Scholarly Research Journal for Interdisciplinary Studies,
Online ISSN 2278-8808, SJIF 2019 = 6.38, www.srjis.com
PEER REVIEWED & REFERRED JOURNAL, SEPT-OCT, 2019, VOL- 7/53

COMPOSTING AS A SUSTAINABLE WASTE REDUCTION STRATEGY IN THE CITIES OF JOHANNESBURG AND LAGOS

O. E. Taiwo

Department of Civil Engineering, Tshwane University of Technology, Private bag X680, Pretoria 0001, South Africa

Department of Chemical, Fibre and Environmental Technology, Federal Institute of Industrial Research (FIIRO), P.M.B 21023, Lagos, Nigeria. E-mail: toytaiwous@yahoo.com; oluwatoyin.taiwo@gmail.com

Abstract

Solid waste management challenges facing the cities of Johannesburg and Lagos are real; where residents hardly bother about issues pertaining to environmental care. As landfills reach their capacity, composting has become an increasingly viable means of organic waste management. The paper identified environmental and economic benefits of composting.

Through the review of quantitative data, the composition of municipal solid waste arising from the two cities was obtained in order to ascertain the potential for composting organic waste fraction of the waste stream. The data showed that the organic fraction of the waste stream of Johannesburg and Lagos are 38% and 50% respectively.

The aim of this paper is to examine composting as a sustainable waste reduction strategy in two developing cities in Africa namely, the cities of Johannesburg (South Africa) and Lagos (Nigeria) which have similar solid waste management problems. Recommendations were also made on the sustainability of composting in both cities.

***Keywords**: Composting, Sustainable, Waste reduction, City of Johannesburg, City of Lagos*

1 Introduction: Historically humankind has always been a waste generator. At global level, municipal solid waste (MSW), synonymous with "garbage", "trash", "refuse" and "rubbish" (Wikipedia, 2019a) is a growing concern. As landfill space for MSW disposal decreases, worldwide interest in recycling by means of composting is growing. Composting is a biological process in which organic waste material (Figure 1) is aerobically degraded by microorganisms (mainly fungi and bacteria) and invertebrates and turned into a dark brown or black humus material with earthy smell, known as compost (Ekelund & Nyström, 2007). This finished product which looks like soil is high in carbon and nitrogen and an excellent medium for growing plants. Compost is used in gardens, landscaping, horticulture, urban agriculture and organic farming.

The main objectives of composting is to transform biodegradable organic materials into a saleable biological stable material (compost), and in the process reduce the original volume of waste, thereby saving on disposal costs and extending the operational lifespan of landfill sites. For the purpose of this paper, organic waste is defined as biodegradable waste that is generated from previously living plants or vegetation. It includes green waste, woody waste and food waste (Heydenrych & Drake, 2012).

Although, composting will be appropriate for all organic wastes, source separated organic waste is the preferred feedstock since contamination by plastics, glass, metals, and household hazardous materials is minimised. Wastes such as plastic, paper, metals and glasses are better handled through recycling.

FIGURE 1-: ORGANIC WASTE

Source: *Frankson (2018)*

Rapid population growth, urbanisation, technological development, rising living standard as well as modern life styles and consumption patterns has resulted in an increase in the amounts of MSW being generated in many African cities. The resultant effect is increasing pressure on waste management resources and the environment. Solid waste management challenges facing the developing cities of Johannesburg and Lagos are real; where residents hardly bother about issues pertaining to environmental care. Both cities are densely populated with a lot of informal settlements and acute shortage of land for waste disposal. It is difficult to find suitable land to develop new landfill sites in the nearby vicinity which does not conflict with residential and other planned developments. As concern for landfills and dumpsites space increases, it is important that an alternative approach based on waste

hierarchy, namely composting be explored to deal with the biodegradable organic component of the municipal solid waste stream.

The waste hierarchy (Figure 2) indicates the need to shift waste trends away from landfills towards progressive waste minimisation. There is a need for urgent action to reduce, re-use and recycle waste in order to achieve sustainable development. It is within the framework of solid waste management hierarchy that waste minimization emerges as a tool to integrate the 3R's, Reduce, Reuse, Recovery (Recycling, Composting, Energy Recovery), then disposal (Incineration, Landfill).

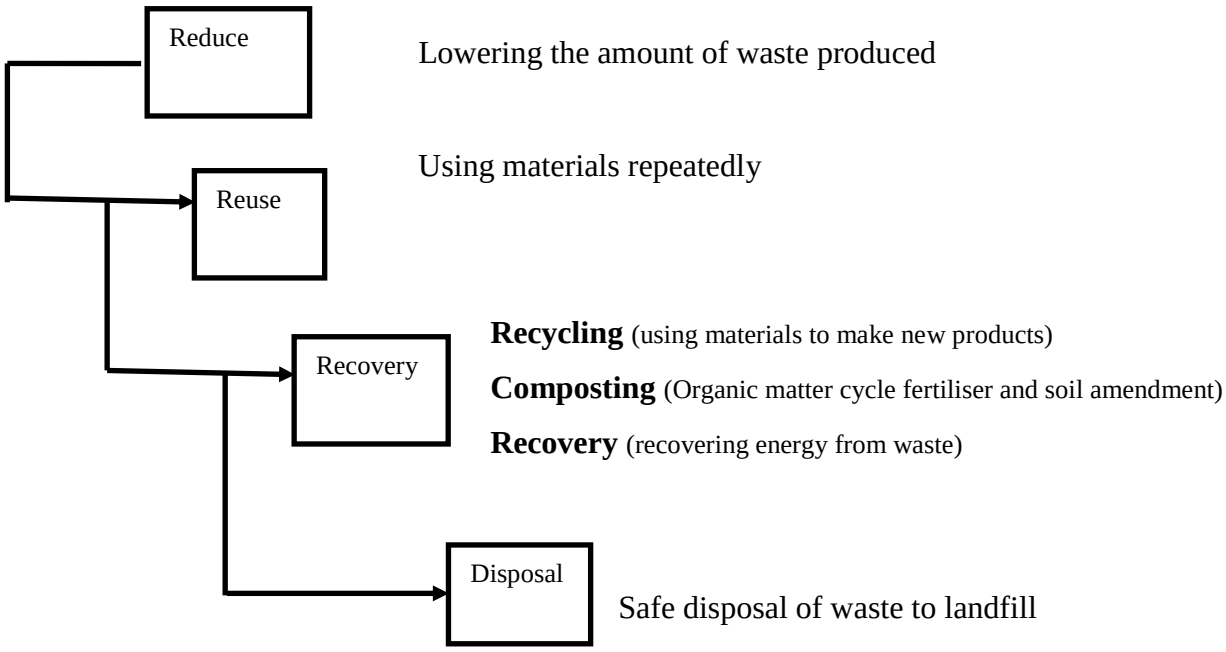

FIG 2: SOLID WASTE MANAGEMENT HIERARCHY

Source: *ECSIP Consortium, 2013*

Tools used for this investigation include direct observation, photography, discussions with waste management specialists, secondary data obtained from waste stream analysis, documents and literature search. In this study, direct observation was used to gain an insight into the composting process by site visits to composting plants in the City of Johannesburg (COJ) and City of Lagos (COL). Observation was also made by site visits to landfill sites and garden refuse sites.

2 STUDY AREAS

The profile of the study areas is shown in Table 1.

Table 1: **Profile of the City of Johannesburg and City of Lagos**

PARAMETER	CITY OF JOHANNESBURG	CITY OF LAGOS
Location	Gauteng Province, largest city in South Africa	South-West Coast of Nigeria, most populous city in Nigeria
Land Mass (Area of City)	1645 km^2	3600 km^2
Population	4.4 million	18 million
Annual Growth Rate	3.18%	6-8%
Population Density	2696 persons/km^2	2957 persons/km^2
Waste Generation	1.6 million tons per year	3.65 million tons per year
Per Capita Waste Generation (per person per day)	1.6 kilograms	0.65 kilograms
Waste Management Service Provider	Pikitup Johannesburg	Lagos State Waste Management Authority (LAWMA)
No of Landfills	4	8

Source: *City of Johannesburg, 2018; StatsSA, 2011; LAWMA, 2013*

3 TYPES OF COMPOSTING: There are two ways to compost – home compost pile, or a commercial facility. Commercial or industrial composting is large-scale composting which is designed to handle a very high volume of organic waste, as opposed to private or home composting, which handles organic waste from one household or facility. Both methods have the same basic requirements – the right mix of greens and browns, or food scraps and yard waste.

Commercial composting can be employed using either a centralised or decentralised system. In a centralised system, organic material is collected in bulk and taken to a central composting plant while in a decentralised system there are multiple sites usually operating on a smaller scale.

3.1 Composting Process: At the simplest level, the process requires making a heap of wet organic matter (also called green waste) such as leaves, grass, and food scraps, mixing it up with a shovel or pitchfork once in a while, and waiting for the materials to break down into humus after a period of months (**Wikipedia 2019b**). Animal manure (horses, goats,

sheep, and chickens), fruit and vegetable food materials and garden materials are excellent raw materials for home composting. A home composting container is shown in Figure 3.

FIGURE 3: HOME COMPOST BARREL

Composting can also take place as a multi-step, closely monitored process with measured inputs of water, air, and carbon- and nitrogen-rich materials (**Figure 4**).

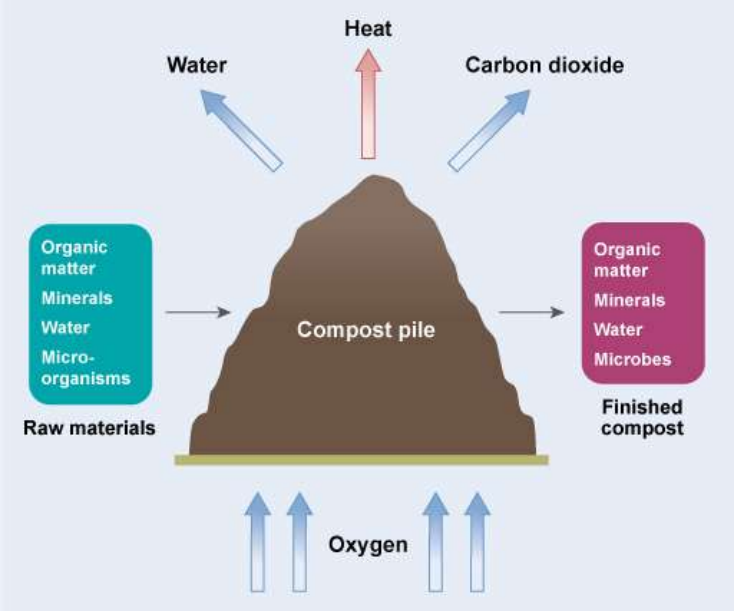

FIGURE 4: THE COMPOSTING PROCESS *Source:* *Open WASH (2016)*

The stages in the composting process are outlined below (Magongwa, Vorster & Forbes, 2004; Cooperband, 2002):

(1) **Separation of compostable materials**: Municipal solid waste composting commences with sorting and separating operations to isolate organic, decomposable waste materials from non-biodegradable substances such as plastics, glass and metal.

(2) **Shredding and pulverizing**: Reduction of the size of the individual pieces of organic waste in order to have a uniform mass of material which will eventually facilitate the handling, moisture control and aeration of the decomposing waste. Size reduction also helps to optimize bacterial activity and increase the rate of decomposition.

(3) **Blending or proportioning of materials**: Composting works best with the right mixture of wastes so that the moisture content and the proportions of the chemical elements carbon and nitrogen are suitable. Generally, the ideal mix for composting is three parts (buckets, for example) of 'brown' waste (such as leaves, hay, straw, eggshells, shredded paper, card and woody material), with one part 'green' material (such as grass, food waste and animal manure). 'Brown' waste contains a higher proportion of carbon and 'green' waste contains more nitrogen and has higher moisture content. Thus the ratio of brown waste to green waste is 3:1.

(4) **Composting**: The waste materials are now ready for the actual composting or digestion which may take place in open windrows where air is introduced into the windrows of the composting material either actively or passively or in closed composting plants. The ideal pile is 1.5-2 m wide and about 1.5 m high. The length of the pile is determined by the space and the amount of waste available.

(5) **Finished Compost**: Under optimum conditions, the processing cycle for composting is about 20-25 days with active degradation taking place over a 10-15 day period. The duration to produce finished compost (Figure 5**)** depends on the raw materials, composting method and management. Bagged compost is shown in Figure 6.

Figure 5: Finished Compost

Figure 6: Bagged compost

3.2 Composting Technologies: The most common commercial composting technologies are windrow composting (turned or passive), aerated static pile composting (or tunnel) composting and Closed in-vessel composting (Magongwa, Vorster & Forbes, 2004; Cooperband, 2002; Kiely, 1997; BCMAF, 1996). The method of choice depends on the volume of waste to be composted and the availability of space for composting. The windrow composting technology is the one employed in the two cities under review. There is a variety of equipment in the market for making compost. These include tub grinders, low speed shredders, high speed shredders, windrow turners and screens (Bernard, no date).

3.2.1 Windrow Composting: The windrow-based processes require the pile of stacked raw materials to be placed into long narrow piles, which are typically triangular or trapezoidal in cross-section, to compost, primarily outdoors with or without a roof (Nelson, 2006; Magongwa, Vorster & Forbes, 2004). A turned windrow (Cooperband, 2002) is one that is mechanically turned using a windrow turner (Figure 7). This is done every few days with water added each time the windrow is turned using specially made compost turners (Figure 9) Turning the windrow remixes the materials, allowing all the raw materials to be colonised by microorganisms, in the warmer, more active internal part of the compost pile. Oxygen is reintroduced; heat, water vapour and gases escape (Figure 5). The most important part of turning the pile which should be small (3-6') is the re-establishment of porosity and the ability of air to get into the pile over a long period of time. This method represents a low technology and medium labour approach (BCMAF, 1996).

FIGURE 7: WINDROW TURNER

Source: *Taiwo, 2009*

3.3 Benefits of Composting: There are both environmental and economic benefits for composting (Nabegu, 2011; Farrell & Jones, 2009; Ekelund & Nyström, 2007; Venter & Mulder (2006).

3.3.1 Environmental benefits

(1) It reduces the amount of waste going to landfills, since landfills can cause serious environmental impacts. First it results in reduced health risk of having pathogenic materials in the environment. Secondly it reduces the production of landfill gasses, such as methane formation since less waste goes to the landfills so there is less organic matter in the landfills, which in turn reduces the negative environmental impact of leachate. Thirdly with less organic waste going to the landfill, the risk of fire can be reduced.

(2) It returns organic matter to the ecological circle.

(3) It is an environmentally compatible fertilizer. It has advantages over inorganic fertilizers because the quality of the soil (poor and sandy soils) is improved and more productive.

(4) Since compost generally has a pH of 6.5 to 7.0, the same as preferred by most plants, it can modify the pH of soil which may have a pH either below or above this range, and bring it closer to what plants prefer.

(5) Compost keeps the environment free from unnecessary toxins that may affect health and well-being, thereby increasing the quality of human life.

(6) It improves the aesthetic quality of the surroundings.

3.3.2 Economic benefits:

(1) It reduces waste to landfill and saves disposal costs.

(2) It results in significant cost savings by reducing the need for water, fertilizers and pesticides.

(3) It extends the operational lifespan of landfill sites by diverting organic materials from the waste stream.

(4) In some cases, it reduces transportation costs.

(5) There is creation of a new saleable product.

4 RESULTS AND DISCUSSION: The composition of the waste streams of the COJ and COL was obtained from secondary sources. The yearly average composition of Johannesburg waste streams is shown in Table 2. Organics, paper, fines/residues and plastics are the main components found in the waste stream. The fine/residue fraction is the waste remaining after all fractions had been separated out and includes soil, yard sweepings, wet ash, undefined waste, and mashed putrescibles.

TABLE 2: COMPOSITION OF JOHANNESBURG WASTE STREAM

COMPONENTS OF WASTE STREAM	COMPOSITION (%)
Metals	2
Glass	6
Plastics	9
Paper	18
Organic	38
Other (Fines/Residues)	27

Source: *Aurecon, 2015*

Pikitup management embarked on a process of developing a long-term waste management services plan (WMSP), which seeks, among other things, to divert 93% of waste away from landfills by 2040 (Pikitup, 2012). The company also embarked on a process of developing supporting strategies to amplify the WMSP. The Organic Waste Strategy (Heydenrych & Drake, 2012) is just but one of the strategies. The primary focus of the organic waste strategy is on garden waste (i.e. green and woody wastes) and food waste (dailies and household waste) emanating from plant based materials (such as fruit and vegetables) which are generated by both the residential and commercial customers.

The primary method of disposing of municipal solid waste in Johannesburg is via landfills. Part of the initiative of the city to reduce waste going to landfill site, in response to dwindling landfill capacity is by diverting garden waste, which is 19.4% **(**Aurecon, 2015, Ball, 2001) of the total waste stream. Garden waste contributes the largest amount of household waste disposed to landfills in Johannesburg. Pikitup has 44 garden sites strategically located throughout the metro, all receiving garden waste and other recyclables from residents. Garden waste is generated from normal gardening activities, such as grass cuttings, leaves and pruning clippings, is volume orientated in relation to the total waste stream and demands huge landfill space if dumped.

Pikitup's Panorama composting plant situated on an old compacted landfill site at Roodepoort uses a highly mechanised, centralised aerobic composting system. The composting process used at Panorama (Figure 10) comprises of a milling, windrow formation

and screening phase. During the composting process, the plant makes use of equipment which includes a milling machine, a loader, an 1800 compo-screen, a Rhino SP4 windrow turner, and a compost shredder MZA-2500 to produce the compost (Venter, pers comm, 2007; Shelabi &McKay, 2016).

The composting plant has the capacity to process approximately 40 000 tons of garden waste per annum into compost and mulch (Liebenberg & Van Aswegen, 2006). The composting process utilizes only clean organic material. However, Pikitup is considering whether manure should be added during the process to improve the quality of the compost, but concerns about the odour are holding this initiative back (Sehlabi & McKay, 2016). A well-blended mixture of raw materials, carbon to nitrogen (C:N) ratio of 20:1 is employed in the composting process. The plant produces other products such as potting soil, unscreened compost and top dressing.

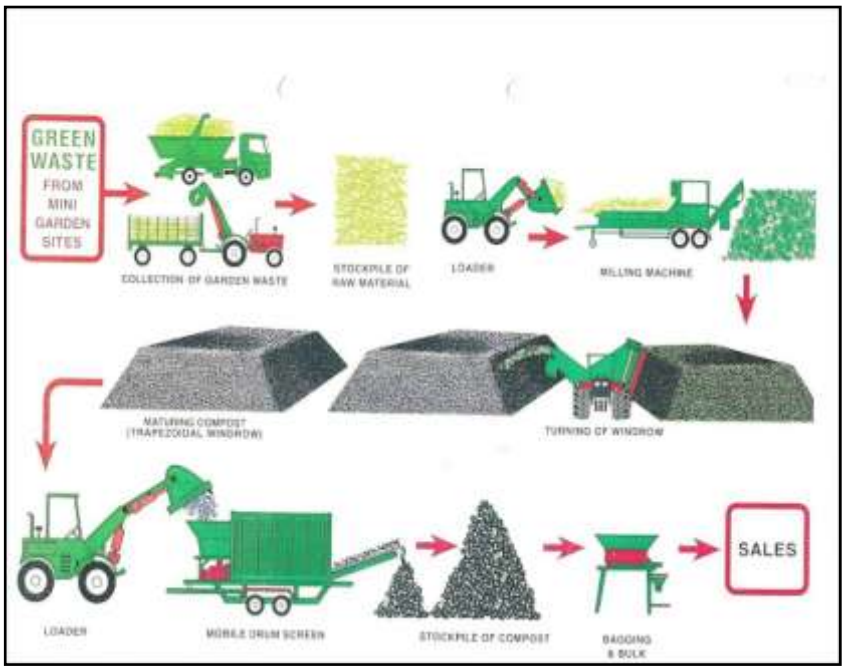

FIGURE 10: COMPOSTING PROCESS

Photo courtesy of Composting Services (Pty) Ltd

Pikitup is unable to achieve its target of recycling 40 000 tons of garden waste through composting per annum due to poor location of the plant and regular periods of equipment failure (Seehlabi & Mckay, 2016). However, the city already has the infrastructure for composting garden waste and this need to be expanded rapidly. This is because there is a ready market for compost materials in Johannesburg from the horticulture sectors,

landscapers, garden services, golf courses and home gardening due to poor soil quality. Additional 3 plants strategically located within the city may be required to process all the garden waste produced as the composting plant is too small to process all the garden waste generated in the City.

In order to deal with food waste a local company has developed a food waste composting machine, known as Earth Cycler. The machine can process up to 5000kg of waste per month, making it ideal for hotels, universities and office parks (Frankson, 2018).

The yearly average composition of Lagos State waste stream is shown in Table 3.

TABLE 3: COMPOSITION OF LAGOS WASTE STREAM

COMPONENTS OF WASTE STREAM	COMPOSITION (%)
Paper	6
Plastic	6
Glass	8
Metal	10
Textiles	6
Putrescibles	4
Fines/Residues	10
Vegetables (Organic Waste)	50

Source: LAWMA, 2013

From the waste composition data, vegetables, metal and fines/residue are the main components found in the waste stream. The Vegetable fraction (50%) and Putrescible fraction (4%) are potential raw materials for composting. Raw materials used for composting include domestic waste from which non-biodegradable material have been removed, pig manure, chicken dung, sawdust and fruits and vegetables.

The primary method of disposing of municipal solid waste in Lagos is via landfills and dumpsites. LAWMA recovers reusable, recyclable materials from landfill sites for manual sorting and separation at materials recycling facility (MRF). Separation of waste at household level does not take place formally although waste pickers collect recyclable materials from household waste bins and landfill sites, but the rate of recovery is low. Each day, the City of Lagos generates 10,000 metric tons of waste – 60% of it organic. LAWMA decided to look

for alternative use for this waste. EarthCare is one of the pioneers of the city's recycling programme and owns a compost plant at Odogiyan at Ikorodu.

The pre-sorted waste is delivered to the composting facility by trucks, received at the facility entrance and run across the weigh bridge to establish the weight of the waste delivered. It will be shredded and processed as shown in the Figure 11 (**Earthcare Nigeria Limited, 2009).** Rows are formed on compost pads made of cement concrete and a synthetic polymer laid for strength, durability and low permeability (**Earthcare Nigeria Limited, 2009**).

Two compost inoculants (RGP and RCL) are added to speed up the composting process, mixed by a plough and trimmed to form a row. The windrow is monitored for temperature, moisture, carbon dioxide and oxygen. The finished compost is tested for heavy metals, pathogens; and moved to the screening area. The screened compost is then bagged or sold bulk. The "overs" are then utilized for pipe bedding, drainage material in place of gravel or as land reclamation fill material.

Each day EarthCare recycles 600 tons of organic waste into compost but with a capacity of 1500 tons per day, the company needs to develop so as to meet the demand of the city (**Earthcare Nigeria Limited, 2009**).There is a potential increase in market demand due to rise in non-organic fertilizer prices. Also small scale farmers in suburbs of Lagos engage in composting farm wastes to further enrich their crop lands. These small scale farmers carry out composting on small scale level.

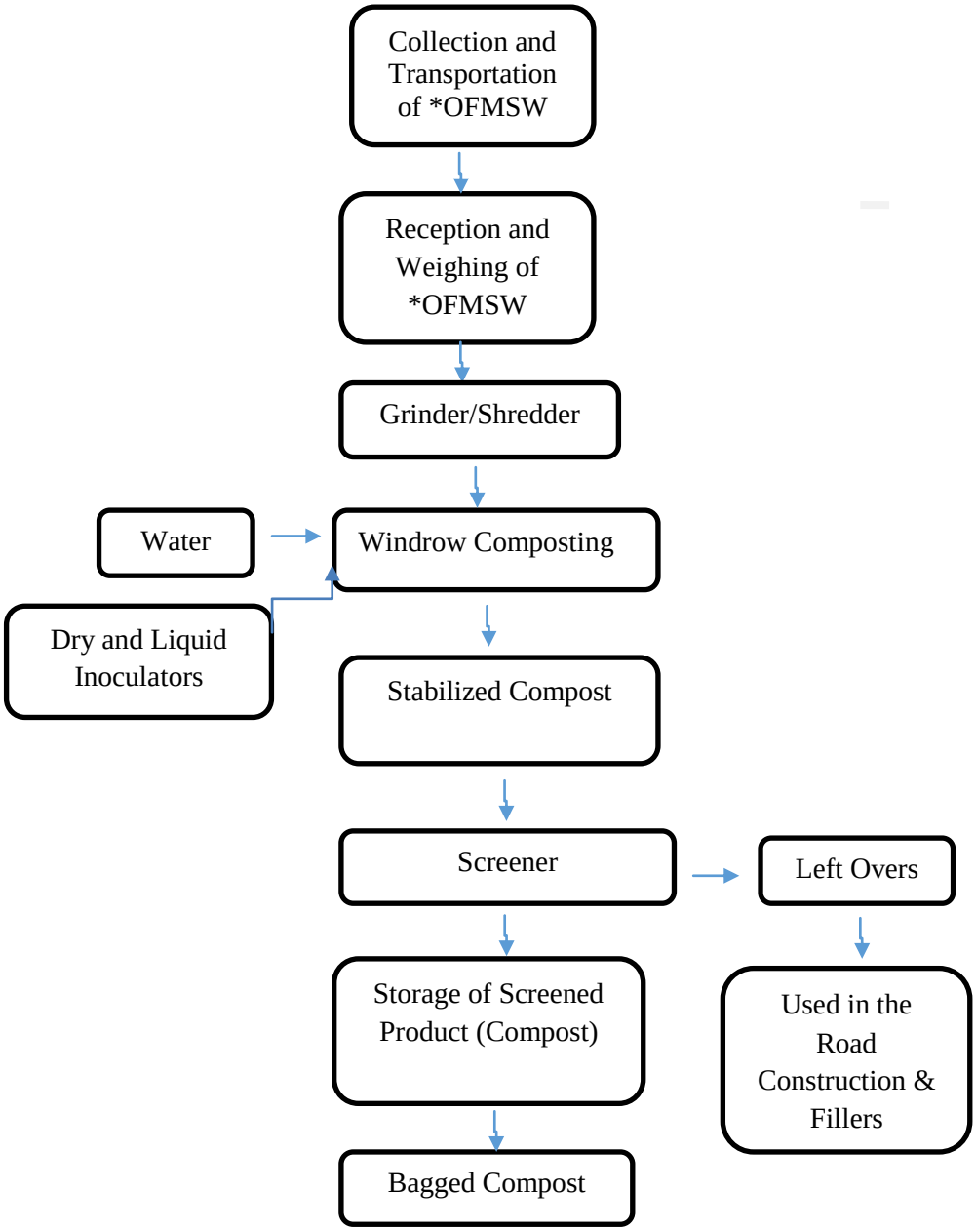

FIG.11. FLOW DIAGRAM OF COMPOST PROCESS BY ENL

Source: *Olukanni and Aremu (2017)*

*OFMSW – Organic Fraction of MSW

6 Conclusion and Recommendations: Composting can be a sustainable method of waste management if the problems associated with it are solved. Separation of waste at source offers the opportunity of a high quality clean feedstock for composting and the prospect of an uncontaminated product. Therefore a well-articulated legislation and policy framework

needs to be put in place in the City of Lagos like the COJ. Establishment of an institutional framework for implementation, enforcement and monitoring is vital.

Home composting is an important waste management option that reduces waste at source, and is more effective in reducing waste management costs. In addition, it would encourage homeowners to be more interested in the proper management of waste. This form of composting needs to be encouraged in both cities.

Environmental education and awareness campaigns are important in promoting house-hold level composting since there may be concerns regarding possible disease, odours and pest problems. People need to be educated about the type of waste to compost, how to properly construct a compost bin to eliminate rodents and benefits and importance of composting. In addition, people must have basic understanding of the microbiology of household composting.

The Panorama and Odogiyan composting plants contributed positively to sustainable development as they divert organic material from the waste streams of both cities to produce compost. This has however happened on a small scale mainly due to the adoption of a centralised, mechanised composting system by these cities. A systematic data collection process is needed in order to establish exactly how much waste is diverted. The ultimate goal should be the adoption of appropriate technology that ensures that the unit production cost of compost is not too expensive, so is affordable to compost users. In addition, more labour-intensive technologies should be considered so as to boost the number of job opportunities created.

The municipality in Johannesburg and Lagos needs to expand beyond the Panorama and Odogiyan compost plants but lack the funds to do so. Having some private investors buying into the plants may be a good idea. Also, there are smaller compost producers operating in these cities. Partnership with these small-scale entrepreneurs to create a new micro-scale composting industry is recommended. This could increase the number of people participating in the supply and marketing chain, and improve the rate at which organic waste is diverted into composting.

A cornerstone of the approach to composting must be the realization that the quality and marketing of compost are crucial composting issues. Compost must be properly branded. Long-term markets and distribution outlets should be sought, properly organised and promoted in order to increase compost sales. Ensuring sustained markets for compost is

important in order to ensure the social, economic and environmental sustainability of this waste disposal method.

Composting if successfully implemented will benefit the agricultural sector as compost would be a good substitute for inorganic fertilisers that are imported and this would result in preservation of foreign exchange, reduce agricultural production costs and increase local agricultural production. If compost is of high enough quality and properly packaged, it may be imported to neighbouring countries and serve as a source of foreign exchange earnings.

Composting is an important element in sustainable waste management. It is a sound long-term disposal strategy after landfill sites have closed down because compost operations will continue.

REFERENCES

Aurecon South Africa (Pty) Ltd (2015). Waste Characterisation Study for City of Johannesburg. August: 1 – 88.

Ball, J. & Associates (2001). A Waste Stream Analysis of the General Waste Stream: Current Waste Management in the City of Johannesburg. Danced Environmental Capacity Building Project, Report 1A. Johannesburg. December: 1 – 30.

Bernard, E. No Date. Volume Reduction & Composting: Processes and Equipment. Golder Associates Africa (Pty) Ltd.

British Columbia Ministry of Agriculture, Food and Fisheries (BCMAF). (1996). Order No. 382.500-5. Agdex: 537/727. September: 1 – 6.

City of Johannesburg. (2018). 2017/2018 Integrated Development Plan (IDP) Review. City of Johannesburg.

Cooperband, I. (2002). The Art and Science of Composting: A Resource for Farmers and Compost Producers. March: 1 – 14 [Online]. Retrieved from: https://www.cias.wisc.edu/wp-content/uploads/2008/07/artofcompost.pdf on 31/07/2019.

EarthCare Nigeria Limited, (2009). Environmental Impact Assessment of the Proposed Earthcare Compost Facility at Odogunyan Farm Settlement, Ikorodu, Lagos State. Revised Report, Earth Care, Nigeria Limited, October, 2009

Ecsip Consortium, (2013), SIP Conference, 27 May 2013, Brussels.

Ekelund, L & Nyström, K, (2007). Composting of Municipal Waste in South Africa: Sustainability Aspects. January: 1 – 61.

Farrell, M. & Jones, D.L. (2009). Critical Evaluation of Municipal Solid Waste Composting and Potential Compost Markets. Bioresource Technology, 100, 4301-4310.

Frankson, L. (2018). Keeping Organic Waste out of Landfills. Infrastructurenews. Retrieved from: https://infrastructurenews.co.za/2018/11/14/keeping-organic-waste-out-of-landfills/ on 14/09/2019.

Heydenrych & Drake (2012). The National Organic Waste Composting Strategy: Draft Status Quo Report. Jeffares & Green. November: 1 – 61.

Kiely, G. (1998). Environmental Engineering. UK: Irwin/McGraw – Hill.

LAWMA. (2013). Waste Management in Lagos State: The Journey so Far. Lagos State Waste Management Authority (LAWMA).

Liebenberg, C.J. & Van Aswegen, F.P. (2006). Striving Towards Zero Waste to Landfill in Johannesburg: Dream or Attainable Goal? Proceedings of the Biennial Conference of the Institute of Waste Management of Southern Africa held in Somerset West, Cape Town on September 5 – 8, 2006. Johannesburg: Shorten Publications (Pty)

Magongwa, T., Vorster, K. & Forbes, P. (2004). An Evaluation of the Dome Aeration Method for Local use. Proceedings of the Biennial Congress of the Institute of Waste Management of Southern Africa held at Sun City, South Africa on 11th-15th October, 2004. Johannesburg: Document Transformation Technologies cc.: 653 – 661.

Nabegu, A.B. (2011). Solid Waste and Its Implications for Climate Change in Nigeria. Journal of Human Ecology, 34, 67-73.

Nelson, V. (2006). The Right Turn: Choosing the Proper Tool from the Wide Range of Compost Turners. Waste Management World Review, Issue 2006 – 2007. July – August: 87 – 95.

Olukanni, D.O & Aremu, D.O. (2017). Provisional Evaluation of Composting a Priority Option for Sustainable Waste Management in South-West Nigeria. Pollution 3(3): 417 – 428.

OpenWASH (2016). Urban Sanitation and Solid Waste Management, The Open University UK/World Vision Ethiopia/UNICEF.

Pikitup. (2012). Pikitup Organic Waste Strategy, 2012/40 (Draft). June: 1 – 29.

Sehlabi, R & McKay, T.M. (2016). Municipalities, Commercial Composting and Sustainable Development, the Case of Johannesburg, South Africa. Environmental Economics, 7 (1), 53 – 59.

Statistics South Africa. (2011). City of Johannesburg Key Statistics. Retrieved from: http://www.statssagov.za on 22/09/2019.

Taiwo, O.E. (2009). Integrated Solid Waste Management as a Solution to Dwindling Landfill Capacity in Johannesburg. D.Tech thesis. Pretoria: Tshwane University of Technology. July: 1 – 419.

Wikipedia. (2019a). Municipal Solid Waste Retrieved from: https://en.wikipedia.org/wiki/Muncipal_solid_waste on 24/07/2019

Wikipedia. (2019b). Compost. Retrieved from: https://en.wikipedia.org/wiki/Compost on 04/08/2019.

Williams, P.T. (2005). Waste Treatment and Disposal. 2nd edi. England: John Wiley & Sons, Ltd.

Venter, C. (2007). Personal Communication with Regard to Composting. Formerly Manager of Special Projects, Pikitup (Johannesburg) (Pty) Ltd, 10 January.

Venter, C & Mulder, D. (2006). Composting as an Alternative to Disposal of Garden Waste. Capacity Building Session of IWMSA held in Midrand on 23 February, 2006.