

SUSTAINABLE SOLID WASTE MANAGEMENT SYSTEM IN BUILT ENVIRONMENT: A REVIEWFATIMA BABA CIROMA^{1,2}

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ABSTRACT

In Nigeria today, cities and towns are faced with environmental problems resulting from poor solid waste management. Proper waste management is key to environmental sustainability of any environment. In this study therefore, it is evident that the rapid increase in urbanization has led to the ever-increasing heap of solid waste often found on streets and major roads thus, as an alarming feature of the Nigeria's urban landscape. This paper was aimed at making findings of already conducted studies in Nigeria about the physical and chemical properties of different kinds of generated and collected waste and their energy potential in terms of caloric values and socio economic and environmental problems associated with Nigeria's solid waste system and their link with the presence and absence of energy recovery and resource conservation principle. In view of above, the paper was based on empirical environmental assessments with a view to proposing an effective and efficient solid waste management system in Nigerian cities. The result of the findings indicated that

Introduction:

Sustainable solid waste management puts waste reduction and waste separation practices as the most preferred elements in the waste hierarchy (Minghua *et al.* (2009). It is realistic that these two elements in the hierarchy significantly influence the end-products of the overall solid waste management process. Otherwise, public attitudes become lax and persistent solid waste management problems develop. Burntley (2007) asserted that carbon emissions from municipal solid waste (MSW) treatment is one of the anthropogenic sources of climate change and accounts for 3 - 5% of global greenhouse gas emissions.

the rate of solid waste disposal is out-paced by its generation and that waste dump sites on major streets and other open spaces are left unattended for long periods such that it heaps and encroaches roads limiting width usage and generating pollution denying the urban landscape of its aesthetics value another is, solid wastes are heterogeneous in nature as it constitutes biodegradable and non-biodegradable from a wide range of materials. Therefore, the recommendations provided by this paper is for solid waste management to be optimized through recovery, re-use, recycled as secondary materials for re-manufacturing and or privatization of such agencies in search of monitoring, collection, transport, processing, recycling and disposal. So that consideration towards “waste to energy” can be appreciated.

Keywords sustainability, solid waste, waste management, recycling, disposal.

Cities face chronic archetypal problems of developing countries in solid waste management. They turn to opening disposal sites despite having limited land, increasing waste generation while management capacity remains constant, reduced rates of waste processing, and crumbling solid waste management infrastructure. These individuals can be change agents to promote a waste reduction and waste separation movement with the goal of sustainable solid waste management. We conducted this review on Nigeria, where the sole solid waste management authority faced persistent problems in coping with the continuous increase of waste generation. Concurrently, the capacity to manage solid waste was practically constant. Thus, it always lagged behind in meeting its needs for appropriate solid waste management. This is in agreement with the findings by Burntley (2007). They delineated that solid waste management is a challenge for city authorities in developing countries mainly due to increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated with its management the lack of understanding of a variety of factors that affect the different stages of waste management and linkages necessary to enable the entire system to function.

Minghua *et al.* (2009) identified that increasing population, economic growth, increased well-being, and rapid urbanization are significant factors that increase waste generation. This is true regardless of the nation's development status or whether it is a developed or developing country. Burntley (2007) identified additional variables including lack of organizational capacity, insufficient

financial resources, complexity of the problems and multidimensionality of the management system. However, developing countries like Nigeria are in particular the most suitable for review so as to ascertain the level of preparedness to embrace sustainable waste management system for efficiency and improved waste management standard.

1.1 The Issues of Waste Management in Developing Countries

Waste is generated as a result of most of our daily activities (Moberg *et al.*, 2005). Through the 20th century, solid waste management has evolved very significantly (Diaz and Warith, 2006). Today, the debate on waste management has become paramount due to overload of human needs and activities than the assimilative capacity of the biosphere (Marchettini *et al.*, 2007). The question of concern is how to take care of this waste in the most efficient way and with the least negative impacts especially in the rapid urbanizing cities of the developing world like Nigeria, where the problems and issues of solid waste management are becoming a serious threat to the human health and the environment (Zurbrugg, 2003).

To make solid waste management system sustainable, energy and resource conservation and reduced environmental impacts are necessary to be considered (Liamsanguan and Gheewala, 2007). The European Union guidelines mentioned the reduction of the present levels of waste generation and the increase in energy and materials recovery as important steps in the environmentally-sound waste management system (Marchettini *et al.*, 2007).

Nowadays, refuse is considered as a potential source through which something must be recovered or re-used so, it is no longer considered as a 'waste' (Dijkema *et al.*, 2000 and Korhonen *et al.*, 2004).

Landfill is also no longer the first choice for disposal among other methods such as recycling, composting, incineration but a last step in waste management after all possible material and energy recovery. Electricity and heat are produced from the recovered biogas from landfill. To reduce waste mass, incinerators were used initially but nowadays energy is recovered from incinerators. From a mass viewpoint of material recycling, composting represents the most important system, this interactive process defines sustainable waste management system (Marchettini *et al.*, 2007).

The environmental and sanitary conditions of Nigeria is becoming serious year by year and people are forced to live in such conditions due to poverty. Regardless of the size of the city the collection, transportation and disposal or dumping is insufficient and improper. Regarding solid waste management, the

scope of problems is very wide, and it involves other aspects to be considered directly or indirectly. These include, the rate of urbanization, pattern and density of urban areas, physical planning and control of development, the physical composition of waste etc.

To identify the overall environmental burdens and to assess the potential environmental impacts, the life cycle assessment (LCA) is successfully applied to solid waste management systems (Harrison *et al.*, 2000). This remained also helpful for comparing the environmental performance of different scenarios for the management of mixed solid waste (Denison, 1996; Finnveden *et al.*, 2000; Arena *et al.*, Chaya and Gheewala, 2006; Wanichpongan and Gheewala, 2006). With the help of this tool, the solid waste management system is evaluated based on a system wide or life cycle perspective, so this provides a system that recovers energy from incineration, landfill and composting (Liamsanguan and Gheewala, 2007).

Solid Waste Management: Nigerian Experience

In Nigeria, it is estimated that 54,888 tons of solid waste are generated per day (FEPA, 2007), while it is 0.6 to 0.8 kg /capita/ day. The growth rate of waste-generation is 2.4% (WWF, 2001). There is a big difference between solid waste generation and the amounts reaching at final disposal sites. Only 51-69% waste is collected of the total waste generated (FEPA, 2007) and around 40% of the generated waste remains in streets or collection points (WWF, 2001). Much of the collected waste finds its way in dumping grounds, open pits, ponds, rivers and agricultural land because of the lack of adequate disposal sites. As the urbanization and industrialization increase, the environmental degradation also advances which is causing economic losses (FEPA, 2005).

No weighing facilities are currently present at disposal sites. There is no waste sampling and analysis practice carrying out. At various steps of existing solid waste management, the scavengers play an important role as they separate recyclables (FEPA, 2007). Presently, food waste represents 8.4 % to 21% of the total collected waste. 10.2% to 15.6% waste is composed of leaves, grass, straw, fodder while, recyclable materials represent 13.6% to 23% of the total fraction of waste. Industrial and hospital waste is treated as an ordinary waste. Air is polluting due to open burning of waste especially non-degradable components like plastic bags (FEPA, 2007). The public health is being degraded due to clogging of drains, formation of stagnant ponds, which provide a breeding ground

for mosquitoes and flies with consequent risks of malaria and cholera (FEPA, 2005).

Table 1.0: Waste Quantities Generated in selected cities in tones Per Annum

S/No.	State/Cities	Waste Generated Tonnes/Annum
1.	Kaduna	190,498.5
2.	Kano	373,313.8
3.	Lagos	1,164,126.9
4.	Port-Harcourt	103,972.4
5.	Owerri	42,720.4
6.	Ibadan	274,029.4

Source: FEPA, 2007

Institutional Arrangement for Solid Waste Management in Nigeria

- Statutorily the Local Government Authorities are charged with the direct responsibility of municipal Solid Waste Management.
- However, they lack the capacity to fulfill this obligation to the Nigeria Nation.
- The State and Federal Governments intervene to provide assistance.
- Current institutional arrangements for Solid Waste Management include:
 - Local Government Authorities (Department of Health etc).
 - Federal Ministry of Environment
 - NESREA
 - State Ministries of Environment
 - State Environmental Protection Boards, Agencies, Commissions, etc.
 - Refuse Management Authorities.
- The private sector is also involved formally and informally in Solid Waste Management

Solid Waste Management Practices

- The existing Solid Waste Management Practices in most States could at best be described as rudimentary, Inefficient and unsustainable.
- Solid waste management in Nigeria is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal.

- Disposal in most Nigerian cities include, co-disposal of hazardous and municipal waste in open, unlined dumps, open burning of municipal solid wastes, dumping on water bodies and in other unauthorized places.
- The situation is that bad that presently Nigeria cannot boast of even a single properly engineered sanitary landfill for its municipal solid wastes.

Role of Women in Waste Management

Many women work daily on the streets and in waste dumps in search of recyclable refuse.

It may be necessary for low-cost waste collection as that of this informal sector to be integrated into the formal waste collection system. This has been successful in cities such as in Ciudad Juarez (Mexico), where informal collectors were organised into a recycling cooperative which obtained a concession arrangement to operate the city landfill and also in Medellin (Colombia), where they were organised into “small firms for collecting commercial wastes and for purchasing recyclable materials door-to-door”. Thus, the improvement in refuse collection creates the least social dislocation and best utilises scarce skilled labour when it encourages the informal participation of low-opportunity-cost labour.

A major problem faced by our waste management system is the reliance on sophisticated imported equipment which are expensive and difficult to maintain. A sustainable solution to our solid waste management problems should be through the highest standards of service and environmental protection and which are adaptable to the immediate environment.

Government policies in Nigeria can be channelled to be favourable to women participation in waste management businesses across states in Nigeria.

Identification of Problem

The handling of solid waste in Nigeria lacks ‘energy recovery’ principle. The energy potential of generating waste is distributed and circulating in the environment in an un-useful way. The problem is the non-recovery of energy in the form of electricity, bio-gas and fertilizers from waste. So, these energy contents are released into the air (toxic gases) due to open dumping and open burning and into the ground water (water contamination) due to non-sanitary landfill.

Socioeconomic and environmental impacts are resulting due to current practices of treating solid waste. The economic development and the health and well-being

of Nigeria's population are closely linked with improved environmental management and protection. According to a recent study by Batool *et al* (2006) in Lagos have found that if the recycling practices are adopted as an industry, they can generate a revenue of N530 million (US\$ 1.8) million per year with the saving of enormous amounts of energy and natural resources. Resource conservation, creation of jobs, provisions of economic opportunities and a reduction in the impacts of waste disposal are the various benefits that can be created if energy recovery and resource conservation are considered.

Possible Approach and Methodology

Empirical based environmental assessments, studies of institutions and system modelling will be carried out as possible methods for Nigeria. The main approach will be constituted by the socio-economic-ecological science. Through sampling and interviews, empirical data will be gathered and compared with the already available data and information, while the synthesis analysis (literature) will be carried out to get the theoretical data. The technical considerations and derived data with the help of LCA will be transferred into suitable modelling works.

LCA will be a major helping tool to achieve this, it will be used to evaluate the performance of different MSW management systems. According to UNEP (2003), to document the environmental considerations that are needed for decision making process towards sustainability, LCA is an important tool. Different solid waste management system scenarios will be developed and compared by using the life cycle assessment (LCA) methodology. Processes such as the collection of wastes, source reduction, material recovery facility (MRF), transfer stations (TS), incineration, anaerobic digestion and land filling will be considered in these scenarios.

The environmental impacts will be quantified with the weighing factors of each category to develop the environmental profiles of each scenario. The source reduction scenario will be preferred. They will be evaluated on the basis of their water emission, air emission, final solid waste produced, energy consumption and economics.

By the assessment of scenarios, the comparison of different technologies of the waste management system of Nigeria will be carried out, so that the most energy efficient, cost effective and least polluting waste management option could be achieved. According to ISO (1997), four different phases of LCA will be performed in an iterative manner. They are: goal and scope definition, life cycle inventory

analysis, life cycle impact assessment is finally the interpretation using results from all three previous steps. In impact assessment phase, the contents necessary for consideration are selection of impacts categories, indicators and models, classification, characterization and weighting.

Relevant Questions Raised from the Review

Following questions are made to meet up the above-mentioned aims.

- i. What are the findings of already conducted studies in Nigeria about the physical and chemical properties of different kinds of generated and collected waste and their energy potential in terms of caloric values against the reality of big cities of Nigeria like Lagos, Port-Harcourt and Kano?
- ii. What are socioeconomic and environmental problems associated with Nigeria's solid waste system and their link with the presence and absence of energy recovery and resource conservation principle?
- iii. What are the different ground realities (e.g. Conflicting interests of different actors) important to be considered in finding of the most feasible waste management option for Nigeria?
- iv. What policies or strategies are necessary to develop or improve to make integrated solid waste management system applicable in Nigeria?
- v. What are the different sustainability indicators necessary for consideration to make this sector sustainable in Nigeria?

Applicability of Sustainable Solid Waste Management System in built environment in Nigeria

The applicability of Sustainable Solid Waste Management System in Nigeria is relied on a detailed assessment and evaluation study of different solid waste management technologies such as recycling, composting, incineration etc., with respect to their potential of energy recovery, the environmental impacts and economy. This will help to develop an integrated solid waste management system of Pakistan that will be environmentally effective, economically affordable and socially acceptable. This will further ensure the quality of life now and for coming generations. This can be achieved by doing the following things:

- To evaluate the socio-economic-ecological potential to implement the energy recovery principle in different solid waste management technologies.

- Based on above mentioned evaluation, to identify the most energy efficient, most cost effective and least polluting waste management option from a system perspective
- To identify the different actors, their role and participation in policy and decision-making process in the solid waste sector.
- To develop life cycle assessment for different waste management methods and procedures in terms of energy recovery, the environmental impacts and economy

Significance of Sustainable Solid Waste Management System

This review will attain a milestone for different stakeholders, policy makers and decision makers at national and international levels who are or will be interested to develop different waste management technologies in Nigeria because, this will provide them a complete feasibility assessment of different waste management options with respect to energy recovery, the environmental impacts and economy and will also tell what is possible to implement in the presence of different conflicting interests.

In the long run, it will be helpful to municipalities if the energy recovery and resource conservation principle would be considered in solid waste management system because;

- Waste management practices will be optimized.
- Disposal options with new recovery for managing particular material and material streams will be examined.
- As a result of integrated and optimized waste management, the benefits such as resource conservation, creation of jobs, provisions of economic opportunities and a reduction in the impacts of waste disposal will be realized.
- Environmental assessment reports on the 'state of environment' will be prepared.

Conclusion

- Government should be looking at a situation where most of the solid waste generated in the country would be recovered, reused or recycled as secondary materials for re-manufacturing.
- In pursuit of this, it activities should focus on those actions that would promote the reduction of waste at source, segregation, reuse, recovery, recycling, etc.

- This will reduce greatly the need for expansive and expensive waste treatment and disposal options.
- Government should be desirous to make the Private Sector the main driving force behind Solid Waste Management in Nigeria. Governments' role should now be limited to providing enabling environment such as effective legal and regulatory framework to promote sustainable waste management in Nigeria.

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