A Comparison of Waste Management Systems in the Towns of Walvis Bay and Limbe: Experience from Vienna, Austria

Tangeni Haimbala*, Helmine Egokom Agulaba Ambi,**

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Abstract- This paper aims to give an analysis of solid waste management (SWM) performance of two coastal cities in Africa, Limbe (Cameroon) and Walvis Bay (Namibia). The authors present detailed challenges as well as management analysis, including waste collection, waste disposal, waste generation, and waste composition. A comparative study is taken from the waste management of Austria particularly the city of Vienna. In both cases, effective governance and policy framework are key. Namibia practices a form of public-private partnership (PPP) through tendering to handle the waste. Cameroon just like Namibia also practices PPP with the company HYSACAM, leading Cameroon private municipal solid waste management operators. These two developing countries are still facing challenges in managing their solid waste. Some of the challenges include the lack of enacted law, institutional capacity, unavailability of reliable data, and financial capacities. The authors observed from a careful review of literature that, unlike Vienna where a well-established legal system, central data collecting system, and decentralization in SWM is in place, Limbe and Walvis Bay are falling short in these aspects. Therefore, municipal authorities of these towns should adopt a modern waste management system that takes into consideration proper data collection and accumulation, capacity building, and community participation. Additionally, the authors advocated for the increment of taxes on organic waste for fertilizers. This will go a long way to encouraging and boosting the composting sector. Furthermore, de-monopolizing SWM is seen as key to promoting the establishment of regional recycling companies and improving cooperation between local stakeholders.

Index Terms- stakeholders, sustainability, waste composition, waste management

I. Introduction

Solid waste management is one of the topics of sustainable development that has in recent years become a key point of discussion aimed at improving the level of service provision, particularly in developing countries. Improving SWM is a critical issue in the rapidly growing cities of Africa (Kabera et al., 2019). At the same time, solid waste requires further investigation regarding its future use (Mohee & Simelane, 2015). As noted in the target 6.3 of Sustainable Development Goal (SDG) 6, the world and its people should strive to reduce pollution, eliminating dumping and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

According to UN Environment (2018), 145 000 tons of residue are produced daily in Latin American and Caribbean cities and discarded in inappropriate places, whereas in Sub-Saharan Africa, nearly 62 million tons of waste is produced annually. In India alone, about 0.3-0.4 million tons of solid waste are generated annually in rural areas (Das et al., 2019). In Africa, for example, less than half of the solid waste are generated and collected in urban centers, of which 95% is neither contained nor recycled, but thrown away at dumping sites and nearby water sources (Rasmeni & Madyira, 2019).

The situation in Africa is alarming, as many countries do not collect data on their waste. To some extent, the quality and availability of data on solid waste generation and management in Africa are, however, scanty, and this hinders the development of programs that will promote efficient use of solid waste in Africa (Mohee & Simelane, 2015). Equally important, there are little scientific studies on waste management and strategies (even for project financing) in African countries. Though waste generation is unavoidable, sustainable waste management solutions are required to address waste challenges (UNEP, 2018). For instance, African Environment Outlook (AEO) of the United Nations Environmental Program (UNEP) pointed out that population growth, urbanization, and growing middle class, changing consumption habits, economic development, and global trade, are the drivers of waste generation in Africa. Similarly, natural environmental concerns, social norms and associated concerns, historical influences, political contexts, local, regional and national legislation, institutional factors, educational factors, technological developments, and human resource deployment directly or indirectly bring to the fore challenges associated with future directions of MSW management in Africa (Mohee & Simelane, 2015).

In this context, solid waste production has a significant global footprint and a high management cost (Das et al., 2019), given that it corresponded to 3-5% of anthropogenic emissions in 2005 (Paes et al., 2020; UNEP, 2010). On the other hand, landfills account for approximately 5% of global greenhouse gas (GHG) emissions (Zhang et al., 2019). This implies that, if solid waste

collection and management become efficient, there would be a reduction of GHG emissions.

Understanding how much waste is generated, especially with rapid urbanization and population growth, as well as the types of waste generated, allows local governments to adopt sustainable waste management measures (Kaza et al., 2018). Furthermore, a multi-dimensional approach needs to be taken to address the issue of waste management. This involves the proper engagement at a public level with the intervention of raising awareness in schools and in the surrounding communities about the negative impact of waste on people and the environment. Thus, it should be highlighted that waste management through sustainable management strategies such as source reduction and reuse, recycling, and energy recovery plays an important role in waste management (Rajaeifar et al., 2017).

In this review, we intend to provide an overview of the situation of SWM in two developing countries, Namibia, and Cameroon. We will further use two cities of these respective countries as case studies to illustrate the patterns in the management of solid waste streams that exist within other major cities and towns of the corresponding countries. Furthermore, we compare the approach used in these developing countries with that of Austria. Given that every comparative study in SWM must consider the system of collection, transportation, treatment, reuse, recycling, recovery, and disposal and also the involvement of stakeholders (the waste generators, waste processors, formal and informal sectors, financial institutions, and private initiatives such as non-governmental and community-based organizations), we based our comparison on these relevant points. Austria has earned its place as the country with the most advanced recycling system in Europe, recycling up to an approximation of 63 % of its MSW generated (Herczeg, 2013). We, therefore, intend to show the differences that exist between the management of MSW streams of Cameroon and Namibia. By comparing the different approaches of these developing countries with that of Austria, we hope to give some recommendations that will be beneficial for the backcasting and road mapping of SWM in these developing countries.

II. Methodology

Focusing on Cameroon and Namibia, this article provides management analysis, challenges, and opportunities for waste management in the towns of Walvis Bay and Limbe. To bring together the recent analysis as well as the most recent and reliable information on the state of waste management in Namibia and Cameroon, more specifically in the towns of Walvis Bay and Limbe, a complete search for reviewed scientific literature, articles, and government reports was carried out. The municipal town of Walvis Bay was contacted to provide recent data that would enable the authors to provide the current state of waste management. A desktop review of environmental policies related to waste management in each of the mentioned countries was carried out. To perform the bibliographical research, some engine searches such as Google, Google Scholar, ScienceDirect, and Web of Knowledge were used using the following keywords: waste management, sustainable waste, waste collection in Africa, waste management in Cameroon and waste management in Namibia. The search results were used to extract data from a set of studies.

III. Austria

Austria is a landlocked country located at the center of Europe and bordered by 6 other European countries. It is a federally administered state with every land, except for Vienna split into districts (administrative regions), which are themselves again split into local authorities. With a smaller proportion of its landmass lying lower than 550m above sea level, most of the country is situated in the Alpine region (Hofmarcher & Quentin, 2013). As a developed country, standards of living in Austria ousts most parts of the world. The country is almost completely urbanized, with its urban areas not short of the provision of social amenities. On the other hand, the tendency in developing countries is that as urbanization upsurges the provision of social amenities is compromised (especially the management of waste streams). Austria, on the one hand, has experienced especially in its major cities increases in population and urbanization, two factors that come along with surges in waste production. Nevertheless, the country stands at the highest recycling level in Europe, recycling more than half of its total waste. Recycling has been facilitated in Austria by the inclusion of energy recovery for district heating in all municipal waste incineration plants. Furthermore, the enactment of rock-solid laws to prevent the use of landfills, led to the decline of the landfilling of biodegradable municipal waste (Herczeg, 2013).

The Austrian constitution stipulates that the responsibility of municipal waste management be split between the federal and provincial governments (ETC/SCP, 2009). The specific waste streams, as well as waste treatment methods, are also spelled out by the federal governments. The 2002 Act sets the framework for SWM in Austria supplemented by several decrees (Herczeg, 2013). These decrees ensure that environmental and human health are not undermined, natural resources and energy are saved, landfill space is saved, and only inert residuals are deposited. Some of these decrees include the thresholds of the landfill decree, which stipulates that only materials with a total organic carbon content (TOC) < 5% or a gross calorific value < 6 000 kJ/kg be deposited into landfill, and the federal decree for compost which sets standards for compost and ensures that there be the labeling of compost from sewage sludge (Herczeg, 2013).

The legal framework is not the only factor that has contributed to the successful management of waste streams across Austria. Over the years, the law has created an environment in which companies and organizations have been able to cooperate. This has yielded several tradeoffs better known as synergistic effects (Herczeg, 2013).

IV. CAMEROON

The Republic of Cameroon is a Central African country located at the very armpit of Africa along the Atlantic Ocean and

bordered by six other African countries. It is situated between the latitudes 2° and 12°E and longitudes 2° and 18°N (Manga et al., 2008). Sitting on a land surface area of 475,440 square kilometers, the varied relief, and the coast, as well as the effects of the mountains and seas, present varying climatic gradations within the country (Molua, 2006). The population is approximated to be 24.05 million and mostly distributed to the west and north, with the interior of the country mostly sparsely populated. In recent years, its cities have experienced an exponential increase in urbanization, with 55.8%, now residing in urban areas (Toyota Motor Corporation, 2019). Unfortunately, the population growth rate has over the years superseded the curb on poverty. This is principally due to some influential factors such as the effects of climate change on the agricultural sector and political unrest (Molua, 2006). As a result, the overall number of poor in Cameroon has increased by 12% to 8.1 million in the last few years (Outlook, 2019).

Projections by the United Nations suggest that a total of 70% of Cameroon's population will reside in urban areas by 2050. While the Government of Cameroon combats the increase in urbanization, experience has proven that it is virtually impossible to put a curb on urbanization due to the push factors that push citizens away from the countryside and the pull factors that pull citizens into the urban areas. As climate change continues to adversely affect the yields of agricultural productivity in the country, Rural-urban migration is most likely to follow the same trend (World Bank, 2017). Experts advise that rather than Cameroon laying down a policy that will cap urbanization at 57% by 2026, a more attainable approach will be to focus on taking advantage of the population increase in cities and thus improve the livability and productivity of cities so they can cope with increases in population and effectively contribute to the country's economic growth and job creation (The World Bank Group, 2018).

In Cameroon, the responsibility to ensure that solid waste is effectively managed is borne by the Department of Standards and Control under the Ministry of Environment. The responsibility for the management of medical waste is held by the Ministry of Health and Municipal Waste Management by the Ministry of Habitat (Manga et al., 2008). In that light, there exists a national strategy for the management of MSW and a budget of approximately XAF 4 billion. Nevertheless, there is no fundamental law on municipal MSWM, no sanitary landfill apart from the Nkolfoulou Landfill in Yaoundé whose state-of-the-art technology is not up to standard (without landfill, gas capture and leachate control) and no reputable system for assembly of MSW data from local governments (Toyota Motor Corporation, 2019). The just mentioned factors contribute to the many constraints that are observed in the management of waste streams around major cities and towns of the country. Even though other African countries like Kenya (Edjabou et al. 2015), Ethiopia (Kassaye, 2018) and Namibia (Ministry of Health and Social Services, 2010), are experiencing an ongoing upward trend in the management of their waste streams around neighborhoods, Cameroon seems to be taking a downward trend.

HYSACAM (French acronym for hygiene and health in Cameroon) leads Cameroons private municipal solid waste management operators. The private company Operates in 17 cities and collects over 1.5 million tons of waste a year which is approximately 4000 tonnes (Achankeg, 2004). With approximately 15 million Cameroonians benefitting from its services there remains a significant proportion of the population whose waste streams are not attended to. To meet up with the waste streams of the remaining fraction of the population not serviced by HYSACAM several NGOs and CBOs work in partnership with HYSACAM and the city councils. But, sometimes some of the waste management operators in the various cities and towns are usually informal.

The 80 major towns and cities of Cameroon (Wikipedia, 2020), all face similar problems about the management of their SW streams. The increase in urbanization, political unrest, poverty, and the failure of the Governmental bodies to state laws that bind and assign the roles of the different stakeholders in waste management is casting a dark cloud over SWM. With HYSACAM the main SWM provider operating just in 17 of these cities and servicing only about 15 million of the total population (Achankeg, 2004), MSW management faces significant constraints. In this review, we decided to consider Limbe as a case study because, Limbe with a population of about 120,000 inhabitants and urbanization of 2.9% (Manga et al., 2008) falls approximately midway to major cities like Douala and Yaoundé and major towns like Nkambe and Mamfe in terms of population size and urbanization rate. A careful analysis of the problems faced in Limbe can offer a holistic assessment of the problems faced by many if not all the other major cities and towns in Cameroon.

Waste Management System in Limbe, Cameroon

Limbe is a coastal city located in the South-West Region of Cameroon. With a population of about 140982 inhabitants (Tiafack et al., 2014) and a growth rate of 2.9%, Limbe is no exception to the trend in increased urbanization observed in several other African cities (Manga et al., 2008). Dominated by a strongly tropical climate, with some areas only a few meters above the water table, flooding is thus quite common in Limbe during the rainy season (Cheo, 2012). This, therefore, makes Limbe an open vent taking up plastic and waste into the oceans affecting marine life. Home to one of the most beautiful beaches of the country which serves as a major pull factor for urbanization justifies the fact that immigration into Limbe is yet to peak. An increase in hotels, nightclubs, and bars has brought with it a significant change in lifestyle and culture. These changes have been reflected in the amount and composition of SW generated over the last few years (Manga et al., 2008).

For administrative purposes, the city of Limbe is divided into four local councils which include the Limbe councils managed by the Government Delegate, then Limbe I, Limbe II, and Limbe III managed by Mayors. Generally, in Cameroon, the municipal councils are responsible for the delivery of all SWM services, this includes, waste disposal facilities, financing of all activities related to waste management. These councils can either decide to

be responsible for SWM or subcontract to HYSACAM. Unlike some major cities like Bamenda wherein the urban council is still responsible for SWM (Achankeg, 2004), the Limbe Council plays an extremely limited role in the management of its waste streams because the whole system has been subcontracted to HYSACAM. For the financing of the management of these waste streams, the Limbe council has three principal sources of finances which include Taxes and revenues generated by council activities, subsidiary budgets from the state through the Ministry of Economy and Finance (MINEFI), and Lending facilities from the Government's Council Development Fund (FEICOM). Supplementary budgets are subject to scrutiny by MINEFI which is responsible for the allocation of government funds based on projected fiscal revenue flows (Manga et al., 2008).

Waste Volumes and Composition

The estimated volume of waste produced in Limbe cannot be legitimized because no standardized studies have been carried out so far to accurately determine that volume. Well, estimates of waste generation in Limbe stand to be approximately 7300 tons per year (i.e. 20 tonnes/day) (Manga et al., 2008). Because this study was carried out almost two decades ago, this estimate cannot accurately fit into the context of the current population and society that has been established over the years. Given the current capacity and activities of HYSACAM, it is fair to state that little of the SW streams are attended to. The reason being that, there still exist illegal dumping sites and waste all over the metropolis.

Generally, in Limbe, the waste stream is a heterogeneous mixture of materials and products whose composition varies with its sources of generation, as well as the socio-economic classification of the locality. Households, industries, and commercial establishments such as hospitals, schools, and hotels are the principal waste generators. The variation in the material composition of the waste stream from different locales of the Limbe municipality is incredibly significant as illustrated on the graph on **(Figure 1)** below.

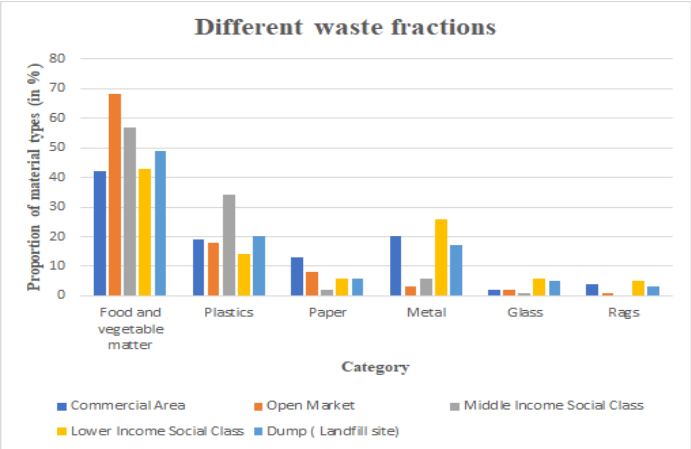

Figure 1: Estimation of different waste fractions from different locales throughout the Limbe municipality

Source: Manga (2008)

Waste Collection

The entire system of waste collection, treatment and disposal is attended to by HYSACAM. The company, for easy supervision, divides the city of Limbe into seven sections with two appointed heads to oversee the management of waste in these areas (Cheo, 2012). The approach used by HYSACAM in Limbe faces several constraints that are remarkably similar across many cities and towns of the country. A significant fraction of waste is most often not collected; this is evident by the persistence of waste along major streets of the Limbe municipality. Even though HYSACAM does its utmost best to manage a very tight budget and provide good services, unfortunately, the results gotten over the years question their competence in handling the waste problem in Limbe. Additionally, treatment/disposal is further made practically impossible for the reason that the waste streams are commonly mixed before disposal, therefore, there is scanty or nonexistence of data clearly stating the composition and generation rate of the various fractions of waste.

The Limbe council uses three main approaches in a bit to increase the effectiveness of the collection of waste in Limbe, they include:
Firstly, the pre-collection approach which involves the assembly of waste from the point of generation to municipal collection bins. It has been reported that 80% of household waste to public bins is done by children (Achankeg, 2004). A great dependency on children for the transportation of waste to collection points has already been reported to be a failure (Parrot, 2009). This is because most of this waste ends up on roadside gutters or illegal dumpsites. After all, children are usually not keen and responsible. An immediate solution to this issue will be a collaboration between municipal authorities and community initiatives which can eliminate this problem (Manga et al., 2008).

Secondly, “household to household” collection, usually done on fixed days which involves the use of collection trucks that give out loud sounds to announce their imminence. This alerts the occupants of the respective households to bring out their waste. This waste is loaded directly into the trucks for transportation. However, HYSACAM faces frequent breakdowns of trucks which leads to the accumulation of waste at household levels leading to illegal dumping of waste or overflow of waste at collection bins disrupting the whole system in place (Manga et al., 2008).

Thirdly, the Stationary point collection, which is the most widely used collection system in Limbe. This approach involves the positioning of large communal bins at designated locations for scheduled pickups. The rate of waste generated, access, and activities carried out in the area determine the type of skip, size, location, and frequency of pickups (Manga et al., 2008). Unfortunately, the decision by HYSACAM workers on where to place these skips does not take into consideration the proximity to settlements, farms, streams, and the height of the water table (Cheo, 2012). Waste managers do not do any proper engineering and thus only look out for flat and low-lying areas which are usually highly favorable for them to locate a skip point.

Waste Treatment and Disposal

Because of the nonexistence of recycling companies, a great percentage if not all municipal solid waste collected in the towns and major cities of Cameroon end up in landfills or better still dumpsites. The only prevalent recycling is done by scavengers who pick up metals and bottles mostly shipped to China and India. In Limbe, it is guesstimated that biodegradable material makes up 60% of the total waste generated (Manga et al., 2008). This is a good fraction that can serve for cost-effective municipal waste management (Couth & Trois, 2012). Unfortunately, the great dependence on fertilizers makes this almost impossible. If the government can increase taxes on fertilizers this will go a long way to encourage growth in the composting sector (Ymele, 2013). Over the last 15 years, about six dumpsites or 'landfills' as they are locally known, have been established in different parts of Limbe. Most often, these dumps are sited and operated without the consideration of environmental health impacts. There is usually no form of supervision or management documentation. Because of the lack of proper engineering, it is quite common to see ponds filled with stagnant rubbish around neighborhoods (Manga et al., 2008). These are breeding grounds for vectors, especially mosquitoes. Additionally, due to the lack of professionally trained health and safety personnel, monitoring of the health and environmental risks associated with these practices is not done.

Periodic burning of the dumped waste as a means of volume reduction is still prevalent in several of the dumping sites and only increases the number of greenhouse gasses and thus climate change. However, the potential impacts of the noxious gases that are emitted from such sites have previously not been quantified or documented. Studies carried out by Cheo (2012) on Municipal Solid Waste Management and Groundwater Contamination in Limbe, Cameroon concluded that if municipal waste streams are not effectively managed the quality of groundwater in Limbe will drop drastically. It is essential to bear in mind that, placing environmental health at risk intricately places human health and wellbeing in jeopardy.

V. NAMIBIA

Namibia is situated in southern Africa, sharing borders with Zambia and Angola to the north, Botswana to the east, South Africa to the south, and the Atlantic Ocean to the west. Geographically, Namibia covers an area of 824,290 km2, with Windhoek it's the capital city and Walvis Bay its largest port town on the west coast. Namibia has a population of 2.4 million, according to the World Bank (2018). However, almost half of the population (49%) resides in urban areas (NSA, 2018). SWM falls under the responsibility of the Department of Environmental Affairs, part of the Ministry of Environment, Forestry, and Tourism. Among different institutions involved in solid waste management include, the Ministry of Urban and Rural Development, the Ministry of Health and Social Services, and the Ministry of Works and Transport. The informal sector, on the other hand, is involved in collecting and recycling recyclable materials, and there is a policy for supporting this sector.

In the Namibian context, SWM, treatment, handling, and disposal activities are listed in terms of the Environmental Management Act, 2007 (Act No. 7 of 2007) which promotes the sustainable use of resources as an approach to waste management. Namibia has enacted SWM legislation and has a national SWM budget. Since the regulations of the Environmental Management Act were gazetted in 2012, the ministry of environment and tourism has been engaging local authorities, regional councils, and local industry to improve standards of waste management and waste disposal sites as well as to ensure that all waste disposal sites apply for environmental clearance-certificates. A strategy on national SWM was implemented and approved by the cabinet. It is believed that this strategy will deliver significant socio-economic benefits in terms of job creation especially to the youth. According to the National Solid Waste Management Strategy, Namibia aims to be the leading country in Africa in terms of standards of solid waste management by the year 2028 (Ministry of Environment and Tourism, 2018).

Waste management in Walvis Bay, Namibia

The coastal town of Walvis Bay is situated on the west coast of Namibia in Erongo region with a population of about 60,000. The town is home to Namport (Namibian Port Authority), two hospitals, three police stations, three military bases, an airport, and about twenty schools. The fishing industry is the largest sector, employing around 16 000 residents (Adam, 2019).

The municipality of Walvis Bay through the department of Water, Waste and Environmental Management, is responsible for the provision and maintenance of an acceptable site for all domestic gardens including sensitive waste as well as refuse removal services. Additionally, the department ensures continuous functional sewage purification works, and adherence to the principles of good environmental management. Findings show that the town of Walvis Bay practices a form of public-private partnership in handling its waste. Furthermore, private companies participate in the entire waste management process such as collection, disposal, and recycling. Among the Companies involved in the collection of solid waste is Rent-A-Drum. The following chapters discuss the waste collection, disposal, composition, and treatment.

Waste Generation and Composition

Based on the recent waste data collected from the town of Walvis Bay between 2019 and February 2020, the composition of waste generated annually is above 100 000 tonnes as shown in **[Table 1]**.

Table 1: Walvis Bay waste composition from 2019-Feb 2020

	19\20	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Black sand	23593	6985	5798	2300	5	4780	1483	1148	1095
Boxes	161	19	9	21	30	29	22	17	14
Building material	12900	1506	1262	1733	2738	1487	1359	1205	1610
Burials	595	88	63	68	63	41	129	68	74
Cans/Tins	15	2	0	1	9	1	0	1	1
Car wrecks	17	3	1	2	2	2	4	3	0
Condemn Food	16	7	0	0	0	0	3	2	5
Domestic waste	7766	1133	873	1097	764	891	972	1098	938
Garden refuse	2097	229	187	280	259	330	215	307	291
Glass	12	0	2	2	0	4	0	2	1
Industrial waste	14910	1543	2142	1738	2954	1239	1692	1496	2107
Metals	47	1	0	0	0	0	0	0	45
Oil	469	151	55	61	91	7	28	50	26
Other waste	524	64	80	42	139	137	24	22	15
Plastic/Paper	133	26	15	20	20	19	1	19	12
Salt	2755	240	36	887	323	0	311	260	697
Sewage	176	66	4	2	20	20	2	54	8
Tyres	310	49	24	60	52	26	29	24	45
Wood	142	31	17	28	12	19	1	18	18
Total	**66638**	**12143**	**10569**	**8342**	**7480**	**9033**	**6276**	**5792**	**7003**

Source: Municipality of Walvis Bay (2020)

Waste Collection and Disposal

The main generators of waste in the town of Walvis Bay are households, fishing industries and factories, business facilities, industrial institutions, Namport, and informal living areas with no proper housing services. The Solid Waste Management Division of the Municipality of Walvis Bay provides housing with garbage bins of 240L known as ‘refuse wheelie bins' and collect the waste (Laili, 2009). In addition to the refuse wheelie bins, there are black plastic bags provided by the municipality in the informal residential areas to collect waste in. The waste is collected once a week from the households and daily from the businesses upon request. Up until February 2020, about 2160 bins were distributed in Walvis Bay. In addition to the routine collection of waste by the municipality of Walvis Bay, the town has general cleaning operations under four contractors, namely: Contractors Beaches and Roads (CB&R), Kuisebmond Cleaning Contractors (KCC), and Naraville Cleaning Contractors (NCC).

There is only one landfill site in Walvis Bay denominated as the Walvis Bay dumpsite. The site is one of 11 such sites countrywide that received stamps of approval from the Ministry of Environment, Forestry, and Tourism in 2019 (Leandrea, 2019). Prior to its approval, several inspections were undertaken to determine whether due procedures were followed by improving standards of waste management. However, it was determined that the town management complies with the approved environmental management plans, which led to the official granting of the environmental clearance certificates for the dumpsite.

Waste Treatment

Waste recycling is becoming a well-known practice in Namibia. In Walvis Bay, recyclables are collected at the landfill site and people properly employed by the private companies do the work. The waste employees work under safe conditions provided with protective wear. Each staff member receives a bottle of sanitizing solution and an information pamphlet as part of the prevention of diseases. The materials collected for recycling are papers, plastics, glasses, and cans. These materials are compacted, semi-processed, and sent to South Africa for recycling since there are no recycling plants in Namibia. However, the glass-recycling project that was built with Rent-a-drum and Indongo Toyota

Company is functional though not giving the results envisaged. The major companies involved in recycling are the Rent-a Drum (a group of companies), Collect-a-Can, and The Glass Recycling Company. The composition of recycled material is shown in **[Table 2]**.

Table 2: Waste recycled at the Walvis Bay Landfill between July 2019-February 2020

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carton	2	2	2	4	4	0		
Cans	5	5	3	2	0	0		2
Glass	10	11	0	0	0	10		
Paper	1	2	2	2	5	1		
Plastic	2	11	13	18	25	13		
Steel	11	9	6	4	3	3		4
Total	**31**	**39**	**26**	**30**	**36**	**27**	**0**	**6**

Source: Municipality of Walvis Bay (2020)

To address waste management challenges, the Government of Namibia needs to support the implementation of the National Solid Waste Management Strategy on both the rural and urban levels.

Experience from the City of Vienna

According to Mohee and Simelane (2015), in developed countries, waste is no longer a burden of the state, but a resource that has been integrated into energy-generating strategies. Austria is one of the good examples of the best practices in modern recycling management. Waste is managed under the Federal Waste Management Act 2002 (AWG 2002) and the waste management laws of the nine federal states (Federal Waste Management Plan, 2017). These laws regulate the waste collection including waste fees and transfer of ownership, the responsibilities and organization of MWM as well as the contents of the Regional Waste Management Plan. It is no doubt that waste management in Austria revolves around the principle of sustainable development. The system is based on the Waste Management Act, with its priority being the protection of humans and the environment and is achieved through minimizing emissions and optimizing resource use (Federal Waste Management Plan, 2017).

The City of Vienna employs several targeted measures to minimize the generation of waste. More importantly, the Viennese city is responsible for the entire chain of waste management: collection, treatment, and disposal. The main areas of focus include green public procurement, eco-efficiency consulting for small and medium enterprises, the promotion of reuse and repair of goods, awareness-raising, and support for cultural services (City of Vienna, 2017). In Vienna, the Municipal Department 48 (MA 48) is part of the city administration department responsible for the municipal waste collection and treatment, street cleaning, and winter services (City of Vienna, 2017).

In addition to the AWG 2002, the Viennese Waste Management Act (Wiener AWG) regulates waste management in the city of Vienna (City of Vienna, 2017). There are municipal departments responsible for waste management in Vienna, namely: the Municipal Department for Waste Management, Street Cleaning and Vehicle Fleet (MA 48), and the Municipal Department for Environmental Protection (MA 22) (City of Vienna, 2017). While MA 48 is responsible for the communal collection and treatment of waste from private households and companies, MA 22 has the task of monitoring the implementation of waste regulations (City of Vienna, 2017). At a strategic level, they work together on the realization of the Strategic Environmental Assessment (SEA) for the Viennese Waste Management Plan.

Tools Used to Manage Waste in the City of Vienna

Waste Avoidance - Residents of Vienna contribute significantly to waste avoidance using their conscious behavior. This is quite evident from the ongoing demand for multicycle systems (City of Vienna, 2017). Some offers such as the leasing of reusable mugs or crockery trailers for events are also used as measures to avoid waste.

Correct Disposal - The city of Vienna continuously invests in improved waste separation and disposal that conserves resources and saves raw materials (City of Vienna, 2017). When it comes to manufacturing and packaging, only a small amount of energy is required for the recycling of packaging material. Thus, correct recycling methods therefore mean energy conservation, which makes an important contribution to climate conservation.

Individual Contribution - Waste disposals are simplified as a color-coded system which helps the households to correctly separate the waste. The MA 48 ensures its appropriate further utilization, by emptying containers, and sorting and disposing of waste, which can no longer be recycled (City of Vienna, 2017). The more the collected materials are sorted, the better they can be reused thus creating opportunity for the new materials to be created by recycling.

Waste to Energy - While substances such as glass and metal are recycled, MA 48 disposes the residual waste at the three Viennese waste incineration plants (City of Vienna, 2017). It employs energy recovery following the guidelines of the environmental laws which makes sure that waste is transformed into energy to serve the needs of the residents (Paleologos et al., 2016). This technology supplies energy to about 270 000 Viennese households and makes a significant contribution towards climate protection (City of Vienna, 2017).

Composting of Organic Waste - The separated collected organic materials in Vienna are first submitted to pretreatment at the waste treatment plant (City of Vienna, 2017). The bio residual substances are released from rough impurities, cut-up parts, and finally mixed with other materials. In this manner, an optimal mixing proportion is obtained each time from damp bio-waste materials as well as from tree and shrub cuttings (Gajalakshmi & Abbasi., 2008).

VI. Comparing the National Strategies

To make a comparison between the cities, the authors emphasized the importance of effective national strategy as well

as good governance. According to the research, the structure and functionality of the Austrian municipal waste management is completely different from that of Namibia and Cameroon. Austrian legislation has implemented a ban on landfill for untreated waste. This means that municipal waste is diverted from landfills thereby reducing environmental impact. Additionally, the authors highlighted the employment of technology in the waste management system as a novel method of addressing waste management issues. The experience from Austria shows that developing countries can make good progress in improving and modernizing waste infrastructure. For example, the city of Vienna applies a wide variety of smart initiatives. Among these initiatives, it is important to mention the separation and processing of scrap glasses. Through this process, recovered glasses are used in the glass factory to produce new glasses, thus, employing the concept of recycling.

Developing countries such Namibia and Cameroon are commonly using a conventional waste management system as indicated in (**Figure 2**) which is usually linear. Austria on the one hand is using a circular system (**Figure 3**), which is sustainable and it goes beyond the principles of "drop and store" but rather function as a "reuse, sanitize and recycle" principle.

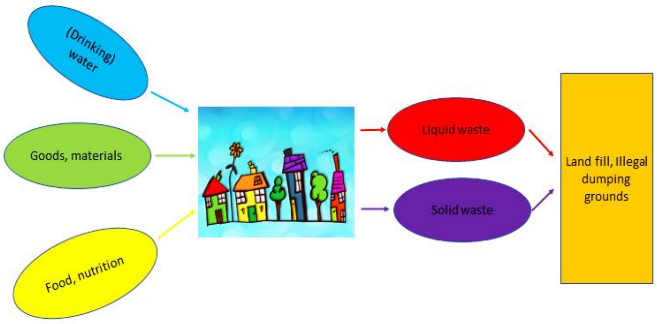

Figure 2:Schematic flow chart of a linear waste management system used in developing countries

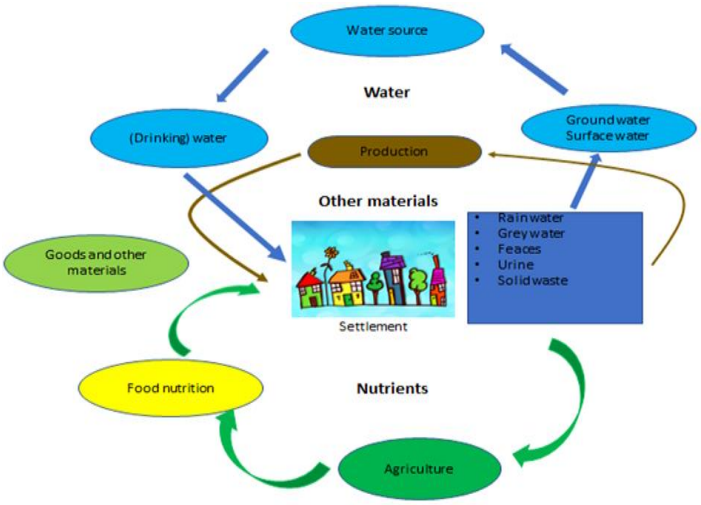

Figure 3: Schematic flow chart of a circular waste management system used in Austria

VII. Challenges

Legal Framework and Policies

The importance of proper policies in every sustainable SWM system cannot be overemphasized. Whereas in developing countries like Cameroon where most laws on waste management are affiliated to each other and concentrated at the top. Austria on the one hand, ensures that under the 2002 Act a good number of decrees are stated to address different facets of SWM. In Cameroon for example, the local government action remains very restrictive whereby the central Government´s autonomy and its role in urban affairs create an environment where local authorities cannot exercise their full mandate. Therefore, if the law is unable to define the role of stakeholders in waste management, the policies to guide their actions, and the enactment of the law, there is going to be no accountability in SWM.

Availability of Data

The availability of data from the African countries remains a big challenge. This is mainly because not all waste collected is weighed especially in the town of Limbe; it is not clear how much waste is generated and what type of wastes are collected. Additionally, data on waste management at municipal levels are relatively rare and often the available data is outdated and cannot be relied on. Due to this, it is often difficult for private investors who are willing to coordinate pilot schemes aimed at developing a sustainable management system. Furthermore, with no accurate data or reference, it is almost impossible to compare the MSWM system of developing countries with those of developed countries.

Financing Resources

Since most MSWM systems in Cameroon and Namibia are not sustainable, they are always financially dependent on governmental annual budgets. In Cameroon for example, local authorities have difficulties in generating resources independently because most of the essential taxes are collected by the deconcentrated services of the Ministry of Finance. There are usually not enough financial resources allocated to the municipal authority. Additionally, waste management is not given the importance it deserves as companies involved in MSWM are often not allocated enough budget, thus making it hard for them to buy modern equipment or even invest in recycling technologies. In some cases, when modern equipment is acquired, maintenance is also a challenge due to the lack of technical expertise

VIII. CONCLUSION AND RECOMMENDATIONS

The municipal authorities of Walvis Bay and Limbe should adopt a modern waste management system which includes circularity, recycling, and proper data collection. Lack of proper data infrastructure would hamper the implementation of quality waste management measures. If universities, research institutions, and the waste management companies come on board to ensure that proper studies on waste are carried out and accurate data is documented, this will provide the bases for the accessibility and

availability to reliable data. Further, investments should be done in capacity building through community engagement for example through education awareness. The community needs to understand how household waste is handled through the lens of the '4Rs' (acronyms for the term Refuse, Reduce, Reuse and Recycle) of waste management. Additionally, efforts for the provision of the simple and affordable methods of applying home-based sustainable waste management should be encouraged.

Policymakers should define funding priorities to set up sustainable waste management in their cities. For example, ministries and local authorities can ease the acquisition of licenses or make them free for recycling companies willing to establish waste management systems in these cities or provide structures as well as land for the establishment recycling companies. As highlighted earlier in this review, the main challenge for sustainable development in Walvis Bay and Limbe is urbanization which is not adequately managed with proper financial capacity. Implementing proper economic policies will improve infrastructures especially road networks within inaccessible neighborhoods and thus ensure that wastes are collected. Furthermore, the de-monopolization in SWM in these cities especially Limbe should be enforced. For example, Unlike Walvis Bay with registered PPPs handling the services of its MSW streams, and even more so Vienna, Limbe on the one hand has HYSACAM completely running in monopoly. A monopoly system does not encourage competition and accountability.

There are several inherent advantages to forming alliances in waste management. The authors, therefore, suggest that the municipal authorities should create an atmosphere wherein different stakeholders involved in the management of waste can cooperate and share information. As already mentioned before a decentralized structure in waste management whereby power and information flow are not concentrated at the top or one-sided but shared among the key accountable actors can lead to a very productive waste management system.

By using this illustration in **(Figure 5)** to show the three main phases in the development of networks between key players in SWM, we will like to suggest an approach that can be used to stepwise lay a structure that can be functional and productive.

Unlike Austria, Cameroon and Namibia are already running a centralized waste management system. A top-down approach one in which information flows from the central Government and local councils to the stakeholders **(phase 1).** Moving on to an upper level on this hierarchy requires a mutual and an unbiased relationship **(phase 2).** Here it will be required that in addition to the already top-down approach implored in phase 1, a bottom-top approach should be considered as well. In the third phase, the central Government and municipal councils become more engaging with the stakeholders who are themselves very engaging with each other **(phase 3).** This approach can pay off significantly in all aspects of MSW like information flow, management and capacity building.

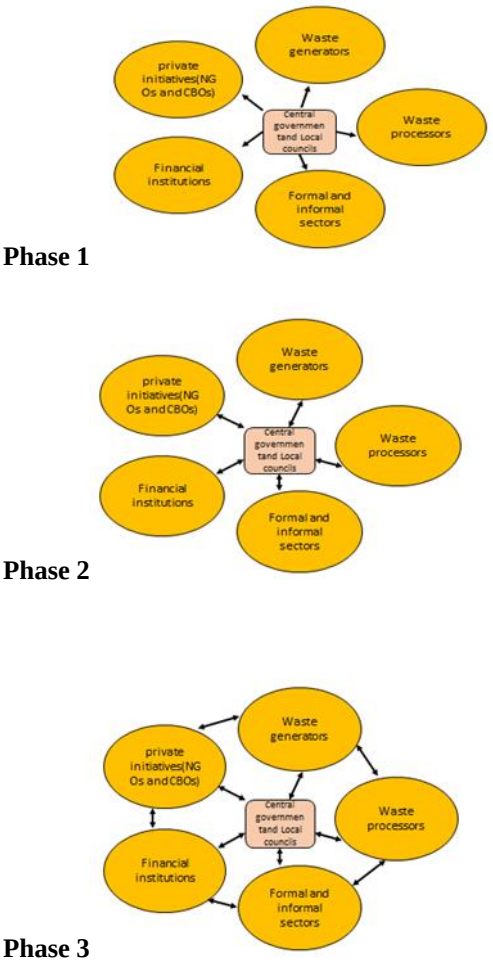

Figure 4:Three main phases of network development

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AUTHORS

First Author – Tangeni Haimbala, MSc Ocean Sustainability, Governance and Management, haimbalatangeni@gmail.com

Second Author – Helmine Egokom Agulaba Ambi, MSc Ecology and Ecosystems, forkumhelmine@yahoo.com.