Implementing 'Greenwaste' Management in a Sustainable City of Lagos, Nigeria

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Key words: Classical waste management; environmental degradation; Lagos mega city; knowledge based 'greenwaste' management; sustainable city; integrated waste management.

ABSTRACT

Management of municipal solid waste (MSW) is one thing that is common in every city government, though service levels, environmental impacts and costs may vary depending on the level of funding, waste stream composition, waste management methodology and the habits of the people. Globally, the biggest waste management problem is the contribution of greenhouse gases to the environment. But classical waste management processes causes other problems like underground water contaminations, inefficient resource utilization, ozone depletion and toxic emissions into the environment, leading to environmental degradation and negative health implications. But the implementing of new technologies and habit change in waste handling and management can help in reducing or eliminating these problems.
The paper attempts a synthesis of waste management strategies for solving the prolonged waste management problems of the Lagos mega city. Using a city-specific approach, it assesses typical success and failure factors. With a standing population of over 21 million people, generating over 10, 000 tonnes of waste daily, the application of knowledge based 'greenwaste' management approach in a strategic planning scenario are crucial in the face of the plan for the city to emerge as a sustainable city. Considering the waste stream composition, the variation in the settlement pattern of Lagos and the habit of the residents, the paper discusses the steps to be adopted to follow the impact factors and succeed in the execution of the 'greenwaste' management. The 'greenwaste' management supported by strategic planning, integrated with spatial analysis will eliminate all the negative effects of classical waste management, leading to integrated waste management hence a sustainable city. This is termed 'greenwaste' management in this paper.

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1. INTRODUCTION

Traditionally, rubbish is forgotten after leaving them out for collection, or after visiting 'the dump'. In recent years, however, growing awareness of the environmental and health effects of simply throwing waste has increased the expectations for enhanced environmental standard. This was triggered by a number of problems and scandals related to the handling of waste. These resulted to increased pressure to act in response to waste problems. Then in 1975, "Waste Framework Directive, the Hazardous Waste Directive, and later the Waste Shipment Regulation were adopted by the EU Member States to put in place the basis of the regulatory structure on waste today (European Commission, n.d.). In the United States (US), The Resource Conservation and Recovery Act (RCRA) was passed on October 21, 1976 (amending the Solid Waste Disposal Act of 1965), to address the increasing problems the nation faced from growing volume of municipal and industrial waste. RCRA set the national goals for: Protecting human health and the environment from the potential hazards of waste disposal, Conserving energy and natural resources, Reducing the amount of waste generated, Ensuring that wastes are managed in an environmentally-sound manner (US EPA, 2013, 2 November).

In response to these legislations, visionaries, through research and development, have developed various tools and methods which are adopted in managing municipal solid waste (MSW) in order to reduce its negative impact on the environment and health of citizens. Even where these legislations are absent, the "visible and political sensitivity of waste management on the credibility of a public administration" (van de Klundert & Anschütz, 2001), is another impetus to strive to put things right in waste management sector. "Waste management requires a concerted chain of activities starting from services to segregation at point of generation, transport, treatment, landfill, and disposal of refuse. Major source of solid wastes are residual materials from homes, cumulative aggregation of all from municipal and commercial establishments and industrial firms" (Achari, 2005). Therefore, "planning and selection of waste management system structure is a multi-stage process involving identification of differences and common elements of variant solutions, selection of the most favourable solution, and evaluation of operation result (Kowalski & Kulczycka, 2004; Kulczycka, 2007; Kulczycka, & Kowalski, 2008; Kulczycka, Kowalski, & Cholewa, 2008; Perman, Ma, & McGilvray, 1996). According to van de Klundert & Anschütz (2001), "there is the tendency to move directly from problems to solutions without an analysis of what is actually is occuring. The answer always being more money or more equipment, even when money and equipment are not the essence of the problem. As a result, money and equipment are used incorreewctly and at large expense, for the many problems that they cannot solve".

Therefore, the problems are not due to the increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated to its management, but mainly the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning (Guerrero, Maas, & Hogland, 2013).

In a city like Lagos megacity, with population increase of 6-8%, at the face of continuous increase in indiscriminate disposal of MSW, "benchmarking of waste management services is far from a straight forward exercise" (Mvulirwenande & Rodic, 2012). 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 (Adewuyi et al., 2009; Ogu, 2000) and inadequate management of environmental knowledge (Abila & Kantola, 2013).

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 (Abila & Kantola, 2013).

This paper advocates a systematic implementation of Greenwaste Management strategy, which involves all stake holders and considering all prevailing circumstances so that MSW management is done in a manner that is safe to the environment and human health while improving on effective resource utilization.

2 WHY 'GREENWASTE' MANAGEMENT (GM)

Greening the waste sector refers to a shift from less preferred waste treatment and disposal methods such as incineration (without energy recovery) and different forms of landfilling towards the three Rs: Reduce, Reuse and Recycle. The strategy is to move upstream in the waste management hierarchy (Figure 1), based on the internationally recognised approach of Integrated Solid Waste Management (UNEP, 2011).

The key aim for a transition to a GM is "to enable economic growth and investment while increasing environmental quality and social inclusiveness. Critical to attaining such an objective is to create the conditions for public and private investments to incorporate broader environmental and social criteria. In addition, the main indicators of economic performance, such as growth in Gross Domestic Product (GDP) need to be adjusted to account for pollution, resource depletion, declining ecosystem services, and the distributional consequences of natural capital loss to the poor" (UNEP, 2011a). This is in line with UNEP "green economy" thinking which results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2010). In its simplest expression, a green economy is low-carbon, resource efficient, and socially

inclusive. This marks a departure from the usual approach where wastes are managed mainly from a compliance point of view characterised by end-of-pipe treatment such as incineration (without energy recovery) and landfilling (UNEP, 2011).

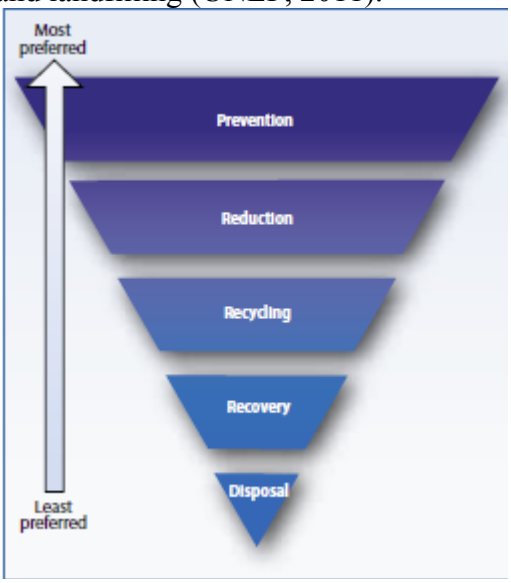

Figure 1: Waste management hierarchy (Source: UNEP, 2011)

The GM concept is built around the concept of integrated and sustainable (solid) waste management, known as ISWM (Ijgosse, Anschütz, & Scheinberg, 2004; Schübeler, 1996; van de Klundert & Anschütz, 2001). The ISWM framework distinguishes three dimensions for analysis of solid waste management and recycling systems: the physical system and its technological components, sustainability aspects (social, institutional, political, financial, economic, environmental and technical) and the various groups of stakeholders involved. The ISWM system for analytical for purposes into two 'triangles', the physical components and the governance features (Scheinberg, Wilson, & Rodic, 2010). The first 'triangle' focuses on three key drivers for development of waste management (Wilson, 2007), corresponding to the three key physical, 'hardware', components:

- Public health: maintaining healthy conditions in cities through a good waste collection service.
- Environment: protection of the environment throughout the waste chain, especially during waste treatment and disposal.
- Resource management: 'closing the loop' and returning both materials and nutrients to beneficial use, through preventing waste and striving for high rates of reuse, materials recycling and organics recovery.

Sustainable development has been variously conceived in terms of vision expression (Lee, 1993), value change (Clark, 1989), moral development (Rolston, 1994), social reorganization (Gore, 1992) or transformational process (Viederman, 1994) toward a desired future or better world. The core idea was defined most influentially by The World Commission on Environment and Development (i.e., The Brundtland Commission) as "development which

meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). In its broadest sense, this normative abstraction has been widely accepted and endorsed by thousands of governmental, corporate, and other organizations worldwide (Gladwin & Krause, In press).

The GM analyzes how key sectors that are interlinked with MSW can make the transition towards a greener environment. The idea underline that a shift to sustainability in terms of improved human wellbeing and social equity, can lead to healthier and more economically productive society that can simultaneously benefit all citizens, leading to a sustainable city.

According to McMahon (2013, 15 November) "One goal of a sustainable city is to reduce needs and reliance on surrounding areas. In addition to being environmentally sustainable, this can be economically beneficial, and may allow a city to be more secured in the event of a natural or civil emergency. Reduction of reliance on surrounding areas includes growing food in a city, reducing water needs and reusing water as much as possible, and generating energy inside the city. The city may become independent of the surrounding area, reducing strain on outlying communities. She went further to conclude that "A sustainable city must also think about what it is putting out into the surrounding environment. Sustainable cities want to reduce waste in addition to lowering pollution. This is especially important in cities with limited processing capacity for things like waste; as such materials may be pushed onto surrounding communities unless the city takes responsibility for them".

3. LAGOS MEGACITY

Lagos is a port city made up of the mainland and a string of islands. The population of Lagos is currently estimated to be 21,883,047 millions (Lagos Bureau of Statistics, 2011). If this is confirmed, Lagos should be contesting the position of the most populous city in the world. The rate of population increase is estimated at about 3.2 per cent (600,000 people) per annum with a population density of about 4,193 persons per sq. km. In the built-up areas of Metropolitan Lagos, the average density is over 20,000 persons per square km (Lagos State Government, n.d.).

Lagos is the foremost manufacturing city in West Africa, and the hub of business and economic development in Nigeria. This coastal city is situated within latitudes 6o 23′N and 6o 41′N and longitudes 2o 42′E and 3o 42′E. The city has the largest concentration of multinationals and commercial institutions and is home to about 60 per cent of Nigeria's non-oil economy. Lagos grew from 300,000 in 1950 to 7.7 million people in 1990. United Nations estimates indicate that that by 2000 the total population for Lagos had reached 13.4 million, projecting it to reach over 20 million by 2010 (World Bank, 2006)

Therefore, the first problem facing Lagos Waste Management Authority (LAWMA) is rapid urbanization and problem of dysfunctional solid waste management facilities and services. For Lagos to emerge as a sustainable mega city, the policy makers and local councils have to tackle this issue and find economically sustainable solutions to the urban waste problem without compromising environmental goals.

The GM approach is a comprehensive approach to prevent (reduce waste from source), recycle more waste and management solid waste in ways that most effectively increases resource utilization; protect human health and the environment.

4. WASTE SITUATION IN LAGOS

With a daily influx of more than 2000 people, carrying about 2 tonnes of generated MSW, Lagos certainly faces daunting environmental problems. "These problems include dumping of often toxic industrial waste, ineffective solid waste management, insufficient sanitary infrastructure; soil, air and water pollution; flooding, ocean surge, insecurity, and limited access to basic infrastructure and municipal services" (Ogunsote et al., n.d.).

Waste management has been a great problem to the government of Lagos State. In most parts of the city, streets are partially or wholly blocked by solid waste, similarly, open spaces, market places are littered with solid waste. Shortly, after Nigeria's independence, the metamorphic stage of Lagos from a clean and tidy city to a crowded, dirty and smelly city, went almost unmentioned until in the 70's when Lagos was tagged the dirtiest city in the world (Adedibu & Okekunle, 1989).

As time went by, the volume and nature of waste generated in the State continued to rise geometrically until it became conspicuously embarrassing. The then Lagos State government came up with various strategies aimed at combating the growing menace. One of such strategies adopted was the establishment of the Lagos State Refuse Disposal Board (LSRDB) vide Edit No 9 of 1977 (Oresanya, 1998). In 1991, LSWDB was renamed Lagos State Waste Management Authority (LAWMA) by virtue of Edit No 55 of Lagos State, this time as a commercialized autonomous authority with statutory duties of collection and disposal of municipal and industrial waste in the Metropolis and to provide commercial services to the State and Local Governments. It was also mandated to collect and transport commercial and industrial waste to designated landfill sites as well as manage the landfills (Akinmuleya, 2006). In 1997, Private Sector Participation (PSP) scheme was introduced to complement the efforts of LAWMA. According to Popoola (2001), there has been no time in the past ten years when the Waste Management Agencies in Lagos catered for more than 70% of the waste generated. While the population of the city was increasing at an estimated annual rate of at least 6%, the municipal authority in charge of waste was collecting, on the average, almost 10% less refuse per capita every year (Onibokun et al., 2000). The method of disposal in use in Lagos is the operation of open dumpsites. Although, some residents discharge their waste indiscriminately in unauthorized places e.g. open spaces, gutters and streams, and some burn theirs openly (Popoola, 2001).

Service delivery from existing limited MSW management infrastructure stock is depleted as a result of the neglect of its systematic and routine maintenance over the past three decades. Under-investment in new municipal assets due to lack of resources has depleted further basic service delivery to a large and growing population, including waste management.

The current administration has made impressive progress in fundamental areas essential for improving urban management and service delivery. The ambitious MSW management in collaboration with World Bank, USTDA, UNDP, DFID, Clinton Foundation and indigenous Banks (Oresanya, 2008) is commended. Under the new dispensation, Table 1 summarizes the collection situation between 2007 and 2012.

From unconfirmed sources, it is estimated that an average Lagosian generates between 0.50kg and 0.70kg per day. Therefore, Lagos produces between (10.5kg and 14.7kg) millions of waste daily. This puts the annual per capita waste generation at more than 220kg. This will be increasing at the same rate as population, if no positive action is taken towards effective management. GM initiative will ameliorate the problem and contribute economically to the growth of Lagos State.

Generally, waste arising data are lacking and reporting waste generation data is very difficult since there are no deliberate framework focusing on data collection and reporting. Lagos like most third world cities have not developed a sustainable system of waste management over time, hence waste generation data is lacking. But base on recent attempt to make Lagos attractive for investment and tourism, collection has improved and there is an improved record of waste collection and disposal (Table 1) in the existing landfills or dump sites (Table 2)

Table 1. Summary of MSW collection in Lagos between 2007 and 2012

Year	Projected Population *	Per capita Waste Generation **	Expected Annual Waste Generation (metric tonne)	Volume of Waste Collected (metric tonnes)**	Estimated Volume of MSW not collected (metric tonnes	Percentage of waste not collected
2007	18114636	0.5kg/per/day	3305921.070	2222745.5	1083175.57	32.76
2008	18694305	0.5kg/per/day	3411710.663	2814543.45	597167.213	17.50
2009	19292522	0.5kg/per/day	3520885.265	3831708	-310822.735	-8.83 ***
2010	19909883	0.5kg/per/day	3633553.648	2549629.55	1083924.098	29.83
2011	20546999	0.5kg/per/day	3749827.318	Incomplete data	Incomplete data	
2012	21204503	0.5kg/per/day	3869821.797.5	3948902.52	-79080.722	-2.04 ***

***(Lagos Bureau of Statistics, 2011), **(Oresanya, 2011), ***Collection more than generation**

Figure 2: A typical dumpsite at Lagos (Olusosun waste dump)

(Source: Source: LAWMA, n.d.)

5. STRATEGIES

The GM encompasses planning and management systems, waste generation processes, and organisations, procedures and facilities for waste handling.
Development strategies comprise specific objectives and measures in these areas. They need to consider the specific interests, roles and responsibilities of numerous actors, including: (Schübeler, 1996)

- Households, community-based organisations (CBO) and other service users,
- Local and national government authorities,
- Non-governmental organisations (NGO)
- Formal and informal private sector enterprises, and
- External support agencies (ESAs).

To achieve sustainable and effective waste management, development strategies must go beyond purely technical considerations to formulate specific objectives and implement appropriate measures with regard to political, institutional, social, financial, economic and technical aspects of MSWM (Schübeler, 1996)

5.1 Political Component

This is a very important component of the strategic steps that need to be taken. It involves the formulation of goals and priorities, determination of roles and jurisdiction, and the legal and regulatory framework:

- This involves articulation of bylaws, ordinances and regulations, which should be few and transparent, unambiguous and equitable. Therefore, the Lagos people must be involved in this process, so that they are already aware even before the regulations are implemented. This will equally help in behavioural change and mobilising popular support which is needed for its realisation.

- A clear definition of jurisdiction and roles is essential to the political sustainability of GM systems. Therefore, the roles of government authorities and other stake holders must be defined.

5.2 Institutional Component

This involves the distribution of functions and responsibilities and correspond to organisational structures, procedures, methods, institutional capacities and private sector involvement:

- An appropriate distribution of responsibilities, authority and revenues between the state government, LAWMA and local governments is very important. This will act as incentive for commitment. If tasks are extended to development areas, they should be included in the equation of distribution of tasks and revenues. Therefore, decentralisation of responsibility for GM requires a corresponding distribution of powers and capacities.
- Capacity-building measures should give primary attention to strategic planning and financial management.
- Private sector involvement in GM implies a shift in the role of government institutions from service provision to regulation. Essential conditions for successful private sector involvement include competitive bidding, technical and organisational capacity, regulatory instruments and monitoring and control systems.
- The contribution of informal waste collection workers should be significantly improved through appropriate organisational measures.

5.3 Social Component of GM

This covers the patterns of waste generation and handling of households and other users, community-based waste management and the social conditions of waste workers:

- Waste generation patterns are determined by people's attitudes as well as their socio-economic characteristics. Attitudes towards waste may be positively influenced by awareness-building campaigns and educational measures.
- Community-based solid waste management should be encouraged, especially in areas where waste collection trucks may not be able to ply or manoeuvrability is difficult.
- Even where municipal waste collection services are provided, user cooperation is essential to efficient GM operations. Cooperation may be promoted through general awareness-building programmes as well as focused GM information campaigns.
- Waste workers especially those in the informal private sector live and work under socially precarious conditions and are subject to serious health risks. Support should aim to improve their working conditions, earnings, and access to social services.

5.4 Financial Component

Budgeting and cost accounting, capital investment, cost recovery and cost reduction are very strategic in every enterprise, including a GM;

Deficiencies in the provision of waste services are the result of inadequate financial resources, lacking management, and technical skills of municipalities and government authorities to deal with the rapid growth in demand for service. Although budgets are limited, the willingness to pay for well rendered services is high (Zurbrügg, 2003). The main options for financing recurrent MSW management costs are user charges, local taxes and intergovernmental transfers; clear preference should be given to user charges. To achieve equitable service access, some degree of cross-subsidisation and/or financing out of general revenues is often needed, however. Cost accounting, financial monitoring and financial evaluation leading to cost reduction is very important.

5.5 Economic Component

This is the consideration of the impact of services on economic activities, cost-effectiveness of the systems, macro-economic dimensions of resource use and conservation, and income generation:

- As the economic nerve centre of Nigeria, housing about 592,000 industries (Oresanya, 2008), Lagos need to take a lead in influencing a national discuss to roll out legislations that will affect the generation of wastes by these industries.
- Solid waste generation and the demand for waste collection services generally increase with economic development (Alhassan & Mohammed, 2013; Sumukwo, Kiptui & Cheserek, 2012; Wang et al., 2011).
- Therefore, measures should be introduced which discourage wasteful use of materials and encourage waste minimisation. The best way to promote efficient use and conservation of materials is to internalise the costs of waste management as far as possible in the production, distribution and consumption phases. In this line, product stewardship where companies contribute in the management of wastes generated by their products will be introduced (Schübeler, 1996).

5.6 Technical Component

The technical area of the GM are concerned with the planning and implementation and maintenance of collection and transfer systems, waste recovery, final disposal and hazardous waste management: (Schübeler, 1996).

- Technical facilities and equipment must be designed and selected with careful regard to their operating characteristics, performance, and maintenance requirements and expected life-cycle costs. Close attention should be paid to preventive maintenance, repair and spare parts availability. In all, local characteristics and circumstances should be considered in the whole process.
- Informal waste recovery and scavenging may be rendered more productive through support measures and appropriate technical design of the waste management systems. Public sector involvement in waste recovery and/or leasing of waste recovery rights to private sector enterprises may be considered.
- To minimise their environmental impacts of landfills, they must be carefully sited, correctly designed and well operated.

- As most hazardous wastes are industrial waste, a state-wide industrial audit is necessary to identify Sources of hazardous waste materials which must be registered and targeted for appropriate management.

In the present situation, where "reliable data for informed planning and decision-making to credibly prioritize and target expenditures from limited resources does not exist and there is absence of locally relevant information and pertinent analytic tools, it is difficult for Lagos to credibly identify, evaluate, and prioritize interventions and measure their results" (World Bank, 2006). There is need for general update of spatial infrastructure to support this endeavour.

6. DISCUSSIONS

Developing an integrated waste management system which will help the development of recycling and reuse system in the suburbs of Lagos where movement of collection trucks are difficult or impossible is very crucial in this endeavour. This can be in the form of small scale composting projects or establishing recycling centres (resource recovery centres).

Looking at the MSW composition of Lagos (Figure 3), it is clear that composting will be a good investment. With the understanding of the politics of fertilizer (Aiytan & Pindiga, 2013, 03 October), there is a good market for the compost. LAWMA is already making progress in

Table 2. Comparison of material recovery by formal and informal sector, baseline scenario (in tonnes and as a percentage of total waste generated) (Scheinberg, 2011)

Table 2: Comparison of material recovery by formal and informal sector, baseline scenario (in tonnes and as a percentage of total waste generated)

Cairo		Cluj	
13 % 433,200 Tonnes	30% 979,400 Tonnes	5% 8,900 Tonnes	8% 14,600 Tonnes
Lima		**Lusaka**	
0.3% 9,400 Tonnes	19% 529,400 Tonnes	4% 12,000 Tonnes	2% 5,400 Tonnes
Pune		**Quezon**	
0 % - Tonnes	22% 117,900 Tonnes	2% 15,600 Tonnes	23% 141,800 Tonnes
Formal sector	Informal sector	Formal sector	Informal sector

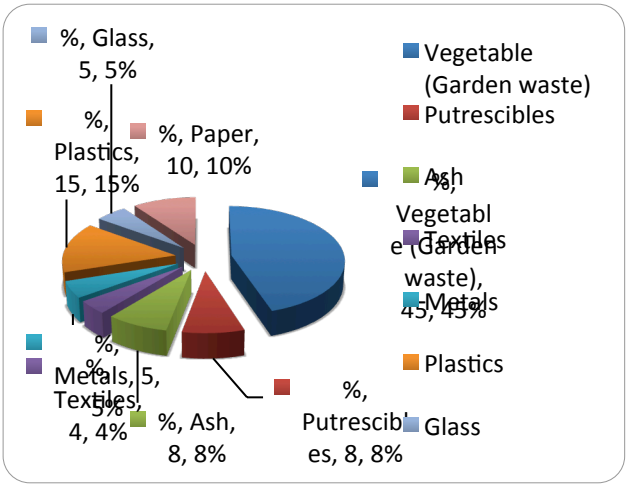

Figure 3. Waste Composition of Lagos State(Data source: http://www.lawma.gov.ng/)

this direction (Oresanya, 2010). Involving local residence through cooperatives within the inaccessible parts of Lagos megacity will increase the supply and empower the poor in the society while increasing the utilization of the biodegradable fractions of waste in the city. These are impact indicators which can easily be used to assess the progress of the project (African Development Bank, 2003; Rietbergen-McCracken & Narayan, 1998).

Implementing source separation will improve on the quality of the waste fractions and their utilization for purposes like bio-fuel.

Informal waste recycling is carried out by poor and marginalised social groups who resort to scavenging/waste picking for income generation and some even for everyday survival. This is widespread throughout urban areas of the developing world (Medina, 2000), including Lagos. Though there is no available record to show the contribution of this group to the MSW industry in Lagos, (Scheinberg, 2011) in Figure 2 demonstrates their contribution to resource recovery in developing countries. From a macroeconomic perspective; they are well adapted to the prevailing conditions, namely abundant supply of working force, but scarce capital (Haan, Coad & Lardinois, 1998; Scheinberg, 2001a) and from the environmental point, the informal sector takes over a part of the burden of the municipalities and proving employment and livelihood to many (van Beukering, Schoon & Mani, 1996). Recognising them as part of the system will create enabling environment that will help the system to achieve the set goals.

Through awareness campaign and legislations, creation of database of the sources and quantity of MSW, collaboration through integration, the volume of waste disposal can be reduced to about 30 per cent in the first year of implementation. This is expected to increase systematically to about 70 per cent within five years of continuous improvement.

Although waste-to-energy (WTE) is a very expensive endeavour, a comprehensive research on the true composition of Lagos MSW and other characteristics will help in knowing the viability of venturing into a WTE project, as the best technology for the project can be decided.

Because of the high vehicular density of Lagos megacity, consideration should be given to considering restrict waste collection trucks to night time. This will have a considerable impact on cost and emissions reduction and improving the general traffic flow.

7. CONCLUSION

The cost of MSW management is high but if managed through an integrated approach, is worth billions of dollar in a city like Lagos because of the supply of waste is sure for different purposes. It is therefore recommended that the Lagos State government invest into the future of waste management in the city by commissioning a state wide waste characterization study which will open the waste sector for investment.

The growth of the waste market will increase resource utilization and may lead to scarcity as the availability of new technologies are offering opportunities for greening the waste sector.

Investing in GM can generate multiple economic and environmental benefits – energy saving, reduction in crime through job creation, emission saving, improved health, economic growth, etc.

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