online daily newspapers and other online publications. The data collected were analyzed and presented using tables and charts.

The instrument was administered by the researcher and 4 research assistants trained by the researcher. The instrument was administered and collected on the spot to avoid loss. The completion and return of the instrument was 100%.

The Chi square was used to analyse the hypothesis @ 0.05 level of significance. If the calculated value is higher than the critical or tabulated value, the null hypothesis is rejected if not the null hypothesis is accepted.

The questionnaire of 5-point Likert scales of strongly agreed, Agreed, strongly disagreed and undecided was used and simple percentages were used to analyse the results.

Chi-Square test was used in this study. A chi-square (X^2) test is a statistical technique used to compare two categorical independent variables in a contingency table to see if they are related. Chi-Square is a statistical technique used to test how variables differ from each another. According to [32], a *chi-square* (x^2) statistic is a *test* that measures how a model compares to actual observed data. A chi-square (x^2) statistic is a measure of the difference between the observed and expected frequencies of the outcomes of a set of events or variables. Chi-Square is mathematically expressed as:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

Where O = Observed value(s)

E = Expected value(s)

VIII. RESULTS AND FINDINGS

8.1 Demographic Characteristics

Distribution by area of resident			
State	Frequency	Percentage	Total
Kosofe	100	25	100
Ikorodu	100	25	100
Ikeja	100	25	100
Agege	100	25	100
Total	400	100	400
Age of Respondents			
	Frequency	Percentage	Total
15 – 24	100	25	100
25 – 34	100	25	100
35 – 44	100	25	100
45 and above	100	25	100
Total	400	100	400
Sex of Respondents			
	Frequency	Percentage	Total
Male	240	60	240
Female	160	40	160
Total	400	100	400
Marital Status of Respondents			
	Frequency	Percentage	Total
Single	120	30	60
Married	240	60	120
Divorced	12	3	6
Widowed	28	7	14
Total	400	100	400
Educational Qualification of Respondents			
	Frequency	Percentage	Total
School Cert	0	0	0
OND/N.C. E	0	0	0
HND/BSC	300	75	300
Masters	95	23.75	95
PhD	5	1.25	5
No Certificate	0	0	0
Total	400	100	400
Religion of Respondents			

	Frequency	Percentage	Total
Christianity	220	55	220
Moslem	140	35	140
Others	40	10	40
Total	400	100	400
Occupation of Respondents			
	Frequency	Percentage	Total
Waste Supervisors	60	15	60
Waste Managers	40	10	40
Waste to wealth business owners	60	15	60
Conversation managers	180	45	180
Workers of municipal solid waste	40	10	40
Enviro, conservation supervisors	20	5	20
Total	400	100	400
Area of residence			
	Frequency	Percentage	Total
Ikorodu	100	25	100
Kosofe	100	25	100
Ikeja	100	25	100
Agege	100	25	100
Total	400	100	400

Source: Researcher fieldwork, 2022

The table presented above reveals the age distribution of the respondents as follows, 25% each of the respondents are in the age brackets of 15-24, 25 – 34, 35- 44, and 45 and above respectively showing that each age bracket was dully represented. Furthermore, from the analysis above, 60% of the respondents were male while 40% were female, the analysis showed that both male and females were represented. It further shows that 30% of the respondents are single, 60% are married, 3% are divorced while 7% are widowed. The research reveals the academic qualification of the respondents as follows; respondents hold School Cert, OND/NCE, 75% hold HND/ BSC, 23.75% hold Masters degrees, while 1.25% holds PhD. The religion of the respondents is as follows; 55% of the respondents are Christians, 35% Muslims while 10% are in other religions. The responsibility of the respondents are as follows; 15% of the respondents are waste supervisors, 10% are waste managers, 15% owe waste business, 45% are conservation managers, 10% are workers of municipal solid waste, while 5% are environmental conservation supervisors. 25% of the respondents came from each area under sample. Each area under study were equally represented.

A total of 15 item point statements Likert Scale of Strongly Agreed, Agreed, Strongly Disagreed, Disagreed and Undecided were distributed and collected. The analysis showed that 75% and 17.5% of the respondents strongly agreed and agreed that Nigerians are aware of how solid waste are managed, 5% are undecided while 2.5% % and 2% disagreed to the statement. The analysis showed that 45% and 17.5% of the respondents strongly agreed and agreed 2.5% were undecided while 15% and 20% disagreed and strongly disagreed and disagreed that the level of the level of household involvement in solid waste management is encouraging. 52% and 22.5% of the respondents agreed and strongly agreed to the statement that government is trying in the area of solid waste management while 5% and 20% disagreed and strongly disagreed.

To examine the public/private partnership in solid management will positively impact upon waste management and wealth creation, 50% and 25% strongly agreed and agreed while 10% and 5% strongly disagreed and disagreed to the statement. 10% and 90% of the “respondents strongly agreed and agreed that effective conservation of solid waste management leads to creation of wealth and improves the economy of Nigeria. 87.5% and 10% of the respondents strongly agreed and agreed that the effective solid waste conservation produces energy, 2.5% disagreed to the statement. While 75% and 17.5% of the respondents strongly agreed and agreed that public enlightenment campaign on solid waste management will improve waste management 5% and 2.5% disagreed and strongly disagreed to the statement.

To examine the impact of poor public campaign on solid waste management is a factor that militate against solid waste management 72.5% and 20% strongly agreed and agreed while 2.5% disagreed and 5% were undecided. While 67.5% and 22.5% of the respondents strongly agreed and agreed that the level of technology

advancement affects the conversion of solid waste to wealth in Nigeria 6.25% are undecided and 3.75% disagreed.

To examine the impact of individual involvement in solid waste collection and management is very paramount 70% strongly agreed, 17.5% agreed to the statement while 7.5% and 5% each strongly disagreed, disagreed. While 75% and 17.5% strongly agreed and agreed that the nature of roads and infrastructural development militates against solid waste management and recycling in Nigeria 5% and 2.5% strongly disagreed and disagreed.

To examine the extent of awareness and importance of solid waste management and conservation to other products is on the increase in Nigeria 72.5% and 20% strongly agreed and agreed while 5% each strongly disagreed and disagreed. While 80% and 17.5% each strongly agreed and agreed to the statement that government should assist individuals and organizations to involve in waste management and conservation with grants and tax holidays to improve waste to wealth 1.25% disagreed and strongly disagreed to the statement. In the statement waste management and conservation to wealth is an untapped venture in Nigeria 63.2% and 17.5% strongly agreed and agreed, 1.25% were undecided while 15.5% and 2.5% disagreed and strongly disagreed.

8.2 Test of Hypothesis

Hypothesis 1 – There will be no significant relationship in the Nigerian economy and economic value of municipal waste conversion.

S/N	Statement	Strongly Agreed	Agreed	Undecided	Disagreed	Strongly Disagreed	Total
1	Effective solid waste management and conversion has economic value in Nigeria	260	80	40	10	10	400
2	Effective conversion of solid waste leads to creation of wealth and improves the economy of Nigeria	360	40	0	0	0	400
Total		620	120	40	10	10	800

Fo	Fe	Fo-fe	(fo-fe) ²	(fo-fe) ² /fe
260	310	-50	2500	8.07
80	60	20	400	6.7
40	20	20	400	20
10	5	5	25	5
10	5	5	25	5
360	310	50	2500	8.07
40	60	-20	400	6.7
0	20	-20	400	20
0	5	-5	25	5
0	5	-5	25	5
Total	Calculated chi square		X ²	89.54

Critical value $(c-1) * (r-1) = (2-1) * (5- 1) = 1 * 4 = 4$

@0.05 level of significant = 9.49

The calculated Chi Square value of 89.54 is greater than the critical value of 9.49 tested at 0.05 level of significance. The Null hypothesis is therefore rejected and the alternate hypothesis accepted.

Decision Rule: There is therefore a significant relationship in the Nigerian economy and economic value of municipal waste conversion

Hypothesis 2 – There will be no significant relationship in the role of public private partnership in solid waste management and Nigerian Economy

S/N	Statement	Strongly Agreed	Agreed	Undecided	Disagreed	Strongly disagreed	Total
1	The role of the public private partnership in solid waste management will positively impact upon waste management and wealth creation	200	100	0	40	60	400
2	Individuals' involvement in the solid waste collection and management is very paramount	280	70	0	30	20	400
Total		480	170	0	70	80	800

Fo	Fe	Fo-fe	(fo-fe) ²	(fo-fe) ² /fe
200	240	-40	1600	6.67
100	85	15	225	2.647
0	0	0	0	0
40	35	5	25	0.71
60	40	20	400	10
280	240	40	1600	6.67
70	85	-15	225	2.65
0	0	0	0	0
30	35	-5	25	0.71
20	40	-20	400	10
Total	Calculated chi square		X ²	40.057

Critical value $(c-1) * (r-1) = (2-1) * (5- 1) = 1 * 4 = 4$

@0.05 level of significant = 9.49

The calculated Chi Square value of 264.65 is greater than the critical value of 9.49 tested at 0.05 level of significance. The Null hypothesis is therefore rejected and the alternate hypothesis accepted.

Decision Rule: There is therefore a significant relationship in the role of public private partnership in solid waste management and Nigeria economy.

Hypothesis 3 – There will be no significant relationship between public enlightenment campaign on solid waste management and improvement in the environment

S/N	Statement	Strongly Agreed	Agreed	Undecided	Disagreed	Strongly Disagreed	Total
1	Public enlightenment campaign on solid waste management will improve waste management	300	70	0	20	10	400
2	Poor public campaign on solid waste management is a factor that militates against solid waste management	290	80	0	20	10	400
Total		590	150	0	40	20	800

Fo	Fe	Fo-fe	(fo-fe) ²	(fo-fe) ² /fe
300	295	5	25	0.0848
70	75	-5	25	0.333
0	0	0	0	0
20	20	0	0	0
10	10	0	0	0
290	295	-5	25	0.0848
80	75	5	25	0.333
0	0	0	0	0
20	20	0	0	0
10	10	0	0	0
Total	Calculated chi square		X ²	0.8356

Critical value $(c-1) * (r-1) = (2-1) * (5- 1) = 1 * 4 = 4$

@0.05 level of significant = 9.49

The calculated Chi Square value of 0.8356 is less than the critical value of 9.49 tested at 0.05 level of significance. The Null hypothesis is therefore upheld.

Decision Rule: There will be no significant relationship between public enlightenment campaign on solid waste management and improvement in the environment

8.3 Discussion of Results

[33] noted that “heap of waste in Nigeria are growing in geo metric proportion and without waste management there will be subsequent extension of degradation of the environment. The phenomenal increase of people has put environmental pressure on land and water resources used by communities that is characterized by competition over space and waste disposition and management”. The success of any country is the hygienic and

sustainability of its environment, every community wants to live comfortable in neatness, health and sustainability of life. Whatever affects populations of people in any particular society affects their performance and livelihood and over all wellbeing of the entire country, conversion of waste to wealth will help in recovering space that would have been taken over by waste, health of healthy environment and subsequent generation of resources for the country.

Findings from the study shows that elements of environmental degradation and none utilization of waste in conversion into other usable products for waste management and minimal waste. The tested hypothesis found out that there is a significant relationship between Nigerian economy and economic value of municipal waste conversion Adedokun, [34] and [35] who found out that there is a relationship in the Nigerian economy and economic value of municipal waste conversion. This result is in line and also reflects the findings and works of [36] and [35] government enlightenment campaign has not impacted or improved on the environment.

The hypothesis also found out that there is a significant relationship in the role of public private partnership in solid waste management and Nigeria economy. These findings correspond with the works of [34], [37], who found out that there is a significant relationship between the role of public private partnership in solid waste management and Nigeria economy. The study also found out that the when government partners with private persons on solid waste management will impact positively on the environment. This is consistent with [39] proper enlightenment, education and good government policies can help address the issues of waste management. Finally, the study revealed that good governance will play an important role in positively influencing the communities for cleanliness and bringing out policies that will favour waste management while improving the economic development of Nigeria.

In regards to tested hypothesis that found out that there is no significant relationship between public enlightenment campaign on solid waste management and improvement of the environment. impact of public enlightenment campaign on solid waste management and improvement in the environment are not significant. there is no significant relationship between public enlightenment campaign on solid waste management and improvement in the environment. These results were consistent with [36], whose work confirmed that public enlightenment campaign on solid waste management and improvement in the environment are not significant.

IX. SUMMARY OF FINDINGS

Practical approach to effective solid waste management to ensure sustainability, environmental protection and creating wealth to boost the economic value of solid waste lived more to be desired in Lagos State and the Nation in general. Solid waste management is not seen especially at the rural area as a very important strategy in economic development.

The poor solid waste management approach is as a result of some factors such as the rate of urbanization, overpopulation. Low level of public enlightenment and the habits of burning solid wastes leading to air pollution. The conversion of solid waste materials into other useful products can improve economic value of wastes.

Plastic waste is a global menace and environmental challenge that must be tackled by all. Research has found out that there is hope in the management of plastic waste through the application of Waxworm. The organism has been identified to degrade plastic materials and as such more research works on this will proffer solution to plastic waste management.

X. RECOMMENDATION

The followings are recommendations:

- i. The Government of Nigeria should ensure proper integration of waste management across all the states reaching the nooks and crannies of Lagos and the Nation Nigeria in general.
- ii. Create intensive and unified waste management awareness programmes to the grassroot to encourage people collect, segregate and store wastes for recycling.
- iii. Public & private partnership should be encouraged and ensure that there is budget and resources for integrated waste conversion technology and practice.
- iv. The Government in all the tiers should provide facilities at the reach of all the household adequate to incorporate waste segregation and sorting.
- v. At the Federal & State levels, there should be waste to wealth awareness programmes. When the populace knows what can be derived from waste materials they will buy-in into Government wastes management programmes.
- vi. The government should train personnel in the field of waste to energy conversion programmes and establish latest technologies and plants for conversion of municipal solid waste to wealth and energy.
- vii. The practice of composting should largely be embraced as, it is a relatively low-cost option to convert organic waste into a fertilizer-like product while generating employment opportunities and environmental benefits.

- viii. Income can be generated from the adoption of anaerobic digestion of municipal solid wastes by any Government; by distributing the biogas directly to end-users, selling electricity generated from the biogas, and potentially selling the fertilizer to farms. The Government should invest in construction of biochemical waste to energy technology, as this will relax on the excessive reliance of fossil fuel which has more devastating effects on the environment.
- ix. Pyrolysis and gasification are emerging technologies in municipal solid wastes that have not yet been demonstrated at large-scale for treating municipal solid waste. They can generate a range of products, mostly a synthetic gas (that can be condensed to a liquid fuel) and a soil amendment and as such the Federal Government should invest in this sector.

XI. CONCLUSION

This research work focused on the various ways that municipal solid wastes can be harnessed to generate wealth at all levels with focus on Lagos State. From this work the researcher is disposed to conclude that there are so much to derived from solid wastes if properly harnessed. The Nation Nigeria has so much to derive and gain if proper public enlightenment is made on efficient waste management strategies and the need to invest in the waste to energy (WTE) technologies.

The Government of Nigeria in general must ensure that creating wealth from waste technology and practices are embraced. This is a practice that can create good employment opportunities and generate so much income to the nation. The Government at all levels should therefore embrace turning waste to wealth philosophy as this will reduce carbon footprint and environmental impact.

REFERENCES

- [1]. Edward, O., & Umana, Etim & Markson, Aniedi-Abasi & Okey, P.. (2013). Municipal solid waste characterization and management in Uyo, Akwa Ibom State, Nigeria. 639-648. 10.2495/SDP130531.
- [2]. Boyle (1994). Biodiversity, Temperate Ecosystems, and Global Change, Berlin: Springer-Verlag (https://link.springer.com/chapter/10.1007/978-3-642-78972-4_1). Pp. 1 paragraph 2
- [3]. Obabueki, Omo-Okhirelen & John, Ugah. (2023). Persuasive Technology: An Overview of SMS-Based Persuasion for Waste Management in Low-Income Areas. 8. 1 - 10.
- [4]. Gruber, A. (1998). Gruber Technology and Global Change, Cambridge, UK: Cambridge University Press, <https://books.google.com.ng/books>.
- [5]. Olasokan, O. O., & Akinde, O. J. (2019). The Impact of Urban Growth on Slum Development in Mega City of Lagos (A Case Study of Ajegunle Lagos). East African Scholars Journal of Education, Humanities and Literature, 2(4), 213–222.
- [6]. Olasokan, O. O., & Toki, E. O. (2022). The effects of waste pollution on property value and residents around Igando dumpsite, Nigeria. Global Scientific Journal, 10(2), 1321–1342.
- [7]. Leton, T.G. and Omotosho, O. (2004). Landfill Operations in the Niger Delta Region of Nigeria. Engineering Geology, 73, 171-177. <https://www.scrip.org/reference/referencespapers?referenceid=1751809>
- [8]. Onibokun, A. G. and Kumuyi, A. J. (1996). Urban Poverty in Nigeria: Towards Sustainable Strategies for Its Alleviation. Centre for African Settlement Studies and Development, Ibadan, <https://www.scrip.org/reference/referencespapers?referenceid=1120972>
- [9]. Babayemi & Dauda, (2009). Evaluation of Solid Waste Generation, Categories and Disposal Options in Developing Countries: A Case Study of Nigeria.
- [10]. Geoffrey, N. (2005). The Urban Informal Sector in Nigeria. Towards Economic Development, Environmental Health and Social Harmony. Global Urban Development Magazine, 1, 1. <https://www.scrip.org/reference/referencespapers?referenceid=2671672>
- [11]. Ajani, (2007). Determinants of an effective solid waste management in Ibadan metropolis, Oyo State, Nigeria. <https://www.semanticscholar.org/paper/Determinants-of-an-effective-solid-waste-management-Ajani/ba84f3da919e55af313de291c3138de296b4c4c8>
- [12]. Sridhar (1985). Urbanization and solid waste management challenges in Nigeria
- [13]. Tolba (2003). Urbanization and Solid Waste Management Challenges in Nigeria
- [14]. Ugwuanyi, R. and Chima Isife, T. (2012). Urbanization and Solid Waste Management Challenges in Nigeria. Environment Project. <https://www.researchgate.net/publication/319448696>
- [15]. Satterthwarite, D. (2009). "The Implications of Population Growth and Urbanization for Climate change," Environment and Urbanization, 21(2) 545-567
- [16]. UN, (1987). The UN-sponsored World Commission on Environment and Development issued the Brundtland Report.
- [17]. Efstratios, N. Kalgirou (2018). Waste-to-Energy Technologies and Global Applications Environmental Impact Assessment (2021); Recycling of scrap tyres to mat. <https://ead.gov.ng>
- [18]. Jayarama, R. (2011). Municipal Solid Waste Management- Processing & Energy recovery, pp. 15. 15-26
- [19]. Osibanjo & Nnorom, (2007). The Challenge of Electronic Waste (E-Waste) Management in Developing Countries," Waste Management Research, Vol. 25, No. 6, pp. 489-501. <http://dx.doi.org/10.1177/0734242X07082028>
- [20]. Schlupe, (2009). Recycling of e-waste to resources
- [21]. Seik, F.T. (1997). Recycling of domestic waste: early experiences in Singapore. Habitat. Int., 21(3), 277-289. [https://doi.org/10.1016/S0197-3975\(97\)00060-X](https://doi.org/10.1016/S0197-3975(97)00060-X). See section 2.2, paragraph 5)
- [22]. Laftah, W.A., Wan Abdul Rahman, W.A. (2016). Pulping process and the potential of using non-wood pineapple leaves fiber for pulp and paper production: A review. J. nat. fibers., 13(1), 85-102. <https://doi.org/10.1080/15440478.2014.984060>
- [23]. Gilpin, A. (1996). Dictionary of environment and development, Chester and New York, John Wiley and Sons.
- [24]. Crittenden and Kolaczowski (1995). Waste Minimization, a Practical Guide, Institution of Chemical Engineers, Rugby.
- [25]. Chandak, S. (2010). Trends in Solid Waste Management: Issues, Challenges and Opportunities. In International Consultative Meeting on Expanding Waste Management Services in Developing Countries.
- [26]. Brunner & Fellner (2007). Setting priorities for waste management strategies in developing countries.
- [27]. Rahmesha and Diganta (2012). Solid waste Management; Principle & Practice.

- [28]. IPCC (2006). Intergovernmental Panel on climate Change Guidelines for National Greenhouse Gas Inventories.
- [29]. Chandrappa R. and D. B. Das (2012). Solid Waste Management, Environmental Science and Engineering; pp.117-118
- [30]. Chem Technology Biotechnology (2011). ;86:473–80. <http://dx.doi.org/10.1002/jctb.2580>: See section 2.12.5.2.
- [31]. Nwifo (2010). Legal Framework for the regulation of waste in Nigeria.
- [32]. Nwadinigwe, I. P. (2005). Fundamentals of research methods and statistics. Lagos: Sibon Books Limited.
- [33]. Adam, A. M. (2020). Sample Size Determination in Survey Research. Journal of Scientific Research and Reports, 26, 90-97. <https://doi.org/10.9734/jsrr/2020/v26i530263>.
- [34]. Akinbile (2022). Restaurant Waste Recycle and Disposal. https://www.researchgate.net/publication/359276351_Restaurant_Waste_Recycle_and_Disposal?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InByb2ZpbGUifX0.
- [35]. Akinbile, C. O., Ikuomola, B. T., & Ralphael, O. D. (2019). Development and performance evaluation of low-cost wastewater treatment plant. Sustainable Water Resources Management, 5, 1217-1226.
- [36]. Ofuoku, A. U. & Isife, B. I. (2009). Causes, effects and resolutions of farmers-nomadic cattle herders conflict in Delta state, Nigeria. International Journal of Sociology & Anthropology, 1(2), 047-054.
- [37]. Oli, N. P, Ibekwe, C. C Nwankwo, & Ignatius U (2017). Prevalence of Herdsmen and Farmers Conflict in Nigeria. International Journal of Innovative Studies in Sociology and Humanities (IJSSH) ISSN 2456- 4931 (Online) Volume: 3 Issue: 1 | January
- [38]. Musa, S. D., Shabu, T. & Igbawua, M.I. (2014). Conflict between herdsmen and farmers in Guma local government area of Benue State. Journal of Basic and Applied Research International, 3(6), 17-25.
- [39]. Ofuokwu, K. and Agbo, A. (2008). "Let's change the Union". Nigeria: Tell.