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Towards a Framework for Sustainable Municipal Solid Waste Management: The Case of Swakopmund Municipality, Namibia

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ABSTRACT

If municipal solid waste (MSW) is not properly managed, harmful environmental consequences are imminent. MSW materials are rarely wasted in many affluent countries, but rather are kept in the economic cycle through circular economy models. While in many developing countries, MSW materials are discarded with little to no effort of repairing or recycling. Moving to a circular economy will drastically reduce the amount of waste currently disposed of. This study examines how the Swakopmund Municipality in Namibia's present municipal solid waste management techniques could be adjusted toward sustainability to reap environmental and socioeconomic benefits from the trash. Source reduction, separation at source, and recycling are some of the most effective strategies in the circular economy models that will help achieve the United Nations (UN) Sustainable Development Goals (SDGs). Swakopmund Municipality should invest in infrastructure, techniques, and programs that are within the circular economy model as an emerging system for sustainability.

INTRODUCTION

Generally, the issue of global waste requires sound waste management and governance to curb an increase in waste generation. Effective MSW management systems, according to Krista et al. (2015), are built on a good understanding of waste disposal drivers, the amount of trash produced, the economic expenses involved, and the environmental implications connected with waste treatment technologies. As a result, waste is treated in different methods around the world. Gertsakis & Lewis (2003) emphasized that waste prevention and reduction should be the preferred options, to avoid harmful environmental impacts across the entire product life cycle, including disposal.

Gower & Schröder (2016) discovered a link between waste management and circular economy (CE) practices, which include lifting people out of poverty and protecting the environment, as well as significantly expanding the scope for achieving the United Nations (UN) Sustainable Development Goals (SDGs) (United Nations 2018). The strongest links between CE practices and the aims of SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 15 (Responsible Consumption and Production) are notable (Life on Land) (Schröder et al. 2018).

It is essential to realize that poor implementation of MSW strategies also hinders municipalities' progress towards job creation, improvement of livelihood, and achievement of the SDGs (UNDP 2016). As a result, the need for more comprehensive strategies and their implementation for waste management within development processes needs to be considered key. A review on global solid waste management by Hoornweg & Bhada-Tata (2012) revealed that cities and towns that are unable to handle waste effectively are less likely to succeed in the provision of critical services such as health, education, and transportation. In low-income countries, the challenges of MSW management and governance in cities and towns have been contributing factors to environmental problems such as water and ground pollution (Lee & Jones 1991). Consequently, some low-income countries particularly in Africa are left in a dilemma on how to handle the increasing waste volumes, given their weak economies (low technical capacities and poor physical infrastructures), inabilities to enforce environmental legislation, financial mismanagement, and poor administrative capacities (Muniafu & Otiato 2010). Given these challenges, Hoornweg & Bhada-Tata (2012), estimated that waste generation in Africa is expected to increase to 244 million tonnes per year by 2025.

Although high-income countries generate more trash, solid waste management is a top priority in such countries, while it is a low priority in emerging or low- and middle-in-

come countries (Coad 2003). Financial constraints, a lack of awareness, insufficient incentives, and low waste value addition make waste management a low priority in low- and middle-income countries (Coad 2003). Additionally, inadequate support from the government, lack of waste management data, and lack of waste management research, also contribute to ineffective planning for waste management (Nwofe 2015). Interestingly, Ogawa (1996) revealed that several municipal solid waste management projects have been carried out in developing countries, however, many of them failed to support themselves or to expand further in the absence of support from external agencies, local authorities, or governments.

Namibia as a developing middle-income country is not an exception to the municipal solid waste management challenges like urbanization, economic activities and population growth significantly increase the volume of municipal solid waste (Nwofe 2015). Therefore, Namibia is also facing serious environmental problems associated with municipal solid wastes such as ground pollution (Croset 2014). The issue of illegal dumping is alarming in Namibia, which necessitates the importance of developing waste management policies and plans across the entire country. For example, several municipalities such as Swakopmund Municipality implemented the waste management policy of 2015 to curb waste management issues including illegal dumping. However, when compared to smaller towns and villages, waste management laws and strategies are mostly implemented well in major cities (Ngoc & Schnitzer 2009). Some of Namibia's smallest cities and communities, for example, lack waste management policies and plans.

In fast urbanizing towns like Swakopmund (estimated population of 44, 908 in 2014), waste generation keeps increasing and is frequently disposed of at disposal sites (Kadhila 2018). However, some residents, especially the poor communities regard waste as a resource that is sent to the disposal site, therefore they informally collect waste materials for reuse and recycling, using informal methods to transform waste into useful products. The current MSW issue gives an opportunity for academic discussion with many stakeholders about potential implications and solutions to develop a sustainable waste management strategy in Swakopmund that will contribute to socioeconomic advantages. Although similar research has been carried out elsewhere, there are currently no studies on MSW in Namibia in general and Swakopmund in particular. It implies that there is a knowledge gap on this topic in the context of Swakopmund Municipality. Therefore, this study aimed to contribute to the body of knowledge on how sustainable MSW management and governance can effectively be implemented in Swakopmund, with general recommendations of other towns with similar situations elsewhere.

Conceptual Framework

The study adopts the circular economy (CE) model developed by Ezeudu & Ezeudu (2019) as a suitable concept underpinning sustainable waste management systems, which can be adopted to ensure sustainable waste management in Swakopmund. The CE is a system of production and consumption based on reusable and sustainable design (Ezeudu & Ezeudu 2019). It aims to eliminate waste from the present and dominating linear manufacturing system, often known as "take-make-use-dispose of," in which raw materials are harvested and then disposed of promptly (Ezeudu & Ezeudu 2019). According to studies, most municipalities today build their waste management systems using LE models (Gower & Schröder 2016). The LE models of waste handling modalities view waste products as a nuisance that often entails the disposing of scarce resources as a management approach. In LE models, production companies extract materials, apply energy to manufacture a product, and sell the product to an end consumer, who then discards it when it no longer serves the user's purpose (Ellen MacArthur Foundation 2013). Sadly, the linear economy (LE) models caused unnecessary resource losses in the production chain, energy use, and damage to ecosystem services (Drljača 2015). For example, during manufacturing, companies produce large volumes of materials such as parting materials that are not physically incorporated into the formal economic system but are disposed of at disposal sites. Yet, the LE models of waste management have often been criticized by economic and environmental pundits and commentators, as being counterproductive in promoting job creation to improve livelihoods, but rather causing environmental degeneration.

Globally, there has been a renewed effort toward a shift away from LE to CE models of waste management, whereby the CE concept has become part of the political, economic, social, and environmental discourse around the world, and hence a policy priority in many countries (Esposito et al. 2018). The need for a paradigm shift toward CE models is attributed to the fast exploitation of natural resources in the face of resource decline, while at the same time the volumes of waste and pollutants due to human activities are increasing (Velenturf et al. 2019). A CE model varies from an LE model in which the materials used to produce the products are lost as waste (Gower & Schröder 2016). For example, in a LE model, chairs are made from timber, used, and when they break, they are thrown away as waste. It implies that at this point, all the resources (i.e. energy, timber, and metal) used to make those chairs are lost. Generally, the CE model of waste management would address these challenges by eliminating waste and inefficiency at each stage of the product's life cycle, from reducing the amount of time the product sits idle,

to increasing the scope for reparability or re-manufacturing of the used components (Lieder & Rashid 2015). This would help to shut the loop by providing regenerative, restorative, and reusable products and services. Waste does not exist in the product design scenario if materials are made to be non-toxic so that they can be composted, or if they are designed to be reused with minimal energy (Lieder & Rashid 2015).

Deselnicu et al. (2018) pointed out that the ability of the CE to respond positively to socio-economic and environmental welfare depends on how waste is managed, and waste management options that deliver the best overall environmental and socio-economic outcomes. Waste management policies at national and municipal levels must, therefore, provide conducive environments for CE models (UNEP 2018). However, in some parts of the world, waste management is still based on LE models, which view waste products as a nuisance that threatens the environment and public health (Ezeudu & Ezeudu 2019). As a result, the methods of waste management are still based on traditional landfills and dumpsites. In this context, the present study sought to explore how Swakopmund Municipality could shift to the CE model of waste management in effort to take advantage of opportunities presented by this model in view of sustainable development, an action that can also be applied in other towns.

MATERIALS AND METHODS

This study employed a mixed-methods approach whereby qualitative and qualitative data were collected using a case study research design. Data collection tools were mainly: document analysis, Semi-Structured Interview Schedule (SSIS), and a field observation checklist. The CE concept for sustainability assisted the researcher in yielding the data and results, which served as a lens through which the study is viewed. The purposive sampling technique was used to select two (2) participants directly working with waste management in Swakopmund municipality, and a direct oral interview method was adopted to collect information through the SSIS. The SSISs were done in August and September 2018 with two MSW management and governance specialists from the Swakopmund Municipality's Health Department. Additionally, between August and September 2018, direct field observations at the municipal waste disposal plant were employed to acquire quantitative data, with the researcher visiting the site twice a week. A simple percentage was used to summarize and organize data gathered from field observations based on the volume of waste observed at the disposal site to estimate the composition of waste fractions in the disposal site.

RESULTS AND DISCUSSION

The study presents an analysis of the current implementation of MSW management and governance, with a particular focus on Swakopmund, based on the qualitative and quantitative data collected, direct observations, and the CE concept for waste management. The findings are as follows:

Sources of MSW in Swakopmund

The study established that generally, MSW in Swakopmund is generated from different sources. Based on direct observations, different sources of waste generated in Swakopmund are summarized in Table 1.

As seen in Table 1, it is evident that various types of solid waste are found in the municipal disposal facility, except the types of waste from agricultural sources. Agricultural activities are less common within Swakopmund municipal jurisdiction due to the lack of seasonal rainfall in the area. Among the waste types found in the disposal facility, most of them are recyclables.

Table 1: Sources of MSW.

Source	Typical waste generators	Types of solid wastes
Residential	Single and multifamily dwellings	Food waste, paper, cardboard, plastics, textiles, leather, wood, glass, metals, ashes
Industrial	Light and heavy manufacturing, fabrication, construction	Packaging, food waste, building rubbles, ashes, special waste
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food waste, glass, metals
Institutional	Schools, hospitals, prisons, government centers	Same as commercial
Construction and demolition	Construction and demolition sites, road repair, renovation sites	Wood, steel, concrete, dirt, metals
Municipal services	Street cleaning, landscaping, recreational areas	Street sweepings, landscape, and tree trimmings, general wastes
Processing	Heavy and light manufacturing, refineries	Scrap materials, off-specification products, slag, tailings

Source: Fieldwork (2018).

Characterization of MSW in Swakopmund

The Swakopmund municipal dumpsite receives large amounts of mixed MSW regularly. Swakopmund Municipality collects estimated waste generating volumes, which is critical information for planning, developing, and operating the disposal site. The lack of a weighbridge system to take accurate readings of the trash volumes entering the dumpsite was highlighted as a data accuracy problem in this study.

Table 2 summarizes the solid waste composition observed at the Swakopmund municipality dumpsite raised out of 100%. In table 2, the term abundant means waste occurs in large quantities, common means waste occurs in medium quantities, while not common means waste occurs in low quantity.

It is essential to have background information about the composition of MSW generated in any municipality to be able to manage waste appropriately (Supriyadi et al. 2000). The composition of MSW in Swakopmund contains a high fraction of compostable organic waste, recyclables such as plastics and papers, and a very low fraction of hazardous waste such as pesticides, paints, used health care waste, and batteries. Papers, glasses, and cans, among other household trash, are abundant and common in the waste portion. In general, the large and commonly occurring waste fractions at the Swakopmund waste disposal site are environmentally hazardous, but they also present a potential to contribute to the economy if CE activities to handle these waste types are intensified. In China, for example, the formal recycling sector has grown steadily under regulation and financing from municipalities, which has enabled the establishment of waste recycling processes that are safer and more environmentally and economically sound (Song & Li 2014).

The informal sector plays an important role in MSW management, even though not integrated into the formal SWM systems. In Swakopmund, the informal sector is characterized by small-scale, labor-intensive, largely unregulated, and unregistered low-technology manufacturing, provision of materials and services. Many of the informal waste pickers in Swakopmund depend on waste to earn income, despite health and social issues associated with informal waste picking. These people derive potential value from waste bins, streets, and dumpsites. Waste collection is frequently a family's only source of income, providing a living for a large number of urban poor people. Around 60 informal recyclers and pickers were seen collecting tonnes of rubbish at the dumpsite in Swakopmund.

Methods of MSW Management Employed by Swakopmund Municipality

One of the objectives of the study was to explore the waste management methods being implemented by Swakopmund municipality. According to the Swakopmund Municipality's Waste Management Policy of 2015, the municipality is responsible for developing infrastructure for waste collection, storage, separation, transportation, processing, and disposal. The study established that the following methods are employed, mainly: prevention, separation, collection and transportation, treatment, and disposal. These methods are discussed in detail as follows:

Table 2: Estimated composition and fractions of MSW.

Fractions	Waste components	Occurrence status	Volume estimate [%]
Organic	Compostable organic (i.e. food waste, wood, garden refuse)	Abundant	15
Plastics	Hard plastics, carry bag plastics, clear & color plastic bottles	Abundant	14
Paper	Newspapers, white papers, magazines,	Abundant	13
Building Rubble	Bricks, tiles, concrete, ceiling boards, timber	Common	10
Boxes	Packaging boxes, cement bags, potato bags	Abundant	9
Glass	Recyclable glass	Common	9
Cans	Metal cans, steel cans, aluminum cans	Common	7
Refuse-Driven Fuel	Rubber, tailings	Common	6
Non-ferrous	Aluminum	Common	5
Tetra	Tetra packs (Milk & fruit juice boxes	Common	5
Rubbers	Tyres, worn out footwear	Common	4
E-waste	Computer, TVs and radio parts	Not common	1
Ferrous	Steel packaging	Not common	1
Earth-based	Ceramics	Not common	1

Source: Fieldwork (2018).

Prevention

The study established that the Swakopmund Municipality has assigned a high priority to waste prevention, as emphasized by the National Waste Management Strategy of 1999 and the Municipality's Waste Policy of 2015. In so doing, the municipality ensures that uncontrolled dumping of MSW is prevented by providing formal and informal settlements, businesses, institutions, and recreational areas with the 240L waste containers called "wheelie bins", street garbage bins, and black plastic bags for depositing the MSW. This service's delivery system prevents MSW from dispersing into the environment. This technique, however, does not prevent trash generation per capita, waste generation at the source, or waste accumulation at the dump. However, as a counter-act, the municipality reduces the flow of MSW by providing wheelie bins, black plastic bags, and skip containers across settlements, entertainment and business areas.

The wheelie bins are used to serve different purposes such as the orange wheelie bin to deposit recyclables, and the black and brown bins are for general waste. Furthermore, the municipality provides street sweeping services to ensure that streets are free of litter, and also provides cleaning services for public open spaces, in partnership with members of the community. Most importantly, Swakopmund Municipality monitors and regulates MSW management services, to ensure that these services conform with the country's legal standards and waste compliance processes. To ensure revenue generation from solid waste management services, the municipality has set rates and tariffs that residents pay for the services provided. The standard refuse removal and cleaning services cost residents about N$ 16/month/household, however, this amount differs from suburb to suburb.

Separation

The study established that there is a lack of effective waste separation at the household level. Currently, large volumes of MSW generated in households are transported by trucks to the dumpsite for disposal. However, some formal recycling companies in Swakopmund implemented waste management strategies such as the Clear Bag System (for collecting recyclable waste from households), orange wheelie bins (for collecting recyclable waste generated in households and public places), the File13 Recycling Box (for separating office papers), however, these services are only available in certain places. For this reason, large volumes of MSW recyclables are still transported to the dumpsite unsorted. Of these, a low fraction of recyclable materials such as papers, boxes, plastics, glass, cans, tetra, and RDF are mostly recovered and recycled at the Material Recovery Facilities (MFRs) such as that of a local company Rent-A-Drum (2018), which is however less compared to the potential recyclable materials that are disposed of at the dumpsite on daily basis. Apart from the formal waste separation, informal waste pickers were observed at the disposal site separating and recovering recyclable and re-usable waste materials for selling and for personal use. If Swakopmund Municipality implements an efficient waste material separation system, the waste management system is likely to focus more on recycling, reducing the use of recyclables as a source of income for underprivileged communities. It is recommended that Swakopmund Municipality should reduce the costs of recycling services to encourage residents to intensify recycling activities.

Collection and Transportation

MSW collection and transportation involves the removal of MSW from collection points, frequencies, storage containers, crew, route, secondary storage, and transfer stations (Singh et al. 2014). In Swakopmund, MSW is normally collected from various points such as households, business premises, institutions, and road walkways weekly, as organized by the Health Department of Swakopmund Municipality and transferred to the disposal site (open controlled dumpsite). During an interview conducted on 9 October 2018, Mwanangombe (2018) pointed out that the solid waste transportation fleet consists of 10 compactor trucks, 3 Skip trucks, and a dumper truck that is used for MSW collection and transportation.

The following is a summary of the commonly observed MSW collection methods within Swakopmund Municipality's jurisdiction:

- House-to-House: Municipal waste collectors visit each house with a compactor truck to collect waste materials once a week.
- Skip containers (heavy-duty bins): These bins are shared with the rest of the community and are usually placed in densely populated areas, and at construction sites.
- Kerbside Pick-Up: Residents leave black garbage plastics outside their homes or alongside the roads.
- Self-delivery: Sometimes solid waste generators deliver waste directly to the disposal sites or transfer stations (normally at the skip container).
- Contracted or delegated services: Municipality and businesses hire accredited waste collection firms on a contract basis.
- Street cleaning: Municipal workers sweep the streets to remove solid waste and sand.
- Molok Deep Collection System: A semi-underground waste containment system that compacts waste.

Treatment and Disposal

The municipality dispose of MSW (Table 2) at an open controlled dumpsite, where the dumped solid waste materials are covered with sand and building rubble, as an effort to reduce its negative environmental impacts. Noteworthy, the MSW disposed of at the dumpsite does not include hazardous wastes. The hazardous wastes are transferred to the hazardous wastes management facility that belongs to the municipality of Walvis Bay (Engelbrecht 2018). This includes wastes such as batteries, herbicides, pesticides, and medical wastes.

Trajectory

If Swakopmund Municipality applies the CE models that phase out the disposal of recyclables, more job opportunities could be created and UN-SDGs mentioned earlier could be accomplished. For example, if the municipality formalizes informal waste activities, more recovery and recycling create substantial job opportunities in the waste sector. As stated by Ellen MacArthur Foundation (2013) CE models keep waste materials longer in the economic cycle for recycling activities to carry on. Various projects, ranging from composting organic waste to making fertilizers are some potential projects. There are several MSW treatment good practices elsewhere, from which Swakopmund Municipality can learn from. An example, Ethiopia's capital Addis Ababa launched Africa's first waste-to-energy facility in 2013 that produces 30% of household electricity needs while conforming to global standards on air emissions (Shaban 2018). Other examples, composting and aerobic digestion of organic waste materials produce excellent fertilizers for gardening and horticultural activities (Al-Khatib et al. 2010). On the other hand, anaerobic digestion can produce renewable energy-source methane and carbon dioxide from solid wastes (Nandan et al. 2017). Both contexts can be applied to waste management to satisfy energy needs in Swakopmund and Namibia at large. It is therefore essential that the government and municipal policies must promote zero-waste business models, based on activities such as waste collection and sorting, recycling, repair and remanufacturing, recovery, and re-use of resources in industrial processes, considering the current socio-economic status in Namibia. The government and the municipality should invest in technology to enable adding value to waste products. The current waste recovering activities particularly in the informal sector are detrimental hence need to be enhanced, to contribute to socio-economic development and capacity building. This study recommends that the informal waste sector should be formalized, to boost the status of socio-economic development in Swakopmund. Additionally, the municipality should consider moving away from an open controlled dumpsite to a landfill site to minimize public health risks along with negative environmental impacts.

CONCLUSION

Volumes of waste generated in Swakopmund can be prevented and when cannot be prevented, these waste materials can be reused, recycled, and composted. MSW generated within the Swakopmund jurisdiction is disposed of at an unsustainable open controlled dumpsite covered with sand and building rubbles. Noteworthy, the current MSW management operation in Swakopmund is in accordance with the national legal frameworks related to waste management, however, still based on the LE model of waste management. The operation is strengthened by the implementation of the municipality's Waste Management Policy of 2015 that was drafted with the guidance of the national waste management legal framework. However, Swakopmund Municipality needs an integrated waste management plan.

Although recycling activities are currently taking place, particularly in the private sector, more efforts should be placed on these activities across both sectors, to reduce the amount of waste entering the dumpsite, while reducing negative environmental impacts. Plastics, glasses, and cans are problematic to the environment; therefore, these waste types should be reduced through circularity. If Swakopmund Municipality implements an efficient waste material separation system, the waste management system is likely to focus more on recycling, reducing the use of recyclables as a source of income for underprivileged communities. Robust waste treatment techniques such as composting, aerobic digestion, and incineration should be promoted to extract maximum benefits from waste materials.

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