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INTEGRATED WASTE MANAGEMENT SYSTEM

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Abstract: *In order to maintain the global trends of waste management, many developed countries are focused on sustainable integrated solid waste management approach based on the reduction, reuse and recycling of waste. Thus the study is carried out to provide a technical understanding of the principles and potentials of integrated solid waste management system. Integrated waste management practices involve the reduction of the waste at the source, followed by recovery and recycling of the resources. Integrated solid waste management system is a complete waste reduction, collection, composting, recycling and recovery system. It involves evaluating local conditions and needs, choosing, combining and applying the most suitable solid waste management facilities according to the existing condition.*

An important tool that can be applied for sustainable solid waste management is the waste management hierarchy. The waste hierarchy is now used globally as a communication tool to remind waste generators and waste managers that preventing waste through efficient use of resources and raw materials is the best option. Re-using discarded goods without reprocessing or remanufacturing is assumed to provide greater savings in resource consumption and is given priority over recycling. Integrated waste management system has the potential of encouraging the development of new innovation, job creation, the improving and sustaining the economy and waste management efficiency, reducing green house gas emission. The main components of the integrated waste management system are the stakeholders, the system elements and the influencing factors such as political, financial, technical and environmental. Applying the polluter pay principle as part of the integrated waste management will be beneficial for waste reduction.Thus integrated approach for solid waste management could create room for a greener environment and a circular economy in developing countries.

Keywords: Integrated, sustainable, management, source reduction, recycling

1 INTRODUCTION

As the world continues to grow in population and economy, waste production is growing steadily, with stronger trends of ineffective management in developing countries. The expansion of industries and increasing population has drastically increased the amount of solid waste generated in most countries. However, issues relating to environmentally sound solid waste management have not been addressed sufficiently (Abdelsalam and Gebril 2013, Premakumara et al 2011). There is therefore need for urgent research and development in the area of effective waste management system(Nassour et al 2016)

The health and environmental implications associated with garbage disposal are mounting in urgency particularly in developing countries. However, the growth of the solid-waste market, increasing resource scarcity and the availability of new technologies are offering opportunities for turning waste into a resource (EPA 2015, EPA 2014, UNEP 2013). The types of municipal solid waste produced change according to the standard of living in the city. Low and middle income cities generate larger proportion of organic waste, while the wastes in high-income cities are more diversified with relatively larger shares of plastics and paper (Chalmin and Gaillochet 2009). Thus this change in composition of waste will in turn influences the choice of technology and waste management infrastructure, and hence underscore the importance of waste separation (Simelane and Mohee, 2012). No single techniques or technologies can on their own treat every type of solid waste effectively, they need to be used in combination. An efficient integrated waste management system considers how to reduce, reuse, recycle, and manage waste to protect human health and the natural environment.

Integrated waste management system is a complete waste reduction, collection, composting, recycling, and disposal system. It involves evaluating local conditions and needs, a choosing, combining and applying the most suitable solid waste management activities according to the existing condition (Hornsby et al 2017, LeBlanc 2017).

The main objective is to reduce the amount of waste generation at source. However, these efforts are still very limited because of the inability to regulate organic materials that usually comprise over 50% of the total waste generation in the cities (Premakumara et al 2011).

2 LITERATURE REVIEW

Several research and field work on waste management have been carried out in various region of the world, however no single waste management technology or approach seems to have completely solve waste management problem especially in the developing countries of the world. Some of these researchers have attributed the lack of effective waste management to several factors. Gebril 2011 in his study on the factors affecting solid waste management explained that the problem of environmental pollution in many cities and towns are caused by the lack of

environmental planning and sound environmental management (Abdelsalam and Gebril 2013).

Wilson et al., 2012, explained that in developing countries, data on waste generation and composition are largely unreliable and insufficient. Thus without proper data it might be difficult to design sound waste management technologies or make meaningful budget for waste management.

Adewale M.T 2011 stated that attaining sustainability in waste management requires an option that employs environmental friendliness. Such a technique must be effective, efficient and less costly than many options. He further explained that disposal methods such as incinerator, landfill, pyrolysis and gasification are efficient but have negative impacts on the environment as well as threat to public health. Composting if properly handled is sustainable with various advantages such as production of bio-fertilizer, relatively low air and water pollution, low operational cost and income generation.

Saeid et al 2014 from their design of an integrated solid waste management system in Iran stated that integrated solid waste system is useful tool for strategic planning and management of solid wastes in an industrial zone since it creates relations between producers, consumers, scavengers and decomposers such as a natural ecosystem. They explained that this pattern is economically valuable because it re-introduce solid waste back into the production cycle, leading to the conservation of natural resources and reduction of solid wastes disposal rate and cost of production.

Lane.T,2016, stated that various energy conversion technologies (Thermochemical extraction, biochemical extraction, and mechanical extraction) can produce useful products such as electricity, heat, and transportation fuel, thus significantly reducing both pollution and greenhouse gas emissions.

Similarly,EPA, 2013 in separate research work explained that material recovery operations used to obtain reusable materials from waste (reuse or recycling) is a very suitable and effective method for dealing with increasing waste management problems in most developed countries and is at the top of the famous hierarchy of waste treatment methods. Although prevention has been considered as the best option, however it is not easily achievable.

Parkes et al 2015 carried out a study to evaluate the direct and indirect emissions resulting from various treatment options of municipal solid waste , he concluded that advanced thermal treatment and incineration with energy recovery have the lowest Global Warming Potential than landfill treatment process due to higher direct emissions.

Gertsakis and Lewis 2004 suggest that true sustainability will require significant increases in the efficiency of resource use, recovering more valuable products from the municipal waste stream. He further stated that the practice of the waste reduction, reuse and recycling is the basic requirement for sustainability in municipal waste management.

According to Smith and Scott 2005, the waste management hierarchy form part of the basis for achieving sustainable waste management, as it maximize the reduction and recovery options to minimize disposal through open dumping, thus reducing the negative impact on the environment and natural resources.

Guerrero et al., 2013 explained that sustainable waste management not only presents the opportunity for resource recovery but also provide the platform for realizing environmental, economic, social and sustainable future. Thus decision makers responsible for planning and policy making need to be well informed on the importance of effective waste management system in order to develop adaptable integrated waste-management strategies that can meet the needs of residence.

3 METHODOLOGY

The study was conducted from desktop review various field work and research on the modern approaches for waste management in developed countries. Field visit and personal consultation of waste management companies, professional, waste management authorities were initiated to get background information on the sustainable waste management practices.Technical analysis of waste management journals. Publications and articles were carried out. The process of data collection was carried out after establishing the research problem and the study design. Inferences and conclusions for the study were drawn from the secondary data collected. Qualitative approach was adopted for this study so as to provide a view point of the present situation.

4 RESULTS AND DISCUSSION

4.1 Waste management

Integrated waste management practices involve the reduction of the waste at the source, followed by recovery and recycling of the resources. A shift from conventional waste management practices to Integrated Solid Waste Management is essential for many developing countries in order to effectively manage the waste stream. An effective integrated system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment (Nassour et al 2016). By reducing production of wastes, maximizing the use of reusable and recyclable materials, a city can achieve greater resource efficiency. Thus, smaller amounts of physical resources could produce the same amount of products or services while generating less waste (Lane.T, 2016). These could be achieved through effective planning, policies and researching for waste management options (Abdelsalam and Gebril 2013). It is important systematically integrate the processes of transporting waste with other waste management activities to ensure smooth and efficient waste management.

Basically integrated waste management system is built upon the 3 Rs –reduce, reuse and recycle and

on the waste hierarchy(Hornsby et al 2017, LeBlanc 2017, Lane.T, 2016, Parkes et al 2015, Premakumara et al 2011, EPA 2013).

4.1.1 Waste reduction at source

This is the prevention or reduction of waste production; it involves reducing unnecessary waste generation. Some of the ways in which waste can be reduce at source include; avoiding buying over-packaged products or ,redesign of goods with less or no packaging , using less raw materials to make a given product, purchasing more of reusable products, refurbishing of goods to prolong product life or make them to easily reused or recycled, reduction of food spoilage and waste through better attention to food processing and storage.

4.1.2 Waste reuse/ recycling

Waste reuse involves the repeated use of a material or product more than once from its original purpose. This can be achieved simply by using the package of a particular product in storing other valuable product after delivery rather than disposing it as waste, using drink and beverage bottles for storing drinking water and other valuable product.

Recycling is the reprocessing of sorted waste materials so that they can be used as raw materials in manufacturing processes or chain. So it necessary to emphasis that sorting of waste is paramount to effective recycling. One important process of recycling is the melting of used glass bottles and forming them into new bottles. A major way of reusing and recycling waste which form part of the integrated waste management system is the waste to energy technology.

4.1.3 Waste to energy technology

Waste to Energy technology are implemented for value conversion from municipal solid waste subsequent to waste diversion and recycling. Since most of the waste generated in municipalities contain high organic context, the waste to energy technique make use of the large quantities of carbon based materials and use them to provide energy for manufacturing and other processes.

Some of the promising waste to energy treatment options available for integrated waste management system include Anaerobic digester, Composting incineration, gasification and pyrolysis(Michael 2014).

4.1.4 Land filling

Although land filling of waste is been practiced in many countries, it should be considered a last resort in integrated waste management system, because too many valuable, reusable materials end up in the landfill. This has resulted to economic loses and environmental pollution.

The waste management hierarchy use for waste management have illustrated the fact that waste disposal option like land fill should be discourage in any waste management system.

4.1.5 The waste management hierarchy

The waste management hierarchy form part of the basis for achieving sustainable waste management, as it maximize the reduction and recovery options to minimize disposal through open dumping, thus reducing the negative impact on the environment and natural resources. The waste management hierarchy is now used globally as a communication tool to remind waste generators and waste managers that preventing waste through efficient use of resources and raw materials is the best option. Re-using discarded goods without reprocessing or remanufacturing is assumed to provide greater savings in resource consumption and is given priority over recycling.

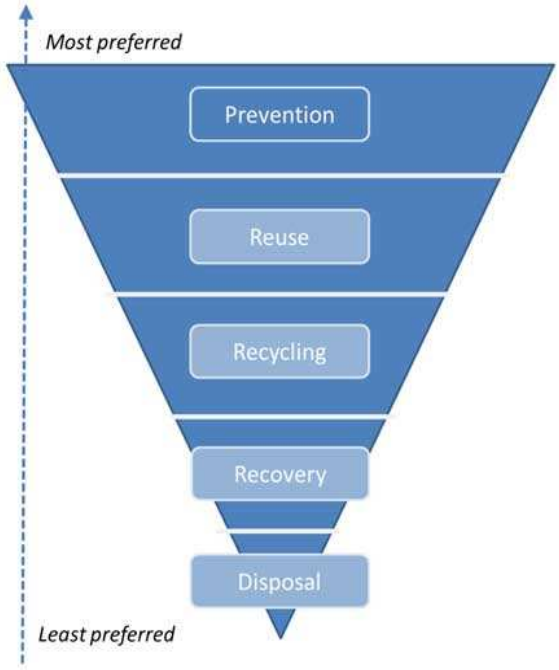

Fig. 1 Waste management hierarchy (Lane.T,2016 adapted from EPA, 2013).

The resource value of waste cannot be realized unless separation of wastes is practiced effectively at the source. Goods without reprocessing or remanufacturing are assumed to provide greater savings in resource consumption and is given priority over recycling.

Thus integrated approach for solid waste management provide the opportunity of separating waste at source thus creating room for a circular economy in developing country like Libya (Lane.T,2016, Saeid et al 2014 Chalmin and Gaillochet 2009).

4.2 Components of integrated waste management system

The Integrated sustainable solid waste management system takes into account three critical components; The stakeholders, the Waste system elements and the influencing factors (Figure 2. above).

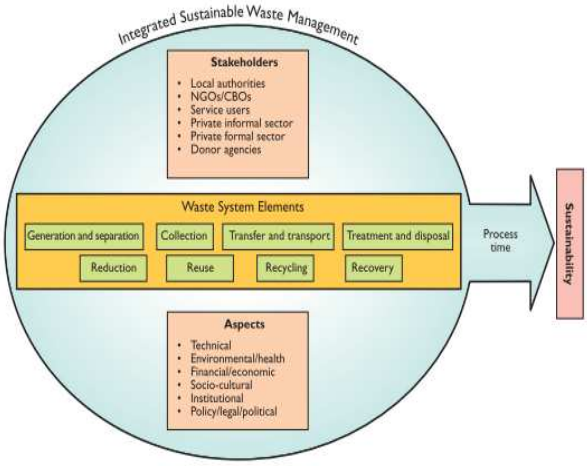

Fig. 2 The Integrated Sustainable Waste Management System. Source: UN Habitat 2010).

4.2.1 The stakeholders

The stakeholders include the local authority, the nongovernmental organization, the service user, private sectors and donor agencies. Although the responsibility to effectively manage waste primarily lie with cities and municipalities, however, many of the successful cases in waste management involve a wide range of stakeholders in their implementation (Abdelsalam and Gebril 2013). Municipalities cannot effectively collect and remove waste without active cooperation from the service users, institution, governance and policy frameworks.

Thus a sustainable municipal waste management cannot be separated from good governance (Gilbert et al. UN-Habitat, 2010). So it is necessary to identify stakeholders and their areas of interest and degrees of involvement in waste management.

4.2.2 The waste management system elements

These are the stages in the waste management system, it is an interrelated aspect that takes into account the possible result/ outcome of such sustainable approach. It deals with the technical, environmental health, Finance, policy and institutional framework. (Nassour et al 2016, Pfaff-Simoneit and Nassour 2014). Every stage in the in the system should be guided by strategies to minimize the waste that reaches the disposal site, to protect the environment and where possible to generate income from waste.

4.2.3 Essential factors for integrated waste management

Hornsby et al 2017, Saeid et al 2014, Premakumara, 2011 and UN-HABITAT 2010, explain that several factors need to be considered when planning a successful integrated solid waste management programe:

- Political and legal factors, to be considered include existing ,propose or planned administrative, legal and regulatory framework and the decision-making processes as it relate to the waste management system.
- Socio-cultural factors, this factor takes into consideration the influence of culture on waste generation.
- Technical factors of importance include the selection of technologies that are available for the effective treatment of the volume and composition of the waste produced. The applicability of the technology needs to be taken into account cost, environment and operational aspect.
- Financial factors, this is a very critical aspect that influence the planning process of the waste management programme. It deals with budgeting and costs of the waste management system, it considers the effect of private sector and government involvement and the market prices of recovered materials.
- Environmental factors, This factor influence the effects of waste management on land, water and air, the need for pollution control, and public health concerns.

4.3 The polluter pay principle

The polluter pay principle ensures that every pollution cause by an individual, cooperate bodies or organization fine or sanction in proportion to the level of pollution.

The polluter pays principle should be annex in such a way that its primary objective is to promote the concept of Cleaner Production and the use of Green Technology. The polluter pay principle when effectively enforced will give municipalities the responsibilities to care for their immediate environment. All form of biasness must be avoided; in other word it should be fair to all polluter towards all different polluters.

For the principle to be sustainable all money realize from polluters should be invested in the environment or region that suffer from the specific polluter (NAIT 2015).

4.4 Potentials of integrated solid waste management system

Integrated solid waste management system have various advantages over conventional waste management, some of such advantages includes:

- It improves waste management efficiency through the combination waste management options, effective separation and sorting at source, effective pollution control systems such as leachate treatment and gas capture

systems, leading to economic gains, overall cost reduction, minimal environmental impacts and social acceptance.

- Strategically planned waste minimization and green procurement programmes leading to more sustainable consumption patterns along with economic development.
- Integrated waste management system facilitates recycling of valuable resources such as plastic, glass, paper and metals, recovery of alternate energy sources. recovery of biogas or compost from biodegradable waste.
- Ensures multi-stakeholder participation in decision-making process by involving Non-Governmental Organization, Community Based Organization, private sector with the government.
- Provide the platform for effectively managing of both the municipal solid waste and other newer waste streams such as e-waste, construction waste and scrapped vehicles. Thus encouraging the development of innovative technology in new area of waste management (Hornsby et al 2017, Saeid et al 2014).

5 CONCLUSION

Integrated approach for solid waste management provide the opportunity of separating waste at source thus creating room for a circular economy in developing, however its success will depends on the cooperation among the stakeholders, the waste generators, private sector, national and local governments, and international partners.

Thus by introducing waste reduction, reused and separation at source, effective waste collection and transportation, waste to energy facilities and the polluter pay principle, a sustainable economy and healthy environment is guaranteed.

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