

Full Length Research Paper

Municipal Solid Waste Generation and Characterization: A Case Study of Ota, Nigeria

David O. Olukanni* and Myem U. Mnenga

Department of Civil Engineering, School of Engineering, College of Science & Technology, Covenant University, KM 10 Idiroko Road, PMB 1023 Ota, Ogun State, Nigeria

Abstract

This study is aimed at assessing the rate of solid waste generation in Ado-Odo Ota local government, Ogun State, Nigeria and its associated challenges. The study involved the assessment of procedures available in waste collection, treatment, disposal practices and compliances with institutional rules and regulations. The survey involved the use of structured questionnaires, interviews, on-site observations and focus group discussions in the various communities that was grouped into 7 zones. The data assessed captured social demographic, housing, socio cultural-characteristics, sanitation and hygiene behaviour and problems with poor sanitation. Both quantitative and qualitative techniques in data collection and analysis were utilized as main instruments. The results of average solid waste generation per capita per day for each coded zone are 1.44kg/h/d, 0.29kg/h/day, 0.22kg/h/d, 0.52kg/h/d, 0.57kg/h/d, 1.47kg/h/d and 0.94kg/h/d for zones A to G, respectively. The solid wastes comprised of biodegradable materials which amount to 38.49% while non-biodegradable take the remaining 61.51%. It is therefore recommended, that a sustained cooperation be developed among all key actors (government, waste managers, public health workers and inhabitants) so as to implement an economic, sustainable, and reliable management practices. This would help in realizing the potential resources that could be generated from the waste materials.

Keywords: Solid Waste Generation, Ota, Characterization, biodegradables, non-biodegradables.

INTRODUCTION

The generation of solid waste and its management in urban areas of developing nations has been a major challenge. This is due to the high rate of turnover of goods produced, sold, and bought which consequently bring about the waste products. The factors affecting such incremental change include; increase in population, change in life style, and increasing use of disposable materials, excessive packaging of items and consumer habit (Seo et al., 2004). However, the capacity to develop an efficient and sustainable waste management programs in developing nations has been limited by insufficient documentation of the volume and characterization of solid waste generation (Ogwueleka, 2009; Olukanni, 2013; Olukanni et al. 2014). Most studies regard cities as a single entity and do not pay

attention to the variation in waste generation from one municipality to the other (Abel, 2009; Olukanni and Akinyinka, 2012). Contributory factors to this challenge include inadequate regulatory framework that has manifested in lack of interest of private sector investment in service delivery (infrastructure); uncoordinated institutional functions; low political will, low capacity to discharges duties, poor data information for planning, and wrong attitude of waste generator amongst others (Agunwamba, 2003; Ogwueleka, 2009; Olukanni et al., 2014).

In developed countries like United State; nearly 65% of the total municipal solid waste generated is made of organic materials, including paper products, yard trimmings, food scraps and wood. Studies in Palo Alto and San Diego have found residential waste composed of 72% and 79% compostable materials, respectively (Palo Alto Waste Composition Analysis, 2006; City of San Diego Waste Characterization Study, 2014). High-income earners consume more packaged products,

*Corresponding Author E-mail:
david.olukanni@covenantuniversity.edu.ng; Tel: +234-8030726472

which result in a higher percentage of inorganic materials like metals, plastics, glass, and textile (Ogwueleka, 2009). In developing countries, waste stream is over 50% organic material (Hoornweg et al., 1999). A study conducted at Rahman Nagar Residential Area of Bangladesh revealed that the rate of waste generation varies in the different socioeconomic groups as the waste generation rate by an average household was found to be 0.36 kg/day (minimum) by the low socioeconomic group and 3.15 kg/day (maximum) by the high socioeconomic group due to the differences in purchasing power and consequently high consumption practices (Rahman et al., 2006).

In Nigeria, municipal waste densities generally range from 250-370 kg/m³. Waste generation rate is 25 million tons annually and at a daily rate of 0.44kg - 0.66 kg/capital/day (Ogwueleka, 2009) as opposed to 0.7kg - 1.2 kg/h/d in developed countries (Guangyu, 2002). Solid waste management has emerged as one of the greatest challenges facing State and Local Government Environmental Protection Agencies in Nigeria. 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 conventional methods employed by development agencies and non-governmental organizations usually involve strategies that are centralized and undiversified. These approaches do not distinguish the different needs and heterogeneity of cities. Most of these approaches are capital intensive that would involve advanced technology and equipment (Ogwueleka, 2009). Examining the present state of the management problems encountered, more can be done to maximize the efforts put in place by Ogun State Environmental Protection Agency which was further buttressed by Olukanni and Akinyinka (2012). Presently, the rate of waste generation in Lagos (with estimated population of over 10 million in 2012) is 9, 000 tonnes/day (Lagos State Waste Management Authority, LAWMA) while in Kano State, the rate is 3, 849 tonnes/day (Bayero University Kano Consultancy Unit). Generally, the average rate of generation is estimated as 0.5kg/capital/day (Ogwueleka, 2009).

Ota metropolis, Ogun State in South-Western Nigeria has witnessed a rapid urbanization over the past decades providing a large market for manufacturing industries and organizations. Its population growth has led to the rapid expansion of the city which has resulted in urban sprawl and uncontrolled increase of occupancy ratios in existing housing units (Olukanni and Akinyinka, 2012). The population increase and human activities in Ota is on the high side, and has resulted to increased solid waste generation. Hence, the call for an urgent need of waste assessment. In order to achieve the aim

of the study, the following objectives were highlighted: i) determine the per capita solid waste generated in Ota, ii) find out the average size of solid waste generated per day in a household, iii) determine the solid waste composition so as to highlight some specific features capable of promoting researches for the effective recovery of solid waste in Ota. The paper considers several factors and provides information that could help in enacting appropriate policies that would forestall the generation of avoidable waste, decide on possibilities for waste management hierarchy (Source reduction, reuse, recycle and recovery of materials), and plan for equipment required for efficient collection of waste.

MATERIALS AND METHOD

Area description

Ota is the capital of the Ado-Odo/Ota local government area and has the third largest concentration of industries in Nigeria (Salako, 1999). It covers an area of 878 square kilometers and lies between latitude 6°41'N and 6°68'N and longitude 3°41'E and 3°68'E. Ado-Odo/Ota Local Government has an estimated population of 527,242 (Male 261,523 and Female 265,719) (NPC, 2006) with about four hundred and fifty (450) towns, villages and settlements. Other towns and cities include Ado-Odo, Igbesa, Agbara, Sango-Ota, and Itele. It also possesses a large market and an important road junction, found north of the Tollgate on the Lagos-Abeokuta expressway. Ota is also well known to be the location of the Canaan Land where the mega church Winner's Chapel, renowned as the world's largest single auditorium is situated. Ota is gradually becoming a busy place because of its proximity to Lagos thereby increasing the migration of people into it (Olukanni and Akinyinka, 2012; Olukanni et al., 2014).

Selected Solid Waste Locations

Selection of zones is associated with the problems of waste management experienced within the zones. The zones are coded alphabetically and Figure 1 shows the description of the township map with the selected locations:

- i. Zone A (Iju-Ota)
- ii. Zone B (Ogun State Housing Corporation)
- iii. Zone C (Oju-Ore)
- iv. Zone D (Sango Ota)
- v. Zone E (NITEL Residential Areas)
- vi. Zone F (Okede Residential Area)
- vii. Zone G (Lafenwa Area)

Each zone exhibits certain consistent features in terms of location, types, structures and housing layouts. Generally, population, housing density and size, and intensity of land use decreases from city center to the

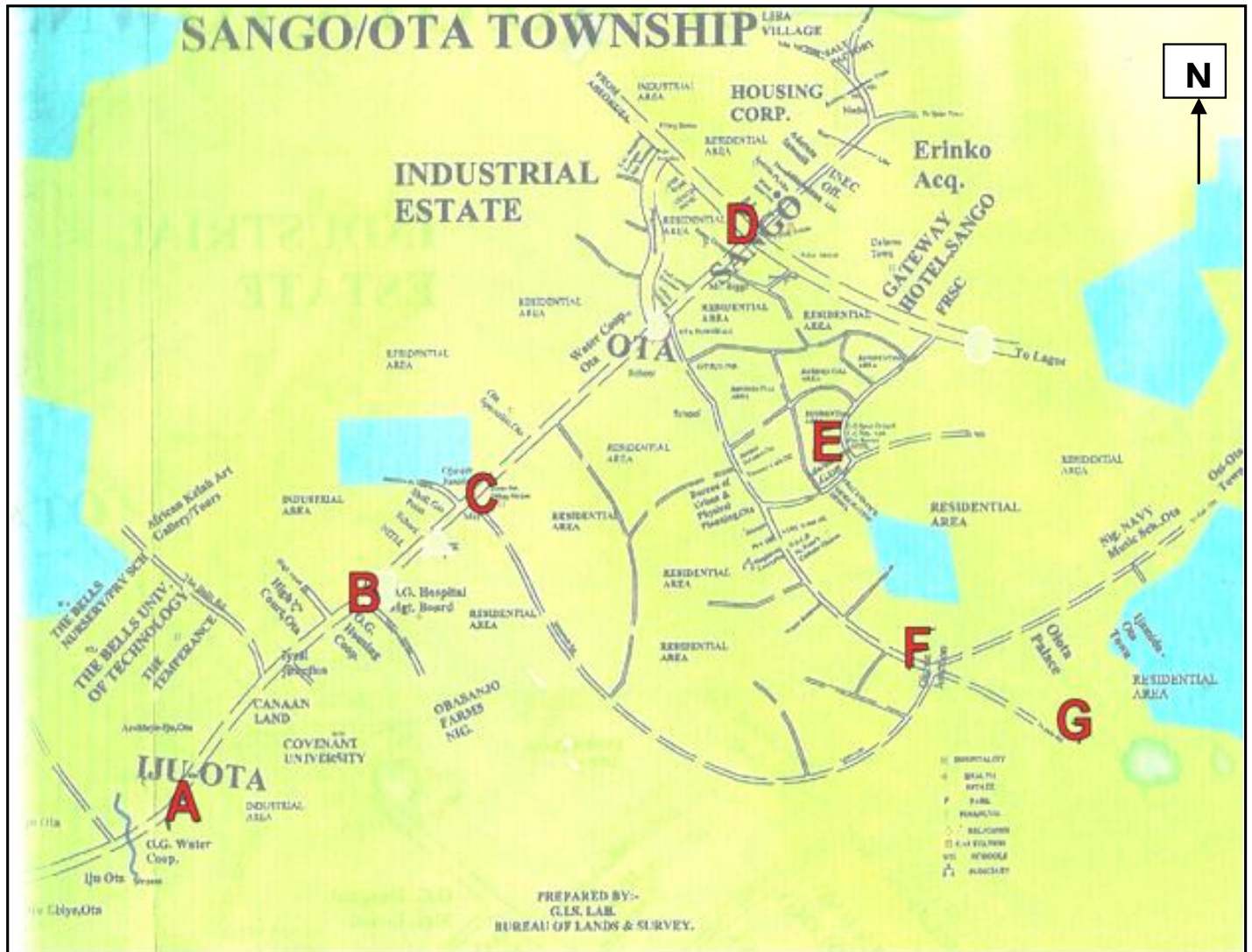


Figure 1. Location map of Ota

sub-urban zone. Analyzing the urban environment on the basis of these different zones has specific advantages in the sense that commercial activities in all these zones reflect the social, economic and cultural attributes of the residents. This further simplifies the analysis of various urban issues, including a consideration of solid waste management.

Study Approach

The study involved the use of structured questionnaires, interviews, on-site observations and focus group discussions in the various local communities and villages drawn across the 16 wards of the municipality and grouped into 7 zones. The zones (A-G) were chosen as a representation of the current solid waste management in Ota. The choice of these zones is premised on the existing situation with different waste management

challenges. The study involved the assessment of procedures and techniques available in waste collection, treatment, disposal practices and compliances with institutional rules and regulations. The study also assesses the generation of municipal household solid waste and its characterization. The data assessed captured social demographic-, housing-, socio cultural-characteristics, sanitation and hygiene behaviour and problems with poor sanitation. Both quantitative and qualitative techniques in data collection and analysis were utilized as main instruments. The study was conducted in the month of February through to April, 2013. The survey captured a population with a minimum of primary school education and within the age bracket of 10 to 75 years old. Other information such as age, education, and quantity of water consumed daily, satisfaction in terms of water quality supplied and other health related problems were captured.

Waste Characterization

The data collection consists of quantitative data which includes waste characteristics and quantities as described by Bamgboye and Ojolo (2004), and Oyelola and Babatunde (2008). Generated solid waste was obtained from bins at residential sites from selected locations in Ota. The materials were then sorted according to material types which include: paper/cardboard, plastic materials, bottles, metal cans, polythene bags, and other combustible miscellaneous waste materials. The weight of each of these sorted wastes was obtained. The average of waste was taken in kg per day. Some of the results show that 62% of the population generate more waste during the weekends, 18% of the populations generate an equal ratio of waste on average and 20% of individuals generate more waste during week days, 22% use sack as household waste collector, 26% use 0.04m³ basket as waste bin, 8% use 0.06m³ basket as waste bin, 10% individuals use carton as waste bin, 4% use drums as waste bin and 34% do not have waste bin. This data informed on the kind of materials used mostly by the inhabitants. These waste all have potential for recycling if they are all sorted out from source as done in developed nations.

RESULTS

From analysis of the research data as shown in Table 1, it is obvious that paper material and nylon are the common categories found in the waste stream. Other categories include; i). Breakables: involving glasses of any kind, ii) Biodegradables: involving food remains, iii) kitchen waste, leaves, seeds and wood, iv) Cloth or any cloth-like material like leather and sack, v) Rubber and plastic of any kind, vi) Ironic/metallic material, vii) Hair, batteries, diapers/pads etc. Olukanni and Akinyinka (2012) expressed that the amount of energy that is wasted by not recycling paper, printed material, glass, plastic and aluminum and steel cans could be much. Plastic can be recycled and reused depending on the quality. Recycling process of plastics involves washing, shredding, drying, wet grinding; extrusion, pelletizing and the final product are package and sold to consumers. Paper recycling saves the forest of trees which would produce new paper. It reduces the quantity of solid waste disposed and the pollution also reduces during manufacturing because the fibers have been processed once. A productive, healthy, competitive and well-functioning city is a function of effective solid waste management systems. Waste can be a source of both earnings and savings in the local economy.

Table 1 shows the results obtained from different households at the 7 dispersed selected locations while Figure 2 presents the respective per capita generation rates of the zones in bar charts. Table 1 shows the relative values of wastes generated within the area of

study which is as a result of the rapid development and migration into the areas. The survey obtained wastes generation rates in zones A-F as 1.44kg/h/day, 0.29 kg/h/day, 0.22 kg/h/day, 0.52 kg/h/day, 0.57 kg/h/day, 1.47 kg/h/day and 0.94 kg/h/day, respectively. Similar results were found in literature on per capita solid waste generation rate in other cities in Nigeria. The average rate of waste generation in some Nigerian cities is as follows: Abeokuta in Ogun State (0.60 kg/h/day), Ado-Ekiti in Ekiti State (0.71Kg/h/day), Akure in Ondo State (0.54Kg/h/day), Ile-Ife in Osun State (0.46Kg/h/day) and Ibadan in Oyo State (0.71Kg/h/day) (Adewumi et al., 2005; Ogwueleka, 2003).

It could be observed that zones B and C areas have the lowest waste generation rates of 0.29kg/h/day and 0.22kg/h/day, respectively which is characterized by low population and income rates while zones A and F have 1.44kg/h/day and 1.47kg/h/day, respectively. The high rates of waste generation in zones A and F is as a result of the population density and the high level of income generated within these areas. The characteristics of these municipal wastes vary from location to location where larger zones exhibit significant difference, having more organic wastes but few inorganic wastes. The waste characterization and quantities obtained showed significant difference with zone F producing the largest waste in Ota, followed closely by zone A; the regions with the least per capita waste generation are zones B and C as shown in Figure 2.

The total population of Ota by the 2006 census was estimated at 527,242 people. As estimated in previous study by Olukanni and Akinyinka (2012), the total approximate waste generated by the residents of Ota people is 0.58kg/h/day. When this value (0.58kg/h/day) is multiplied by the population (527, 242 people), a total of 305,800.36 kg/day is arrived at. Using 4% estimated growth rate of Ota, given by OMICS Publishing group, the estimated population would be 693,815 people. Going by the survey result that average number of 6 persons per household in Ota, therefore, there are approximately 115, 635.83 households in Ota and the estimated household waste generated in a day is 3.48 kg/day (6 × 0.58). The current total daily waste generated in Ota would be 402, 412.70 kg/day by multiplying the estimated population by the average per capita waste generated in Ota (0.58kg/h/d). From the questionnaire analysis, 8% of Ota citizens segregate their waste, 32% burn their waste, 24% practice open dumping and 44% of citizens take waste to a nearby public collecting point before it is finally taken to the dump site. Most of the solid wastes comprised of biodegradable materials which amount to 38.49% of the waste stream while non-biodegradable take the remaining 61.51%.

- i. Zone F is associated with the presence of tertiary institutions, The King's Palace and other Local Government administrative offices.
- ii. Zone A has a lot of retail shops.

Table 1. Physical Composition of MSW in Ota

WASTE CATEGORY	Zone A (kg/day)	Zone B (kg/day)	Zone C (kg/day)	Zone D (kg/day)	Zone E (kg/day)	Zone F (kg/day)	Zone G (kg/day)
Average Waste Generated							
Nylon bags	2.24	0.45	0.11	0.44	0.50	0.18	2.53
Paper/carton/cardboard	0.75	0.25	0.04	0.25	0.47	0.35	1.01
Breakables	1.04	0.04	0.06	0.02	0.43	0.26	1.25
Seeds	-	-	0.05	-	-	-	-
Cloth/leather/sack	1.21	0.03	0.05	0.29	0.28	0.80	0.12
Diapers/pads	-	1	-	1.57	-	-	0.54
Foam	0.07	-	0.02	-	-	-	-
Pieces of Wood	0.1	0.06	0.25	-	0.10	-	-
Cotton wool	-	-	-	-	-	-	0.02
Leave	0.63	0.06	-	-	0.10	0.88	0.04
Hair	0.3	-	-	-	0.20	0.50	0.40
Food remains	1.12	0.01	0.38	0.12	0.54	0.91	1.23
Medicine	-	-	-	0.01	-	-	-
Rubber/plastics	0.35	0.25	0.09	0.05	0.13	0.58	0.01
Iron/metal	0.12	0.04	0.04	0.05	0.08	0.02	0.05
Appliances	0.18	-	0.03	-	0.05	0.10	-
Battery	-	-	0.01	-	-	-	-
Kitchen	3.4	0.38	-	0.46	0.55	2.00	1.58
Others	-	-	-	0.37	-	-	0.02

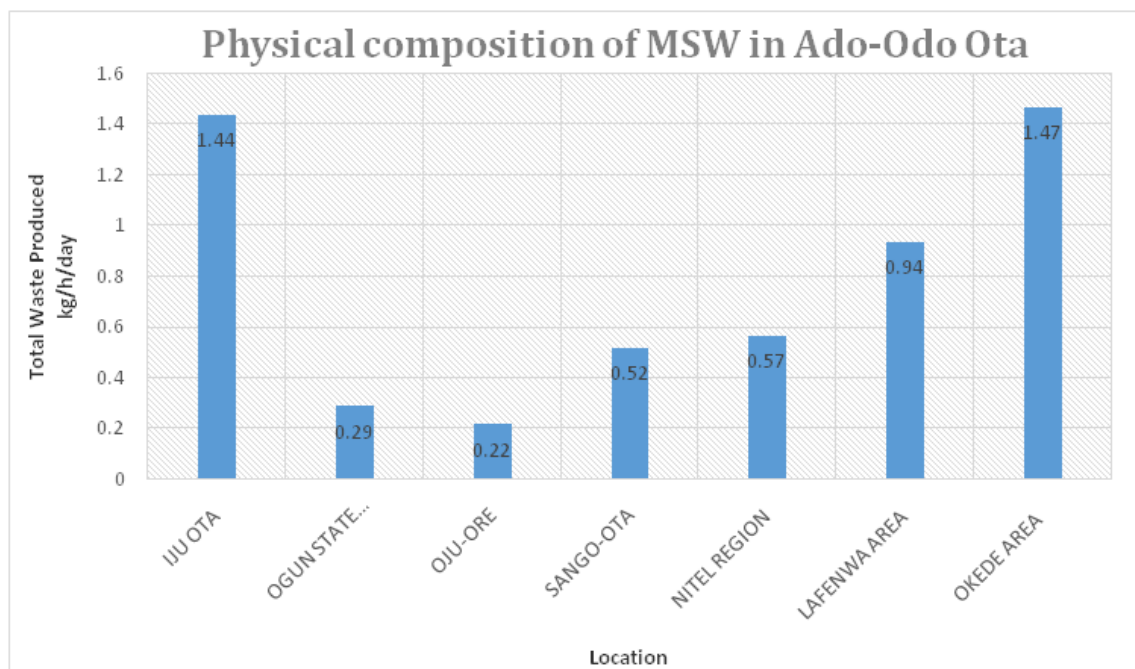


Figure 2. Per capita generated waste at the chosen locations in Ado-Odo Ota

- iii. Zone G is moderately filled with houses and few markets.
- iv. Zone D is a large congested market area.
- v. Zone C is a small market area.

Municipal waste generated within these locations depends on a number of factors such as variations in

seasons, level of commercial activities, living standard and food habits. Due to the increasing rate of urbanization and changing standards of living, information on waste quantities at regular intervals are helpful in providing efficient planning, collection and disposal mechanisms. It has been discovered that

ineffective waste management practices make an unfavorable impression on foreign investors and tourists which may result in loss of both investment and revenues from these sources.

DISCUSSION

Waste Collection and Disposal Practices

Waste collection in Ota is significantly drawn back by inadequacy and inconsistency of collection vehicles. Infrequent collection and rapid decomposition of wastes provide an attractive feeding and breeding site for flies, rats and other scavengers. The current collection practice is the conventional hauled container system and there is no form of processing. Piles of waste are heaped around waste bin and along road sides for days without collection. The waste management's agency determines the frequency of the collection. The collection is designed to be on a weekly basis which unfortunately could not match the rate at which the wastes are being generated. Babayemi and Daudu (2009) reveal in their study that there is high rate of generation of MSW without a corresponding efficient technology to manage the wastes generated. There is no house-to-house service and most cases, residents pack their waste in bag and sacks and placed by road sides which last for days before the local authorities come to pack them. The effectiveness of waste collection initiated by both public and private sectors is largely controlled by location, ability and willingness of the owner of the waste to pay the amount charged. A significant number of scavengers pack refuse for a fee and salvage any recyclable prior to the disposal of the waste (Olukanni and Akinyinka, 2012). Some residents also formed the habit of dumping waste in public space, drainage channels and rivers or burn it in their backyard, thereby polluting the air. The population, consumption and frequency of waste generation have made it obvious that the waste bins at selected locations in Ota are not enough to serve the disposal need of the community. The current disposal practice is by dumping waste at dumpsite whereas; the existing dumpsites are a concern for political, environmental, public health and safety reasons. In addition, finding new sites is becoming more difficult due to land shortages and opposition.

Treatment

In Ota, there is no form of sorting of the collected waste from the generation sources to the disposal site, but scavengers pick materials which are reused and the bulk of the waste are burnt. Ogwueleka (2009) stated that open dumping is the most common practice in most cities of developing nations which is without exception to Ota, the case study. There is no landfill regulation or

standard that provides a basis for compliance and monitoring. Wastes in open dumps are set on fires in order to reduce the volume of the wastes. The organic fraction of municipal solid waste is an important component, not only because it constitutes a sizeable fraction of the solid waste stream, but also because of its potentially adverse impact upon public health and environmental quality. A major adverse impact is due to its attraction of rodents and vector insects for which it provides food and shelter. Impact on environmental quality takes the form of foul odors, unsightliness, land, water and air pollution. Unless an organic waste is appropriately managed, its adverse impact will continue until it has fully decomposed or otherwise stabilized. Conversely, compost/organic fertilizer can be obtained from the food waste by converting biowaste into organic fertilizer. This is an aerobic process whereby micro-organism decomposes biodegradable waste to produce organic fertilizer in the presence of ample oxygen. This waste has its usefulness rooted in fertilizer generation which would be of great benefit and in fact cheap for farmers.

Compliance with Institutional Rules and Regulations

Participation and compliance in waste management has been on the ebb because residents are not monitored by institutions and are not regulated nor sanctioned by government. However, the private sector took initiative to participate in waste management but funding has made the waste management experience a set back because solid waste management is very expensive. There is little financing even for the private sector participation. Therefore, waste management agencies cannot meet the demand of collection effectively. The present analysis highlighted that the existing system of waste collection and its disposal within the municipality is not only inadequate and insufficient but also unscientific. Proper management of municipal solid waste should have minimum effect on the environment. Olukanni and Akinyinka (2012) stated that the role of the informal sector in waste collection is significant. This sector could be responsible for removing a significant percent of total generated waste in the urban areas. To achieve sustainable and effective waste management of municipal solid waste, there is need to consider the political, institutional, social, economic and technical aspects (Agunwamba, 2003). It is imperative that the local government realizes that increasing environmental education and awareness are key factors to changing the current paradigm.

CONCLUSION

Based on the findings of this study, it is imperative to

stress that resources for running the waste management are harnessed and attention should be paid to storage, separation/sorting, collection and transfer to respective processing unit before final disposal. Waste generation is inevitable due to human activities. As long as the population's demand for goods increase, so also would the waste. Therefore, the proper management and reduction of waste generated should be a task to be employed at all times. The frequency of collection and route planning for collection vehicle should also be developed for the ease of collection from all generation point. The public should be sensitized on the locations for disposal of waste and there should be stringent policies to facilitate it. Public education campaigns should be developed to encourage public participation of sustainable waste management behaviour to improve the awareness and understanding of the SWM in the municipality.

Future Concerns

The current waste management in all the zones is a concern. Therefore, strategies need to be put in place in order to control the generation of solid wastes. The generation of these solid wastes can be addressed by various means, such as enforcing waste management policies, recycling, waste segregation at source points, and sensitization of the public on waste-related issues, among others. The methods of mitigating waste management system aforementioned could turn out to be a daunting task depending on the attitude of people living within these areas. However, the socio-economic lifestyle of people living within these areas is a function of the public awareness on environmental issues, particularly as regards to solid waste. Therefore, it is of utmost importance for the government and stakeholders to possess qualitative knowledge on the quantity, composition and characteristics of the different types of wastes generated within urban areas. Over the years, studies on waste composition have been undertaken but there is need to put into consideration, the urbanization trend within these areas. This gives room for predicting the outcome of urban growth on waste production, the spatial generation, adequate land needed to satisfy the need for waste management facilities and the siting and location of these facilities for future use. The successful implementation of waste management practices is also dependent on the availability of adequate up-to-date information about the waste profile of any city and this gives the foundation for the assessment of goals and objectives that are set for prediction within the waste management sector of any city.

RECOMMENDATIONS

In order to ensure a sustainable and efficient waste

management practices, the following recommendations are made: i). There is need for a city recycling programs which would ensure that its residents separate their own recyclable materials from the rest of the trash; ii). Necessary measures should be put in place to collect, transport, and dispose or treat solid waste; iii). Policies should be developed based on a renewed understanding of the environmental situation in Ota; iv). Citizens should endeavor to take along their carriage bags to market places to minimize the quantity of nylon bags thrown away; (v). Existing waste legislation should be enforced to promote education and awareness amongst the people toward solid-waste issues and its adverse impacts on health.

REFERENCES

- Abel OA (2009). "An analysis of solid waste generation in a traditional African city: the example of Ogbomosho, Nigeria", *Environment and Urbanization*, SAGE Journals, Vol. 19, No. 2, pp. 527-537.
- Adeyemi IK, Ogedengbe MO, Adepetu JA, Fabiyi YL (2005). "Planning organic fertilizer industries for municipal solid wastes management", *Journal of Applied Sciences Research*, Vol. 1, No. 3, pp. 285-291.
- Agunwamba JC (2003). "Environmental Assessment: Analysis of Scavengers' Activities and Recycling in Some Cities of Nigeria", *Environmental Management*. Vol. 32, No. 1, pp. 116-127.
- Babayemi JO, Daudu KT (2009). "Evaluation of Solid Waste Generation, Categories and Disposal Options in Developing Countries: A Case Study of Nigeria", *J. Appl. Sci. Environ. Manage.* Vol. 13, No. 3, pp. 83 – 88.
- Bangboye AI, Ojolo SJ (2004). "Characterization of Municipal Solid Wastes being generated in Lagos State, Nigeria", *Publisher: LAUTECH Journal of Engineering and Technology*, Vol. 2, pp. 36–38.
- City of San Diego Waste Characterization Study 2012 – 2013; Published by Cascadia Consulting Group 2014.
- Guangyu Y (2002). "Point Sources of Pollution: Local effects and its control" – Vol 1; Amounts and Composition of Municipal Solid Waste.
- Hornweg D, Thomas L, Otten L (1999). "Composting and its applicability in developing Countries", *Urban waste management working paper series 8*. Washington, DC; World Bank.
- National Population Census, (2006). Volume 1 of the national population census. Pp15, Date Accessed: 10/12/2012
- Ogwueleka TC (2003). "Analysis of urban solid waste in Nsukka, Nigeria", *Journal of Solid Waste Technology and Management*, Vol. 29, No. 4, pp. 239-246.
- Ogwueleka TC (2009). "Municipal Solid Waste Characteristics and management in Nigeria", *Publisher, Iran. J. Environ. Health Sci. Eng.* Vol. 6, No. 3, pp. 173-180.
- Olukanni DO (2013). "Analysis of Municipal Solid Waste Management in Ota, Ogun State, Nigeria: Potential for Wealth Generation", *Proceeding of the 28th International Conference on Solid Waste Technology and Management March 10-13, 2013 Philadelphia, PA U.S.A.*
- Olukanni DO, Akinyinka MO (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 DO, Akinyinka MO, Ede AN, Akinwumi II, Ajanaku KO (2014). "Appraisal of Municipal Solid Waste Management, Its Effect and Resource Potential in a Semi-Urban City: a Case Study", *Journal of South African Business Research*. Vol. 2014, Article ID 705695, 13 pages.
- OMICs Publishing Group. Available at www.omicsonline.org/JCMHE/JCMHE-2-126.php. Accessed: 6/22/2013
- Oyelola OT, Babatunde AI (2008). "Characterization of domestic and market solid wastes at source in Lagos metropolis. Nigeria", *Afr. J. Environ. Sci. Technol.*, Vol. 3, No. 12, pp.430-437.

- Palo Alto Waste Composition Study (2006). Prepared by Cascadia Consulting Group, Seattle, WA, USA.
- Rahman MA, Alam MS, Al-Amin M (2006). "Segregation of biodegradable solid waste of Chittagong metropolitan area based on specific physical and chemical properties", *Pakistan Journal of Biological Sciences*. Vol. 9, No. 3, pp. 460–464.
- Salako RA (1999). "Ota: The Biography of the Foremost Awori Town", Penink and Co. pp. 85-87.
- Seo S, Aramaki T, Hwang Y, Hanaki K (2004). "Environmental impact of solid waste treatment methods in Korea", *Journal of Environmental Engineering Div., ASCE* Vol. 130, No. 1, pp. 81–89.
- United Nation Development Programme, (2007). 'Sustainable human development'. Available: <http://www.undp.org/> Date accessed: 18/1/2012.
- World Bank (1999). "What a Waste: Solid Waste Management in Asia", Washington DC, USA, pp. 43.
- 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.

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