A Review of Local Factors Affecting Solid Waste Collection in Nigeria

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ABSTRACT: The knowledge of local and regional factors that affect effective solid waste collection plays an important role in choosing appropriate technology. Waste collection has grown to become a major challenge demanding daily response from waste managers and it becomes inevitable to provide stakeholders with necessary information to aid key decision-making. This paper provides a comprehensive and detailed review of local-based factors that affect waste collection in Nigeria. Literature study and on-site observation were used for getting theoretical and useful information on the collection of waste in the study area. The study considered various standard collection technologies and their supporting factors in order to assess the effectiveness of existing methods. The current collection techniques existing in different parts of the country together with unique local factors for these various areas are reported. The findings in many cases reveal that the method of waste collection adopted and equipment used are faced with many challenges. This paper revealed that there is no investment presently made on the existing development plan to initiate a modern waste collection system. The study recommends a new approach that could be used by institutions and government agencies for efficient municipal solid waste collection to achieve sustainable and effective sanitation which will consequently facilitate the development of an aesthetically balanced and friendly environment.

Keywords: effective sanitation, investment, local factors, Nigeria, solid waste collection.

INTRODUCTION

Globalization and urbanization are being experienced in various parts of the world today. These have led to an increase in population in urban areas and its consequence is witnessed in an increase in waste generation (UNEP, 2002; Ukpong and Udofia, 2011; Olukanni and Akinyinka, 2012; Tahir *et al*., 2015). Most developing countries have solid waste management problems, different from those found in developed countries, in areas of composition, density, waste amount, access to waste collection, awareness and attitudes, and political and economic framework. However, in developing countries, the major existing challenge is in coping with the volume of waste generated. Available facilities and equipment to cater for the wastes generated are insufficient, coupled with inadequate

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awareness and technical knowhow, uncoordinated institutional functions, poor data information for planning, poor regulatory framework that is manifested in lack of interest of private sector investment in service delivery (infrastructure), low political will, low capacity to discharge duties, and wrong attitude of waste generator amongst others (Ogwueleka, 2009a; Abila and Kantola, 2013; Olukanni *et al*., 2014; Olukanni and Mnenga, 2015).

Nigeria, the most populous country in Africa with over 160 million populations, has witnessed a rapid population growth over the past decades providing a large market for manufacturing industries and organizations. These industries provide goods and services to the citizenry and consequent wastes generated after the usage of these goods are enormous (Seo *et al*., 2004; Schwarz *et al*., 2005; Olukanni, 2013). However, the lack of proper and comprehensive waste collection system has hindered effective sanitation, thus the citizenry reeling under indiscipline and haphazard way of dumping refuse in an objectionable manner. The waste generated include refuse from households, non-hazardous solid waste from industries, commercial and institutional establishments (including hospitals), market waste, yard waste, and street sweepings. The general practice in most places has been indiscriminate disposal of solid waste thereby creating unsanitary environments in many part of the country. In addition, the waste disposal site is faced with poorly developed dumping ground that is potentially threatening to public and environmental health (Ayotamuno and Gobo, 2004; Olukanni *et al*., 2014; Olukanni and Mnenga, 2015).

The quantity and type of waste found in an area depend on a number of prevailing factors which are unique to each area (Birly and Lock, 1998; Olukanni, 2013). Pressure on the local environment is caused by the growing population and some of the influencing factors are witnessed in the form

of economy, environment, infrastructure, and social, technical, and quality of the waste. However, basic aspects of sustainable waste management are protection of man and environment, economic compatibility, and social compatibility (Li, 2007). Tahir *et al*. (2015) identified urbanization, change in consumption patterns, industrialization, economic growth, and per capita income as the influencers of solid waste generation. The collection and transportation of these solid wastes usually accounts for the bulk of Municipal budget spending and these processes are known to have the greatest impact on urban living (UN Habitat, 2010).

Solid waste management as a whole has thus emerged as one of the greatest challenges facing State and Local Government Environmental Protection Agencies in Nigeria. More wastes are produced with fast increase in population and urbanization which consequently place great pressure on the waste managers. The World Bank, in its report in 2005, expressed that there is a need for consistent national policies on municipal solid waste legislation which should encourage cross-jurisdictions and inter-agency coordination, and facilitate implementation of economic instruments for improving waste management. However, Li (2007) objects that waste management strategies cannot be implemented without the support of legislative framework which should have a series of ordinances and regulations aimed at managing solid waste, including procedures and methodologies for monitoring and enforcing the regulations.

The importance of solid waste collection and management as a whole cannot be overemphasized. The collection of solid waste is an integral part of solid waste management (SWM). Its effectiveness is initiated by both public and private sectors which is largely controlled by location, ability, and willingness of the owner of the waste (waste generator) to pay the amount charged. SWC involves the initial collection on house-to-house basis,

collection from industrial and business outlets, roadside sweeping, removal of garbage from open drainages, including collection from other waste generating points. This initial collection is effectively carried out when the necessary equipment are provided and utilized. The applicable equipment may include: bins, brooms, shovel, carts, etc.

The effectiveness of collection is enhanced through strategic allocation of bins within the managed region. The bins could be available either for general or initial-on-site sorted collection. The advanced stage of collection involves heavier and costlier equipment and man-power. Equipment such as waste vehicles are chosen in a way that maximizes operational demands. According to Coad (2011), collection equipment which is purchased in large numbers, in many cases, is either been under-utilized or never lived out their entire life spans. Areas experiencing greater waste generation with lack of appropriate technology to manage them or haphazard method of disposing solid wastes are more likely to encounter degradation in the quality of air in such locations which have harmful effects on human health and several other problems. These problems include disease transmission, odor, nuisance, pollution (atmosphere, land and water), fire hazards, aesthetical nuisance, and economic losses as identified (Aliu *et al.*, 2014).

There are many factors that contribute to the effectiveness of waste collection techniques as we move from one region to another. Each region has its specific contributory factors, the understanding of which can provide policymakers with necessary information to help make quality and cost effective decisions. The focus of this study is to explore the existing waste technologies in use in Nigeria and provide information on the current local factors that inhibit the successful collection of wastes generated by citizens, and give recommendation on how effective waste collection could be achieved. The paper also assesses the solid waste management problem and documents the potential environmental and health implications.

SOLID WASTE COLLECTION SYSTEMS

According to Aliu *et al.* (2014), the method of waste collection and disposal form the majority of the problems encountered by developing countries in the management of solid waste. Ogwueleka (2009a) expressed that solid waste collection is one of the most difficult operational problems faced by most cities in Nigeria. The collections are done in an adhoc manner that contributes to huge solid waste collection cost. The volume of solid waste generated continues to increase at a faster rate than the ability of the agencies to improve on the financial and technical resources needed to balance this growth. The rate of waste generation exceeds collection capacity as it was described by Zurbrugg (2003) that one to two thirds of the solid waste generation in developing countries is not collected and there is no regular routine collection. The system to be adopted for SWC depends largely on a number of factors. The peculiarity of these factors to different regions has necessitated different collection systems. Overall, these systems can be categorized based on modes of operation, types of vehicle, and the types of waste collected (Mourao and Almeida, 2000; Tchobanoglous and Kreith, 2002; Agunwamba *et al.*, 2003).

Collection Based on Mode of Operation
There are a number of factors that affect operational quality which are very crucial to the waste collector in choosing the mode of operation to be adopted. These include the number of vehicles, vehicle maintenance, trip rate, vehicle capacity, frequency of collection, and number and quality of personnel (Aliu *et al.*, 2014; Olukanni *et al.*, 2015).

On the basis of mode operation, the system of collection can be by

a) Haul container system
   i. Conventional model
   ii. Exchange model
b) Stationary container system

The conventional mode of the haul system is ideal for areas with high generation rates with high flexibility by reason of availability of different sizes and shapes of containers. It is also known for low utilization of containers. Container utilization being the fraction of the total container volume is actually filled with wastes. Under this system, dedicated trucks are used to move loaded/filled containers to transfer station, empty them, and then return to their original location. The exchange mode is characterized by loaded containers used for collection to transport wastes to transfer stations or disposal sites.

These containers are emptied and transferred to a different location in exchange version (Olukanni *et al.*, 2015). The driver begins his tour with empty container from the dispatch station (depot) and deposits it at the first collection site. This system is advantageous in situations where sizes of the containers are similar. Among the few types of trucks commonly used under this system of waste collection are: hoist truck, tilt-frame container, and trash trailer. Figure 1 describes the conventional mode of haul container system. It can be observed from Figure 1 that there are connectors between the waste sources. This implies that for every waste collection trip made from a point, there is a trip back to that same point.
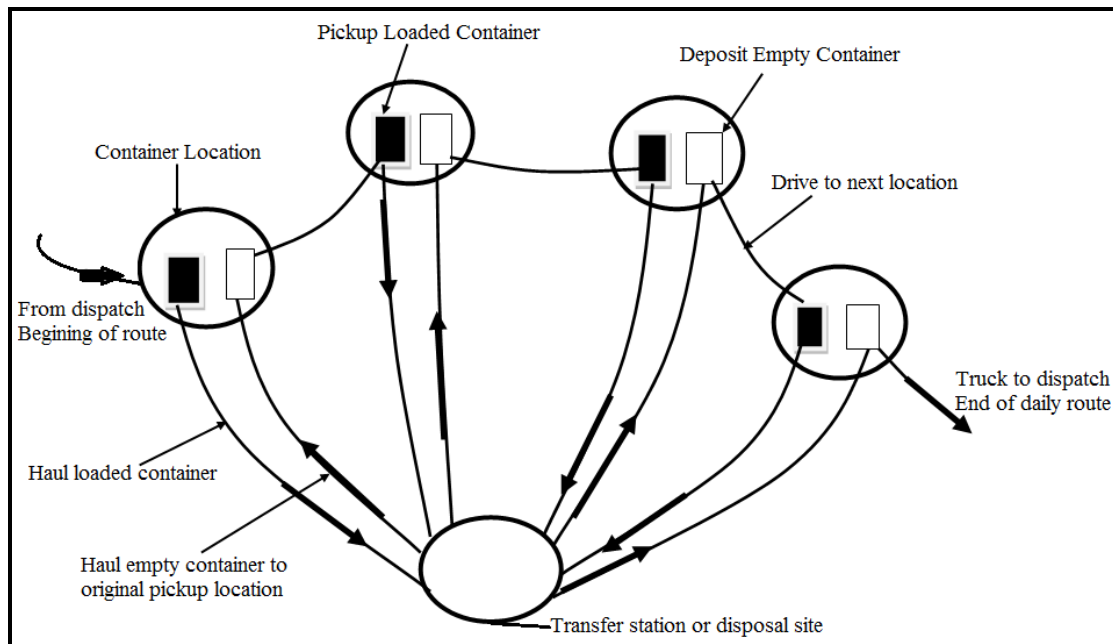
Fig. 1. Conventional mode of Haul Container System
Source: Agunwamba (2001) in Olukanni *et al*. (2015)

Figure 2 shows the modified hauled container system. In this method of collection, the collection crew sets out of the station with an empty bin and at the first station, the bin is dropped off while the filled bin at the site is collected and taken to disposal point. The filled waste bin whose content has been disposed from

the previous site is then taken to the next source and dropped off as the new empty bin for that source. Then, the filled bin on site is carried on for disposal and then dropped off at the next source. This loop continues for as many sources as there are in the collection plan (Olukanni *et al.*, 2015).
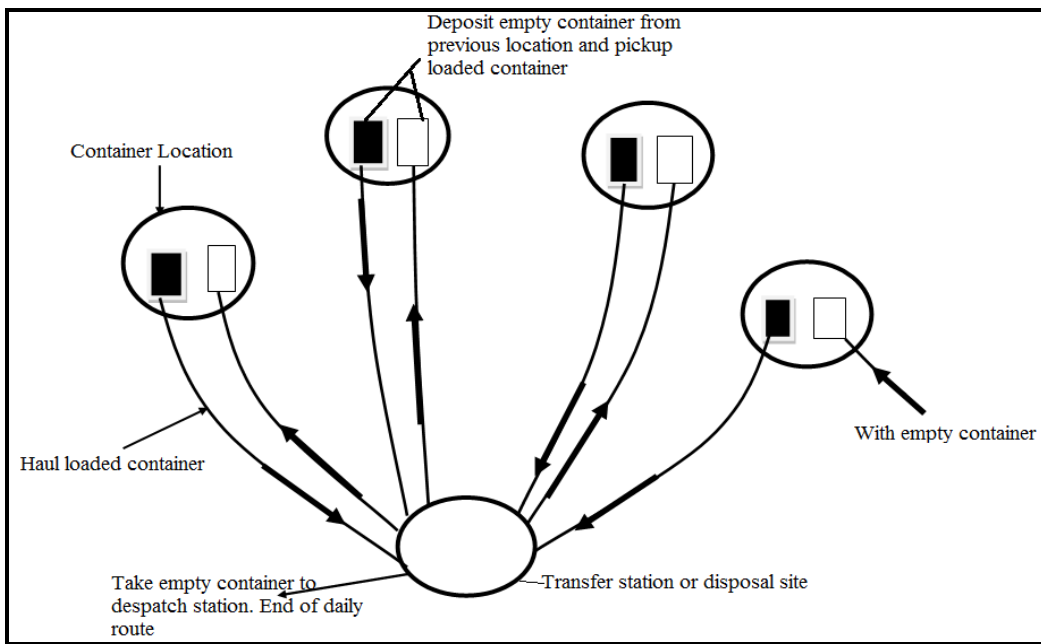
Fig. 2. Exchange mode of Haul Container System
Source: Agunwamba (2001) in Olukanni *et al*. (2015)

In the stationary container system, designated containers remain at the source of generation except when moved to the curb or other location to be emptied. The collection truck is driven from pickup location to pickup location until it is fully loaded. It is characterized by continuous collection of waste from point to point until all the places for which waste is to be collected from have been exhausted and the waste vehicle is ready to return to the disposal station. The system of loading could either be mechanical or manual. Due to economic advantages involved, internal compactment trucks are usually engaged especially in situations of long haul distances. Figure 3 describes the stationary container system.
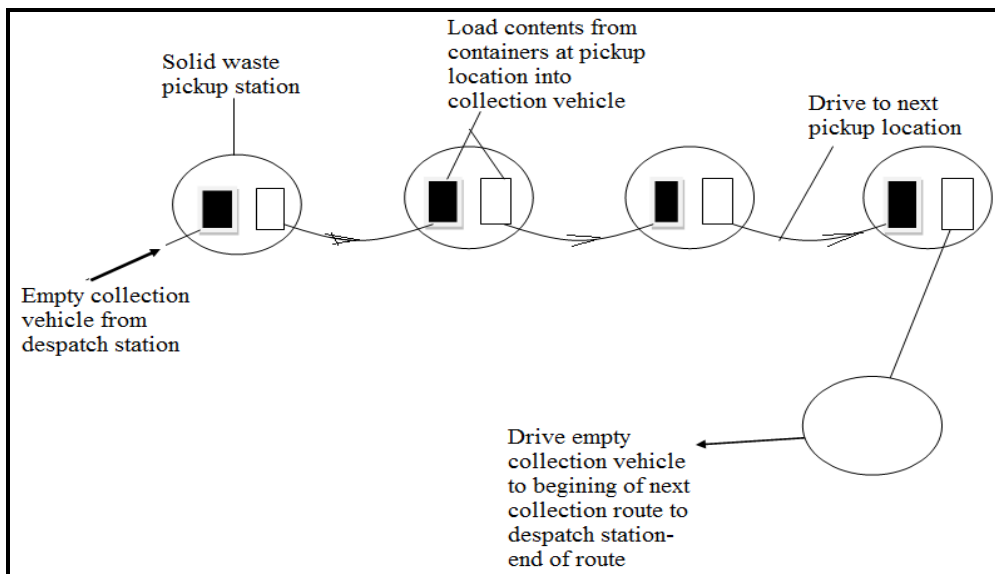
Fig. 3. Stationary container system
Source: Agunwamba (2001) in Olukanni *et al*. (2015)

Collection Based on Types of Waste

Two broad categories of systems of collection are recognized based on the types of wastes collected. These are:

    i. collection of commingled (unseperated) and

    ii. segregated (sorted) wastes.

In the former, collection can be from low-rise detached buildings, high-rise apartments, and commercial facilities. Collection from low-rise detached buildings includes kerb, alley, and setout-setback collections. For kerb collection, landlords (house owners) place container at the curb. Alley storage containers are commonly used where alleys are part of the general layout of a particular residential area. In set out-set back collection system, containers are carried out from houses and returned after being emptied by collection workers. There is, however, some low- and medium- rise apartments which make use of curb side collection service and engaged the services of maintenance workers for transporting containers to the streets.

Tchobanoglous and Kreith (2002) identified three methods of collecting commingled wastes from high-rise apartments:

    i. Pickup from various floors down to the basement

    ii. Tenants take waste to the basement/service area and

    iii. Use of waste chute system.

High-rise apartments are more prominent in developing countries and this practice has given rise to the modern pneumatic systems for transporting wastes through underground to central processing facilities. The collection of commercial waste is usually affected by extreme traffic congestion during the day forcing collection activities to take place during off-peak periods which normally fall between late in the night and early in the morning. Due to security concerns, collection during these periods usually involves more workers. However, where congestion of traffic is minimal and enough space is available to hold containers, large movable containers can be used to collect wastes.

Sorted wastes should be collected separately for the purpose of recycle or reuse. Recyclable materials from residential areas may be collected using the curb side system which makes use of specially designed vehicles such as the Modified flat-bed truck, Open-bin recycling truck, Closed-body recycling truck, etc. (Thiesen, 2002 in Tchobanoglous and Kreith (2002). Contracted private collectors also deal in sorted wastes from households and commercial units. Another arrangement is where individual residents drop off their waste materials at buy-back centers.

Solid Waste Collection Practices in Different Parts of the World

In many parts of the world, challenges with solid waste collection are still being experienced. There are several solid waste collection systems adopted in different countries based on several factors which may include political considerations, public acceptance, economics, public health, and environmental condition (Visvanathan *et al.*, 2006). Waste collection processes form the bulk of the expenditure of solid waste managemnet in these nations. Usually, the waste requires more expensive removal or collection due to its concentration, especially in big cities (Visvanathan, 2005).

In Asia, much effort has been made in the management of solid waste across its nations. However, up till this point, some of the nations are still battling with effectiveness in their collection and transportation schemes (Visvanathan, 2005). In east-Asia/Pacific region, the bulk of the cost for solid waste management goes into the collection and transfer of these wastes. Also, most countries in south and west Asia are faced with the issue of the unnecessary time wasting procedures involved in the handling of wastes. This could pose health risks to the workers

handling the wastes. Public health issues may also arise as a result of lack of waste services for illegal residents in settlements not endorsed by the government or insufficient waste facilities for congested low-income areas (UNEP, 2005)

There is diversity in collection strategies across the countries in Europe and the range of performance in separately collecting fractions of municipal waste suggests that their collection strategy is nearly perfect (Eunomia Research and Consulting Limited, 2002). They usually adopt different collection methods for the different types of recyclable wastes. For example, paper is often collected from kerb sides or collection containers from apartments while glass may be collected using closed recycling collection containers sometimes referred to as igloos (UNEP, 2005).

Fairly good waste collection is experienced in large cities in Latin America and the Caribbean. Although some cities in the region are faced with issues relating to frequency and efficiency of waste collection (UNEP, 2005), collection frequency is very crucial to the environment and public health. House flies are known to develop at specific temperature within 9–21 days and as such it will be ideal to clear wastes from collection points at least once a week to avoid the spread of diseases through this medium (Visvanathan *et al.*, 2006). In North America, four common methods of solid waste collection are adopted, the kerb side or alley collection being the most commonly used. The back yard collection requires more labor and as such is costlier than the former. The drop-off or mailbox collection point method is usually adopted in rural areas and is usually adopted as a cost saving technique. The fourth option is direct hauling of waste by the waste generators to the disposal sites (UNEP, 2005).

Waste generated in Antarctica is handled at different levels. Wastes that are likely to become putrid are incinerated in a two-stage, high temperature incinerator, with the resultant ash returned to Australia. Metals, plastics, paper, cardboard, and glass are separated and returned to Australia for recycling. Non-recyclable wastes are returned to Australia for appropriate disposal. Reusable packaging materials are used wherever possible. Also, biological sewage treatment plants have been installed at all Australian Antarctic stations. Sludge from the plant is removed to Australia, and the UV sterilization of the effluent is currently being trailed to ensure that no harmful organisms are released into the environment (Australian Government, 2012).

In many cities in Africa, challenges facing solid waste collection are usually as a result of vehicle immobility, lack of sufficient funds for operation, lack of public enlightenment on hazards associated with wastes and so on. However, improvements have been made due to the recent involvement of the private sector in the management of waste. Solid waste in most African cities is disposed of near the perimeter of the city, within easy reach of vehicles and collection crews (UNEP, 2005). In a review of study carried in Dar es Salaam, Tanzania by Chinamo (2003). The author expressed that the drop in proportion of waste collected by 5% in 1992 before an emergency clean-up of the city was initiated under UN Sustainable Cities Programmed. By 2003 it had been increased to an estimated 32%.

Ngainayo, in 1986, had earlier stated that some of the challenges associated with waste collection are excessive high downtimes which are often exacerbated by slow rates of repair and the resulting delays in returning vehicles to service. The author pointed out that small repair could take up to one week, and large repairs anything up to one month to complete, provided that the parts were available. It is not uncommon for vehicles to be out of service for many months awaiting the finance for the purchase of spare parts (Ngainayo, 1986). Several solutions have been

proposed. However, it seems the costs of developing a type of non-compaction waste collection body that is particularly suited to local conditions may appear to be beyond the scope of a particular municipal budget or a small international co-operation project (Ayininuola and Muibi, 2008)

THE STUDY AREA

Nigeria is located in the western hemisphere of Africa and lies between Cameroun and Benin. It is bordered to the south by the gulf of Guinea and to the north by Niger and Chad. It has an approximately land area of 910,768 km^2 and a total land boundary of 4,477 km. Nigeria is the most populous country in Africa and ranked 7th in the world. Figure 4 shows the map of Nigeria and the neighboring countries.

Fig. 4. Map of Nigeria depicting the Study Area (Source: Google Map, 2016)

Nigeria is further divided into 36 States and a Federal Capital Territory. Each of these States is also divided into local government areas. These subdivisions allow the Federal government to effectively impact the grassroots with its policies. With expected growth in population and economy, the annual rate of solid waste generation is expected to increase. Waste collection in Nigeria is primarily undertaken by the public sector. The government of each State is responsible for this task. The main approach to solid waste collection in the country can broadly be divided into two. The first consists of situations where households, shop outlets, and industries bring their refuse and empty them in dedicated containers at designated locations. In some States, however, as Walling *et al*. (2004) noted, there are no public waste containers, as the quantity of wastes that accumulate in a very short time would exceed the capacity that can be hauled in a day by waste collectors. The authors pointed out that waste dumps are located by the highway sides at the edge of cities and slums. The country is faced with the enormous task of effective waste collection system that will produce clean and healthy environments.

Solid waste management in Nigeria has been described by inefficient collection methods, insufficient coverage of the collection system, and improper disposal of solid waste (Ogwueleka, 2009b). At various times, the Federal Government of Nigeria has enacted various laws and regulations

with the hope of creating a safe environment. Among other environmental challenges, the huge amount of solid wastes that deface Nigerian cities motivated the Federal Government of Nigeria to promulgate Decree 58 for the establishment of a Federal Environmental Protection Agency (FEPA) in 1988 (Olukanni and Akinyinka, 2012) which translated into a national policy formulation.

The agency was saddled with the responsibilities of administering and enforcing compliance in order to secure for all Nigerians a quality of environment adequate for their health and wellbeing, raising public awareness and promoting understanding of the essential linkages between the environment and development, and to encourage individual and community to participate in environmental protection and improvement efforts (FEPA, 1989 in Agunwamba, 1998). FEPA Act allows each State and Local Government to set up its own environmental protection body: Lagos Waste Management Authority (LAWMA), River State Environmental Protection Agency (RSEPA), Ogun State Environmental Protection Agency (OGEPA), Enugu State Environmental Protection Agency (ESEPA), Ondo State Integrated Waste Recycling and Treatment Project (OSIWRTP), Kaduna State Environmental Protection Agency (KASEPA), Anambra State Environmental Protection Agency (ANSEPA), Oyo State Environmental Protection Agency (OSEPA), and others.

The agencies are charged with the responsibility of handling, employing, and disposing of solid waste generated. These agencies generate are funded from subvention from State governments and internally generated revenue through sanitary levy and stringent regulations with heavy penalties for offenders of illegal dumping and littering of refuse along streets (Ogwueleka, 2009a; 2009b; Olukanni and Akinyinka, 2012). Later in 1999, FEPA was re-organized to become

what is now known as the Federal Ministry of Environment (FME). The solid waste practices in Nigeria may differ from region to region however; the underlying factors that influence their effectiveness are similar. The waste collection practices of four selected locations in Nigeria are discussed in later sections and the common factors affecting theses states and other parts of Nigeria are discussed in the section that follows.

Current State of Solid Waste Collection in Different Selected Locations in Nigeria

Up until recently, the public sector had the upper hand in the provision of solid waste management services in urban cities as is the case in many developing countries in Africa (Akaateba and Yakubu, 2013). However, there are major lapses resulting from their managerial, operational, financial, and technical incompetence. This has given rise to the more recent involvement of the private sector in solid waste management. In this section, four States in Nigeria have been randomly selected in order to representatively describe the current waste collection practices in the different regions of the country. Lagos State representing Western Nigeria, Awka- the capital city of Anambra State- representing Eastern area, Port Harcourt city representing the Southern region, and the Federal Capital Territory (FCT) Abuja representing Northern Nigeria have been chosen for this purpose.

Lagos State is located in between longitudes $2^{°}$ 42`E and $3^{°}$ 42`E, Latitudes $6^{°}$ 22`N and $6^{°}$ 52`N on the South-western coast of Nigeria. The State accounts for over 65% of Nigeria`s commercial and industrial activities with about 45% of national electricity consumption and over 70% of total national cargo freight. The State is cosmopolitan in nature with an urban-rural distribution of 70-30 and a vehicular density of 224 vehicles per kilometer. It is known to be the first State

in Nigeria to have adopted a new model in waste management known as the public private partnership (PPP) model in 1997 (Lasisi, 2007), although some other States have followed suit. In this model, both the government (public) and the private sectors share the risks and benefits of waste management (Nwachukwu, 2009; Aliu *et al*., 2014).

Given the numerous lapses associated with government controlled enterprises, the PPP serves as an intervention in improving waste collection and disposal processes, especially in rapidly growing urban centers such as Lagos, by instilling greater efficiency in its operations, cost reduction as well as improving the quality of service delivery (Massoud *et al*., 2003; Morrissey and Browne, 2004; Solomon, 2009; Wilson and Scheinberg, 2010). Lagos is known to have struggled a great deal in past times with waste management, but since the Lagos State Waste Management Authority (LAWMA) have been brought on board and with collaborations from other private sector participants; solid waste management issues have been largely reduced in the State.

Awka is the capital city of Anambra State located in the Eastern part of Nigeria. An extensive study of the waste management practice in the city has been carried out by Okonkwo (2014). It was reported that the city has witnessed a number of waste management problems in recent times, resulting in an unpleasant sight to behold. Although, numerous changes have been made to the management agencies controlling the waste management activities, desired results have not been achieved. The inadequate method or systems being adopted (especially with regards to collection and disposal of unknown volume of unseparated or non-classified waste) are reported as the causes for majority of the SWM issues experienced in Awka.

After a series of changes in waste management authorities from 1985, Anambra State Waste Management Authority was brought on board in 2011 and is saddled with the responsibility of waste collection and disposal across the State. Their current practice involves the use of receptacles which are placed at particular locations for the collection of wastes. Although no data, especially relating to volume and type of waste generated, is available to inform the location where the receptacles would be placed, judgements are made due to the level of activity in the area. Street sweepers are also employed for cleaning major roads. The waste collected are emptied and transported by means of a chain up or compactor vehicle and are disposed of in a gully erosion site where scavengers come to pick useful items (Okonkwo, 2014). The solid waste management practice in the city is generally poor and requires attention although some recommendations have been made to remedy the situation.

A research carried out by Agwu (2012), revealed that residents of the study zones in Port Harcourt City, Capital of Rivers State in Southern Nigeria, engage in poor waste management practices despite the fact that they are aware of the solid waste management problems in their environment. The study also revealed that there were differences in the propensity for good solid waste management practices based on different backgrounds, ages, sex, and social class. It can be inferred that the residents' attitude and behavior are the major challenges faced in this area as they are not responsive or do not see the need for adequate or effective solid waste management. However, with strict policies and grievous punishments set in place, an attempt to instill discipline may be made.

In the Federal Capital Territory (FCT), Abuja, State and Local Government Protection Agencies are responsible for waste collection and transport. Abuja,

being the capital of the nation Nigeria, is a typical urban center characterized by industrialization and rapid population growth resulting in high rates of waste generation. This necessitates the involvement of private contractors for some areas in the city. The Director General of FEPA affirmed that only 40% of the 300 tons of waste generated daily in Abuja are successfully cleared, relating the failure to lack of machinery and personnel required to clear the generated waste (Oyeniyi, 2011). According to Abur *et al*. (2014), the private companies are usually more efficient than the government agencies, although they offer their services at a fee. All through the city, the stationary container system of waste collection is adopted where both fixed and movable containers are utilized.

Abuja Environmental Protection Agency (AEPA) as well as the private operators (where appropriate) are saddled with the responsibility of collection of the wastes from the containers placed at the various waste generation points and transporting them with the use of vehicles such as compactor trucks, pay loaders, tippers, etc. These vehicles, however, are just few which results in their overuse leading to frequent breakdowns. Imam *et al*. (2008) reported that twelve private companies are involved in waste collection operations in Abuja. Informal sectors also provide house-to-house collection services. Due to high traffic jam in the city, collection and transportation of waste during the day has not been desirable. However, owing to security concerns, night collection by AEPA has been the order of the day. In Abuja, the waste management agencies face challenges as a result of minimal budget allocation, lack of properly trained staff, lack of a proper structure for waste management, and inadequate knowledge about the volume and types of waste generated amongst others (Abur *et al*., 2014).

Waste collection is a very crucial issue as lingering wastes may pose serious environmental and health risks. Only about 20-80% of the wastes generated are successfully collected despite the fact that most cities spend close to half of their annual budgets on solid waste management (Fehr, 2002; Achankeng, 2003; Kadafa *et al*., 2013). Other factors influencing the effectiveness of solid waste collection in Nigerian cities are examined in the following section. It is observed that these factors have not been explicitly considered as a whole in literature. However, efforts have been made to study peculiar challenges associated to waste management in the country.

The gaps identified in the existing waste collection systems which inhibit effective service delivery are seen in the light of the following: there is deficiency in the waste collection structure coupled with weak legal framework that does not enforce the existing regulations; administrative human capacity is in shortfall and there are associated technical issues in addition to uncoordinated institutional functions; most States' waste management agencies are not adequately funded and there is little or no investment in infrastructure; the entire system requires a strong political will that encourages the public to actively participate in the waste management programs (Ogu, 2000; Olanrewaju and Ilemobade, 2009; Ezeah and Roberts, 2012).

People's attitude

The general gesture of citizens is that waste constitutes non-essential materials that should be destroyed rather than processed into useful resources. It is not uncommon in Nigeria to find residents who expect their wastes to be collected either beside the roads on the highways or right in front of their apartments. Most people who dwell in urban areas consider the collection activities as the sole responsibility of the local authorities. When these authorities

fail in this expected task, they are strongly attacked especially on local media and social networks. This is sharply in contrast to the practice in most advanced nations where residents are aware of the cost implications attached to unnecessary waste generation and the hazardous effects of undisposed waste.

According to Zurbrugg (2003), human activities are responsible for the creation of waste which has direct impact on the environment and human health. However, these activities are not only one-sided as even the waste collectors (the authorities and the paid workers) often show low concerns to the huge challenge posed by collection. Due to this negligence, streets are often seen littered with refuse on daily basis. This is especially true of roads which are closer to market areas (Onwughara *et al.*, 2010).

Desa *et al.* (2012) conducted a study on the impact of attitudes and behavior on SWM. Though the research revealed that these factors are moderate among students, it still suggested that the general citizens must be encouraged through educational awareness programs on SWM in order to promote attitudinal change and sustainable environment. In an earlier study, Ekere *et al.* (2009) had shown that these attitudinal imbalances are caused by gender differences, peer influence, household location, and land size. Scheinberg et al. (2011) also pointed out that when fees are paid for collection services, it tends to affect the active support from residents.

In Nigerian urban areas, private collectors are now being involved. These private operators demand some amount of money before rendering services. Because of the income level of most citizens, high fees tend to lower the morale of people. The above assertion can indirectly be inferred from Adebola (2006) who observed that a cart pusher (a form of informal private involvement) made an average of two thousand six hundred naira

(US $20.00) per day while an average government worker earned about seven thousand five hundred naira (US $57.69) per month.

Type of Waste and Rate of Generation
Huge differences exist in the nature of domestic solid waste from one region to another, even in different parts of the same city (Omrad and Read, 2008; Coad, 2011). Wastes are generally categorized into low and high density wastes. In Nigeria, most household wastes have a very low density because they consist of largely light materials. In coastal areas like Lagos and Port-Harcourt where large scale fishing is carried out and the consumption rate of fish is high, more frequent collection of waste may be necessary to reduce the outbreak of bad odors. Different areas are characterized with different waste types. For instance, business districts and expensive housing estates are generally characterized by low density wastes while industrial areas where coal or charcoal are used for heating are known to generate high density wastes.

The type and density of waste impact significantly on the choice of technology to adopt in the process of collection. In most places in Nigeria, wastes are not sorted at the point of collection, making it very impossible to make use of modern vehicles with compartments for waste collection. Depending on the density of the waste, some local authorities provided compactor vehicles for unsorted wastes. On the average, the rate of generation of waste in Nigeria ranges from 0.44-0.66 kg/capita/day. At present, Lagos and Abuja have the highest rate of generation at > 0.63 kg/capita/day and > 0.56 kg/capita/day, respectively (Ogwueleka, 2009a). These rates increase as the population increases. For instance, Roberts *et al.* (2010) claimed that at an annual population growth rate of 3%, the estimated 70,000 tons per annum of waste generated in Abuja is likely to double by 2025. Without necessary measures, there

are clear indications that these rates may double in the next couple of years.

Legislation

Legislations on environmental issues include enactments and regulations comprising provisions concerned with the environment as they broadly affect land, water, and air (Nwufo, 2010). These enactments are usually enforced by some instruments such as fines, damages, and imprisonments as the case may be. Legislations greatly impact the overall success of the people vested with the task of waste collection. The reason for this is not far-fetched as people tend to be law abiding when the amount to be paid as penalty is high. In some cases, legislations may designate a day for environmental sanitation as is commonly found in most States in Nigeria. In Lagos and Ogun States, for instance, the last Saturday of every month has been set aside to observe sanitation. During the stipulated hours, the streets are patrolled by the law enforcement agency in order to control people and vehicular movements and all residents are expected to comb their neighborhood of every waste.

The commercial activities within Lagos have also prompted the State authority to compel markets and shop outlets to be shut every Thursday morning to observe sanitation exercise. The administration of environment issues is generally conducted by the Ministry of Environment both at the Federal and State levels. However, at the Local Government level, the Departments of Environment and Health are established to enforce compliance to established legislations (Iriruaga, 2010). While some States in Nigeria are actively driving the collection of waste through relevant laws and regulations, others are still trying to meet up. In this regard, Lagos has become a model for sustainable waste management in the country.

In 1987, a foreign company was said to have dumped some volume of a major toxic substance in Koko town near Warri in Delta State. This action led to the creation of the FEPA act whose functions were later absorbed by FME in 1999. The Decree 55 of 1988 empowers FEPA to issue environmental guidelines and standards for the reduction and control of pollution of all kinds. Table 1 summarizes some existing Environmental legislations at the Federal level.

Infrastructure and Architecture

The architectural aspect deals with the various house designs while the infrastructure comprises of the characteristics of the roads. For houses with courtyards, it is much easier for residents to store wastes for several days. It could also be possible to sort wastes depending on relevant regulations and the

Table 1. Existing Environmental legislations at the Federal level

Legislation	Year	Major Function
FEPA Act	1988	Control of all forms of pollution
The Harmful Waste (Special Criminal Provision, etc.)	1988	Control of hazardous wastes
National Environmental Protection (Pollution Abatement in Industries)	1991	Control of industrial waste and pollution
The Environmental Impact Assessment Act	1992	Control of land utilization and industrial siting
The Mineral and Mining Act		Control of mineral and mines exploration and exploitation related pollutions
The National Environmental Standards and Regulations Enforcement Agency (NESREA) Act	2007	Protection and development of the environment, biodiversity conservation and sustainable development of Nigeria's natural resources and environmental technology

willingness of the citizens. Compact houses with limited or no space for storage may necessitate taking waste outside of the house or to a dedicated collection point. In Nigeria, these two possibilities exist and in most cases, it may be hard to distinguish between houses with spacious yards and those lacking spaces. In Government Rural Areas (GRAs), where Government Secretariats are usually constructed, residential houses in these areas often possess large courtyards. Most of these buildings either belong to the Government or high income earners. This can also be said of high level business districts and Government developed areas. In contrast to this, the commoners dwell in compact houses, most of which are rented apartments. For this group, it is almost unlikely they will engage the services of informal private collectors because most of them are low income earners that live at the mercy of their landlords.

Nigerian cities are characterized by narrow roads and highways. Most of these roads are however in deplorable state and are not motorable to collection vehicles. Hence, waste containers are usually not allocated to these streets. Dwellers on such streets are, therefore, left with little or no option than to travel long distances (in most cases) to dump their waste in the nearest containers in neighboring streets or highways. Those who are not willing often resort to illegal dump sites. In other cases, these roads may be okay but their narrowness makes them unpliable for waste vehicles as there is tendency of causing traffic congestion.

Lack of Sufficient Funds

Many authorities that are tasked with providing collection services in Nigeria suffer many forms of inadequacies. Prominent among these is the lack of sufficient funds to procure collection facilities such as containers, vehicles, loading and sweeping equipment, workers' kits, etc. According to Coad (2011),

shortage of funds may also restrict some operational expenditure such as fuel and maintenance, or the purchase of spare parts. In fact, in most developing nations, this latter challenge tends to slow down daily operations. Majority of the communities in Nigeria do not even know what a modern container or bin looks like. This is partly due to limited availability of these facilities. Modern equipment is very costly and may even be costlier to maintain. Sharholy *et al.* (2008) and Sujaudin *et al.* (2008) claim that huge expenditure is needed to provide collection services and that the absence of financial support and limited resources have hampered the delivery of proper waste management services.

Adhoc Location of Facilities

Not only are facilities limited in supply, the few available are not properly located so that users can easily gain access to them. Unlike in industrialized nations where research is constantly ongoing to determine the optimal locations of waste collection facilities, it is hard to find a literature addressing this problem in this part of the world. This speaks volumes of the insufficient efforts put into solid waste collection. As Kofoworola (2007) noted, inadequacy of collection equipment and improper collection systems exist in most local government areas of Lagos State with the consequential effect that low income earners who are not able to pay the fees of the informal private collectors dump their wastes on the streets and other illegal places.

Household Economic Status

In a study carried out by Hagos *et al.* (2012), it was observed that as the level of income and education of the respondents increased, so did their willingness to partake in more improved Solid waste management scheme. Therefore, it can be inferred that, the demand for proper solid waste management services increases with income and education. Thus, a household with more learned people and moderate or high income earners are more

likely to pay for improved SWM services, especially the more efficient house to house system of waste collection. Whereas, lower income household would rather resort to dumping of refuse in an open space, into drainage, or by river banks, etc. In a related study carried out in the UK, Burkeley (2007) expressed that UK municipal waste policy needs a far closer engagement with the household, the primary unit of consumption, in order to meet the enhanced goals of waste reduction specified in Waste Strategy 2007.

Methodology for Future Study

The methodology for future study should include the assessments of different types of waste and how it affects the selection of the collection vehicles. This should embrace approaches that will address challenges faced by solid waste managers, decision-makers, and all stake-holders in solid waste management systems. Other things that should be embraced are seen in the likes of design of collection systems and the selection of refuse collection vehicles because thorough planning and assessment of initial stage is important for overall system performance and efficiency. To achieve the purposes of the plan, local action strategies must be well defined and managed by municipalities. This process is necessary because each region has specific characteristics and difficulties that are specific to the cities growth pattern, local potential, needs, and volume of generated waste (UN-DESA, 2012; UNEP, 2013). More so, the coordination of all decision makers is key to the success of solid waste collection (Wilson *et al*., 2012; Gilbert *et al*., 2013; Bhat *et al*., 2014).

CONCLUSION AND RECOMMENDATIONS

For effective solid waste collection in Nigeria, the common factors as discussed in section four should be adequately addressed and improvements should be made where applicable. It is also important to note that all the common factors discussed may or may

not be applicable to certain locations, although they are the challenges generally experienced and reported. Majority of the challenges encountered are traceable to lack of sufficient funds, administrative bottlenecks, operation and human resource challenges, inadequate structure for instilling discipline, and lack of sensitization and awareness of the waste generators. The following recommendations are made to address these issues.

i. The Federal government should ensure ample budgetary allocation of funds for the purpose of waste management and put up an appropriate structure to guide the activities of each state in the management of solid wastes.

ii. Private sector participation in solid waste management should be encouraged by each state to improve the efficiency of the process.

iii. Stricter policies should be put in place and punitive measures should be enforced in order to instill discipline.

iv. Orientations and reorientations should be held regularly to adequately inform the public on the need for proper solid waste practices

v. Waste generators should be involved in the solid waste management process by enforcing at-source sorting of wastes before collection and methods of reducing waste generation should also be encouraged.

vi. A structure for re-use and recycle should be put in place, and measures for turning wastes into wealth should be introduced with attractive benefits which would encourage the public to participate in the solid waste management process as a whole.

vii. Attempts should be made to improve operational conditions of the State Service Providers (SSP) including provision of adequate funds to cover costs of operation and maintenance of

the vehicles and other facilities and equipment.

viii. Government should procure smaller trucks to access areas of poor infrastructure and introduction of more community Waste Depot in poor communities.

ix. Sustainability of public enlightenment on proper waste management, and application of sanction where necessary.

x. There should be continuous support of the State Governments for waste collection in poor communities, social institutions, and Markets.

REFERENCE

Abila, B. and Kantola, J. (2013). Municipal Solid Waste Management Problems in Nigeria:

Evolving Knowledge Management Solution. Inter. J. of Environ. Eco. Geo. and Geo. Eng, 7 (6), 172-177.

Abur, B.T., Oguche, E.E. and Duvuna, G.A. (2014). Characterization of Municipal Solid Waste in the Federal Capital Abuja, Nigeria. Glob. J. of Sci. Frontier Res., 14(2), 1-6.

Achankeng, E. (2003). Globilization: Urbanization and municipal solid waste management in Africa. African StudiesAssociation of Australia and Pacific 2000 Conference- Africa on a Global Stage, 1-22.

Adebola, O.O. (2006). The Roles of Informal Private Sector in Integrated Solid Waste Management in the Achievement of the Millennium Development Goals (MDGs) in Lagos. Solid Waste, Health and Millennium Development Goals, CWG-WASH Workshop.

Agunwamba, J.C. (1998). Solid Waste Management in Nigeria: Problems and Issues. Environ. Mgt., 22 (6), 849-856.

Agunwamba, J.C. (2003). Environmental Assessment: Analysis of Scavengers' Activities and Recycling in Some Cities of Nigeria. Environ. Mgt., 32 (1), 116-127.

Agunwamba, J.C., Egbuniwe, N. and Ogwueleka, T.C. (2003). Least Cost Management of Solid Waste Collection. J. of Solid Waste Techno and Mgt., 29 (3), 154-167.

Agwu, M.O. (2012). Issues and Challenges of solid waste Managemnet Practices in Port-Harcourt City, Nigeria- a behavioural perspective. American J. of Social and Mgt. Sciences, 3(2), 83-92.

Akaateba, M.A. and Yakubu, I. (2013). Householders' Satisfaction Towards Solid Waste Collection Services of Zoomlion Ghana Ltd in Wa, Ghana. European Scientific J., 9 (32), 198-213.

Aliu, I.R, Adeyemi, O.E. and Adebayo, A. (2014). Municipal Household Solid Waste Collection Strategies in an African megacity: Analysis of Public Private Partnership Performance in Lagos. Waste Mgt. and Res., 32(9), 67-78 .

Australian Government (2012). Waste Management. Australian Antarctic Division: Leading Australia's Antarctic Program: Retrieved March 30, 2016, from http://www.antarctica.gov.au/environment/pollution -and-waste/waste.

Ayininuola, G.M. and Muibi, M.A. (2008) An Engineering Approach To Solid WasteCollection System: Ibadan North As Case Study. Waste Mgt., 28 (1) 1681-1687.

Ayotamuno, J.M. and Gobo, A.E. (2004). Municipal Solid Waste Management in Port Harcourt, Nigeria: Obstacles and Prospects. Mgt of Environ Quality, 15 (4), 389-398.

Birley, M.H. and Lock, K (1998). Health and peri-urban natural resource production Environment and Urbanization, 10 (1).

Bhat, R.A., Nazir, R. and Ashraf, S. (2014). Municipal Solid Waste Generation Rates and Its Management at Yusmarg Forest Ecosystem: A Tourist Resort in Kashmir. Waste Mgt and Res., 32(2), 165–169.

Bulkeley, H. (2007). Municipal Waste Policy and Household Waste Generation: Why Crossing the Threshold Matters to the Furtherance of UK Waste Policy. Unpublished Report. Retrieved March 30, 2016, from www.dro.dur.ac.uk/10417/1/10417.pdf

Chinamo, E.B. (2003). An Overview of Progress in Dar Es Salaam; Paper 03 Presented At CWG International Workshop Solid Waste Collection That Benefits the Urban Poor; Held in Dares Salaam.

Coad, A. (2011). Collection of Municipal Solid Waste, Key Issues for Decision-makers in Developing Countries. airobi, Kenya: United Nations Human Settlements Programme (UN-H ABITAT).

Desa, A., AbdKadir, N.B. and Yusooff, F. (2012). Waste Education and Awareness Strategy: Towards Solid Waste Management (SWM) Program at UKM. Procedia-Social and Behavioural Sci., 59, 47-50.

Ekere, W., Mugisha, J. and Drake, L. (2009). Factors Influencing Waste Separation and Utilization among Households in the Lake Victoria Crescent, Uganda. J. of Waste Mgt, 31, 2391-2405.

European Research and Consulting Limited (2002). Costs for Municipal Waste Management in the EU. Retrieved March 30, 2016, from http://ec.europa.eu/environment/waste/studies/pdf/eucowaste.pdf.

Ezeah, C. and Roberts, C.L. (2012). Analysis of Barriers and Success Factors Affecting The Adoption of Sustainable Management of Municipal Solid Waste in Nigeria, J. of Environ. Mgt. 103, 9-14.

Fehr, M. (2002). The Prospect of Municipal Waste Landfill Diversion Depends On Geographical Location. The Environmentalist. 22(4), 319–324.

Gilbert, R., Stevenson, D. and Girardet, H. (2013). Making Cities Work: Role of Local Authorities in the Urban Environment. London: Earth Scan Publications.

Hagos, D., Mekonnen, A. and Gebreegziabher, Z. (2012). Households Willingness to Pay for Improved Urban Watse Mangement in Mekelle City, Ethopia. Environment for Development - Resources for the Future.

Imam, A. (2007). Solid Waste Management In Abuja, Nigeria, Waste Management, doi:10.1016/j.wasman.2007.01.006. Retrieved March 30, 2016, from www.sciencedirect.com.

Imam, A., Mohammed, B., Wilson, D.C. and Cheeseman, C.R. (2008). Solid waste management in Abuja, Nigeria. Waste Management 28, 468-472.

Iriruaga, E.T. (2010) Solid Waste Management in Nigeria. D-Waste: Waste Management for Everyone. 1-6.

Kofoworola, O.F. (2007). Recovery and Recycling Practices in Municipal Solid Waste Management in Lagos. Waste Mgt., 27, 1139-1143.

Kadafa, A.A., Latifah, A., Abdullah, H.S. and Sulaiman, W.A. (2013). Current Status of Municipal Solid Waste Practise in FCT Abuja. Research J. of Environ and Earth Sci., 5(6), 295-304.

Lasisi, K. (2007). An Appraisal of Municipal Solid Waste Management in Lagos State. Ibadan: Longman Publications.

Li, K. (2007). Study of Influence Factors in Municipal Solid Waste Management Decision-Making. Master of Science Thesis, Royal Institute of Technology, Sweden.

Massoud, M., El-Fadei, M. and Abdel, M.A. (2003). Assessment of Public Vs Private MSW Management: A Case Study. J. of Environ Mgt., 69, 15-24.

Morrissey, A.J. and Browne, J. (2004). Waste Managemnet Models and their Application to Sustainable Waste Management. Waste Mgt., 24(3), 297-308.

Mourão, M.C. and Almeida, M.T. (2000). Lower Bounding and Heuristic Methods For A Refuse Collection Vehicle Routing Problem. European J. of Operational Res. 121, 420- 434.

Ngainayo, C.M. (1986). Disposal of Solid Wastes in Moshi and Arusha Towns, Tanzania; Department of Civil Engineering, Tampere University of Technology, Finland.

Nwachukwu, M.U. (2009). Solid waste generation and disposal in a Nigerian City: An Empirical Analysis in Onitsha Metropolis. J. of Environ. Mgt. and Safety, 1 (1):180-191.

Nwufo, C. C. (2010). Legal Framework for the Regulation of Waste in Nigeria: African Research Review: An International Multi-Disciplinary Journal, Ethiopia African Journals, 4 (2), 491-501.

Ogu, V.I. (2000). Private Sector Participation and Municipal Waste Management In Benin City, Nigeria. Environmental and Urbanization, 12 (2), 103-117.

Ogwueleka, T.C. (2009a). Municipal Solid Waste Characteristics and Management in Nigeria, Publisher, Iran. J. Environ. Health Sci. Eng., 6 (3), 173-180.

Ogwueleka, T.C. (2009b). Route Optimization for Solid Waste Collection: Onitsha (Nigeria) Case Study. J. Appl. Sci. Environ. Manage, 13(2), 37-40.

Okonkwo, A. (2014). An Effective Solid Waste Management System in Awka, Anambra State, Nigeria: A Proffered Solution of a Well-Articulated Plan of Attributes. Waste Mgt and the Environ., 2, 293-301.

Olanrewaju, O.O. and Ilemobade, A.A. (2009). Waste To Wealth: A Case Study of the Ondo State Integrated Wastes Recycling and Treatment Project, Nigeria, European J. of Soc. Sci., 8 (1), 7-16.

Olukanni, D.O. and Akinyinka, M.O. (2012). Environment, Health and Wealth: Towards an Analysis of Municipal Solid Waste Management in Ota, Ogun State, Nigeria. Proc. ICCEM (2012), pp. 138 – 145.

Olukanni, D.O. (2013). Analysis of Municipal Solid Waste Management in Ota, Ogun State, Nigeria: Potential for Wealth Generation (Paper presented at the International Conference on Solid Waste Management (ICSW), Widener University, Chester, Philadelphia). March, 184-196.

Olukanni, D.O., Akinyinka, O.M., Ede, A.N., Akinwumi, I.I. and Ajanaku, K.O. (2014). Appraisal of Municipal Solid Waste Management, its Effect and Resources Potential in a Semi-Urban City: A Case Study. J. of South African Business Res., 1-13.

Olukanni, D.O., Iroko, T.S. and Aremu, A.S. (2015) Cost Appraisal of Municipal Solid Waste Transfer to Disposal Site Using Visual Basic Program. Pol. 1(4): 427-439.

Olukanni, D.O. and Mnenga, M.U. (2015). Municipal Solid Waste Generation and Characterization: A Case Study of Ota, Nigeria. Int. J. Environ. Sci. Toxic. Res., 3(1): 1-8.

Omran, A. and Read, A.D. (2008). Waste Not, Want Not. A Study of Household Attitude Towards Recycling of Solid Waste. Environ. Engineering and Mgt J., 7, 1-8.

Onwughara, I.N., Nnorom, I.C. and Kanno, O.C. (2010). Issues of Roadside Disposal Habit of Municipal Solid Waste, Environmental Impacts and Implementation of Sound Management Practices in Developing Country. Nigeria Int. J. of Environ. Sci. and Dev., 1(5), 409-418.

Oyeniyi, B.A. (2011). Waste Management in Contemporary Nigeria: The Abuja Example. Int. J. of Politics and Good Governance, 2 (2), 1-18.

Roberts, C.L., Watkin, G.D., Ezeah, C., Philips, P.S. and Odunfa, A. (2010). Seasonal Variation and Municipal Solid Waste Composition: Issues for Development of New Waste Management Strategies in Abuja, Nigeria. J. of Solid Waste Tech. and Mgt, 36(4), 210-219.

Scheinberg A., Wilson D. C. and Rodic L. (2011). Solid Waste Management in the World's Cities. Third Edition in UN-Habitat's State of Water and Sanitation in the World's Cities Series. London and Washington DC: Earthscan for UN-Habitat.

Schwarz, H.O., Omran, A. and Rapp, P. (2005). A Case Study on Successful Municipal Solid Waste Management In Industrialized Country By The Example of Korlsrune City, Germany. J. of Engineering, Tome, 1, 1564-2673.

Seo, S., Aramaki, T., Hwang, Y. and Hanaki, K. (2004). Environmental Impact Of Solid Waste Treatment Methods In Korea, J. of Environ. Engineering Div., ASCE 130 (1), 81–89.

Sharholy, M., Ahmad, K., Mahmood, G. and Trivedi R.C. (2008). Municipal Solid Waste Management in India Cities – A New Review. J. of Waste Mgt., Vol. 28: Pp.459-467.

Solomon, U. (2009). The State of Solid Waste Management in Nigeria, Waste Management, 29 (10), 2787-2788.

Sujuaddin, M., Huda, M. S. and Rafiqul, A. T. M. (2008). Household Solid Waste Characteristics and Management in Chittagong, Bangladesh. J. of Waste Mgt. 28. 1688-1695.

Tahir, M., Hussain T. and Behaylu, A. (2015). Scenerio of Present and Future of Solid Waste Generation in India: A Case study of Delhi Mega City. J. of Environ and Earth Sci., 5(8), 83-91.

UN-DESA (2012) Sustainable Development in the 21st century (SD21). Review of mplementation of Agenda 21 and the Rio Principles. New York, USA: United Nations Department of Economic and Social Affairs.

UNEP (2002). Retrieved March 31, 2016, from http://www.unep.or.jp/letc/publication/spc/state_of_ WasteManagement/index.asp

UNEP (2005). Solid Wate Management (Volume II: Regional Overviews and Information Sources). United Nations Publication.

UNEP (2013) Guidelines for National Waste Management Strategies Moving from Challenges to Opportunities. Nairobi, Kenya: The Inter Organization Programme for the Sound Management of Chemicals (IOMC) United Nations Environment Programme.

UN HABITAT (2010). Collection of Municipal Solid Waste in Developing Countries. Malta: Gutenberg Press.

Ukpong, I. E. and Udofia, E. P. (2011) Domestic Solid Waste Management in a Rapidly Growing Nigerian City of Uyo. J. Hum. Ecol., 36(3), 229-235.

Visvanathan, C. (2005). Solid Waste Management in Asian Perspectives. Retrieved March 30, 2016 from http://dste.puducherry.gov.in.

Visvanathan, C., Norbu, T., Stegmann, R., Körner, I., Allgaier, G., Ritzkowski, M., Kuschke, C., Lehmann, K., Cossu, R., Gadia, R., Awang, M., Abdul Aziz, A., Hassan, M.N., Theng, L.C., Chee, T.M. and Tränkler, J. (2006). TETRAWAMA. Germany: TUHH, Hamburg University of Technology, Institute of Waste Resource.

Walling, E., Walston, A., Warren, E., Warshay, B. and Wilhelm, E. (2004). Municipal Solid Waste Management in Developing countries. NTRES 314 Retrieved May 23, 2016 www.dur.cornell.edu/saw44/NTRESS331

Wilson, C.D. and Scheinberg, A. (2010). What is good practice in solid waste management? Waste Mgt. and Research, 28(12), 1055-1056.

Wilson, D. C., Rodic, L., Scheinberg, A, et al. (2012). Comparative Analysis of Solid Waste Management in 20 Cities. Waste Mgt. and Research. 30 (3), 237–254.

Zurbrugg, C. (2003). Urban Solid Waste Management in Low-Income Countries of Asia: How to Cope with the Garbage Crisis, Urban Solid Waste Management Review Session, Durban, South Africa, 1-10.