

# Circular Economy: Nigeria Perspective



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## 1 Introduction

Nigeria is a lower middle-income country and is ranked as the largest economy in Africa with a gross domestic product of 444.92 billion ([www.imf.org](http://www.imf.org)). The country is located on the western coast of Africa, has an area of 923, 763 km<sup>2</sup> and is bounded by Benin Republic in the west, Niger Republic in the north, Cameroun in the east and Gulf of Guinea in the south. Nigeria got independence from the UK on the 1st of October 1960 and later became a Republic in 1963. The country has maintained its lead in Africa as the most populous country from a population of approximately 31 million in 1953 (Grolier Incorporated 1962) to the present population of about 197 million. Nigeria emerged from various forms of socio-economic developments since independence and now has 36 states and the nation's Federal Capital Territory (FCT), Abuja. Each state and the FCT are further divided into 774 local government areas which are administrative subdivisions.

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In recent years, Nigeria has made significant progress in socio-economic development after getting out of recession in 2017. Population and socio-economic development are key indices that dictate the quantity and quality of solid wastes. Hence, based on population and per capita generation rate of 0.49 kg/capita/day (Nnaji 2015), the output of solid wastes is over 35 million tons per annum. Specifically, solid waste is multidimensional in context when viewed as a nuisance or resource with multiplier effects on various aspects of human life and the environment. The incessant indiscriminate disposal of municipal solid waste is increasing and is linked to poor governance, population growth, poor standards of living, and low level of environmental awareness and poor management of environmental understanding.

The inability of government agencies to manage these enormous quantities of wastes has led to an increase in the associated societal, economic and environmental burdens of solid wastes. Several strategies have over the years been developed involving the active participation of households, public, private, non-governmental and community-based organizations, and Federal, State and Local Government Agencies. The specific goals of several actors involved in solid waste management in Nigeria are to protect public health, maintain and sustain the quality of the environment, to furnish economic returns and act as source of livelihood and to conserve materials and probably generate some forms of energy.

However, these strategies are faced with several challenges which are responsible for the present low levels of collection service, moderate level of resource recovery and underdeveloped disposal method (Aremu and Sule 2010). The challenges are altogether related to traditional, financial, political, social, institutional, regulatory and technical conditions of the country.

Nigeria has a curtailed institutional, legislative and national strategic plan for the management of solid wastes. Solid waste management operational schemes vary from city to city in Nigeria. However, municipal solid waste management system in Nigeria has traditionally been under strong grass-roots control where local governments are responsible for its management. This responsibility in most instances is transferred to State Governments or its agencies, in addition to performance of key oversight functions while the Federal Government provides guidelines and infrastructure. The commonly practised linear economy promotes increasingly use of fossil fuels and relies on continual economic growth and generates waste. The traditional linear economy of manufacture, use and dispose is prominent in Nigeria on a macro-level, perhaps partly because of the weak legislative framework for sanitation and management of solid wastes. No legislation exists for the minimization/control of solid waste generation; hence, industries and households engage in subjective forms of solid waste reduction and reuse while recycling activity is majorly by the private sector. The inherent huge amounts of solid wastes generated create severe health and environmental challenges to linear economies like Nigeria. Private sector participation in municipal solid waste management in Nigeria like other developing countries is mostly for economic gains. Generally, open dumps at the outskirts of the city where the nuisance level to humans is minimal are used as disposal sites. On the other hand, when there are avenues to capture the energy embedded in these wastes, it could be

a sustainable way of producing electricity, heat and fuel to meet basic needs (Aremu and Ganiyu 2019).

According to World Economic Forum (2018), circular economy aims to design out waste from a take–make–use–dispose model to a reduce–reuse–recycle model. In the circular economy, maximum value is extracted from materials or items considered as “wastes” as much as possible, thereby attaining a “zero” waste society. In contrast to the traditional linear economy, it is a cyclical regenerative approach in which reduction, reuse and recycle of wastes dominate the polity. The circular economy is gaining global acceptance and Nigerians, like other developing countries, practise circularity in certain aspects of life. These aspects include microlevel involvement in household waste reduction and reuse strategies, and informal markets involving waste scavengers, merchants and recyclers. That notwithstanding, widespread impact on the society is not felt. Moreover, there is no legislation yet in Nigeria to kick-start the operation of a structured circular economy system despite the fact that the country is well-positioned to take advantage of this concept. Therefore, there is the need for Nigeria to move into a more circular economy by mainstreaming its principles and practices into local, state and national road maps for sustainable transition from linear to circular economy.

## **2 The Legislative Framework and Government Support Towards Implementing 5R’s and Circular Economy Initiatives in Nigeria**

The increasing complexity and quantity of wastes produced in Nigeria has been of increasing concern. Industrial and technological developments have taken a new turn as against what was in the past, together with global trade, which has resulted in enormous economic growth that has enhanced human welfare. However, this development path is rooted in exponentially increasing resource usage, causing increase in solid waste generation.

The circular economy in Nigeria is a change in response to the need for an ecological economy that requires human activities that are consistent with the 5 R’s principles: reduce, repair, reuse, recycle and recover (Ying and Li-Jun 2012; NPSW 2018).

The Nigerian concerns for circular economy result from various factors including lack of a legislative framework to control the incidence of unsound waste management practices and inadequacy of existing infrastructure to adequately manage the amount and types of waste generated, amongst other factors. The core problem of solid waste management in the country is attributable to the non-implementation of existing laws and legislations, need for the upgrade of obsolete legal instruments, inadequate budgetary provisions and funding mechanisms, and poor monitoring and evaluation mechanisms as to guide the environmentally safe and sound practices in solid waste management. Solid waste management programmes have been operated

without a national policy and this has attracted criticisms from various stakeholder groups on solid waste management in the country.

The Federal Ministry of Environment (FMEnv) with support from the United Nations Industrial Development Organization (UNIDO), other technical partners and critical stakeholders in the public and private sectors developed the National Solid Waste Management Policy as a statement of intent to be implemented as a procedure or protocol in the management of solid waste in Nigeria.

Nigeria operates a three-tier of Government—the Executive, Judiciary and Legislature.

The Executive approves/enforces laws made by the Legislative arm of Government. To achieve this mandate, it has several Federal ministries, Department and Agencies to cover all aspects of human endeavours.

The National Assembly represents the Legislature whose primary function is to make laws. It consists of two Chambers—the Upper and Lower Chambers. The Upper Chamber (Senate) is comprised of 109 Senators while the Lower Chamber (House of Representatives) consists of 360 Representatives. The primary function of the judiciary is to interpret laws. The highest appellate court supreme court is headed by the Chief Justice of Nigeria.

The Federal Government of Nigeria is charged with establishing institutional and legal frameworks for solid waste management. The Nigerian policy on solid waste management encompasses the Executive, Legislature and Judiciary at the Federal, State and Local Government. The policy outlines the key sources of solid waste in Nigeria so that segregation, collection, transportation, storage, treatment and disposal of waste are carried out in a manner that provides protection for the environment and human health and in compliance with legal requirements.

The institutional framework within the Legislature responsible for policy and regulatory matters on solid waste and the environment in general is the Senate Committee on the Environment and Ecology and the House Committee on the Environment at the Federal level. Both committees play important roles that enact appropriate legislation that will:

- (a) Foster successful implementation of the “Policy Guidelines” and “Action Plans” for a sustainable and effective management of solid waste within all the territory of Nigeria.
- (b) Ensure the inclusion of solid waste management (SWM) in the National Development agenda of the country.
- (c) Regulate the design, establishment and performance standards for landfills and all solid waste management technologies to be utilized within the country.
- (d) Prevent the indiscriminate disposal of solid wastes into and onto land.
- (e) Prevent the indiscriminate disposal of solid wastes into water bodies.
- (f) Ensure that appropriate assessment is carried out on SWM facilities before the commencement of operation and at defined time periods throughout the life of the facility.

- (g) Incorporate applicable principles and domesticate appropriate international conventions, protocols and treaties into solid waste management laws and management practices within the country.
- (h) Focus strongly on environmental and solid waste data procurement, storage and management.
- (i) Review old laws and regulations and adopt new regulations that will make SWM programmes achievable.
- (j) Review and reform existing national/state legislations and regulations relating to SWM in order to create a legislative framework which gives legal effect to this Policy and facilitates a comprehensive, integrated and sustainable approach to SWM.
- (k) Ensure SWM programme evaluation and long-term priorities settings are made and achievable.

The State and Local Government legislatures at their individual levels of governance shall have the right to introduce more stringent legislation in their areas of jurisdiction, but at all times standards must not be lower than that stipulated at the Federal level. The State and Local Government legislatures shall reserve the right to add, delete or change solid waste management taxes and fees to enforce scale-up of waste management activities. Legislative discretion is, however, required to ensure the burden of solid waste taxes and is not too high as to become a disincentive to effective and sustainable SWM.

In terms of solid waste management in Nigeria, the Judiciary is responsible for the interpretation of principles, protocols, rules and legislations, and the trial of solid waste management legislation defaulters. Basically, the judiciary shall:

- (a) Have jurisdiction and power over all solid waste matters specified under any environmental protection law, regulations or sanitation and waste management laws of the country (Federal, State and Local Government levels).
- (b) Provide mechanisms for the resolution of solid waste jurisdiction and management concerns between different tiers of government, public institutions, private agencies and individuals.
- (c) Establish specialized tribunals for solid waste management issues, as undertaken in other areas of national life such as with trade or labour disputes.
- (d) Provide public access to solid waste management dispute resolution and remedy.
- (e) Provide solid waste management dispute resolution mechanisms, public interest litigation protocols, class action legal processes and the ability to represent and protect the interest of future generations.
- (f) Be guided on environmental sentencing information.

### 3 Compliance and Enforcement

The compliance and enforcement of the National Solid Waste Management Policy enacted in 2018 to follow the Federal Government of Nigeria 5R's hierarchy for solid waste management (reduce, repair, reuse, recycle, recover) shall include:

- (a) Protection of environmental standards.
- (b) Enforcement of regulations and legislation.
- (c) Compliance with international treaties and standards.

### 4 Sanctions

1. The Federal Ministry of Environment (FMEnv) in conjunction with the State Ministry of Environment (SMEnv) shall develop guidelines for various categories of offences, non-compliance and associated sanctions and penalties.
2. Major offences of high impact shall be documented in national plan of action.
3. Relevant laws on solid waste management stipulating service standards and operations shall be enacted and adequately disseminated.
4. The FMEnv/SMEnv/NESREA/States Waste Management Authorities shall impose penalties, taxes, fines and charges for non-compliance to solid waste management standards and regulations.

The existing documents in Nigeria which contain some form of regulations related to solid waste management are:

- i. Constitution of the Federal Republic of Nigeria
- ii. National Policy on Environment, revised
- iii. Federal Environmental Protection Agency Act, 1992
- iv. Environmental Impact Assessment Act of 1992
- v. National Environmental (Sanitation and Wastes Control) Regulations, S.I No. 28 of 2009
- vi. National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations S.I.9 of 1991
- vii. National Environmental Protection Management of Solid and Hazardous Waste Regulations S.I.15 of 1991
- viii. The National Guidelines and Standards for Environmental Pollution Control in Nigeria
- ix. The National Environmental Standards and Regulations Enforcement Agency Act, 2007 (NESREA Act)
- x. The National Environmental (Electrical/Electronic Sector) Regulations 2011, as gazette in Federal Government Gazette No. 5, Vol. 98. In the gazette, the 3R's of waste management was expanded to 5R's, namely reduce, repair, reuse, recycle and recover

- xi. The National Oil Spill Detection and Response Agency Act 2005 (NOSDRA Act)
- xii. Environmental Guidelines and Standards for the Petroleum Industry in Nigeria
- xiii. National Environmental (Base Metal, Iron and Steel Manufacturing/Recycling Industries Sector) Regulations, 2011
- xiv. National Policy on Municipal and Agricultural Waste Management, 2012 (Draft)IO
- xv. National Environmental (Pulp and Paper, Wood and wood Products sector) Regulations, S.I 34 of 2013
- xvi. National Environmental (Motor Vehicle and Miscellaneous Assembly Sector) Regulations, S.I 35 of 2013
- xvii. Merchant Shipping Act, 2007
- xviii. Merchant Sea Dumping Regulations, 2013
- xix. Nigerian Maritime and Safety Administration (NIMASA) Act, 2007.

## **5 Institutional Arrangements for Solid Waste Management in Nigeria**

The institutions responsible for solid waste management in Nigeria are:

- (i) Senate Committee on Environment and Ecology
- (ii) House Committee on Environment and Habitat
- (iii) Federal Ministry of Environment (FMEnv)
- (iv) National Environmental Standards, Regulation and Enforcement Agency (NESREA)
- (v) Environmental Health Officers Registration Council (EHORCON)
- (vi) Nigerian Maritime Administration and Safety Agency (NIMASA)
- (vii) National Oil Spill Detection and Response Agency (NOSDRA)
- (viii) Department of Petroleum Resources (DPR)
- (ix) Abuja Environmental Protection Board (AEPB)
- (x) States Ministries of Environment (SMEnv)
- (xi) States Environmental Protection Boards, Agencies, Commissions, etc.
- (xii) Local Governments' Authorities (Departments' of Environment and Health, Works, etc.)
- (xiii) Waste/Refuse Management Authorities
- (xiv) Private sector—formal and informal (“Scavengers”) in Solid Waste Management.

## 6 Future Plans and Targets in the Country or Any Localized Targets

The main problems are related to collection, transportation and disposal, with one-third to half of the solid waste generated in the developing countries remaining uncollected (Sujauddin et al. 2008; Thanh et al. 2011; Wilson et al. 2012; Olukanni et al. 2016; Olukanni and Oresanya 2018). Due to the myriad of challenges related to solid waste management in Nigeria, the idea in the minds of governments, institutions and all stakeholders in waste management sector now is the concept of circular economy. The concept recognizes that population growth and traditional (linear) processes, where majority of products are eventually disposed of after use, are unsustainable. The actual performance of the public sector in Nigeria has left much to be desired, and many government-owned enterprises are not responsive to the changing requirements of the growing and dynamic economy because they do not have the required tools for effective service delivery (Olukanni and Nwafor 2019). Relying on PPP without providing the necessary legal and institutional framework will not produce the desired results in effective waste management. As Nigeria is faced with the pressure to provide critical services to its population, the way forward is to deliver the needed infrastructure to carry out the essential services by using the resources effectively and produce maximum benefits for the citizenry.

The development of material supply chain management through the combination of waste hierarchy thinking should now be in place, and there is a need for sustainable energy solutions. As a result of the scarcity of raw materials necessary for technological innovation, encouragement of progressive development of circular economy models should be of utmost priority and modalities should be set to put this in place, with increasing awareness of social, financial and economic barriers.

Furthermore, the practice of collecting, transfer, treating and disposal of solid waste (integrated solid waste management) has become a necessity. It has become a common knowledge that most wastes have a recovery value; that is, they can be recycled and reused, which ultimately reduces the pressure of consumption of fresh materials in the production line. Specifically, material recovery is a strategy low-income earners use as a survival strategy. Figures 1 and 2 show scavenging activities are dumpsites while Figs. 3 and 4 show salvaged materials. The idea is to first sort out plastics, paper and other combustibles after which the solid wastes are set ablaze so as to be able to retrieve the incombustibles like iron and aluminium.

The scavengers sell the salvaged materials to middlemen who, in turn, sell to recycling industries. Table 1 shows the prices of some salvaged materials. The prices are varying from N30 to N55.

Material recovery facilities (MRF) are provided in some places to recover valuable resources from wastes by Local Authorities or recyclers. A case in point is the waste to wealth initiative set-up by the government of some states such as Lagos, Ogun, Oyo, Ekiti and Osun (Olukanni and Aremu 2017), and some universities are currently driving different initiatives. These projects are geared towards effective waste management processes to reduce, reuse and recycle waste materials.



**Fig. 1** Scavenging activities at a dumpsite before burning (to retrieve combustibles)



**Fig. 2** Scavenging activities at a dumpsite after burning (to retrieve incombustible)



**Fig. 3** Salvaged metals



**Fig. 4** Salvaged plastics**Table 1** Prices of some salvaged materials

Recyclable waste materials	Average percentage of each item in the waste stream (%)	Prices of recyclables in Naira/kg
Pet bottles	12.69	N 55
Paper	3.79	N 5
Plastic food packs	11.92	N 30
Nylon	9.07	N 30
Tin cans	4.41	N 35
Tetra packs	5.72	N 35
Food waste	52.40	Compostable
Total	100.00	

Polyethylene Terephthalate Ethylene (PETE) bottle waste (plastic waste) generation is getting beyond levels that communities and cities are comfortable with, and the uncontrollable effect is becoming alarming even as it gets through to the water bodies. Promoting healthier lifestyles and commitment to build a sustainable and friendly environment is the way forward. Evidence from pilot project tagged “Waste to Wealth” (W2 W) initiative, which commenced in 2015 at Covenant University in Nigeria, shows that materials and valuable resource can be harnessed and converted to useful products. The idea of driving this scalable project is to:

- (i) promote excellence in plastic waste reduction management by enhancing environmental sustainability and sustainable strategies;
- (ii) create and implement innovative strategies that engage relevant stakeholders to reduce plastic use;

- (iii) provide students at all levels with direct experience in environmental management through environmental stewardship, academic internship, paid positions and volunteer opportunities; and
- (iv) Carry out research on the reuse of the plastic waste as partial substitutes for other construction materials and other engineering infrastructures.

Figure 5 shows an accumulation of sorted plastics ready for recycling. The accumulated plastics were derived from scavengers who source for plastics from households, commercial centres and dumpsites. Figure 6 shows a small-scale metal recycling facility in Lagos, Nigeria. Cans are melted in open pits for export to Japan and India.



**Fig. 5** An accumulation of sorted plastics ready for recycling



**Fig. 6** A small-scale metal recycling facility in Lagos, Nigeria

## 7 The Challenges

Circular economy is relevant for adoption essentially because of its sustainable development concept, promotes zero waste of materials, resource efficiency and especially low energy utilization, thus providing several advantages to the society and nature. Nigeria has mostly remained locked into the linear economy model despite various circular economy advances made globally (Ogunmakinde 2016).

Nigeria, like many African countries, does not have large-scale recyclable collection from source, less than 12% of waste is formally recycled from dumpsites in an unsafe and hazardous condition. The poor waste disposal methods lead to clogged drains, flooding and other environmental problems.

## 8 Municipal Waste Management

Over 35 million tonnes of municipal solid waste are produced yearly in Nigeria, including food waste, textiles and plastics.

Tires: an estimated 90% of tires are imported used from abroad and therefore are disposed off regularly, requiring a better solution than landfilling.

Biomass: Agriculture is the dominant sector in rural areas (70% of the workforce), generating a massive quantity of residue, impacting the ecosystem.

## 9 E-Wastes

Dell, HP and a host of electronics manufacturers have created an alliance that will purchase electronic waste from consumers for recycling purpose. Currently, Hinckley a company established by in 1989 by HP developed a sustainable business model on e-waste and the first and leading registered electronic waste recycler in Nigeria. The developed recycling facility can share the metals but important elements such as gold, copper, mercury are not extracted due to lack of equipment.

## 10 Plastic Waste

According to Weblers, eight (8) million tons of plastics make their way into the ocean annually, 100,000 tons of PET bottles are produced in Nigeria annually and 91% of plastics are not recycled. Lagos currently generates about 730,000 tons of plastic waste annually with just 5% recycled. The World Bank projects that plastic usage in Lagos is set to grow at 9.6% annually leading to about 1.9 million tons by 2025.

Extended producer responsibility gradually been practised in Nigeria. For example, the food and beverages industry have formed a recycling alliance under Coca-Cola to collect all plastics and packaging materials which are thereafter recycled. This model is based on polluter pays principle, where the manufacturers of packaging materials are now responsible for managing of used plastic.

## 11 Research and Opportunities

Circular economy is a concept that has been increasingly gaining ground in global conversations over the past few years. A few cities and companies have already started executing this concept as new business models and technologies emerge, the opportunities for agriculture, manufacturing and waste management can be harnessed to improve livelihoods and reduce poverty.

## 12 Private Sector Practices in Nigeria

Sunray Ventures developed “Green Compass Recycling” to introduce the principles of Circular economy to Africa, with a focus on electronic and electrical waste. According to Sunray Ventures, e-waste generated in Nigeria is growing by 8% per annum as 80% of electronic goods imported into Africa are second-hand. In providing solutions for Nigeria, the Sunray Ventures Founder shared that a GC plant covering 7,000 hectares of land will be developed in Lagos, while discussions are on-going with six (6) states in the country on effective waste management measures and service.

Lagos Deep Ocean Logistics Base (LADOL) suggested that “Local Content Policy” in sectors like the oil and gas companies have to be challenged to adopt best business practices. Investment in skills, training and jobs is critical to driving a sustainable circular economy in the country, for instance, through its “Upskilling Academy—World Class Campus” which set a target of training 2,000 Nigerians annually by 2022.

Lafarge Africa Plc in 2018 outlined initiatives driven by the company to support the circular economy. The “Geocycle Nigeria” by Lafarge initiative according to Lafarge is a global network that specializes in co-processing and alternative raw materials with cement mineral content. They also mentioned that the “RoadCem” innovative product which is ideal for sustainable road construction, reduces the need to repair bad roads and a soil-stabilizing cementitious binder and calcium hydroxide enabling plasticity and enhanced strength.

### 13 Research Supporting Circular Economy in Nigeria

Nigeria committed itself to move towards zero waste at the United Nations (Anukam 2011). There is dearth of research works targeted directly at circular economy in Nigeria. However, many works have reported studies related to various aspects of the circular economy (3R's) such as reduce, reuse/repair and recycle or the 5R's such as refuse, reduce, reuse/repair, recycle and recovery/repurpose/rot. These research works, looking into the various components (either 3R or 5R), support the attainment of circular economy in Nigeria and help in her bid to achieve sustainable development.

Ogunmakinde (2016) developed a circular economy-based waste management framework for Nigeria and assessed its adaptability to the management of construction wastes. Ezeohaa and Ugwuishiwu (2011) conducted a literature review to investigate the potential of abattoir wastes to befoul the environment, or cause hazards to human health, and harm to living resources and ecological systems. The paper proposes some research considerations on the pollution potential of abattoir wastes in Nigeria and developed optimized abattoir waste management strategies that would ensure reduction in environmental pollution.

There are many researches in Nigeria which reported studies related to the conversion of solid waste to energy products through torrefaction, pyrolysis and gasification.

Few researches reported the upgrading of solid waste through densification techniques such as briquette, pelletization and cubing while others studied how to determine the optimum location of waste to energy facilities in Nigeria. Lasode et al. (2015) evaluated the amount of wood waste available for energy generation in Ilorin, Nigeria through the assessment of twenty potential energy facility sites. They used the single facility location with rectilinear distance model to determine an optimum location for an energy generating facility based on the impact of four major constraining factors: the net amount of waste available, transportation cost, social effect and environmental effect. The most feasible location away from the optimum location was chosen through the construction of a contour, which is within the Industrial zone of Ilorin, Nigeria.

### 14 Special Learning

The circular economy concept is gathering momentum, but significant effort is required to move the level of an idea to action. There is an increasing understanding of what the circular economy offers. Hence, important strategies must be put in place to address some of the most pressing environmental, economic and social challenges of the twenty-first century, while also providing positive economic benefits. There are a lot for Nigeria and her populace to learn from the developed economies on the policies and strategies to adapt to achieve the desired goal. There is need for the government to action to her commitment to zero waste through sound policy frameworks that will address the emerging challenges of attainment of set objectives. The

problems militating against effective waste management in Nigeria has attained an emergency status. A circular economy task force may be required to address specific barriers to the attainment of the goals under the auspices of the National Environmental Standard and Enforcement Agency (NESREA) as was created at the G20 Summit in Germany on July 2017 (World Economic Forum 2018). Efforts must be geared towards bringing the private and public sector into collaborations to scale impact around circular economy initiatives.

## **15 Factors Affecting the Implementation of Circular Economy in Nigeria**

The problems militating against municipal waste management in Nigeria are numerous and diverse, and these problems are related to economical, technological, psychological and political aspects.

### **(a) Poor Funding**

This is one of the major problems constraining the waste management sector. Inability of purchasing new waste collection trucks, limited staffs, poor vehicle maintenance, unsubsidized waste storage containers, inability to purchase equipment amongst others are all attributed to a shortage of capital. Actualizing waste management projects require consistent funding to achieve answers to strategies yet to be implemented.

### **(b) Poor Legislation and Implementation of Policy**

The constitutional strength of municipal waste management policy is weak and ineffective. Also, the implementation of this policy is not monitored. The policy is not well structured and definitely tends to be weak. There are instances in which due process is obstructed and sanctioned penalty is not expended on certain municipalities and individuals. Policies are yet to be aimed at the 3R's of waste management—reduce, reuse and recycle. Government policies on waste are not revisited, reaffirmed, restructured and upgraded in a comprehensive tune and form.

### **(c) Limited Infrastructures and Professionals**

Limited solid waste infrastructures are one of the major contributing indexes of poor waste management system in Nigeria. The environmental protection agencies and waste management personals are not experts and exposed to workshops and trainings that meet international standards on technology use, information management and knowledge management. Most of the state environmental protection agencies lack adequately trained personals.

### **(d) Level of Awareness in Nigeria**

Populace awareness on sustainable waste management is still very poor, and effort by the agencies to increase awareness is still very low. Municipal members are not well

informed on the adverse effects of indiscriminate and improper disposal of waste and also the benefits of such act.

(e) Recovering and Recycling

Access to possible recyclable material possesses great difficulty due to poorly limited recycling programmes. The informal recycling programmes involve scavengers' effort search of recyclable items. Presently, the informal sector renders the service of retrieving and recycling of materials in Nigeria. The introduction of an advance formal recycling programme presents positive and accelerating outcomes for municipal waste management sector.

(f) Disposal

The landfill disposal technique of waste materials with a dearth of treatment processes and open dumping possesses increasing public health hazards to human lives, animals and plants. However, the emission of poisonous gases such as methane and carbon dioxide cause alteration of weather, leading to climate change.

## 16 Drive for Circular Economy

- A. Cultural belief wastes are viewed as invaluable and useless materials rather than wealth. Wastes are not seen as valuable materials that can be recycled for actual use, material recovery and energy recovery. The value of waste to people enhances the actualization of the process involved in the management of waste. The conception of waste as worthless is inherently linked with societal organized cultural systems of where things belong. However, consumer's activities are largely a function of common societal cultural values and norms.
- B. Communication channels: the dearth of an effective communication channels affects the knowledge acquisition of municipalities in the management of waste. Communication channels such as mass media and posters are often adopted in the transfer of new information rather than the face to face which involves one on one practical interaction process.
- C. Collaboration with International Solid Waste Management Organization/Agencies: the existence of limited collaboration with International Solid Waste Management organizations impedes rapid sustainable development within the waste sector. Interaction with International waste agencies is rarely a focus area for waste management.
- D. Centralized Waste Collection Containers: in Nigeria, centralized municipal storage containers are not in place. This presents the municipalities with placement challenges of sorted and recycled materials of different categories. The need for centralized municipal collection points is not viewed as a means to a solution for recycling and material recovery. Thus, such agenda is not included in platform for waste management. The available funds are not directed to meet the purchase



- of the waste storage containers for managing waste management. Purchase of municipal storage containers for different collection point is indeed necessary.
- E. Packaging and Product Producer Involvement: the involvement of packaging producer in the management of waste is limited. Producers' interests are mainly in the production of content packages rather than the management of these packages. Due to the low level of material and energy recovery, material cost is not maximized and this directly affects the cost of packaging production. With the increasing effect of improper waste management, the manufacturing sector interest lies mainly on profitability rather than waste reduction.
  - F. Personnel morale field workers in charge of waste collection and transportation often have low morale. Their performance is determined with the extent of stigmatization encountered on the job, poor remuneration and stagnant promotion. Field staffs are not also encouraged by the consumer's manner of habitual waste storage.

## 17 Proposed Knowledge Management Solutions

The presentation of knowledge management solutions in the management of municipal waste in this context is not only in terms of technology centred approach but rather a people centred approach. With respect to municipal waste management, the people-centred approach focuses on individuals that fall within the municipal waste management chains. This includes municipal waste generators, packaging firms or producers and waste management companies while the technology centre approach focuses on the use of ICT's as knowledge and information repository in the management of municipal waste.

People should be orientated knowledgeable to conceive waste as being a valuable resource for material and energy recovery and also on the environmental consequences of waste dumps on drainage channels, streams, pathways and roadsides.

The more interaction with international waste agencies is required to close up existing gaps between developed and developing countries and to ensure efficient municipal waste management. This interaction would open doors to new coping strategies of managing waste effectively in Nigeria, amongst which is knowledge. The need for information flow between waste generators, producers and waste management companies is vital in bridging the knowledge gaps.

The communication and exchange of knowledge are facilitated between waste generators and producers of recyclable packages such as plastic, tins and cartons provided comprehensive descriptive logos or labels are inscribed with expressions in English and three major languages on such containers have been recyclables. The recovery process of these recyclables from consumers will be possibly not challenging if certain incentives are attached to the return of such items. These incentives are consumer-generated incentives that are derived at the point of purchase as the cost of

the actual containers is already added to the purchasing cost of the items. The transfer of information and knowledge to municipalities should be undertaken by waste management (social workers) companies through effective communication channels involving face-to-face communication. Aside other means of communication, the face-to-face channel of communication should be employed by the municipal waste management companies to interact with and orientate members of the municipalities on disposal habits, sorting and storing of waste in an environmental friendly manner. The importance and benefits attached to waste separation, proper storage, collection and effective waste management needs to also be communicated. The eye contact and interaction between the sender and receiver help to achieve the desired goal to a large extent. Efficient management of waste is promoted if municipal storage containers are available at subsidizing price. The storage containers should be of different colours indicating the various categories of municipal waste for a particular storage container. In bridging the knowledge gap existing between packaging and product manufacturers; and waste management companies, the need to deliberate and share knowledge on what ought to and can be reuse and recycled to produce the actual container or alternative containers and energy is paramount. A cohesive collaboration between the packaging manufacturer and waste companies will enhance the prerequisite knowledge and information transferred to communities. Hence, some level of participation is required of them in order speed up actualization process.

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