

Wastes Management and Sustainable Development: A Perspective of Hazardous Industrial Wastes

James Ocholi Ogwu

*Centre for Disaster and Risks
Management,
Department of Geography
Ahmadu Bello University, Zaria*

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Abstract

Humanity directly depends on the environment to sustain its existence. However, industrial wastes are major environmental problem that threatens this existence across metropolitan cities. This study therefore seeks to analyse the challenges and prospects of industrial waste management on sustainable development in Nigeria. The study obtained data from secondary sources and employed explanatory analysis of the literature. This study reveals that sanitary landfills and incineration are the most common waste management methods employed by industries in Nigeria which are serious challenges to environmental sustainability. The study further indicates that there are several opportunities and prospects in exploring other waste management methods such waste recycling, resource recovery facilities and integrated waste management, which will offer more sustainability and development. The study concludes that the current waste management approaches by majority of industries especially petro and agro chemical industries in Nigeria are negatively impacting on the environmental and sustainable development of the country.

Corresponding Author:

James Ocholi Ogwu

Background to the Study

Countries all over the world are engaging in increasing industrialization to serve people's need through provisions of goods which results in lifestyles changes with its own negative consequences of enormous industrial waste generation and natural resources degradation (Karadimas and Loumos, 2018). Industries cannot be managed and operated without wastes generation and disposal, however, in order to tackle this increasingly trend in waste generation by industries, sustainable waste management strategies are developed, hence, the need for improvement of environmental quality with the aim of achieving a major goal of sustainable development (Ivascu, Cioca and Mihai 2014). Industrial waste management in developing countries and economies like Nigeria is approaching high levels of environmental and socio-economic challenges (Modebe and Onyeonoro, 2018). Considerable conditions of environmental degradation and socio-economic threats posed due to unguided and excessive waste generation and poor industrial waste management systems are obvious reality in many cities Nigeria (Kadafa, Ayuba, AbdManaf, Ho and Sulaiman, 2013).

Humanity directly depends on the environment to sustain its existence, however, industrial wastes is a major environmental problem that threatens Nigerian metropolitan cities. Industrial wastes management collection, distribution and disposal have always been issues in the cities because of its negative tendencies on environmental sustainability in terms of balance in the ecosystem (Adekunle, Adebileje, Kayode and Out-Toyin, 2016). About 12.5 billion tonnes of solid wastes alone are collected worldly per year from landfills, inappropriate distributions and disposal of industrial wastes whereby, the decomposition of the waste generated organically from industries accounts for approximately five-percent (5%) of Global Greenhouse Gas emissions especially the methane gases produced which affects global environmental sustainability (Brunner and Rechberger, 2015).

In Nigeria, industrial wastes are at increase especially in urban centres where industrial activities such as mining, petro and agro chemical factories, manufacturing and textile industries among others are located. As such there is need for industrial waste management in those areas to ensure environmental safety and sustainability. There is no known documented research on industrial waste management and sustainable development in Nigeria with particular emphasis on challenges and prospects. To this extent therefore, this study focuses on the challenges of industrial wastes and the prospects of industrial wastes management as a way towards sustainable development. It is based on above, that this study seeks: to analyse the challenges facing industrial wastes management in cities in Nigeria and; to evaluate the prospects of various methods of industrial wastes management towards sustainable development.

Conceptual Analysis

Industrial Waste

Waste is considered as those substances which are generated due to normal operations over which there are controls in terms of how they are produced, disposed or discharged

(Adekunle, *et al.*, 2016). Wastes therefore includes household waste, consumable waste, product containers and packaging, dirt, demolition and rehabilitation wastes and other forms of organic and inorganic wastes from industrial, residential and institutional sources. Industrial wastes therefore, are composed of both hazardous and non-hazardous substances. Hazardous wastes are used to describe wastes which are extremely difficult or dangerous to keep, manage, treat or dispose of, and contain substances that are toxic, carcinogenic, corrosive, reactive, infectious, irritant, or otherwise harmful to the environment (Cruz, Cabral, Simoes and Marues, 2014). Hazardous wastes have remained the ultimate challenge of industrialization across the global because of their negative impacts on environmental sustainability. The improper wastes management poses serious threats to the environment and public health. In many industrial areas in Nigeria, the commonly practiced wastes management option involves the collection of mixed waste materials and subsequent dumping at designated dumpsites or water bodies. It is documented that thirty-six percent (36%) of industrial solid wastes in Nigeria often disposed in open landfill or dumpsites while forty percent (40%) are dumped in water bodies (Modebe and Onyeonoro, 2018).

Generally, industrial solid wastes are materials which the industries discards, intends to discard or is required to be discarded which includes refuse, garbage, sludge, and other discarded solid materials resulting from its operations. However non-solid wastes could be solid or dissolved materials in sewage or other pollutants in water bodies, such as sand, silt and gravel, suspended or dissolved solids in industrial wastewater effluents, chemical kiln dust waste, fly ash, dissolved materials in irrigation return flows or other common water pollutants, drilling fluids, “densified-refuse-derived” fuel and any toxic or radioactive waste (Adekunle, *et al.*, 2016).

The rate of urbanization especially in area of industrial growth and development in Nigeria is rapidly increasing the range, diversity and quantity of industrial wastes that require management (Ityavyar and Tyav, 2020). The industrial wastes, which cannot be utilized in one form or the other are the sources of many types of hazard. However, the quantities of industrial wastes, the nature of the environment, knowledge of the composition of the wastes stream, the nature of the wastes and the frequency of its removal are necessary factors to determine the best form(s) of management to be employed. To this extent therefore, hazardous industrial wastes in Nigeria include but not limited to: used auto oil, antifreeze, car and rechargeable batteries, auto filters, propane tanks, paint, fluorescent light bulbs, pesticides, some industrial cleaners, solvents and paint thinners and pool chemicals (Cruz *et al.*, 2014).

Waste Management

Waste management is considered as the total collection, keeping, treatment and disposal of wastes in order to make it harmless to living beings, the ecology and the environment in general. Waste management involves collection, transportation, storage, treatment, recovery and disposal of wastes. Waste management is a process that involves the management of waste such as storage, collection, transportation and disposal at

designated places (Collins, 2018). According to this study, waste management is considered as the collection, aggregation, conveying, beneficiating, managing and monitoring of waste materials. The basic principle of wastes' management is to reducing the quantity and effects of wastes through recycling and to disposing of wastes through sanitary means so as to improve environmental sustainability.

Sustainable Development

Sustainable development refers to meeting the desires of everyone in addition to fronting the opportunities and possibilities to satisfying their aspirations for improved and healthier societal life for everyone. United Nations considers sustainable development as that development which takes care of the needs of the present without putting at risk or jeopardizing the ability or comfort of the future generations to meet their own needs (Adekunle, *et al.*, 2016). Sustainable development has received significant consideration from numerous institutions, development researchers, governments and environmental organizations and humanitarian agencies alike as a result of the appreciable increase and projections in the rate of environmental pollution and degradation globally (Ityavyar and Tyav, 2020). The basic position in sustainable development is to achieve environmental and societal equity while advancing socio-economic progress.

Industrial Waste and Sustainable Development

Based on the conceptual analysis and the stand point of sustainable development, industrial wastes can be categorized in either broad perspectives or narrow perspectives (Adekunle, *et al.*, 2016). Broadly speaking, it might include various forms of pollution, ranging from discharges of any harmful substances into the commons while a narrow meaning on the other hand, is seen as all byproducts of production and consumption that are the object of certain waste control programmes (Abila and Kantola, 2013). In this regard therefore, there must be a balance between extents of development and the contents of natural resources, its processes and conversion, that is, industrial activities and development must be at an extent that can be sustained incrementally without causing harm to the natural environment or to future generations.

Methods of Study

Data for this study is obtained from both primary and secondary sources. In the primary sources, captain of industries and managers of industries in selected cities of Abuja, Lagos, Rivers and Kano states were interviewed on the subject matter which were analysed descriptively. Information from secondary sources provides sufficient knowledge on industrial waste management and sustainable development which were used to support the information obtained from the field. In addition, secondary sources of data is contemporary - that is, they belong to the present or most usefully, historical. The basic argument here is that; it may be impractical for a receiver to create some forms of data using primary methods when such data already exist. As such the study also employed the use of systematic content analysis which refers to a general set of techniques useful for analyzing and understanding collections of text such as journal, magazine, published and unpublished Thesis and so on.

Findings and Discussion

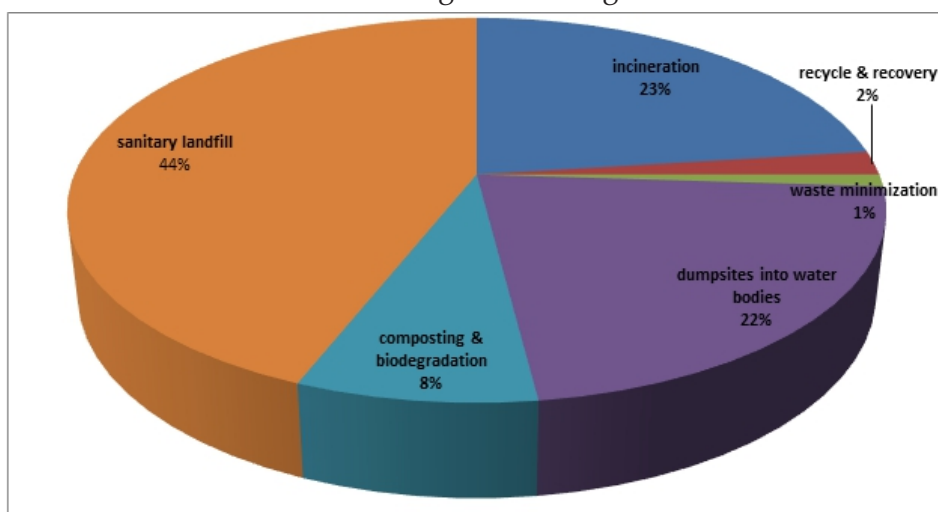
Industrial Waste Management in Nigeria

Industrial waste management is a set of multidisciplinary activities involving scientific principles, economics, urban and community planning and social phenomena. Industrial waste collection and transportation which is termed as management of industrial wastes involves storage at the point of generation and pick-up points by the personnel or instrument around the factory and conveyance to a transfer station. Collection of industrial wastes often consumes 60-80 percent of the total industrial waste management budget of any establishment (Ityavyar and Tyav, 2020). To this extent therefore, efficient wastes' collection system will not only reduce the overall cost of management but also guarantee a better return on management. Industrial waste management is considered as the methods used for collecting, processing, transforming, recycling or disposal of industrial wastes, controlling landfill disposal facilities, transfer stations, resource recovery facilities, incinerators and other similar facilities.

Methods of Industrial Waste Management in Nigeria

It is noted that not all industrial wastes are hazardous that require special treatment and disposal. The compositions of any industrial wastes are dependent of the nature of the industrial activities undertaken. Even though, in Nigeria, much of the industrial wastes are relatively similar to commercial and domestic wastes, there are significant proportions of industrial wastes arising from industrial operations and uses which are hazardous. As a result of the dynamism in the industrialization in Nigeria, the country is challenged with an increasing dimension in hazardous industrial wastes generation. The common notable wastes' management approaches of industries are incineration (23.0%); recycle & recovery (2%), waste minimization (1%), dumpsites into water bodies (22.0%) composting and biodegradation (8.0%) and sanitary landfill (44.0%) as shown in figure below:

Fig. 1: Methods of Industrial Waste Management in Nigeria



Incineration of industrial wastes

Incineration of industrial wastes is a waste treatment and management process that encompasses the combustion of organic substances as therein in the wastes materials. It is basically a high temperature waste treatment that regularly converts waste into heat energy, flue gas and ash. Energy in forms of chemical, electrical and light can be recovered from waste incineration or the combustion of the wastes. The derived energy could be used for either district heating or power generation for neighbourhood communities (Collins, 2018; Cruz, *et al.*, 2014). Furthermore, the utilization of technologies such as gasification and pyrolysis which can recover energy in the form of gas or liquid fuels can further refine and enhance the production and supply of the energy (Cruz, *et al.*, 2014). This makes it possible for the exportation of the power to power stations or used to generate energy sites. This gives the benefit of getting access to on-demand energy with little cost and less risks / less loss on energy transmission for the industries themselves.

Recycling and Recovery Practiced by Industrial Activities

Recycling and recovery of industrial wastes are systems that reduce the demand for raw materials by extending their life and maximizing the value extracted for them (Ityavyar and Tyav, 2020). The products from recycling of industrial wastes products, supplies valuable raw materials to other industries by way of extending their life span and maximizing the values extraction from the used resources. Wastes recycling as system of wastes management are well-known sustainable option of wastes managing in combination with source reduction (Cruz, *et al.*, 2014). Based on the Nigerian systems, this method has social, economic and environmental benefits by cutting down on the costs of disposal and mitigating the destructive effects of the surroundings. Recycling eliminates the possibility of emission of several greenhouse products, gases and water pollutants; it further saves energy, creates jobs, gives necessary raw materials for industrial uses, enhances the progress of greener technologies, preserves resources for the future and reduces the need for other wastes' management facilities.

Waste Minimization in Industries

Wastes minimizations are the environmental exercises which are targeted at removing the wastes at the points of generation. Over time, wastes minimizations have been placed above other levels of wastes management even though they have not gained the necessary attention in the Nigerian industrial space (Modebe and Onyeonoro, 2018). Wastes minimization methods can be obtained by equipment and process modification feed stocks substitutions, industrial-keeping practice and remodel products (Karadimas and Loumos, 2018, Kadafa, *et al.*, 2013). Wastes minimization has long been evaluated as a fundamental component of industries and business entities in other climes leading to a considerable decrease in wastes among industries and firms through the establishment of waste minimization clubs. Cost reductions, improvement in company's perception value and profitability have been achieved by the industries that utilized wastes minimization or source reduction.

Composting and Biodegradation of Industrial Wastes

This method of waste management is also gaining wide acceptance among industries in Nigeria especially the large scale industries within the urban areas as a result of its socio-economic advantages to the industries and their environs. Biodegradation is set natural processes which break down wastes materials to crude oil. According Adekunle, *et al.*, (2016) it is a process by which microbial organism transforms the formation of chemicals introduced into the environment into useful substances (Karadimas and Loumos, 2018). These useful substances could be used a source of significant heat and energy generation which can be utilized by not just the industry producing the wastes but its environment and other small industries therein. On the other hand, composting is another form of biodegradation where aerobes digest organic wastes to create composts which can be utilized as manures for crop and plant productions in the agro-industries.

Sanitary Landfill

Landfill disposal still remains as the main option for handling industrial wastes in both developing and developed countries (Lavee, 2017; Karadimas, Papatzelou and Loumos, 2017). However, sanitary landfill disposal has been used as the most priority among many industries in Nigeria. The arrangement of a sanitary landfill calls for developing significant detailed description programmes that outline the procedures to be observed to provide for the safety of the environment, effective disposal of the materials and types of industrial wastes that are anticipated. The sanitary landfill does not really offer benefit in regards to sustainable development apart from just making spaces for more wastes to be generated by the industries.

Prospects of Industrial Waste Management in Nigeria

A city cannot be sustainable if it generates more waste than it can assimilate; waste reduction is more critical than waste disposal management as the end problem (Modebe and Onyeonoro, 2018). Waste management technology choices can be restricted to technical requirements like waste quantities and composition, area characteristics, haul distances to the disposal site and operational cost. Still a wider perspective can be taken looking at the whole waste management system, including waste prevention and resource recovery and searching for a system that best suits the society, economy and environment in question (Collins, 2018; Abila and Kantola, 2013). Usually in developing countries, such kind of mistakes are often because of limited data and budget as well.

Designing a sanitary landfill is very important in the sense of operation also. Climatic effects such as wind, rain and temperature directly affect the type and cost of the project. Trees planted on the perimeter of a sanitary landfill help keep dust and litter within the site (Ityavyar and Tyav, 2020; Karadimas, Papatzelou and Loumos, 2017). Water sprinkling or the use of other dust palliatives is often necessary along haul roads constructed of soil crushed stone or gravel. Rain infiltrates the sanitary landfill and influences solid waste decomposition. It can also cause operational problems; many wet soils are difficult to spread and compact and the traffic over such soils is impeded.

Industrial wastes management can improve environmental sustainability and furthermore lead to several employment opportunities. Gainful employment and career could be made from within collection, sorting, transporting, processing, recycling and selling of waste components within the Nigerian economy. This is in accordance with the findings of this study that several prospects are available in the industrial wastes management. It creates more jobs than it replaces. According to UNEP in 2014 (as cited in Karadimas, Papatzelou and Loumos, 2017), sorting and processing industrial wastes management in itself sustains ten times more work opportunities than land filling and incineration, considering each tonne. Opportunities for greening the wastes sector are also offered by the expansion and growth of the wastes market, an increase of resource shortage and the availability of new technologies. More recently, interests in industrial wastes as important sources of energy uses and material recovery have increased considerably (Hashim, Gobi, Ho and Li, 2020). Industry owners who have already understood wastes streams within the company and the possibilities of recovery and resources saving usually find that there are large economic benefits if adequate industrial wastes management is carried out. The relevance of successful industrial wastes management programs aiming at sustainable development and minimization of wastes frequently result in significant reductions in more efficient use of valuable resources, production and manufacturing costs, improvements in process and product quality and reductions in waste production, disposal and treatment costs.

Problems of Industrial Waste Management in Nigeria

In the developed countries, most issues in handling of solid wastes generation were solved by utilizing new waste management strategies. However, wastes management remained as one of the biggest challenges in Nigeria. Today, with a Nigerian population of over 200 million, questions about industrial wastes and how to manage them have emerged under several forms (Modebe and Onyeonoro, 2018). In Nigeria, industrial wastes are usually dumped on roadsides, available open pits, flowing gully water, large water bodies and into the space (Karadimas and Loumos, 2018). The indiscriminate disposal of industrial wastes is increasingly prominent in small and medium scale industries in Nigeria. In general, the country faces certain multiple challenges for managing their industrial wastes according to the sustainability principals. In this regard therefore, this study summaries four substantive challenges to industrial wastes management in Nigeria as highlighted and discussed below.

Policy and Institutional Challenges

There are rarely direct and specific environmental and social frameworks that targeted industrial wastes management in Nigeria especially in the areas where there are significant numbers of petrol-agro and manufacturing industries at both small and large scale levels (Modebe and Onyeonoro, 2018; Abila and Kantola, 2013). Local authorities and even State Governments responsible for wastes management have been lacking in technical expertise and institutional capacities to evolve and implement sufficient wastes management policies. Consequently, inadequate regulations and enforcements procedures, source segregation of industrial wastes cannot be substantively managed

(Hashim, *et al.*, 2020). Policy mechanisms and instruments played fundamental roles in encouraging wastes reduction among industries in Nigeria and the country faced serious deficiency of specific wastes management policy for handling especially petrochemical and agro-industries wastes.

Financial Constraints

Financial situations of industries are critical to effective practicing of wastes management especially in the post corona virus pandemic. Insufficiency in financial allocations either in form of incentives or unwillingness to pay, necessary stakeholders are lagging behind in the control wastes management in most of the industries going by their financial records (Fagorite, Anifowose and Chiokwe, 2021). Financial inadequacies necessary to break-even were the main challenges among industries for implementing cleaner production environment (Adekunle, *et al.*, 2016). Financial weaknesses prevent industries from the possibility of applying newer technologies for sustainable wastes management and also industries lack well established wastes management system.

Inadequate Environmental Awareness

Data sources and the nature of information available that need them in wastes management plays a significant role in choosing the rational and needed options for managing industrial wastes. Insufficient information with respect to the situations that surround wastes among industrial players affects industries in their effort to effectively practice wastes management (Modebe and Onyeonoro, 2018; Adekunle, *et al.*, 2016). The supervision authorities in Nigeria lack accurate data and information on industrial wastes generation, compositions and frequency which could assist in better management. In addition, there is reduced necessary knowledge on cost savings opportunities of wastes management behaviour among industries in Nigeria. Stakeholders' education plays an important role in successful waste management.

Lack of Technology and Technical Expertise

One of the concerns associated with executing healthy environmental practices among industries in Nigeria is lack of human resources capabilities such as expertise, technology and skillful employees (Abila and Kantola, 2013). Industries in the country are dealing with technological aspects of managing hazardous wastes; especially in areas of outdated style of process, lack of equipment modifications' technology, inadequate inventory management opportunities and lack of materials and products technology. The applications of knowledge-based management approaches are crucial to inculcating the necessary changes in attitude required to improving the management of industrial wastes.

Conclusion

Effective management of wastes enhances the competitiveness of industries as well as the material welfare of the members of the society. Wastes management prevents wastes from causing harm to the environment and promotes resources use optimization for sustainable development. There is no doubt that, industrial wastes have become more of a

social and environmental concern. Nigeria has been alarmed by reports of both short-term and long-term environmental effects from the past and present management of industrial wastes. The discharge of industrial wastes is inevitable therefore; it is an external obligation for them to secure appropriate and smooth collecting, transport, intermediate treatment, recycling and disposal of wastes in maintaining sustainable environment. This study therefore recommends the integrated wastes management which is a new approach be adopted by industries in growing cities and metropolitans. Integrated waste management differs from the conventional approach towards wastes management by seeking stakeholder participations, covering waste prevention and resource recovery, including interactions with other systems and promoting an integration of different habitat scales (cities and industrial areas). The integrated waste management approach combines a number of management which includes recovery and recycling, wastes minimization and biodegradation which are currently under-utilized by industries in Nigeria.

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