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**IMPROVISING MUNICIPAL WASTE DISPOSAL THROUGH INTEGRATED WASTE MANAGEMENT: THE SOUTHERN NIGERIAN EXPERIENCE**

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**ABSTRACT**

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This paper is aimed at investigating how municipal solid waste are disposed in Nigeria, so as to design an environmental friendly approach to the management of waste in order to effectively control the resultant environmental implications of solid waste. This study involved both personal observation and oral interview of the inhabitants. Also published and unpublished materials were reviewed. Findings of the study revealed that solid wastes that are generated in the study area are mainly from market places, homesteads, factories, workshops, hospitals, seaport, post-primary and tertiary institutions. Pedestrians and hawkers generate a lot of waste on the roadside and streets. Each commercial place in the study and household generates a specific amount of commercial/domestic waste on daily basis. In terms of the problems facing solid waste disposal in the study area, the findings revealed that, there is no public system of primary collection from the source of waste generation. The waste discharged here and there is later collected by municipal sanitation workers through street sweeping and drain cleaning. There is no practice of storing the waste at source in a scientifically segregated way. Irregular street sweeping was also observed to be prevalent. Solid wastes in the study area are collected through traditional handcarts/tricycles which carries only a small quantity. Open sites, masonry bins or concrete structures are used for temporary bulk storage, which necessitates multiple handling of waste. Most of the transport vehicles are old and open. They are usually loaded manually. The fleet is generally inadequate and utilization inoptimal. Disposal of waste in the study area is the most neglected aspect of solid waste management services, and the current practices are grossly unscientific. Almost all municipal authorities deposit solid waste at a dump-yard situated within or outside the city haphazardly and do not bother to spread and cover the waste with inert material. This paper therefore considered and answered some basic question: What are the types of waste generated? How are the wastes disposed? What are the environmental implications of the waste disposal methods? And what new method of municipal waste management will be needed to effectively stored and disposed solid waste in a healthy and friendly manner.

**Keywords:** *Municipal, Solid Waste, Niger Delta, Landfill, Environment*

**INTRODUCTION**

Solid waste is any movable solid objects which the owner wishes to dispose of (Akpofure, 2009). It is no longer useful to the immediate owner. Solid wastes are non-liquid and non-soluble materials ranging from municipal garbage to industrial wastes that contain complex, and sometimes hazardous substances. The World Health Organization (2008) refers to waste as "something, which the owner no longer wants at a given time and

space and which has no current or perceived market value". The line of thought in this definition presented a broad based approach towards the classification of what constitutes waste. However, what one regards as waste may not be totally useless as much can be recycled to produce new products. Wastes may be gaseous, liquid or solid. Solid wastes are not free flowing. Solid wastes have remained man most intractable problems. Waste generation and disposal is a growing problem worldwide and is directly connected to industrial development and population growth. Solid waste management remains one of the most daunting environmental sanitation challenges facing the most developing countries today and it has continually remained at its lowest ebb despite huge investments in the sector (Federal Ministry of Environment, 2005). Waste is generated by activities in all economic sectors and is generally regarded as an unavoidable by-product of economic activity (Stren *et al.*, 2005). Since early modern times, disposing of waste has been an important concern for individuals and community officials (UNEP, 2002). The generation and disposal of waste is an intrinsic part of any developing or industrialized nation. Waste, both from domestic and commercial sources has grown significantly in Nigeria over the past decade. Currently, as a result of industrialization and rapid population growth in many cities and towns, wastes are generated faster than they are collected, transported and disposed. Every time a householder shops at the store and open market, he contributes to the mountain of waste. It is difficult to quantify the volume of waste generated from each house hold in Nigeria, but merely from observation, it shows that the generation of waste amounts to millions of tons. The percent of Nigeria's population living in rural-urban, semi-urban and urban areas has more than doubled in the last 15 years. The cities and urban areas experience continuous growth which contributes to enormous generation of solid waste. In Nigeria, it has been observed that about 75% of the total wastes generated each month are mainly from the urban centres (Nnamani, 2000).

Several researchers have studies the volume of waste generated in Nigerian cities, for example, Maclaren International Ltd (1993) estimated this volume at 182.900 tones. The latest study, concluded by Haskoning and Konsadem Associates (2002) estimated the per capita rate at 0.6kg/day, with a density of 300kg/m<sup>3</sup>. The projections are based on an annual growth rate of population per year. The waste composition in major south-west rural-urban centres comprises of leaves, polythene bags, paper, food waste, tins, metal, glass and rags (Maclaren International Ltd, 1993). This is because these areas are located in the heart of a rice commercial land and has a large old and unplanned section. The management of waste is a matter of national and international concern. The volume of waste does not actually constitute the problem but the ability of governments, individuals and waste disposal firms to keep up with the task of managing waste and the environment becomes the problem. There is no doubt that a dirty environment affects the standard of living, aesthetic sensibilities, health of the people and thus the quality of their lives (World Bank, 1992, Koehn, 1992; Kumuyi, 2005; Stren *et al.*, 2005; Swilling *et al.*, 2006). The corollary is that improper disposal or storage of these wastes can constitute hazards to the environment through the pollution of air, land and water. The indiscriminate disposal and dumping of waste has become a common practice in Nigeria urban centres (Bodija and Oluyole, 2004). Most of the waste dumps are located close to residential areas, markets, farms, roadsides and creeks. The composition of waste dumps varies widely, with many human activities located close to dump sites (World Bank, 1992,

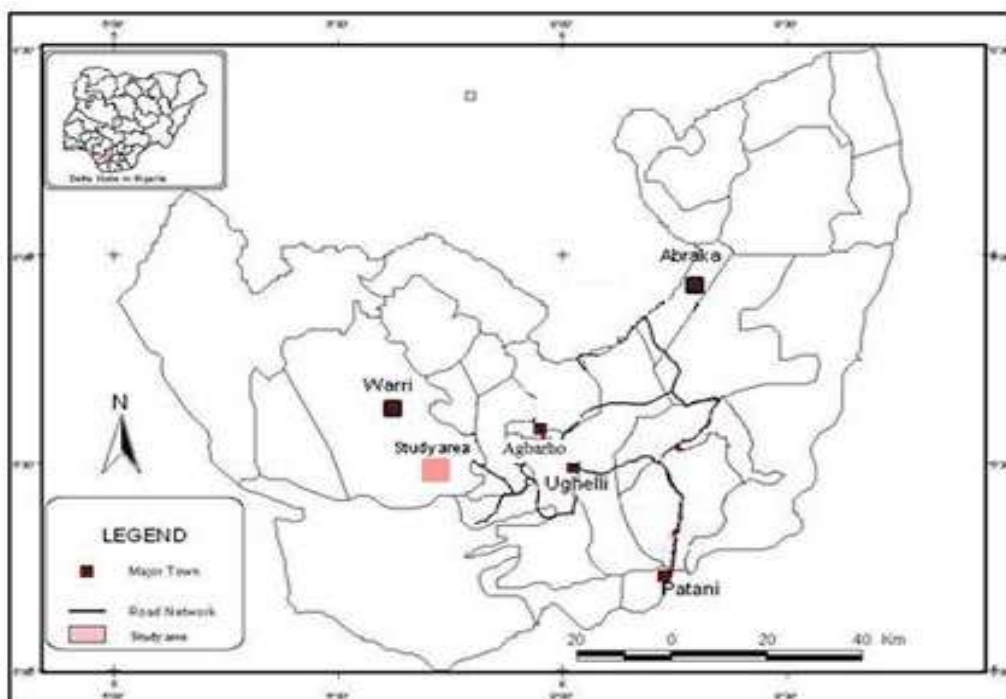
Onibokun and Famran, 1995; Olowu and Akinola, 2008). Significant percentage of what refuse/garbage resident communities generates, are picked up from house or establishment by the sweeper and dumped at near by community bin (Hyden, 2004). The community bins and dumping sites become eye sore, cause foul smell, become breeding places for harmful bacteria and attracts disease carrying vectors such as flies, mosquitoes, birds, rats, dogs etc. the situation gets bad-to-worse when this waste enters into water bodies during wet season (NISER, 1981; Koehn, 1992; Stren *et al.*, 2005). The prime concern arising out of indiscriminate waste disposal system is its impact on community health and environment. No matter who owns the responsibility of waste disposal, reality is that resident communities are the victim of their own apathy towards sustainable solution to the problem (Hyden, 2004). The opportunity cost of using modern waste disposal system in Nigerian urban cities for disposing waste is very high. Apart from land being costly and finite resources, judicial activism on use of land near water bodies is compelling municipal administrators to move towards enforcement of waste segregation and encourage community initiative towards waste generation (Barrett and Lawler, 2009). The disposal of wastes in the world is a problem that continues to grow with the development of industrialized nations and the growth of population (Ahmed, 2004). The growth of human population coupled with increased economic activities in towns and cities result in high rate of solid waste generation (Federal Ministry of Environment, 2005). A fundamental attribute of solid waste is that it is inevitable as almost every human activity involves the generation of waste in solid, liquid or gaseous form. Social dynamics such as modernisation and economic development also influences waste generation. The management of solid waste is far from being satisfactory in Nigeria. Many parts of our cities and towns do not benefit from any organised waste management services and therefore wastes are unattended to, buried, burnt or disposed haphazardly. In areas where the authorities do the collection, it is often irregular and sporadic. Recycling of waste is negligible while the methods used for collection, transportation and final disposal are very unsatisfactory. Inadequate environmental sanitation in many urban centres is a major cause of disease and a drain on the economy by way of lost workdays cost on treatment and cleanup activities. The disposal of wastes in or on the land without careful planning and management can present a danger to health and management can present a danger to health and the environment (Smith, 2005).

In Nigeria especially in major urban centres waste disposal is a critical problem. In fact, Nigeria government has taken different steps in the past and even present to combat the problem without success. You don't need to look far before you see mountain of waste in most of our urban centres. Earlier on, the step taken was based on waste disposal on some designated landfills (that were not sanitary because they were not constructed with underline to prevent leachate problem). Then, when the municipal government could not cope with waste collection and disposal successfully, the people resorted dumping their waste into storm water during rainfall, open dumping sites, stream dumping, burning, landfill e.t.c. Also, wastes generated in the country were characterized by a high percentage (60-80%) of domestic and commercial waste. This gives the wastes high density and makes them very attractive to flies, cockroaches, rats and other vermin (Areme *et al.*, 2007). The term waste disposal and management, in all its ramifications encompasses all steps taken in controlling the generation, storage, collection, transportation, processing and disposal or utilization of waste, in a sanitary manner (Isaac

and Olanike, 2007). Therefore, waste management can be defined as the collection, transportation, processing, recycling or disposal of waste materials produced by human activities (Papper *et al.*, 2008). It is undertaken to reduce their effect on health, the environment or aesthetics. Sustainable waste disposal system provides a comprehensive inter-disciplinary framework for addressing the problems of managing urban solid waste, often with no effective means of recovering them (Sangodoyin, 2003). Upgrading the coverage of modern waste disposal system and services and increasing their efficiency is a precondition for improving the environmental quality of the urban centres. It is against this background that this paper anchored on improvising municipal waste disposal system through integrated waste management approach.

### **DESCRIPTION OF STUDY AREA**

Warri metropolis is an important urban centre in southern Nigeria that comprises of many communities. It lies between latitude 5° 31'N and longitude 5° 45'E of the equator. Warri metropolis has a boundary town with Uvwie, Udu and Okpe. Warri is a commercial and highly industrialized urban centre that is, all types of industries (major and minor industries) are located in the city. It is an important economic area, mostly because of it having a seaport. The main products transported by ship from Warri port consists of rubber, palm products, cocoa, groundnut, hides and skin, cargo and fairly used foreign materials. The centre is surrounded by tropical rainforest and swamp. It experience high rainfall and high humidity for most part of the year. The centre is connected to Benin city by a chief highway. Warri is highly populated, with an estimated population between 507,255 to 1,000,000 and it is necessary that over populated area can enhance the rate of waste generation because the people use all types of materials that results to waste. In attempt to develop technologically; increase in population and industrialization however has led to waste generation which in turn contributes to environmental pollution the price of modernisation.



**Figure 1.1:** A map of Delta State showing the study areas

## **MATERIALS AND METHODS**

The study area was divided into eight (8) zones from which field investigation were conducted. The process of data collection was both on direct personal observations and oral interview. Also, secondary source of data collected was employed; this includes published and unpublished materials. This study was based on the examination of the problems posed on the existing municipal waste disposal methods, environmental and health effects on the individuals in the study area, so as to improvise the waste disposal methods by defining an integrated management approach as a solution to arrest the issue for sustainable development. Therefore the variables determined were the types of waste generated, methods of disposal, their effects on the environment and human health, and the effectiveness of the prevailing methods of control. Methods of disposal and their effectiveness were determined by direct inspection of the dump sites; and also, photographs were taken to give visual impression of the effects of waste on the environment. Table was used to present the different types of waste generated and disposed off in the study area.

## **RESULTS AND DISCUSSION**

### **Types and Composition of Solid Waste Generated**

Solid wastes that are generated in the study area are mainly from market places, homesteads, factories, workshops, hospitals, seaport, primary, post-primary and tertiary institutions. Pedestrians and hawkers generate a lot of waste on the roadside and streets. Each commercial place in the study area like the seaport, oil refinery, market, the university community and household generates a specific amount of commercial/domestic waste on daily basis. The quantity of such waste depends mainly on location, activity and number of people in the household. The rate of solid waste generated per capita increases as the standard of living improvises. Average per capita waste generated from city was at 0.29kg/day (Egunjobi, 2004; Ndakara, 2011).

### **Problems Facing Solid Waste Disposal/Control in the Study Area**

Problems facing solid waste disposal in the study area are discussed below in detail.

**No System of Primary Collection from the Doorstep:** There is no public system of primary collection from the source of waste generation in the area understudy. The waste discharged here and there is later collected by municipal sanitation workers through street sweeping and drain cleaning. Street sweeping during weekends has thus become the principal method of primary collection in the area understudy.

**No Storage of Waste at Source:** There is no practice of storing the waste at source in a scientifically segregated way. Citizens in this locality have not been educated to keep domestic, trade and institutional bins for storage of waste at source and stop littering on the roadside and streets.

**Irregular Street Sweeping:** Even street and roadside sweeping is not carried out on a day-to-day basis in Warri. Generally, the express way and important areas like gas plant, PTI are prioritized and the rest of the streets are swept occasionally or not swept at all. No sweeping is done on Sundays and public holidays and a back log is created on the next working day. The tools used for street and roadside sweeping/cleaning during every

last Saturday of the month (environmental sanitation) are generally inefficient and out-dated. For instance, the broom with a short handle is still in use forcing sweepers to bend for hours resulting in fatigue and loss of productivity. Traditional handcarts/tricycles are used for collection, which do not synchronize with the secondary storage systems. Wastes are deposited on the ground necessitating multiple handling. There are no uniform yardsticks adopted for street sweeping. Though, indigenes in some of the area understudy have prescribed work-norms, these are not very scientific. The agency in charge of managing waste in the area allocates work to sanitation workers on ad hoc basis. The work distribution ranges between 150 metres to 1000 metres of street and roadside sweeping each sanitation day. Some sanitation workers are found under worked while some over burdened.

**Waste Storage Depots:** Wastes are collected through traditional handcarts/tricycles which carries only a small quantity. Generally, open sites or round cement concrete bins, masonry bins or concrete structures are used for temporary bulk storage, which necessitates multiple handling of waste. Waste in the study area often spills over which are both unsightly as well as unhygienic.

**Transportation of Waste:** Transportation of waste from the waste storage depots to the disposal site is done through a variety of vehicles such as bullock carts, three-wheelers, tractors, and trucks. Most of the transport vehicles are old and open. They are usually loaded manually. The fleet is generally inadequate and utilization inoptimal. Inefficient workshop facilities do not do much to support these old and rumbling squad vehicles. The traditional transportation system does not synchronize with the system of primary collection and secondary waste storage facilities and multiple manual handling of waste results.

**Disposal of Waste:** Disposal of waste is the most neglected aspect of solid waste management services in the area understudy, and the current practices are grossly unscientific. Almost all municipal authorities deposit solid waste at a dump-yard situated within or outside the city haphazardly and do not bother to spread and cover the waste with inert material. These sites emanate foul smell and become breeding grounds for flies, rodent and pests. Liquid seeping through the rotting organic waste called leachate pollutes underground water and poses a serious threat to health and environment. Landfill sites also release landfill gas with 50 to 60 percent methane by volume. Methane is 21 times more potent than carbon dioxide aggravating problems related to global warming.

**Disposal on Dunghill and Open Areas:** In the study area especially around the major commercialized area and outskirts of the settlement, regular waste collection is done by each household to be deposited on a dunghill behind the houses, workshop, office and also within open spaces that have not been built up, especially in uncompleted buildings and market areas. Waste deposited in these places are burnt when dry or often left to rot. In many other cases, wastes are indiscriminately dumped on the roadside and streets which often lead to the blockage of drain ways. The general sanitation of the household is under women's, children and sale boy/girl's control, and there is generally no control by the government until the dump site becomes offensive.

**Burning Trash:** In many parts of the study area, waste are gathered near homes, roadside and street and burnt regularly. The burning of waste to a large extent in the study area depends on the type of materials in the waste being burnt. In addition, fire does not completely consume the waste because not all waste can be easily burnt. This practice is quite unhealthy to the populace living in the area due to the resultant pollution effects. A pressurized aerosol can explode, burning paint or batteries could leave a residue of heavy metals, burning solvents might vapourize the liquid into the air, and burning compounds into the atmosphere which last a long time.

### **Environmental Effects of Poor Solid Waste Management**

Modernization and progress has had its share of disadvantages and one of the main aspects of concern is the pollution it is causing to the earth – be it land, air and water. With increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. This waste is ultimately thrown into municipal waste collection centres from where it is collected by the area municipalities to be further thrown into the landfills and dumps. However, either due to resource crunch or inefficient infrastructure, not all of this waste gets collected and transported to the final dumpsites. If at this stage the management and disposal is improperly done, it can cause serious impact to the surrounding environment. In Nigeria, the challenges of urban solid waste management are palpable. The volume of solid waste that is visible at city junctions emitting nauseating smells and causing aesthetic nuisance is a measure of the extent of failure of the current practices. The area under study are increasingly becoming unhealthy places to live, with government both at the local and state levels lacking the capacity to collect and dispose solid waste. Solid waste such as refuse if discharged into drainage system may block the free flow of water which may eventually result to flooding. In the study area, solid waste such as garbage, refuse and scrap metals occupy land space and hence obstruct land use for farming and other purposes. The Warri River has been at the receiving end of solid waste, the water quality has been affected such that the purpose of the water body have been interfered with waste materials.

### **Health Effects of Poor Solid Waste Management**

Inadequate, improper sanitation and poor solid waste management remain two of the main transmitters of diseases in the world's developing countries like Nigeria (Adelegan, 2001). Several studies carried out in Nigeria, India and Egypt indicated the presence of health problems amongst solid waste pickers and those living in close proximity to dump sites (Sridhar, 2006; Ekugo, 1998; Oyemade *et al.*, 1999). The group at risk from the unscientific disposal of solid waste include – the population in the area where there is no proper waste disposal method, especially the pre-school children; waste workers; and workers in facilities producing toxic and infectious material. Other high-risk group includes population living close to a waste dump and those, whose water supply has become contaminated either due to waste dumping or leakage from landfill sites. Uncollected solid waste also increases risk of injury and infection. In particular, organic domestic waste poses a serious threat, since they ferment, creating conditions favourable to the survival and growth of microbial pathogens. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and the rag pickers being the most vulnerable. Waste from agriculture and industries can also cause serious health

risks. Other than this, co-disposal of industrial hazardous waste with municipal waste exposes people to chemical and radioactive hazards. Uncollected solid waste also obstructs storm water runoff, resulting in the forming of stagnant water bodies that become the breeding ground of disease. Waste treatment and disposal sites can also create health hazards for the neighbourhood. Improperly operated incineration plants cause air pollution and improperly managed and designed landfills attract all types of insects and rodents that spread disease.

### **Integrated Waste Management Options**

Integrated waste management options are concerned with strategies aimed at reducing and minimizing the amount of waste generated. A waste minimization programme is an organized comprehensive and continued effort to systematically reduce waste generation, while waste reduction is the reduction of waste for a good and healthy environment (Akpofure, 2009). This paper analyses in detail, the integrated waste management options.

**Avoidance and Reduction Methods:** An important method of waste management is the prevention of waste material being created, also known as waste reduction. Methods of avoidance include reuse of second-hand products, repairing broken items instead of buying new, designing products to be refillable or reusable (such as cotton instead of plastic shopping bags), encouraging consumers to avoid using disposable products (such as disposable cutlery), removing any food/liquid remains from cans, packaging and designing products that use less material to achieve the same purpose.

**Energy Recovery:** Municipal solid waste can be used to generate energy. Several technologies have been developed that make the processing of municipal solid waste (MSW) for energy generation cleaner and more economical than ever before, including landfill gas capture, combustion, pyrolysis, gasification, and plasma arc gasification. The energy content of waste products can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Thermal treatment ranges from using waste as a fuel source for cooking or heating and the use of the gas fuel to fuel for boilers to generate steam and electricity in a turbine. Pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process usually occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other chemical products (chemical refinery). The solid residue (char) can be further refined into products such as activated carbon. Gasification and advanced Plasma arc gasification are used to convert organic materials directly into a synthetic gas (syngas) composed of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam. An alternative to pyrolysis is high temperature and pressure supercritical water decomposition (hydrothermal monophasic oxidation).

**Resource Recovery:** Resource recovery (as opposed to waste management) uses LCA (life cycle analysis), attempts to offer alternatives to waste management. For mixed MSW (Municipal Solid Waste) a number of broad studies have indicated that administration, source separation and collection followed by reuse and recycling of the non-organic



fraction and energy and compost/fertilizer production of the organic waste fraction via anaerobic digestion is to be the favoured path.

**Incineration:** Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This method is useful for disposal of residue of both solid waste management and solid residue from waste water management. This process reduces the volumes of solid waste to 20 to 30 percent of the original volume. Incineration and other high temperature waste treatment systems are sometimes described as "*thermal treatment*". Incinerators convert waste materials into heat, gas, steam and ash. Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials. Incineration is common in countries such as Japan where land is more scarce, as these facilities generally do not require as much area as landfills. Waste-to-energy (WtE) or energy-from-waste (EfW) are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam or electricity.

**Landfill:** The last option for disposal of municipal waste is through landfill. Disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries. Landfills are often established in abandoned or unused quarries, mining voids or borrow pits. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Design characteristics of a modern landfill include methods to contain leachate such as clay or plastic lining material. Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Modern landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity.

## CONCLUSION

This study has revealed critically, that the prevailing processes of solid waste disposal in Warri metropolis have adverse implications on the environment as well as human health within the dump sites. These implications were obvious due to industrialization and population growth which resulted in a failed system of managing waste. It was also observed that waste in the entire study area was not duly managed. Man can not continue to live in such uncomfortable and problem prone environment, hence an integrated management approach is required to tackle holistically the environmental menace of municipal waste disposal.

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