

Municipal Solid Waste Management Problems in Nigeria: Evolving Knowledge Management Solution

Beatrice Abila and Jussi Kantola

Abstract—The paper attempts a synthesis of problems relating to municipal waste management in Nigeria and proposes a conceptual knowledge management approach for tackling municipal waste problems in cities across Nigeria. The application of knowledge management approach and strategy is crucial for inculcating a change of attitude towards improving the management of waste. The paper is a review of existing literatures, information, policies and data on municipal waste management in Nigeria. The inefficient management of waste by individuals, households, consumers and waste management companies can be attributed to inadequate information on waste management benefits, lack of producers' involvement in waste management as well as poor implementation of government policies. The paper presents an alternative approach providing solutions promoting efficient municipal waste management.

Keywords—Environment, Knowledge management, Municipal waste management, Nigeria.

I. INTRODUCTION

THE sustainable management of waste approach aims at global environmental quality, and environmental quality is a pre-requisite for a rise in per capita welfare over a period of time [8]. "Efficient management of waste is a global concern requiring extensive research and development works towards exploring newer application for a sustainable and environmentally sound management" [11]. The problem of waste management is a primordial and present issue in developing countries in Africa, particularly Nigeria. Municipal waste management problems in Nigeria cut across concerns for human health, air, water, and land pollution among others. The analysis of the key problem affecting the efficient management of municipal waste is critical for evolving a workable solution in an emerging economy like Nigeria. The transformation of the existing trends in municipal waste management is necessary for ensuring sustainable environments and other objectives.

The continuous indiscriminate disposal of municipal solid waste is accelerating and is linked to poverty, poor governance, urbanization, population growth, poor standards of living, and low level of environmental awareness [4], [22] and inadequate management of environmental knowledge. Most of these wastes are generated from domestic sources and

are mostly characteristics of household waste [9]. The persisting problems of municipal waste management in Nigeria prompt the need for communicating innovations and knowledge to achieve desire transformation in overcoming socio-economic and environmental challenges. The need to mitigate environmental pollution is crucial due to its direct impacts on human, plants and animals and the increasing contribution to climate change. Furthermore, energy conservation, energy generation, resource and material recovery from waste through improved municipal waste management is possible by deploying best solutions.

Different approaches and interventions have been developed in the past for tackling municipal waste concerns with little or no progress. Managing municipal waste efficiently requires intensification and application of knowledge management tools that guarantee sustainable environment and socio economic growth. "Municipal solid waste management is an important part of urban infrastructure that ensures the protection of environment and human health" [6].

Knowledge management definition varies from author to author, but for the purpose of this paper two different definitions which are applicable are adopted. Knowledge management is a broad term that requires systematic efforts of an organization to manage its personnel knowledge through a broad range of direct and indirect methods such as specific types of ICT, management of social processes, structuring of organizations in a particular pattern or via the use of particular culture and people management practices [17]. In addition, knowledge management is a vast topic which focuses on both technology and people centre strategy. According to [16], Knowledge management is the access and utilization of different resources to create an environment where individuals acquire, share and use information to build on existing knowledge.

The paper attempts a synthesis of problems associated to municipal solid waste management and propose a conceptual knowledge management approach for tackling municipal solid waste problems in Nigeria. For an in depth understanding of these issues and solutions, the article covers the existing management of municipal solid waste, municipal waste policies and regulations, problems affecting municipal waste management, knowledge management challenges relating to municipal solid waste, proposed knowledge management solutions and conclusion.

B. Abila is with the University of Vaasa, P.O.Box 700, 65101 Vaasa, Finland (phone: +358-44-2598644; e-mail: u96398@student.uva.fi).

J. Kantola is with the University of Vaasa, P.O.Box 700, 65101 Vaasa, Finland (e-mail: jussi.kantola@uva.fi).

II. EXISTING WASTE MANAGEMENT PROCESSES AND PRACTICES IN NIGERIA

Municipal waste management is the collective process of sorting, storage, collection, transportation, processing, resource recovering, recycling and disposal of waste. In Nigeria, wastes are usually dumped on roadsides, available open pits, flowing gully water and drainage channels [10], [26]. The indiscriminate disposal of municipal waste is

increasingly a prominent habit in most urban cities of Nigeria. Unlike urban cities, in rural communities municipal solid waste quantity are less and managed in household backyards by burning, composting, as feeds to animals and occasionally disposed at dump sites. In Nigeria the processes involved in the management of waste are, storage, collection, transportation and disposal at dumpsites.

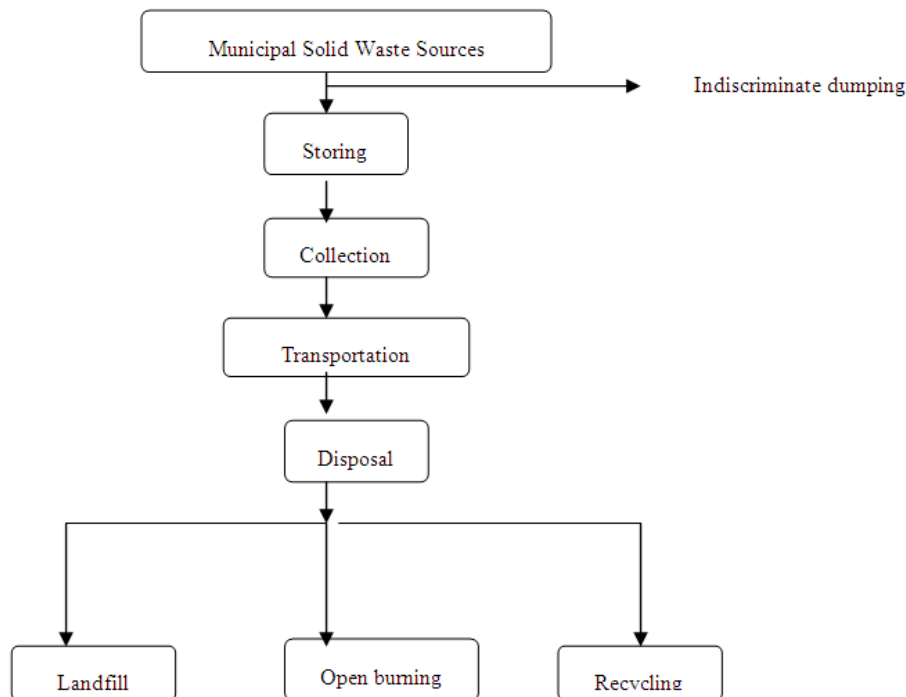


Fig. 1 Existing municipal solid waste management flowchart for Nigeria

There are different techniques of municipal solid waste disposal but the common techniques are landfill, incineration, composting and anaerobic digestion and recycling [18]. Although presently in Nigeria the prominently practiced municipal waste management technique is open dumping, land fill, followed by open burning while incineration method is seldom put to practice. Incineration is a cost effective municipal waste disposal option which is seldom applied in Nigeria hospitals where medical waste are incinerated at a minimal scale [24]. The cheapest and simplest method of waste disposal is landfill. The resulting environmental impact of landfills is enormous but could be mitigated provided sanitary precautions are undertaken and waste reduction is advocated. Landfills were responsible for 49% of England's methane emissions in 2007 [12]. Moreover, recycling which is an environmentally friendly option is not fully adopted. There are no formal recycling sectors in Nigeria. Waste are recycled informally by scavengers who buy un-use valuables from people and also go to legal and illegal dumpsites in search of materials that than can be re-use and recycled.

III. MUNICIPAL SOLID WASTE GENERATION

25 million tonnes of municipal solid waste are generated annually in Nigeria and the waste generation rates ranged from 0.66kg/cap/d in urban areas to 0.44kg/cap/d in rural areas as opposed to 0.7-1.8kg/cap/day in developed countries [24]. There is a continuous increase of municipal solid waste production by households, educational institutions, commercial institutions, and among others. In Nigeria, municipal waste generators include household, commercial, industrial, agricultural and institutional establishments and among others. The quantity and composition of waste generated vary from urban areas to rural areas and likewise from state to state. Waste generated is directly proportional to population, socio-economic status and level of urbanization [2], [3], [25], hence the quantity of waste generated varies from state to state and also increases per year. Also the composition of waste generated per state is a function of the socio economic status, industrialization and commercialization. This is linked to urbanization and socio-economic growth.

TABLE I
MUNICIPAL SOLID WASTE GENERATION FOR SOME CITIES IN GEOPOLITICAL
ZONES IN NIGERIA

Geopolitical Zones	Population	Waste Generation Kg/pers/day	Waste Generation (ton per month)	Waste Generation density (kg/m ³)
South West				
Lagos	8,029,200	0.63	255,556	294
Ibadan	307,840	0.51	135,391	330
Ado-Ekiti	241,200	0.71	9,518	-
Akure	369,700	0.54	-	-
Abeokuta	529,700	0.66	-	-
South East				
Nsukka	100,700	0.44	12,000	370
Onitsha	509,500	0.53	84,137	310
Aba	784,500	0.46	236,703	-
South South				
Port Harcourt	1,053,900	0.60	117,825	300
Warri	500,900	-	66,721	-
Uyo	102,400	-	20,923	-
North Central				
Abuja	159,900	0.66	14,785	280
Markurdi	249,000	0.48	24,242	340
Ilorin	756,400	-	-	0.43
North West				
Kano	3,248,700	0.56	156,676	290
Kaduna	1,458,900	0.58	114,433	320
North East				
Maiduguri	971,700	-	850,000	-

Source: [7], [24]

IV. WASTE MANAGEMENT POLICIES AND REGULATIONS

The waste management policies and regulations were propagated to guide and mitigate the continuous disposal and dumping of waste to rivers, pathways, water channels and illegal dumpsites. The Federal Government of Nigeria enacted Decree number 58 for the establishment of a Federal Environmental Protection Agency (FEPA) on 30th December 1988 to achieve a set of goals. In Nigeria waste management is among the very core management of the local government, state government and federal government. For instance, in Lagos the main government institutions responsible for environmental protection are the Lagos State Waste Management Agencies (LAWMA), Lagos State Environmental Protection Agencies (LASEPA), Local Government Councils (LCGs) and the ministry of environment and Physical Planning (MEPP) [20]. Moreover, at the state levels – the state environmental protection agencies and state waste management agencies are in charge of municipal waste management. Presently wastes are managed by each state environmental protection agency and state waste management agencies in urban cities and big towns in Nigeria. Municipal solid waste collected from the generation point are loaded into waste trucks and transported to designated dumpsites. Consequently, the collection of municipal waste by the state environmental agency requires the payment of certain amount of charges by each household. The size of an apartment determines the allocation of waste collection charges. As a result of income status of people some households cannot afford the monthly payment. This financial limitation promotes indiscriminate dumping of refuse by such

individuals. However, most rural dwellers are not provided with such opportunity.

Federal Government of Nigeria Policy Objectives includes:

- Secure quality environment for all Nigerians for their health and well-being;
- Raise public awareness and promote understanding of the importance of relation between environment and development; and
- To encourage individual and community participation in environmental protection and improvement efforts [28].

The local, state and federal environmental protection agencies enacted laws are similar and include the following:

- The National Protection Management of Solid and Hazardous Wastes Regulation of 1991.
- The Pollution Abatement in Industries and Facilities Generating Waste Regulation of 1991.
- The General Guidelines for Pollution Abatement in Industries 1991. (U.S. Environmental Protection Agencies [1], [19], [28].

V. FACTORS AFFECTING MUNICIPAL WASTE MANAGEMENT AND KNOWLEDGE MANAGEMENT LINKAGES

The problem militating municipal waste management in Nigeria are diverse and numerous; and according to [5] these problems are related to economical, technological, psychological and political aspects in Nigeria. These problems vary from poor funding, poor legislation and implementation of policy, Limited infrastructures and professionals, level of awareness, poor recovery and recycling programme, and disposal technique [13], [15].

A. Poor Funding

This is one of the major problems constraining the waste management sector [22]. Incapability of purchasing new waste collection trucks, limited staffs, poor vehicle maintenance, unsubsidized waste storage containers, inability to purchase equipments among others are all attributed to shortage of capital. Actualizing waste management projects require consistent funding to achieve answers to strategies yet to be implemented.

B. Poor Legislation and Implementation of Policy

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

C. Limited Infrastructures and Professionals

Limited solid waste infrastructures are one of the major contributing indexes of poor waste management system in Nigeria. Nonetheless, experts to man these machineries are

also not on ground. The environmental protection agencies and waste management personals are not experts and exposed to workshops and trainings that meet international standards on technology use, information management and knowledge management. Most of the state environmental protection agencies lack adequately trained personals [5].

D. Level of Awareness

In Nigeria, populace awareness on sustainable waste management is still very poor and effort by the agencies to increase awareness is still very low. Municipal members are not well informed on the adverse effects of indiscriminate and improper disposal of waste and also the benefits of such act.

E. Recovering and Recycling

Access to possible recyclable material possesses great difficulty due to poorly limited recycling programs. The informal recycling programs involve scavengers' effort search of recyclable items. Presently, the informal sector renders the service of retrieving and recycling of materials in Nigeria [23]. The introduction of an advance formal recycling program presents positive and accelerating outcomes for municipal waste management sector.

F. Disposal

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

VI. KNOWLEDGE MANAGEMENT CHALLENGES IN MUNICIPAL WASTE MANAGEMENT IN NIGERIA

A. Cultural Belief

Wastes are viewed as an invaluable and useless materials rather than wealth. Wastes are not seen as valuable materials that can be recycled for actual use, material recovery and energy recovery. The value of waste to people enhances the actualization of the process involved in the management of waste. The conception of waste as worthless is inherently linked with societal organized cultural systems of where things belong [29]. However, consumer's activities are largely a function of common societal cultural values and norms [21].

B. Communication Channels

The dearth of an effective communication channels affects the knowledge acquisition of municipalities in the management of waste. Communication channels such as mass media and posters are often adopted in the transfer of new information rather than the face to face which involves one on one practical interaction process.

C. Collaboration with International Solid Waste Management Organization/Agencies

The existence of limited collaboration with International Solid Waste Management organizations impedes rapid sustainable development within the Waste sector. Interaction

with International waste agencies is rarely a focus area for waste management.

D. Centralized Waste Collection Containers

In Nigeria centralized municipal storage containers are not in place. This presents the municipalities with placement challenges of sorted and recycled materials of different categories. The need for centralized municipal collection points are not viewed as a means to a solution for recycling and material recovery. Thus such agenda are not included in platform for waste management. The available funds are not directed to meet purchase of the waste storage containers for managing waste management. Purchase of municipal storage containers for different collection point is indeed necessary.

E. Packaging and Product Producer Involvement

The involvement of packaging producer in the management of waste is limited. Producers' interests are mainly in the production of content packages rather than the management of these packages. Due to the low level of material and energy recovery, thus material cost are not maximized and this directly affects cost of packaging production. With the increasing effect of improper waste management, the manufacturing sector interest lie mainly on profitability rather than waste reduction [5].

F. Personnel Morale

Field workers in charge of waste collection and transportation often have low morale. Their performance is determined with the extent of stigmatization encountered on the job, poor remuneration and stagnant promotion. Field staffs are not also encouraged with the consumer's manner of habitual waste storage.

VII. PROPOSED KNOWLEDGE MANAGEMENT SOLUTIONS

The presentation of knowledge management solutions in the management of municipal waste in this context is not only in terms of technology centered approach but rather a people centered approach.

With respect to Municipal waste management the people centered approach focuses on individuals that falls within the municipal waste management chains. This includes municipal waste generators, packaging firms or producers and waste management companies while the technology centre approach focuses on the use of ICT's as knowledge and information repository in the management of municipal waste.

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

The more interaction with international waste agencies is required to close up existing gaps between developed and developing countries, and to ensure efficient municipal waste management. This interaction would open doors to new coping strategies of managing waste effectively in Nigeria, among which is knowledge management.

The need for information flow between waste generators, producers and waste management companies is vital in bridging the knowledge gaps. The communication and exchange of knowledge is facilitated between waste generators and producers of recyclable packages such as plastic, tins, and cartons provided comprehensive descriptive logos or label are inscribed with expressions in English and three major languages on such containers as been recyclables. Recovery process of these recyclables from consumers will be possibly not challenging if certain incentives are attached to the return of such items. These incentives are consumer generated incentives that are derived at the point of purchase as the cost of the actual containers is already added to the purchasing cost of the items.

The transfer of information and knowledge to municipalities should be undertaken by waste management (social workers) companies through an effective communication channels involving face-to-face communication. Aside other means of communication, the face- to face channel of communication should be employed by the municipal waste management companies to interact with and orientate members of the

municipalities on disposal habits, sorting and storing of waste in an environmental friendly manner. The importance and benefits attached to waste separation, proper storage, collection and effective waste management needs to also be communicated. The eye contact and interaction between the sender and receiver helps achieve the desired goal to a large extent. Efficient management of waste is promoted if municipal storage containers are available at subsidize price. The storage containers should be of different colours indicating the various category of municipal waste for a particular storage container.

In bridging the knowledge gap existing between packaging and product manufacturers; and waste management companies, the need to deliberate and share knowledge on what ought to and can be re-use and recycled to produce the actual container or alternative containers and energy is paramount. A cohesive collaboration between the packaging manufacturer and waste companies will enhance the prerequisite knowledge and information transferred to communities. Hence, some level of participation is required of them in order speed up actualization process.

TABLE II
PROPOSED KNOWLEDGE MANAGEMENT SOLUTIONS IN MUNICIPAL SOLID WASTE MANAGEMENT

Stakeholders	Stakeholder's Roles	Municipal Waste Management Problems	Source	Proposed Knowledge Management Solutions
Municipal Waste Sources	Partake in the primary management of waste.	Indiscriminate dumping.	[15], [18], [20]	Estblish face- to-face information sharing for waste generators.
• Households	Respond and abide to waste management rules and regulation.	Low level of public education in waste management.		Persistent use of Information Communication Technology (ICT's) to disseminate information.
• Industries	Prompt Payment of waste collection dues.	Poor sorting at source.		Establish local and international networks.
• Commercial Institutions		Absence of storage facilities.	[13], [14] [22]	Utilize both tacit and explicit knowledge.
• Non commercial Institutions		Public attitude towards waste management.		Set up information repositories for data storage.
		Unfriendly environmental disposal technique.		Application of diverse knowledge sharing methods for staffs.
Municipal Waste Management Agencies	Collection, transportation and application of different disposal techniques.	Poor funding, un skilled and limited manpower.	[27],[28]	Begin international collaboration mechanism.
	Facilitate awareness programmes.	Poor maintenance of vehicles.		Initiate and implement motivational factors that promote peoples adoption of material reuse, recovery and recycling.
	Record waste generated per capita/day and annually	Inadequate waste collection vehicles and equipments.		Set up data base and information management system for information capturing.
Municipal Authorities Legislators	Establish monitoring programs	Limited collaboration with international waste management agencies.	[24]	Waste agencies collaboration with research and development institutions.
	Specify waste disposal sites.	Policies lack clear strategies.		
	Specify waste disposal and treatment.	Obsolete policies.		
Informal waste sector	Waste brokers between the waste generators and manufacturers/middlemen	Inadequate and poorly implemented waste management policies.	[5]	
	Resource recovery.	Limited formal education.		
		Highly unskilled workers.		
Producers	Collaborate with waste management to promote recovery, reuse and recycling.	Dearth of involvement in municipal waste management issues.		
	Establish motivational scheme.			

VIII. CONCLUSION

In Nigeria Cultural belief is a major barrier to efficient waste management. Other barriers includes packaging and product manufacturers' involvement and interventions in curbing waste management, ineffective communication, poor personnel morale, absence of centralized waste collection containers, limited collaboration with international

organization. Conclusively, the focus of municipal solid waste management should not only be technology centered strategies but also people centered.

REFERENCES

- [1] A.A. Adedeji, R.T. Ako, "Towards achieving the United Nations' Millennium Development Goals: The imperative of reforming water

- pollution control and waste laws in Nigeria,” *Desalination*, vol. 248, pp. 642-649, 2009.
- [2] P.A. Adeoye, M.A. Sadeeq, J.J. Musa, S.E. Adebayo, “Solid waste management in Minna, North Central Nigeria: present practices and future challenges”, *Journal of Biodiversity and Environmental Sciences*, vol. 1, no. 6, pp.1-8, 2011.
- [3] A.T. Adewole, “Waste management towards sustainable development in Nigeria: A case study of Lagos state,” *International NGO Journal*, vol. 4, no.40, pp. 173-179, 2009
- [4] R. Adewuyi, H. Komine, K. Yasuhara, S. Murakami, “Municipal solid waste management in developed and developing countries – Japan and Nigeria as case studies”. 2009. Available at [www.geo.civil.ibaraki.ac.jp/komine/my_paper/JGS2009\(973\)Rachael.pdf](http://www.geo.civil.ibaraki.ac.jp/komine/my_paper/JGS2009(973)Rachael.pdf) Accessed 10.10.2012
- [5] J.C. Agumwaba, “Solid waste management in Nigeria: problems and issues,” *Environmental Management*, Vol. 22, no. 6, pp. 849-856, 1998.
- [6] B.N. Aliyu, “An analysis of municipal solid waste in Kano Metropolis, Nigeria,” *J.Hum Ecol.*, vol. 31, no. 2, pp. 111-119, 2010.
- [7] I. Amber, D.M. Kulla, N. Gukop, “Municipal waste in Nigeria generation, characteristics and energy potential of solid,” *Asian Journal of Engineering, Sciences and Technology*, vol. 2, no. 2, September 2012.
- [8] G.M. Ayininuola, M.A. Muibi, “An engineering approach to solid waste collection system: Ibadan North as case study,” *Waste Management*, vol. 28, pp. 1681-1687, 2008.
- [9] J.M. Ayotamuno, A.E. Gobo, “Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects,” *Management of Environmental Quality*, vol. 15, no. 4, pp. 389-398, 2004.
- [10] J.O. Babayemi, K.T. Dauda, “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, September 2009.
- [11] Q.H. Bari, K.M. Hassan, M.E. Haque, “Solid waste recycling in Rajshahi city of Bangladesh,” *Waste Management*, vol. 32, no.11, pp. 2029-2036, 2012.
- [12] S. Burney, R. Phillips, T. Coleman, T. Rampling, “Energy implications of the thermal recovery of biodegradable municipal waste materials in the United Kingdom,” *Journal of waste management*, vol. 31, pp. 1949-1959, 2011.
- [13] M. Dauda, O.O. Osita, “Solid waste management and re-use in Maiduguri, Nigeria,” in *Proc. 29th WEDC International Conference towards the Millennium Development Goals*, Abuja, Nigeria, 2003, pp. 20-23.
- [14] I.C. Enete, “Potential impacts of climate change on solid waste management in Nigeria,” *Journal of Sustainable Development in Africa*, Vol. 12, no. 8, pp. 101-110, 2010.
- [15] C. Ezeah, C.L. Roberts, “Analysis of barriers and success factors affecting the adoption of sustainable management of municipal solid waste in Nigeria,” *Journal of Environmental Management*, vol. 103, no. 9-14, 2012.
- [16] P. Haapalainen, K.Pusa, “Knowledge management processes: Storing, searching, and sharing knowledge in practice,” *International Journal of Information Systems in the Service Sector*, vol. 4, no.3, pp.29-39, July-September, 2012.
- [17] D. Hislop, *Knowledge Management in Organizations*. New York: Oxford, 2009, ch.4, pp.59.
- [18] D.I. Igbinomwanhia, “Status of waste management,” *Integrated Waste Management*, vol. 11, pp. 11-34, August 2011.
- [19] A. Imam, B. Mohammed, D.C. Wilson, C.R. Cheeseman, “Solid waste management in Abuja, Nigeria,” *Waste Management*, vol. 28, pp. 468-472, March 2008.
- [20] O.F. Kofoworola, “Recovery and recycling practices in municipal solid waste management in Lagos, Nigeria,” *Waste Management*, vol. 27, pp. 1139-1143, 2007.
- [21] I.C. Nnorom, J. Ohakwe, O. Osibanjo, “Survey of willingness of residents to participate in electronic waste recycling in Nigeria: A case study of mobile phone recycling,” *Journal of cleaner production*, vol. 17, pp. 1629-1637, 2009.
- [22] V.I. Ogu, “Private sector participation and municipal waste management in Benin City, Nigeria,” *Environmental and Urbanization*, vol. 12, no. 2, pp. 103-117, 2000.
- [23] O.O. Oguntoyinbo, “Informal waste management system in Nigeria and barriers to an inclusive modern waste management system: A review,” *Public Health*, vol. 126, pp. 441-447, 2012.
- [24] T.C. Ogwueleka, “Municipal solid waste characteristics and management in Nigeria,” *Iran.J.Environ.Health.Sci.Eng.*, vol. 6 no. 3, pp. 173-180, 2009.
- [25] O.O. Olanrewaju, A.A. Ilemobade, “Waste to wealth: A case study of the Ondo State integrated wastes recycling and treatment project, Nigeria,” *European Journal of Social Sciences*, vol. 8, no. 1, pp. 7-16, 2009.
- [26] I.N. Onwughara, I.C. Nnorom, O.C. Kanno, “Issues of roadside disposal habit of municipal solid waste, environmental impacts and implementation of sound management practices in developing country “Nigeria,” *International Journal of Environmental Science and Development*, vol. 1, no. 5, pp. 409-418, December 2010.
- [27] U.S. Ugwu, “The state of solid waste management in Nigeria. In: *A Glance at the World*,” *Waste Management*, vol. 29, pp. 2787-2790, 2009.
- [28] United State Environmental Protection Agency (USEPA), *Landfill recovery and Use in Nigeria (Pre- feasibility studies of using Landfill Gas Energy (LFG))*. A report prepared by Centre for People and Environment (CPE), June, 2010
- [29] L.E. Zender, “Culture, society and solid waste management. Available at www.zendergroup.org. Accessed 28.08.2012.