IMPLEMENTATION OF A MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM IN SWAKOPMUND, NAMIBIA

By

TIMOTEUS KADHILA

Thesis presented in fulfilment of the requirements for the degree Master of Philosophy in Environmental Management, in the Faculty Economic and Management Sciences (School of Public Leadership) at Stellenbosch University

Supervisor: Professor Martin De Wit

March 2019

DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights; and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: April 2019

ABSTRACT

All over the world, municipal solid waste (MSW) is known for causing a wide variety of environmental pollution ranging from water, ground and air pollutions. If not properly managed, the consequences can be harmful to biodiversity. The Namibian Constitution stipulates that every citizen has the right to a good quality and clean environment. Therefore, as humans we should redouble our efforts to minimise these effects, conserve resources and promote environmental quality. Various institutions, government departments, non-governmental organisations (NGOs) and individuals have obeyed the constitution through implementing various approaches, policies and legislation to curb environmental damage and enhance public welfare. The concept of sustainable waste management requires a need to discuss various environmental matters including the economic costs of the most suitable techniques used for municipal solid waste management, aiming to maintain environmental quality and promote public health. Equally important, there is a need to recommend the best alternative municipal solid waste management and disposal approaches. Municipal Solid Waste management systems are actually fundamental instruments incorporated into successful integrated waste management systems.

This thesis reports on an assessment of a municipal solid waste management (MSWM) in one of the local authorities in Namibia, as a case study of Swakopmund Municipality. The purpose of this study was to investigate and describe the implementation of a MSWM system in the town of Swakopmund. Furthermore, it provides recommendations with regard to MSWM and disposal methods which may be most suitable, considering the economic costs and environmental impacts of MSW. The methodology used to achieve the study objectives involved the review of related literature, interviews with the key personnel from the Health Department working directly with MSW and environmental management. A questionnaire was also prepared and randomly distributed to 200 residents above the age of 18. Disposal site visits and direct observation were conducted weekly to access data about waste composition, quantity and to scrutinise the 4Rs strategic approach. The study found that source reduction,

waste segregation at source, reuse and recycling, are some of the most effective strategies toward improving MSWM. However, at Swakopmund, these strategies are applied at a minimal degree. Based on the findings, the study recommended that the Council of Swakopmund Municipality should invest more in the MSW sector, in terms of constructing a sanitary landfill to replace the current open but controlled dumpsite. It was also recommended that the Council should develop and implement modernised waste management strategy and practices, supported by technology and benchmarked with the best practices in the world.

Key words: *Municipal solid waste, sustainable waste management, quality, environmental impact, municipal solid waste management, economic costs, Swakopmund*

OPSOMMING

Regoor die wêreld is dit bekend dat vaste afval van munisipaliteite (MSW) ’n wye verskeidenheid omgewingsbesoedeling veroorsaak wat water, grond en lug negatief raak. Indien dit nie na wense bestuur word nie, kan die gevolge vir biodiversiteit skadelik wees. Die Namibiese Grondwet bepaal dat elke burger die reg op ’n goeie gehalte en skoon omgewing het. Derhalwe behoort ons as mense ons pogings te verdubbel om hierdie skadelike gevolge te verminder, hulpbronne te bewaar en omgewingsgehalte te bevorder. Verskeie instellings, staatsdepartemente, nie-regeringsorganisasies (NROs) en individue gehoorsaam die Grondwet deur talle benaderings, beleide en wetgewing te implementeer wat skade aan die omgewing bekamp en openbare welsyn verbeter.

Die konsep van volhoubare afvalbestuur vereis die noodsaaklikheid dat verskeie omgewingsaangeleenthede bespreek word, insluitend die koste van die mees geskikte tegnieke wat aangewend word vir munisipale vaste afvalbestuur met die doel om omgewingsgehalte op ’n aanvaarbare standaard te behou en om openbare gesonheid te bevorder. Eweneens belangrik bestaan daar ’n behoefte om die beste alternatiewe munisipale afvalbestuurs- en benuttingsbenaderings aan te beveel. Bestuurstelsels wat op munisipale vaste afval gerig is, is eintlik fundamentele instrumente wat in geslaagde, geïntegreerde afvalbestuurstelsels ingesluit word.

In hierdie verhandeling word verslag gedoen oor die evaluering van ’n munisipale vaste afvalbestuur (MSWM) in een van die plaaslike besture in Namibië, as ’n gevallestudie van die Swakopmundse Munisipaliteit. Die doel met hierdie studie was om die implementering van ’n MSWM-stelsel in die dorp Swakopmund te ondersoek en te beskryf. Vervolgens bied dit aanbevelings oor MSWM en wegdoeninsmetodes wat die mees geskik blyk te wees in die lig van koste en omgewingsimpak van MSW. Die metode wat ingespan word om die studiedoelwitte te bereik, behels die hersiening van

verwante literatuur, asook onderhoude met die sleutelpersoneel van die Department van Gesondheid wat direk met MSW en omgewingsbestuur werk. ’n Vraelys is ook opgestel en lukraak na 200 inwoners bo die ouderdom van 18 jaar versprei. Besoeke aan wegdoeningsterreine en direkte waarneming het weekliks plaasgevind om toegang tot data oor afvalsamestelling en -gehalte te verkry, asook om die 4Rs-strategiese benadering deeglik te bekyk. Die studie het bevind dat bronvermindering, afskeiding van afval by die bron, hergebruik en herwinning van die mees doeltreffendste strategieë is om MSWM te verbeter.

Wat Swakopmund betref, word hierdie strategieë egter minimaal toegepas. Op grond van dié bevindings het die studie aanbeveel dat die Raad van die Swakopmundse Munisipaliteit meer in die MSW-sektor behoort te belê in terme van die oprigting van ’n sanitêre opvullingsterrein wat dan die oop, maar beheerde stortingsterrein kan vervang. Daar is ook aanbeveel dat die Raad gemoderniseerde strategieë en –praktyke vir afvalbestuur ontwikkel en implementeer, wat gerugsteun word deur tegnologie en aan die standaard van die beste praktyke in die wêreld voldoen.

Trefwoorde: *Munisipale vaste afval, volhoubare afvalbestuur, gehalte/kwaliteit, omgewingsimpak, munisipale vaste afvalbestuur, (ekonomiese) koste, Swakopmund.*

DEDICATION

I would like to dedicate this thesis to my parents, Sigrid Amushila and Timoteus Amwaama for bringing me up in a decent manner and providing me with the basic needs that every child needs to develop holistically.

ACKNOWLEDGEMENTS

- First and foremost, I would like to thank the Almighty God, the creator who gives me strength, good health and intellectual ability to pursue my studies.
- Secondly, I would like to thank Stellenbosch University for making this opportunity possible by granting me admission into the MPhil in Environmental Management.
- Thirdly, my sincere gratitude and appreciations go to my supervisor, Professor Martin De Wit for his unwavering support and professional guidance throughout this study.
- Fourthly, I would like to thank all participants in this study, particularly staff members at Swakopmund Municipality, for their cooperation and encouragement in facilitating my research activities. Without them, this study would not have been realised.
- Special thanks go to my parents for bringing me up in a manner that shaped me into who I am today.
- My siblings deserve thunderous applause for their prayers, encouragement and financial support towards making this study a success.
- I don’t want to forget friends for keeping me company that made my journey towards this Master’s degree easy.

ABBREVIATIONS

DEA	Department of Environmental Affairs
EU	European Union
OECD	Organisation for Economic Co-operation and Development
GDP	Gross Domestic Product
GHGs	Greenhouse gases
GRN	Government of the Republic of Namibia
CoW	City of Windhoek
ISWM	Integrated Solid Waste Management
MET	Ministry of Environment and Tourism
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NGOs	Non-Governmental Organisations
NSA	Namibia Statistics Agency
SD	Sustainable Development
SME	Small and Medium sized Enterprises
SW	Solid Waste
SWM	Solid Waste Management
SWM Policy	Solid Waste Management Policy of the City of Windhoek
UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UN	United Nations
UNEP	United Nations Environment Programme
WMH	Waste Management Hierarchy
4-R Strategy	Stands for waste minimisation processes (Reduce, Reuse, Recycle & Recover)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1. Introduction

The purpose of this study was to investigate and describe the implementation of municipal solid waste management (MSWM) and disposal systems and processes of Swakopmund, and recommend the best MSWM or disposal strategy and methods which will be most suitable, considering economic costs and environmental impact with respect to the projected municipal solid waste (MSW) disposal demands. Krista *et al.* *(*2015) emphasised that an effective MSWM system is highly linked to a good understanding of waste disposal drivers, the amount of waste produced, economic costs involved and environmental impacts associated with technology used for waste treatment. In the Namibian context, the process of MSWM has evolved over time; and this necessitates the need to update waste management plans accordingly to keep up with these changes. Through effective research activities, Namibia can be in a better position to upgrade our MSWM system in our towns, cities, villages to be able to manage waste appropriately.

Today, the population of Swakopmund Municipality is growing and the town continues to urbanise; hence more waste keeps being generated and disposed of, every day. Similarly, more resources such as food, water, energy, space and materials are also required. Under these circumstances, some residents have set up goals to reduce waste to zero by using various means. Henceforth, these people will need support in many ways to continue their efforts. The majority of Namibian citizens, especially the poor, regard waste as a resource that was once sent to a dumpsite or landfill thus they are now carefully collecting this resource for reuse and recycling/recovery. Escalating unemployment and poverty is the reason why people started pursuing income generation by selling waste items to earn a living. With this intention, it is not a bad practice because it literally has socio-economic benefit in the society, together with protecting the environment. This study reviewed the Municipality of Swakopmund

policies and practices, to get a holistic understanding of the MSWM system implemented, and to suggest areas for improvement.

1.2. Background to the study

Around the globe, people have been and are still handling waste using many different methods (Zurbrügg, 2002). The common goal is to prevent unpleasant waste products and avoid potential environmental threats. The World Bank (2012) stated that a city which is unable to handle waste effectively is less likely to succeed in the provision of critical services such as health, education and transportation. In many parts of the world, especially in developing countries, the question of MSWM and disposal is a great concern. The issue of MSWM in towns and cities has been causing severe environmental problems (Lee and Jones, 1991). Sub-Saharan Africa is responsible for 62 million tons of waste per year; yet per capita waste generation is low, compared to other parts of the world like India, China and USA (World Bank, 2012). Furthermore, the World Bank also indicated that per capita waste generation is more in high-income countries and less in low-income countries. In the same vein, Croset (2014) also quoted Hoornweg and Bhada-Tata (2012), who emphasised that waste amount produced per capita is directly interconnected to the gross domestic product (GDP) per capita. Figure 1.1 summarises the amount of waste generation per level of development of the country by income category.

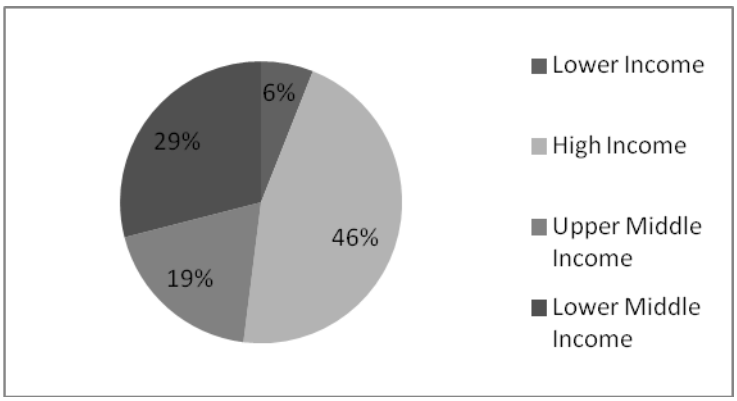

Figure 1.1: Waste generation by income

Source: Hoornweg and Bhata-Tata (2012:11)

Namibia is classified as a developing middle - income country; with its developing economy it is not an exception to the problem of MSWM and disposal. Urbanisation, economic activities as well as population growth are some of the factors identified contributing heavily to solid waste generation (Nwofe, 2015). There are many causes of waste for which disposal methods are not scientific; hence causing environmental pollution on a daily basis (Gogoi, 2013). Namibia is also facing serious environmental problems with regard to municipal solid waste management and disposal, an issue which is also hindering environmental sustainability (Croset, 2014). For this reason, environmental sustainability is crucial to human health and wellbeing, environment, revenue and power generation (Nwofe, 2015).

In cases when municipal solid waste is not properly disposed, the situation causes persisting environmental problems (Lee and Jones-Lee, 2004). On the negative side, water pollution results if wastes are disposed of in low lying areas, land pollution if openly disposed and air pollution if burned (Lee and Jones-Lee, 2004). With this in mind to ensure effective MSWM and disposal in Namibia, the researcher decided to conduct a study in this perspective. Similar to other developing countries, management and disposal of municipal solid waste can be challenged by several factors such as poverty, and the level of development as more money is channelled to critical issues such as education, healthcare and drought relief programmes (Aiyambo, 2017:35).

Right from the initial stage of MSW production to the disposing stage, the challenge is so immense that it is visible in most towns and cities around the globe (Sharholy *et al.,* 2007). Collection of MSW is the initial stage and disposal is towards the last stages in the management of MSW (Reddy, 2011). These two stages are very crucial in the management of MSW; hence they are receiving great attention in various municipal budgets (Sharholy *et al.,* 2007). Solid wastes are managed differently from town to town and city to city. Although this may be true, according to Coad (2003) solid waste management and disposal are given low priority at various places due to factors such as financial constraints, lack of awareness, inadequate incentives, low social status, as well as least value added to waste. In addition, Nwofe (2015) has also identified factors such as unchecked exponential urban population growth, insufficient training on modern

solid waste management techniques, inadequate support from the government, lack of waste management data, and little waste management research, also contributing to ineffective planning of waste management. Consequently, if waste is not properly managed, it may cause harmful effects on environment such as the degradation of valuable land resources, diseases, pests, and health hazards (Moningka, 2000).

In general, wastes are generated from different types of economic activities as leftovers are found to be useful to some residents, especially to the low income group in the society; hence its need to be disposed of, responsibly. As a matter of fact, Henry *et al.,* (2006) stated that responsible waste management is a pillar to achieving quality environmental and socio-economic progression.

Correspondingly, the Geological Survey of Namibia (2017:7-128), pointed out the key principles in achieving environmental quality:

1. *Socio-economic development* – There is a need to improve and grow the economy of the country by utilising natural resources in a sustainable way. Avoid a “natural resource curse” which is described as a situation whereby a government does not reinvest the income it reaps from its natural resources in socio-economic development that benefit the entire population (McMahon and Moreira, 2014).
2. *Job creation* – create employment opportunities in the society. By so doing, poverty and unequal distribution of income can be alleviated.
3. *Infrastructure development* – develop and maintain key infrastructures essential for enabling economic development, public convenience and safety. Failure to do so results in deteriorating socio-economic wellbeing.
4. *Water quality* – ensure that members of the public have access to water at present and in the future. Maintain the integrity of all existing water sources both in quality and in quantity.
5. *Air quality* – ensure that the public does not suffer significant escalating health risks as a result of being exposed to emissions and dusts from operational activities.

6. *Health* – ensure that public health is not compromised. Minimise all type of human-made health risks that occur in the environment.
7. *Effect on tourism* – ensure that the beauty of nature is not compromised by human activities taking place on the environment. Identify ways to avoid conflicts between the tourism industry and other industries so that both can coexist.
8. *Ecological integrity* – do not compromise ecological integrity and fauna and flora diversity. Ensure ecological processes are maintained, protect key inhabitants, rare and endangered species and ensure endemic species are not threatened. Restore ecological functions and rehabilitate disturbed areas.
9. *Education* – provide access to basic, secondary and tertiary education. This is the key to improve skills that enable people to undertake economic activities.
10. *Effective governance* – provides effective public governance through good leadership and ensures all legal requirements are met in all activities that may pose a threat to the environment.
11. *Heritage* – maintain Namibia's international image and build a good international reputation. This can be done through developing the spirit of ethical, trustworthy, reliable, and accountable governance.
12. *Future land use* – ensure that negative socio-economic and biophysical impacts are minimised. Ensure development of plans for future land use.

The impact of mismanagement and inappropriate or uncontrolled disposal of waste may cause harmful conditions to the environment, people and the economy (Aziegbe, 2007). As also mentioned by Croset (2014) uncontrolled open air dumping results in the decomposition of organic waste, producing methane gas emission. Similarly, Arzumanyan (2004) mentioned that the impact of waste involves air pollution, soil and water contamination, land degradation as well as habitant deterioration, or a combination of both; therefore MSW is a priority area of concern all over the world.

Economic growth as well as urbanisation caused by the increasing of world population has led to an alarming increase in the amount of solid waste produced in cities, towns and settlements (Nyarai *et al*., 2016). In addition, Voelia Environmental Services (2006) stated that there is correlation between the Gross Domestic Product (GDP), the GDP

per capita and urbanisation in terms of MSW generation. The most compelling evidence is that MSW is a source of pollution and land degradation, and poses a potential health hazard for humans if treated inappropriately (Lee and Jones-Lee, 2004). It is important to realise that MSWM is one the basic services which municipalities are obliged to provide; equally important to other essential services such as water provision, healthcare services, education, electricity and sewage. However these types are services are not as successful in developing countries, due to factors such as financial constraints (Croset, 2014). As an illustration, Table 1.1 compares the global perspective of how solid waste management services are affected by financial constraints.

Table 1.1: Comparison of how costs affect SWM services worldwide

Activity	Low Income	Middle Income	High Income
Costs	Solid waste collection used up a biggest portion of solid waste management budget (80-90%). Inefficient waste service fees collection. Waste disposal allocated a very small portion of the budget.	Solid waste collection costs represent 50% to 80% of municipal solid waste management budget. Better waste fees collection, more innovation in fee collection, e.g. included in electricity or water bills. Higher expenditure on waste collection fleets and disposal compared to low-income countries.	Very less collection costs that only takes up 10% of the budget. Large portion of the budget allocated to intermediate waste treatment facilities. Very high community participation in solid waste management activities such as recycling and composting.

Source: Hoornweg and Bhada-Tata (2012:5)

In this case indicated in Table 1.1, low income countries tend to spend a lot of money on waste collection to cope with factors such as the alarming illegal dumping and littering. However, these countries spend very little on waste disposal. As a result, improper waste disposal causes huge environmental problems in these countries. As

mentioned by Aiyambo (2017), low income countries prioritise other critical services such as health, water and food provision. For these reasons, most low income countries are dirty and unhygienic. On the other hand, middle income countries like Namibia spend a fair amount of money on solid waste management. Hence, they tend to be doing better in terms of solid waste management. Markedly, the City of Windhoek (CoW) was once ranked as the cleanest city in Africa (CoW, 2008). Certainly, the City is working on retaining their cleanliness status. Above all, high income countries spend less money on waste collection because the level of poverty is low, and education level is high, thus very low issues of illegal dumping and litter.

In the Namibian context, the issue of illegal dumping is alarming hence solid waste management plans need to be in place; specifically at municipal level. By the same token, Ngoc and Schnitzer (2009) mentioned that some countries have waste management policies effectively implemented only in major cities compared to smaller towns and settlements. Furthermore, based on Imam *et al.* (2008) it is important to enforce waste management policies by all residents, since it is one of the best waste management approaches. In addition, more studies should be conducted to inform the citizens about the importance of effective solid waste management systems at national and local levels.

Although similar studies have been conducted elsewhere, particularly at international level, the current lack of studies on Municipal Solid Waste (MSW) in Namibia in general and Swakopmund in particular is evident in the literature. This implies that there is a knowledge gap on this topic in the Swakopmund municipal context. Therefore, this study will aim to contribute to the body of knowledge on how MSWM can effectively be implemented.

Furthermore, this study is significant because it seeks to contribute to the process development of effective policy and strategy on MSWM by the Swakopmund Municipality. In fact other municipalities can also learn lessons from Swakopmund upon successfully implementing the MSWM strategy. The findings of this study can be used by decision-makers and policy formulators to help in the process of formulation and implementation of sustainable solid waste management practices. Equally important,

the study findings can also serve as a basis for debate around this topic and to inform future similar studies.

MSW, which is also locally known as garbage or trash, comprises various wastes from houses, constructions, businesses, and institutions (Aiyambo, 2017). Surely, various instruments are in place to effectively manage MSW. Notably, the Environmental Management Act (EMA) No. 7 of 2007 promulgated by the parliament of the Republic of Namibia provides principles of waste management that must be adhered to. These include, among others: sustainable use of renewable resources; involvement of the public in decisions affecting the environment; conducting environmental impact assessments for developments that affect the environment; promotion of reduction, re-use and recycling of waste material and taking precautions to prevent environmental damage at all times (GRN, 2007). In detail, the government together with local authorities from other parts of the country work together to ensure reduction of environmental issues caused by loads of waste through implementing policies, legal frameworks and stakeholder involvement (Hasheela, 2009). For this reason, all activities engaged at all levels of the government, personal capacities, institutions and companies around the country, must comply with the principles of the Environmental Management Act 7 of 2007 (GRN, 2007).

Apart from EMA, activities in Namibian towns and cities that are environmental based are also regulated by other frameworks such as: Environmental Impact Assessment Policy of 1995, Integrated Pollution Control and Waste Management Bill, Water Act No. 54 of 1956, Town Planning Ordinance No. 18 of 1954, Local Authority Act No. 23 of 1992, Namibia Ports Authority Act No. 2 of 1994 as well as Marine Traffic Act No. 2 of 1981(NACOMA, 2005). A good example is that the CoW as the biggest local authority in the country became the first to adopt a Solid Waste Management Policy in the year 2009. The main objective of this Policy is to "*Provide framework through which the management of waste, irrespective of the nature, toxicity and quantity, shall be governed in Windhoek*" (CoW, 2009:2). In brief the CoW is determined to reduce and avoid adverse impacts caused by unnecessary waste generated and improper waste

management practices, while simultaneously continuing to improve the quality of life for all residents of Windhoek in terms of economic development (CoW, 2009:6).

Namibia is one of the countries in Southern Africa which is highly challenged in terms of handling and disposal of municipal solid waste. Part of the reasons could be that several towns, cities and settlements do not have effective waste management systems in place. After all, the effects of waste to the environment can also extend from one place to another. To support that argument, Hasheela (2009), has quoted Camagni *et al*. (1998) who emphasised that it is quite possible that effects of environmental problems caused from a specific place can be felt at other places, both regional and global. At regional level, the effects of irresponsible MSW management and disposal cause surface and ground water contamination, besides urban air pollution when burned; while at global level, the effects include a release of methane gas at high level, causing greenhouse effect (United Nations ESCAP, 2018).

According to The Namibian, (2008) some of the reasons causing a booming population are the increase in mining activities in the Namibian desert and the rapid growth in tourism in the coastal regions. Even though these developments could boost the economy, the municipality of Swakopmund could face major logistical problems including dealing with MSW (The Namibian, 2008:4). In essence, this situation is expected to put pressure on waste management systems and disposal facilities. It has been observed that many people choose to dwell in and construct houses in Swakopmund; hence the population of this town is increasing rapidly and is expected to increase even more in future.

The town of Swakopmund is one of the tourist destinations in Namibia and also fast growing in terms of the population (Council of Swakopmund, 2015). Another key point is that the town is the capital of Erongo Region with an estimated population of 44 908 in 2014 (Council of Swakopmund, 2015). In the last census of 2011, the Swakopmund population was 44 725 people (Namibia Statistics Agency (NSA), 2014). Based on other statistics, Wahengo (2018) stated that statistics for the year 2016 indicated that the total population of Erongo Region was approximately 182, 402 individuals. Moreover, the Namibia Statistics Agency (2014) stated that the country's population was projected to

be 3.6 million by 2041. In addition, rural areas are also expected to shrink gradually due to emigrations from rural to urban areas; hence urban areas are expected to expand significantly (NSA, 2014). Similarly, NSA projected the population of Erongo Region, in which Swakopmund town is located, to increase in both numerical and percentage terms, of which the third of the whole Namibian population is expected to live in the Erongo and Khomas regions.

It is important to realise that Swakopmund is surrounded by vulnerable ecosystems, namely the desert and marine ecosystems, which are also sensitive biodiversity areas (Ministry of Fisheries and Marine Resources, 2015). Therefore, MSWM should be a matter of urgency to prevent waste from contaminating the vulnerable ecosystem, which may later cause serious environmental and economic issues such as damage to human health/wellbeing, damage to biota and damage to business operations in the area.

On the positive side, MSW may also have economic value attached. Generally speaking, the economic aspect is that appropriate solid waste disposed can have good economic value to the society, especially the poor people who make a living from recovering reusable and recyclable materials. On balance, this study provides a well-defined assessment and valuation of municipal solid waste disposal, in terms of the environment and the economy.

1.3. Problem statement

As has been alluded to in the background section, the Environmental Management Act No. 7 of 2007 provides the strategic basis for waste management in Namibia (GRN, 2007). This Act requires that all public and private institutions put in place effective waste management systems to avoid damage to the environment and negative human health effects from wastes. However, most cities, towns and settlements still do not have comprehensive environmental management systems, policies and strategies in place as yet, due to capacity issues and inadequate resources (Arzumanyan, 2004).

Various studies have been conducted elsewhere to analyse environmental impacts of landfills concerning methane gas emissions and toxic leaching or contamination of

underground water resources. Air emissions and ash disposal have been the focus of studies with respect to MSW in those areas. Based on literatures, studies that have been conducted elsewhere have actually looked at MSWM and disposal systems, policies, processes and methods and environmental impacts of MSW management and disposal processes but not in Swakopmund.

Since a number of studies have only been undertaken elsewhere, but not in Namibia, there is inadequate information on economic costs and environmental impacts of MSW management and disposal processes in Namibia in general and Swakopmund in particular; and this study aimed at providing this information. Particularly, the study sought to answer the following broader question: What MSWM and disposal system, policies and processes does the municipality of Swakopmund have in place?

1.4. Aim statement

The aim of this study was to describe the MSWM and disposal processes in the town of Swakopmund, and to recommend the most effective MSWM and disposal methods which will be suitable, considering economic costs and environmental impact with respect to the projected MSW disposal demands.

1.5. Objectives of the study

The study investigated and described the MSWM and disposal system, policies and processes implemented by Swakopmund municipality, considering economic costs and environmental impacts, given future population growth and increased need for waste disposal. Based on the findings on which waste management and disposal options present the greatest environmental impact, the study made recommendations for the best MSWM and disposal options which may improve the economic costs and minimise environmental impact, in response to high level of projected population growth of the town of Swakopmund.

1.6. Research questions

To achieve the objectives of the study, the following overarching research questions were pursued:

a) *What MSWM and disposal systems, policies, processes and methods does the town of Swakopmund have in place; and*
b) *What are the residents' perceptions on MSWM, including environmental impacts?*

1.7. Significance of the study

The study generated data to close the knowledge gap about waste management systems and strategies in the town of Swakopmund. The findings from the study will be used by policy makers to formulate policies or review existing policies to ensure effective waste management strategy - not only for Swakopmund Municipality where this study was done - but also for other municipalities. In addition, the findings will stimulate the debate about the best ways of waste management and may necessitate further similar studies in other towns in Namibia.

1.8. Scope of the study

There are many towns in Namibia; however, this study investigated the implementation of MSWM and disposal in Swakopmund only. Hence the study mainly focused on waste produced within the geographical area of Swakopmund Municipality. The study noted the absence of a framework for MSWM and observed only relevant bylaws. The study area involved a large area of Swakopmund Municipality jurisdiction, in which the SWM department personnel and Swakopmund community members of different status are engaged.

1.9. Organisation of the thesis

The structure of this thesis has been organised as follows:

Chapter 1: Introduction and background to the study – This chapter gives the background to the study, research problem, objectives of the study, questions of the study, scope, limitations of the study, significance of the study, and definition of concepts related to this study.

Chapter 2: Literature review – This chapter gives a detailed analysis of the literature related to this study.

Chapter 3: Research design and methodology – This chapter discusses the design and methodology used in this study. The study population, sample and sampling techniques, methods and procedures for data production, ethical considerations, and data analysis were discussed.

Chapter 4: Data presentation, discussion and interpretation – This chapter presents, discusses and interprets data to give meaning for the research findings.

Chapter 5: Summary, conclusions, recommendations and implications – This chapter summarises the entire study, made conclusions and offered recommendations based on the research findings, and suggests practical implications for the practice.

1.10. Conclusion

This chapter gave the background to the study, research problem, objectives of the study, questions of the study, scope, limitations of the study, significance of the study, and definition of concepts related to this study. The next chapter discusses the review of the literature related to this study.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter presents the review of the literature related to this study. Literature review plays a major role in justifying the research and identifying the purpose of the study (Soiferman, 2010). Anderson (2013) identifies three different types of literature sources, namely primary literature sources, grey literature, and published literature sources. Primary literature sources are unpublished documents that come from within the organisation being studied. Grey literature includes documents that are more widely available in the public domain; such as company reports, position papers, and records of conference proceedings.

Published literature sources refer to published sources such as books, newspaper and journal articles. For the purpose of this study, all three sources of literature are used. Particularly, Swakopmund Municipality documents such as policies and training programme documents as well as company reports were used in the document analysis. In addition, research articles were used to analyse the literature on similar studies that have been conducted elsewhere to reflect what is known and what is not yet known about the topic under investigation.

2.2. Defining waste

Popov *et al.* (2004) argue that municipalities must invest in waste disposal projects, in order to ensure effective waste disposal methods. However, the key to sustainable waste management is waste minimisation, in particular the reduction of waste sources. To manage waste in a sustainable manner, it is important to define what waste is. There are various definitions of the concept ‘waste’ by various organisations and individual authors, and some of these are summarised as follows:

Table 2.1: Various definitions of the concept 'waste'

EU	Waste shall mean any substance or object which the holder discards or is required to discard.
OECD	Wastes are materials other than radioactive materials intended for disposal, for reasons specified.
UNEP	Wastes are substances or objects, which are disposed of by the provisions of national law.
Lox	Waste is either an output with (negative market) no economic value from an industrial system or any substance or object that has been used for its intended purpose by the consumer and will not be re-uses.
McKinney	Waste is the unnecessary costs that result from inefficient practices, systems or controls.
Baran	Waste is the difference between the level of output of useful goods and services that would be obtained if all productive factors were allocated to their best and highest uses under rational social order, and the level that is actually obtained.
Hollander	Waste is something that needs to be expelled in order that the system continues to function.
Pongracz	Waste is a man-made thing that has no purpose or is not able to perform with respect to its purpose.

Source: Popov et al. (2014:474)

What is common in these definitions is that they are relevant at the time when waste is to be moved from the place of its generation; they thus refer to existing waste. Waste management thus appears to be simply a reaction to waste. A definition for waste must go a step further, to include a proactive approach to waste management. It must include the four waste classes which are listed in Table 2.2.

Table 2.2: Classes of waste

Class 1	Non-wasted things, created not intended, or not avoided, with no purpose.
Class 2	Things with a finite purpose, destined to become useless after fulfilling it.
Class 3	Things with non-acceptable performance due to a flow in structure or state.
Class 4	Things with acceptable performance, but their users fail to use them for their intended purpose.

Source: Popov et al. (2014:475)

Based on the definition for waste, a proper definition for waste management can then be given. It has been suggested that waste management is control of waste-related activities, with the ultimate aim of resource conservation and protection of human health and the environment.

2.3. Types and sources of solid wastes

Basically, different types of solid wastes are produced by day-to-day human activities as classified by Ramachandra (2006). In detail, solid wastes are only solid or semi-solid waste materials that are produced from different sources, such as industrial, within given municipal areas (Ramachandra, 2006). According to Jha *et al*. (2003), Reddy and Galab (1998) and Khan (1994), SW include types of waste such as recyclable metals, plastics, glass, tires, ashes, wood, street sweepings, landscape and tree trimming etc., toxic waste/substances such as medicines, used batteries, pesticides, paints etc., compostable organic matter such as food waste, fruit and vegetable peels as well as soiled waste such as blood-stained cotton, sanitary napkins, disposable syringes etc. Some of these types of solid waste are generated from sources such as domestic, commercial, construction and demolishing works, institutions and waste from the streets (Sharholy *et al*., 2007).

Apart from the descriptions of the previous authors for the term 'waste', Gogoi (2013:55) defined the terms 'solid waste' as "*material which is not in liquid form and has no value to the person who is responsible for it*". Furthermore, this author stated that although human and animal excreta fall under solid waste streams, they are generally not included in the term "solid waste", but only "garbage", "trash", "refuse" and "rubbish" are regarded as types of solid waste. Eventually, all types of waste are in dire need of effective SW management and efficient planning, to enable waste managers and planners to account for environmental effects and costs involved in the holistic SW life cycle (Emery *et al*., 2006).

The U.S.EPA (2009), as an environmental custodian, advocates for possible waste reduction by means of source reduction, recycling as well as composting, in order to achieve sustainable solid waste management.

In particular, solid wastes are classified based on the source as United Nations ESCAP (2018), classified them below:

Table 2.3: Sources and types of solid wastes

Source	Typical waste generator	Types of solid wastes
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government centres	Same as commercial
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.

Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational area, sludge
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off-specification products, slag, tailings
All of the above should be included as "municipal solid waste."		
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g. pesticides)

Source: United Nations ESCAP (2018)

As classified by United Nations ESCAP (2018), they are all regarded as "solid waste" and if occur within certain municipal boundaries they become the responsibility of that specific municipality to manage. However the complexity of composition and continual accumulation per capita waste generation is a huge challenge for waste managers (Agamuthu *et al.,* 2009:1). Furthermore, weak enforcement, inadequate technology and incompetent policy implementation, are also some of the challenges that make waste type and waste source management inefficient with a minimal improvement status (Agamuthu *et al*., 2009).

2.4. Municipal solid waste and the environment

The literature states that MSW in developing countries is challenged by obstacles such as financial, institutional and physical obstacles. Contrary to these obstacles, Van de Klundert and Anschütz, (2001) urge MSW managers to ensure that MSWM systems focus on highly prioritised aspects of public health, environmental protection and resource management.

2.4.1. Public health

Basically, public health does not need to be compromised at all. Generally speaking, this aspect is highly connected to solid waste management systems around the globe (Ejaz *et al.,* 2010). In case a waste management system is poor, more people may get sick and the mortality rate could be high, consequently affecting productivity and

development of the city and country at large. All in all, general environmental awareness and information sharing about health risks need to be communicated constantly to all sectors of the population (Zurbrügg, 2003:8). As aforementioned, lack of proper collecting and disposing of MSW creates an unhygienic environment that negatively affect people's health and the surrounding environment (Vergara and Tchobanoglous, 2012). In addition, polluted environment provides a suitable breeding ground for mice, insects such as flies, mosquitos and other animals that spread various infections including air and water-borne diseases as well as potential cancer risks (Shen *et al.,* 1990). Malaria, Diarrhoea, Cholera, Asthma, chest pain, respiratory diseases, birth defects and human injuries are some of the diseases and health issues associated with an unhygienic environment (Ejaz, *et al.,* 2010). Furthermore, direct solid waste handling expose people to infectious and chronic diseases such as HIV, hepatitis B, nose, eyes and skin irritations and many more (Sankoh, *et al.,* 2013). These same authors also mentioned that domestic animals such as dogs and cats that feed on solid waste carry diseases to homesteads. It is therefore crucial for municipalities to protect the wellbeing of the public, by providing effective solid waste management services and sanitation. Equally important, municipalities should provide a conducive and safe working environment for waste workers.

2.4.2 Environmental protection

As aforementioned, NEMA (GRN, 2007) provides for environmental protection. Environmental policies and technology can be effective tools that provide environmental benefits such as mitigating climate change (Vergara and Tchobanoglous, 2012). Various authors wrote about the importance of environmental protection. Among others, El-Fadel *et al.* (1997) stated that if solid waste is not collected and/or disposed of properly, it may lead to the process of anaerobic decomposition that releases methane and carbon dioxide gases. These gases are known to cause climate change and global warming, which are some of the notorious environmental threats in the world. In addition, El-Fadel *et al.* (1997) highlighted that a mixture of sanitary, hazardous and other MSW can severely contaminate the environment on a large scale and pose potential hazards to the society and the environment.

Ground and surface water pollution, unpleasant odour, vegetation destruction, air pollution, fire and explosive land degradation are some of the harmful effects resulting from improper MSW collection and disposal processes (El-Fadel *et al.,* 1997). In addition, the study conducted by Ejaz *et al.* (2010) pointed out that loss of biodiversity and obstacles in the drainage and sewer system are other negative environmental impacts caused by an inefficient MSWM system. The effect of blockage of sewer and drainage systems causes severe flooding and unhygienic conditions in cities (Ejaz, *et al.,* 2010; Sankoh *et al*., 2013). Soil acidification, bioaccumulation of toxic materials on the ground and in the fauna and flora has the potential to poison the entire ecosystem (Enviros Consulting Ltd. and University of Birmingham, n.d.). In addition, Srivastava and Singhvi (2013) elaborated in detail about characteristics of solid waste relative to how they can harm the environment:

- Corrosive: meaning these type of waste contains acids or bases that can corrode metals (e.g. tanks)
- Ignitable: they can make fires under certain circumstances (e.g. waste oils and solvents)
- Reactive: they are unstable in nature, (cause explosions, toxic fumes when heated).
- Toxicity: Dangerous or deadly when ingested or absorbed (this may kill humans, plants and animals)

2.4.3. Resource management

As mentioned previously, many people regard MSW as a potential resource. Resources have to be managed so that they can remain available for all the people to use; both at present and in future. A point often overlooked is that many types of MSW are recyclable or compostable materials that can be valuable in the global market (Srivastava and Singhvi, 2013). Therefore, if managed properly, they can generate adequate revenue. In most cases, especially in poor and middle income urban areas, informal sector people value MSW resources as the only source of generating income. Then again, to produce a virgin product is typically a costly process that also requires

high energy use; hence many people have opted to recycle or recover energy from solid waste (Srivastava and Singhvi, 2013).

2.5. Municipal solid wastes

In general, households are the major generators of MSW, besides shops, restaurants, hotels, hospitals, construction sites etc. Various authors and environmental institutions have defined Municipal Solid Wastes (MSW) in different ways. According to the U.S EPA (2018), MSW are made up of materials "used and then thrown away, such as product packaging, grass clippings, furniture, clothing, bottles, unwanted food, newspapers, appliances, paint and batteries" which come from "homes, schools, hospitals and businesses". On the other hand, Ramachandra (2006) defined MSW as waste that is generated from sources and activities taking place within defined municipal boundaries. The above definitions of MSW are correlated, however, in the EPA definition, waste materials such as hazardous wastes, construction and demolition wastes and bio-solids are excluded even though they are generally part of MSW.

Generating MSW from various towns or cities varies in volume and it is highly influenced by the level of economic development and activities that are taking place (United Nations ESCAP, 2018:171). Thus, developed countries produce greater volumes of MSW, compared to developing countries. However, waste management services are usually more efficient in developed countries. According to UNEP (2010), it is estimated that 1.3 billion metric tons of MSW was generated worldwide per year and the volume is projected to increase up to 2.2 billion metric tons by 2025. This amount of municipal solid waste production is so alarming in such a way that many developing countries cannot cope with waste production pace. According to Hoornweg and Bhada-Tata (2012) the global solid waste management costs stands at $205.4 billion and is expected to increase to $375.5 billion by 2025. Therefore, MSW is increasing drastically and deserves a lot more attention than it has been given.

2.6. Municipal solid waste management (MSWM)

In fact waste management priorities differ from country to country, depending on the waste management capabilities (Hasheela, 2009). Furthermore, she identified four top priorities of Namibian waste management as listed in Table 2.4 below.

Table 2.4: Waste management priorities in the Namibian perspective

Priorities	Aim
1) **Sustainable development (SD)**	Caring for the future generation
2) **Common policies and standard implementation systems**	Includes waste management principles & hierarchy, economic status, legal frameworks, stakeholder participations.
3) **Environmental Impact Assessment (EIA)**	Assessing possible environmental impacts,
4) **Environmental Monitoring (EM)**	Keeping an eye on the state of the environment

Source: Hasheela (2009)

Sustainability and sustainable development are central concepts about caring for and maintaining a healthy ecosystem and natural resources, as a requirement for human wellbeing (Department of Environmental Affairs, 2014). According to UNCED (1992) sustainability and sustainable development requires integrating economic, social, cultural, political and ecological factors. Hence, the United Nations (UN) Conference on Sustainable Development in Rio+20 launched the Sustainable Development Goals (SDGs) in order to balance environmental concerns with economic growth (Dresner, 2008). Based on Hoornweg and Bhada-Tata (2012), the consequence of non-sustainable development results in negative elements illustrated in Figure 2.1 below:

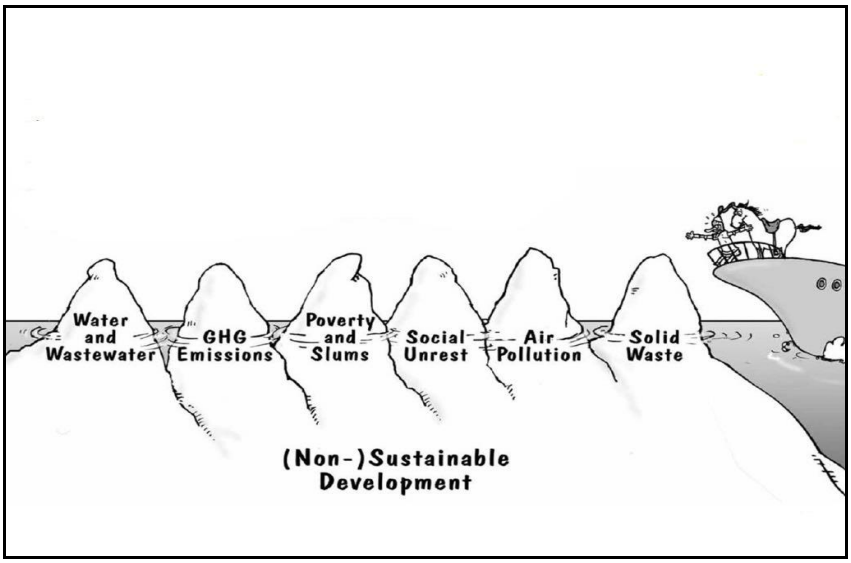

Figure 2.1: Elements of non-sustainable development

Source: Hoornweg and Bhada-Tata (2012)

The emphasis in Figure 2.1 by Hoornweg and Bhada-Tata (2012) is that non-sustainable development should be avoided by all means, since the consequences are non-environmental friendly and may have detrimental impacts on the environment. Despite sustainable development in some developing cities, in contrast others are already suffering all the 6 elements depicted in Figure 2.1. Thus, it would be beneficial if the affected cities seek external support to improve sustainability in their respective areas. Nahman and Godfrey (2009:522) indicated that solid waste can be managed using economic instruments. Table 2.5 below elaborates on this aspect.

Table 2.5: Examples of solid waste management economic instruments

Instrument	Incentives provided	Application	Implementation
Product and input tax	Increase prices of environmentally significant products or inputs so as to reduce consumption/use thereof, thereby reducing waste generation	Tyres, motor vehicles, batteries, non-recyclable containers, non-returnable beverage containers, non-biodegradable plastic bags	Can be applied at national or local level
Deposit-refund scheme	Pay deposit upon purchase and get refund upon return of the used product, provide incentives for return recyclable and reusable items	Glass and plastic beverage containers, steel beverage cans (currently applied in SA), batteries, tyres and even cars	Can be implemented by private or public sector or private-public partnership
Quantity-based waste collection charges	Put price on each unit of waste collected for disposal at landfill, this provide incentive for household to reduce amount of waste	Volume or weight-based collection charges	Can be applied at local (municipal) or national level

Source: Nahman and Godfrey (2009:522)

Based on the study conducted by Nahman and Godfrey (2009), the use of economic instruments could lead to a significant reduction in waste generation and maximise recycling. Other advantages outlined by the authors involve the saving of landfill space, socio-economic benefits as well as improved environmental awareness. In addition, Nahman and Godfrey (2009) emphasise that economic instruments could work effectively if there is efficient monitoring and enforcement capacity at municipal level. Last but not least, the study conducted by Maluleke (2014:36) pointed out two

categories of economic instruments which are: revenue-raising (i.e. licences, user charges) and non-revenue instrument (performance-based management contracting, neighbourhood cleaning competitions, privatisation). In the same view, Arzumanyan (2004) added that a deposit-refund scheme (DRS) is a useful economic instrument that will encourage consumers to return containers instead of throwing them away. In addition, the author stated that economic instruments such as waste collection charges and tax on packaging encourage waste prevention. For example, adding a levy on the usage of plastic bags by retailers may encourage customers not to use them at all. Apart from that, Mwanangombe, *pers. comm*,. (2018) said the Polluter Pay Principle which is also currently applied in municipalities such as Swakopmund and Windhoek is a good example of an economic instrument. This particular instrument encourages polluters to reduce the volume and frequency of waste they produce.

In addition to economic instruments, Arzumannyan (2004) indicated that an Informative instrument can be used to influence the public to make decisions that favour the environment through information sharing and public awareness. For example, members of the public can be encouraged to buy fewer packaging products, less or non-toxic products, buy and recover products that can be reused or recycled.

Henry *et al.* (2006), stated that population health, environmental quality, environmental sustainability and economic productivity are some of the main objectives and top priorities behind MSWM. Furthermore, Henry *et al*. (2006) also stated that these objectives can only be successfully accomplished through public-private partnership. In addition, Hoornweg and Bhata-Tata (2012) indicated that effective MSWM requires a strong collaboration between municipalities and the community. Emery *et al*. (2006) clearly defined the life cycle of waste product, which firstly begins when raw materials are removed from the earth into chronological stages of manufacturing, transporting and usage. Later at the end of the product life cycle, there is then waste management which on a global scale is regarded as a serious environmental concern (Hasheela, 2009). This is due to the fact that waste is a threat to the environment, as it can have negative impacts when not managed (Hasheela, 2009).

The Namibian Environmental Management Act No. 7 of 2007 defines waste as any matter whether gaseous, solid or liquid or any combination thereof, which is as an undesirable or superfluous by-product, emission, residue or a remainder of any process or activity (GRN, 2007). The Act indicates that the government of the Republic of Namibia is dedicated to ensure environmental wellness through activities such as MSWM among others. Various authors elaborated on the processes of MSWM.

Municipal Solid Waste Management (MSWM) is the process of controlling waste at the source, at its storage, collection, transporting, processing and disposal according to the best principles of public health, economy, engineering, conservation, aesthetics, public attitude and the rest of environmental considerations (Ajith, 2014). Based on Shin (2014) the most common methods of managing MSW are: recycling, composting, thermal treatment with energy recovery, and landfills; however, these methods are sometimes facing economic and environmental challenges.

In Africa, many local authorities MSWM systems face various constraints; mainly financial, institutional and physical obstacles (Parrot *et al.,* 2009). These constraints pose a serious challenge to MSWM and disposal in many African cities and towns, hence illegal dumping is so alarming. Some authors have pointed out some notable MSW disposal practices. Mughal (2014) indicated that landfill, incineration and composting are the most commonly practised methods worldwide. Apart from that, Hasheela (2009) pointed out the conducting of waste auditing as one of the most effective ways of solid waste management.

In Namibia, the CoW is the only municipality in the country that uses a landfill as mentioned earlier by Mughal (2014). He referred to the Kupferberg landfill which Haingura and Nakapunda (2014) noted has contributed significantly towards improving solid waste management in Windhoek. Apart from that, Windhoek municipality has also launched a Solid Waste Management Policy (SWMP) in 2010, aiming to effectively minimise and avoid impacts caused by unnecessary waste generation and improper

waste practices (CoW, 2009). In addition, CoW (2009) mentioned that SWMP is governed by principles such as: Integrated Waste Management Hierarchy (IWMH); Sustainable Development (SD); Sustainable Consumption and Cleaner Production (SCCP); Polluter Pays Principle (PPP); Duty of Care; and Best Practical Environmental Option (BPEO). In addition, taxes, subsidies, and incentives are some of the economic instruments used to change human behaviours toward SWM (CoW, 2009).

Similarly, the municipality of Swakopmund has also implemented its Waste Management Policy of 2015. According to the Council of Swakopmund (2015:10), the main aims of this policy are as follows:

1. To provide the basis for a by-law aimed at regulating waste generation and waste management services
2. To be the direct link to Council's Integrated Waste Management Plan that will be the mechanism for the implantation of the Policy
3. To promote and encourage effective waste minimisation and waste management practices as per Waste Management Hierarchy within the Swakopmund Council's jurisdiction
4. To improve socio-economic sustainability, public and environmental health by providing equitable and sustainable waste management services at reasonable prices
5. To integrate and improve waste management in order to maximise efficiency and minimise the associated environmental impacts and financial costs
6. To promote encouragement of effective waste recycling

Furthermore, in the same way as the CoW, the Council of Swakopmund also applies the Polluter Pays Principle, Duty of Care, and the Waste Management Hierarchy to provide effective and efficient waste management (Council of Swakopmund, 2015). Solid waste management systems differ from town to town, local authority to local authority across Namibia, but in most cases they have similar stakeholders in common.

Table: 2.6. Example of existing solid waste management system in Namibia

Stakeholders	Roles/Duties	Linkage
Municipal, District and agencies	Waste collection and management	Employ private waste management companies, educate and legislate activities of waste producers
Private sector players, (i.e. Rent-A-Drum, Enviro-Fill)	Enhance waste services, create employment, provide in-service training, knowledge exchange programmes, door-to-door solid waste collection, provide waste bins, sweeping streets	Ensure effective and efficient waste collection and disposed to enhance environmental quality
Waste producers (i.e. community)	Generate waste and dispose in dust bins, or in dumpsites	Directing benefit form proper waste management

Source: Hasheela (2009); Field Work, 2018

In the Namibian context, MSWM is normally spearheaded by the local authorities in partnership with waste management private entities and the community. For example, community participation may involve carrying waste to a shared container, waste segregating to make recycling activities easier or by willingly paying for waste management services (Zurbrügg, 2003). Stakeholders mentioned in table 2.6 are very common in many municipalities in Namibia. The study conducted by Hasheela (2009) revealed that these stakeholders play a significant role in municipal solid waste management in the whole of Namibia at municipal level.

Hiriya (2003) pinpoints four components involved in MSW as: recycling, composting, landfilling as well as combustion however some of these components are associated with environmental problems if not managed properly. Lagbas–Aranas (2015) mentioned that the general waste management strategy worldwide is by means of the waste hierarchy that involves reduce, reuse, recycle and recover, also known as the "4Rs".

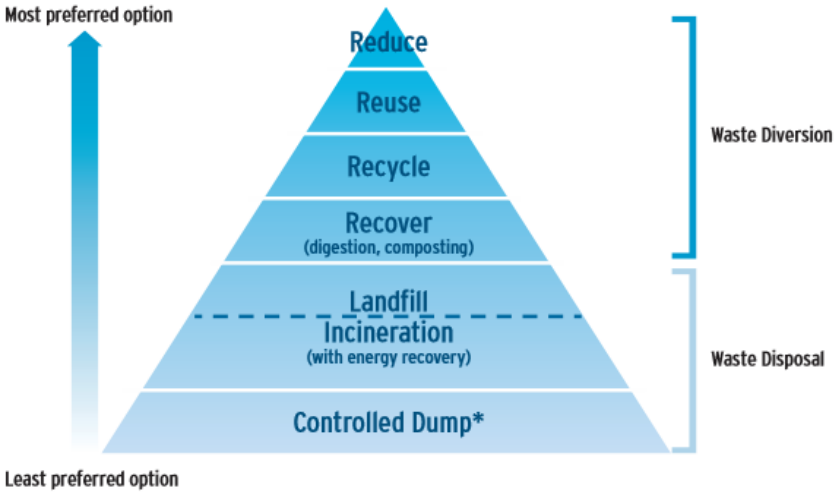

Figure 2.2: Waste hierarchy

Source: Hoornweg and Bhada-Tata (2012:27)

2.6.1. Reduce

This method is highest in the waste management hierarchy, as it is also regarded as the best in curbing waste volume from the source (CoW, 2009); hence, it has been adopted by several countries around the globe (U.S Environmental Protection Agency, 2018). For example in the US, under this waste management method the government implemented programs such as Pay-as-You-Throw (PAYT), whereby people pay for a dust bin or bag of trash they throw away. The more you throw away, the more you pay. In the US, programs such as PAYT achieved 42% solid waste reduction, increased recycling by 74% and decreased solid waste disposal costs (Shin, 2014). Furthermore, In Namibia, for example, the CoW has integrated waste hierarchy into their SWM Policy to reduce the amount of waste through Polluter Pays Principle (PPP) that transfers the cost to the polluters themselves (CoW, 2009) which came into force recently through introduction of a levy on plastic bags. In addition to that, PPP has effectively encouraged polluters to exercise the Duty of Care principle during operations, products and services (CoW, 2009). In addition, CoW expressed that the Duty of Care principle obliges the polluter's accountability for any environmental impacts caused by waste which they produce. Polluters are also required to prevent waste from polluting the environment or causing any damage to human health (CoW, 2009). The table 2.7 below

provided a comparison of Solid Waste Management Practices in terms of waste reduction by income level on a global perspective.

Table: 2.7. Comparison of how income levels influence SW reduction globally

Activity	Low Income	Middle Income	High income
Source Reduction	No organised programs. Low waste reuse Low per capita waste generation rates.	Several discussions about source reduction Discussions rarely incorporated into an organised program.	Planned education programs stressing on the 'R's-reduce, reuse and recycle. Product producers more responsible and take product design seriously

Source: Hoornweg and Bhada-Tata (2012:5)

Municipal solid waste per capita generation varies greatly, depending on the economy of a country (Zurbrügg, 2003). Table 2.7 explains that low income countries have a very low footprint in terms of waste generation at source; this can be due to low production rates. On the other hand, middle income countries like Namibia have moderate waste generation at source because of the on-going campaigns in this matter. However, these campaigns do not always provide expected outcomes with regards to SW reduction. On the contrary, high income countries are much focused on the 4Rs waste hierarchy and they are also conscious about producing reusable and recyclable products.

2.6.2. Reuse

As mentioned by Peprah *et al.* (2015) the 4Rs model offers a comprehensive management approach when it comes to municipal solid waste management. Through the 4Rs strategy, all issues and concerns associated with health, environment, aesthetics, land-use, resource management and the economy could be addressed effectively (Peprah *et al.,* 2015). Many people tend to shy away from reusing products because of the perception that these products are old, worn, empty, ugly or broken, and hence throw them away without thinking of the consequences. Nevertheless, not all people ignore the concept of product reuse. Abdul-Rahman (2014) was quoted by

saying *"Waste after all is in the eye of the beholder, one person's trash is another person's treasure*". Therefore, reusing helps to conserve resources, save money and enhance human's creativity.

Table 2.8: Solid waste items and their reusable potential

Items	Re-used purposes
1. Old jars and pots	Store items in kitchens, sore loose items together
2. Tyres	Can be send to tyre recycling plants, make tyre swings
3. Used wood	Firewood and woodcrafts
4. Newspapers, waste papers, envelops	Send to recycling plants
5. Old books	Donate to poor children or to public libraries
6. Old clothes	Donate to poor children, street kinds, or to a charity institution
7. Old electric equipment	Donate to schools or to NGOs so that they can be reused
8. Rechargeable batteries	Can be used again and again to reduce unnecessary wastage
9. Organic waste	Create a compost bin to turn this waste into manure for plant growing

Source: Conserve Energy Future (2018)

In the event of attempting to throw away or dispose of items into wheelie bins or skip containers for disposal, we need to think twice since most waste products can be useful to another person. Table 2.8 clearly validates this argument by providing some ideas in case a person is not aware of what to do with products they call waste in their homestead, office or business.

2.6.3. Recover

This is a solid waste management method whereby recyclable materials are collected. Generally, it involves collecting recyclables from different places in towns/cities to Material Recovery Facilities (MRFs) where they are sorted and cleaned, before being sold to various entities (Breeze, 2012). In the US, recyclables are collected in four ways

which are: curb side collection, drop off, buy-back, and deposit/refund programs (Shin, 2014). In Namibia, it has been observed that solid waste recovering is widely practised by informal waste pickers who make a living by using or selling recyclable products. Similarly, solid waste management staffs also collect recyclable products for the same reasons.

2.6.4. Recycle

Hasheela (2009) highlighted the implementation of recycling initiatives that are currently taking place in private sectors around Windhoek, of which various other towns are also seen to follow suit. For instance, it was mentioned by Waste Management World (2018) that Wilco Recycling is one of the established private recycling company in northern Namibia that also employs close to 50 poor members of the community. Furthermore, this company pays casual workers N$60 (US$8.8) for every bag filled with crushed bottles and cans for recycling purposes (Waste Management World, 2018). These are some of the companies playing a significant role in environmental sustainability, environmental protection and preservation, hence a good example for people to invest in companies of this nature. In addition, Zurbrügg (2003) also found out that these practices are observed in other parts of the world, especially in low and middle income countries. As long as raw materials and financial resources are scarce, it is crucial that local authorities encourage a recycle-based society in order to enhance socio-economic development and a healthy environment for present and future generations (Breeze, 2012).

To point out an example, it was reported in the local media (*Namib Times*) that an estimated 70 tons of municipal solid waste is generated daily in Swakopmund, and about 80% of these waste materials are recyclable (Namib Times, 2016). According to Van de Klundert and Anschütz (2001), the practicality of recovery and recycling has numerous environmental and socio-economic benefits such as:

1. Income generation and job creation
2. Minimising the amount of solid waste to be collected and disposed, therefore,
3. Extend landfills and dumpsite lifespan, more space in waste handling facilities

4. Minimises transportation and landfilling expenditures
5. Increasing local materials supply and avoid imports
6. Reduce production of virgin materials that require high energy use
7. Reduce deforestation
8. Maximise resources conservation, water and energy
9. More materials available for poor communities

Table 2.9: Comparison of how income levels influence SWM collection and recycling on the global perspective

Activity	Low Income	Middle Income	High Income
Collection	Irregular and inefficient. Service is only given to high visibility areas. Only the wealth and businesses are willing to pay. Overall collection below 50%	Improved collection service. Increased waste collection from residential areas. Larger and mechanised waste collection fleet. Collection rate varies between 50 to 80%. Transfer stations are slowly incorporated into the SWM system.	Collection rate greater than 90%. Highly mechanised waste collection fleet (i.e. compactor trucks) Transfer stations are common. Aging collection workers often a consideration in system design
Recycling	Mostly done by informal sector (i.e. waste pickers) Recycling rate high for both for local and international markets. Imports of materials high. Recycling markets are unregulated with many middlemen, therefore high price fluctuations	Informal sectors still involved Several high technologies for sorting and processing facilities. Recycling rates are relatively high. Materials often imported for recycling. Recycling markets are somehow more regulated. Material prices fluctuate considerably.	Recyclable material collection services high High technology for sorting Common and regulated processing facilities. More focus on long-term markets as well. Overall recycling rates higher compared to low and middle

			income. Some existence of Informal recycling (e.g. aluminium can collection).

Source: Hoornweg and Bhada-Tata (2012:5)

As indicated in table 2.9, low income countries usually have an unstable waste collection/recovery rate, due to factors such as financial constraints in the formal sector. Therefore, the informal sector plays a major role in waste collection for direct benefits such as resource recovery and recycling. In middle income countries, waste collection and recycling activities has improved significantly due to formalised and improved processes and facilities. This is also evident in some parts of Namibia as middle income country. Zurbrügg (2003) also highlighted that recovery and recycling activities in low and middle income countries are usually intensive and unsafe jobs, conducted by very low income earners. Different from low and medium income states, high income countries are doing exceptionally well in terms of waste collection and recycling, for the reason that they have sufficient finances and advanced technology to do the job successfully.

2.6.5. Composting

Ecologically, this method is excellent for recycling of biodegradable waste (Zurbrügg, 2003). In general, compostable organic waste such as food scraps handled by this method usually happens in individual household on a small scale (Nteda and Hauptfleisch, 2014). However, some businesses and institutions practise it on a large scale. For instance, in India the Ministry of Environment and Forestry in the year 2000 implemented solid waste legislation which obliges municipalities to introduce household segregation of organic and non-organic waste for composting purposes (Zurbrügg 2003). In fact, if not managed properly, organic waste can cause destructive impacts on the environment (Popov *et al*., 2004). In addition, Nteda and Hauptfleisch (2014) mentioned that organic waste emits greenhouse gases such as methane, which is known to contribute to environmental issues such climate change, air, water and soil pollution, as well as escalating health hazards.

The CoW generates roughly 63% of organic waste which is managed under the municipal solid waste management system (Nteda and Hauptfleisch, 2014). However, these authors revealed that there were no known and documented existing composting initiatives in Windhoek until 2014, when a study on organic waste was conducted. From an environmental perspective, the study conducted by Nteda and Hauptfleisch, (2014) concluded that if 90% (61 000 tons/annum) of organic waste could be composted in Windhoek, the overall waste quantity disposed at the landfill could reduce; hence a reduction in Green House Gases (GHGs) emissions such as methane (CH_4) from landfill. Furthermore, based on Nteda and Hauptfleisch's findings on the socio-economic perspective, if the CoW could compost 90% of organic waste, a large number of job opportunities could be created, causing a huge reduction in the poverty level in the community. Given these points, their study also concluded that organic composting initiatives are financially viable and profitable. Correspondingly, the study conducted by Srivastava and Singhvi (2013) has provided some of the benefits associated with composting as; it allow the soil to gain more nutrients for plant growing, make soil more cultivatable, regulate seasonal soil temperature, prevent soil erosion and many more.

Table 2.10: Comparison of how global income level influence SWM in terms of solid waste composting

Activity	Low Income	Middle Income	High Income
Composting	Rarely undertaken formally. Waste stream has a high fraction of organic material. Lack of composting awareness. Lacking of composting market.	Large composting plants are often unsuccessful due to contamination and operation costs (little waste separation); Some small composting projects at the community/neighbourhood level are more sustainable. Anaerobic digestion almost popular.	Becoming more popular at both backyard and large-scale facilities. Waste stream has a smaller fraction of compostable than low and middle income countries. More source segregation makes composting easier. Anaerobic digestion increasing in popularity. Odor control critical.

Source: Hoornweg and Bhada-Tata (2012:5)

Based on table 2.10, compostable organic materials tend to be more in low income countries but lack of awareness and the market demands make composting activities almost unsuccessful. On the other hand, in middle income countries larger composting companies always suffer because of high operation costs; thus small scale composting projects are more popular. It is observed in Namibia as a middle income country that small scale composting activities are quite common compared to large scale composting projects. Similar to what happens with other solid waste management activities; high income countries are always doing well in terms of composting because they have enough resources and advanced technology. However, compostable materials in these countries are rare since they have increased awareness about the 3Rs waste management hierarchy, prior to waste generation.

2.6.6. Landfilling

According to Kurian *et al.* (2018) landfilling is practised in two methods; namely open dumps and sanitary landfills. On the contrary, Diaz *et al.* (1999) said landfilling has three methods which are: uncontrolled open dump, controlled open dump and controlled sanitary landfill. The landfilling method is most commonly used in MSWM, whereby waste is collected and disposed at landfills (Zurbrügg, 2003). However, among the three methods, controlled open dump and uncontrolled open dump are most common in developing countries, while controlled sanitary landfills are common in developed countries (Zurbrügg, 2003). In Namibia, the most frequently observed methods are controlled open dumpsites and uncontrolled dumpsites.

Kurian *et al.* (2018) defined open uncontrolled dumps/dumpsites methods as “land disposal sites at which solid wastes are disposed in a manner that does not protect the environment, is susceptible to open burning, and is exposed to the elements, disease vectors and scavengers”. In addition, these authors emphasised that open uncontrolled dumps are contributing to excessive environmental, health and safety hazards because they contains toxic dusts, infectious medical wastes, deadly snakes, broken bottles and glasses, explosives etc. In support of the previous authors, Joseph, Nagendran, Thanasekaran, Visvanathan and Hogland (n.d.:10) pointed out that open uncontrolled

dumpsites are characterised by the following issues: No control authority, no access control, no planning, no controlled waste disposal, open public trespassing, water and air pollution, litter, odour and fly nuisance and uncontrolled waste burning. On the other hand, a controlled open dumpsite is defined as an acceptable solid waste operation that has basic control measures but does not comply with fundamental landfill principles but it is step higher than open uncontrolled dumpsite (Joseph *et al.,* (n.d.:12)). Furthermore these authors also pointed out that a controlled open dumpsite is characterised by: control authority on site, controlled vehicle access, controlled waste type entering, basic waste handling techniques, no uncontrolled waste burning controlled salvaging operations and fenced site. Modak (2010) highlighted that dumpsites whether controlled or uncontrolled are common solid waste disposal methods in Africa, followed by sanitary landfills; while open burning, recycling and incineration are practised the least. Sanitary landfills are defined by Joseph *et al*. (n.d.) as a planned, designed, and constructed engineering practice in which operations cause minimum environmental impacts. However, they are not common in developing countries.

On the African perspective, Vidal (2014) pointed out that one of the biggest dumpsites in Africa and in the world is Mbeubeuss in Senegal. In addition, Ghana, Kenya and Nigeria are also some African countries with the largest dumpsites in the world, which affect over 60 million people (Vidal, 2014). The Environmental Protection Agency stated that landfills are more acceptable solid waste management method allowed to accept MSW and non-MSW materials such as: mining wastes, oil and gas wastes, agricultural wastes, land clearing debris, waste tires, infectious waste, municipal waste combustion ash, household hazardous waste (U.S.EPA, 2006). Fatimata (2005) specified that landfills can produce landfill gases such as methane that can also be used as a waste-to-energy source. A good example is the Durban Municipality Solid Waste Project which is reported to produce 3MW electricity from landfill gas (The World Bank, 2015). Furthermore this project is commented to improve air quality at the landfill by reducing the amount of gas released into the atmosphere (The World Bank, 2015).

Usually, if landfills are not managed properly, they can severely pollute the environment. It was mentioned in The Namibian (2010) that landfills and dumpsites need to be fenced off to keep solid waste such as plastics and papers from being blown into the land. In addition, fencing of landfills and dumpsites helps to control the movement of dump scavengers into the dumpsite/landfill. Equally important, DEA (2017) stated that standards for a well-managed disposal site should be under the following conditions; no open burning of waste, cover waste materials weekly (i.e. the use of a bulldozer), site operator present during the day, site fenced, security at night, organised waste pickers (i.e. groups with financial incentives), and solid waste management reporting by the municipality to MET.

Table 2.11: Comparison of how global income level influence SW landfilling/dumping services

Activity	Low Income	Middle Income	High Income
Landfilling /dumping	Low-technology dumping sites. Usually open dumping of wastes. Polluting of aquifers, water bodies, settlements on high level. Often receive medical waste. Waste regularly burned. Major impacts on the health of local residents and workers	Some controlled and sanitary landfills. Some environmental controls. Open dumping is still common.	Sanitary landfills (leak detection, leachate collection, and gas collection and treatment systems in place). Often difficult to open new landfills due to concerns of neighbouring residents. Post closure use of sites increasingly important, (e.g. golf courses and parks).

Source: Hoornweg and Bhada-Tata (2012:5)

Indeed dumpsites are the common methods for solid waste disposal in low income, normally because of lack of finances to construct modern technology landfills (DEA, 2017). Under those circumstances, many low income governments often experience

difficulties in attempting to define their actual solid waste management costs (Zurbrügg, 2003). In addition, it is difficult to build proper solid waste disposal facilities if citizens are not willing to pay for solid waste management services. Hoornweg and Bhada-Tata (2012) illustrated that in middle income countries, dumpsites are still common; but several landfills are also being used. As mentioned earlier, the CoW is the only Namibian municipality that uses a landfill in a middle income area. It is evident that open dumping is commonly practiced in Namibia which Swakopmund Municipality is included. However, it was noted that several municipalities in the country are working on turning their dumpsites into modernised and controlled sanitary landfills.

2.6.7 Waste-to-energy

This method involves combustion of waste as an alternative to landfilling and recycling (Shin, 2014). MSW are collected and sorted to remove recyclables and burn non-recyclables. Furthermore, Shin (2014) explained that heat energy from combustion produces steam that can be used to run turbines and generate electricity. According to United Nations Environment Programme (UNEP) (2010), waste-to-energy plants are not common in Africa but are popular in Europe. To mention a few, UNEP (2010) pointed out countries in Europe, such as France with 126 waste-to-energy plants, Germany with 121 and Italy with 41 respectively. Apart from that, Finland was also reported to have some of the most successful waste-to-energy plants that incinerated approximately 145, 000 tonnes of municipal solid waste per year and generated 90 GWh of electricity (AF Sweden, 2018).

In the Namibian context, waste-to-energy initiatives are not new. It was reported in the local media, particularly the Windhoek Observer (2017) that the town of Ondangwa has signed a Public Private Partnership with a local firm called Ark Industries Namibia to construct a N$300 million 5MW waste-to-energy power plant that will use municipal sewage waste mixed with organic solid waste and energy crops residues to produce biogas. This project will therefore reduce the amount of waste disposal disposed to the dumpsite.

Apart from that, one of the biggest cement manufacturing companies in Namibia, named Ohorongo Cement, was reported to be the first to inaugurate a Refuse Derived Fuel (RDF) processing plant in the country (Ohorongo Cement, 2017). In conjunction with a local waste management company called Rent-A-Drum, about 20 000 tons of non-recyclable materials will be collected annually by Rent-A-Drum to be used at the RDF plant of the Ohorongo Cement as fuel to fire the kiln (Ohorongo Cement, 2017). Furthermore, Ohorongo Cement stated that cement manufacturing processes will ensure a complete combustion of all organic and non-organic waste with no emission. In the same vein the cement producing company is also determined to utilise non-recyclable materials as their third alternative fuel in their fuel mix. Remarkably, Von Oertzen (2009) stated that Namibia has the potential to refrain from using environmental damaging imported fossil fuels and use non-polluting sustainable energy sources. To elaborate more on these potentials, the author mentioned that: biomass such as wood from invader bushes can generate up to 100MW of biomass-to-electricity capacity. In that view, garden solid waste can also be utilised for this purpose. In addition, biofuel can be manufactured from organic waste that ends up dumped in the landfills, while biogas such as methane can be used to generate electricity (Von Oertzen, 2009). Geothermal energy, wave and tidal energy and wind energy are also some of the energy sources mentioned to have energy generating potential but currently not practised in Namibia. On the contrary, coal, waste-to-energy, solar and hydro-electric energy are already reflecting in the Namibian energy sector (Von Oertzen, 2009). This could mean that waste-to-energy schemes in Namibia remain achievable.

On the African continent, UNEP (2005) indicated that the first African country that introduced a waste-to-energy project was Ethiopia. To clarify that, UNEP mentioned that the Ethiopia's Reppie plant is said to have transformed a waste management approach to a more sustainable standard. Approximately 1400 tons of waste which is close to 80% of solid waste per day is incinerated (UNEP, 2005). Apart from that, the project has met European emission standards and is said to supply 30% of electricity to Addis Ababa households.

Table 2.12: Comparison of how global income level influence SW incineration/waste-to-energy practices

Activity	Low Income	Middle Income	High Income
Incineration	Not common and generally not successful because of high capital, technical and operation costs,	Some incinerators are used, but experiencing financial and operational difficulties. Air pollution control equipment is not advances and often by-passed. Little or no stack emissions monitoring.	Prevalent in areas with high land costs and low availability of land (e.g. islands). Most incinerators have some form of environmental controls and some type of energy recovery system.

Source: Hoornweg and Bhada-Tata (2012:5)

As indicated in table 2.12, waste-to-energy practices in low income countries are hindered by financial constraints; hence very little to no such activity take place. In middle income countries like Namibia, there are some relevant activities going on, but not as much compared to high income countries. It was reported earlier by the local media that Namibia has one functioning waste-to-energy project running and one planned to be constructed in Ondangwa. The above mentioned MSWM options form part of Integrated Solid Waste Management (ISWM) approach that involving the use of appropriate technology, working conditions, waste management authorities and the community (Hoornweg and Bhada-Tata, 2012).

Qdais (2007) identified issues such as public health risks, adverse environmental impacts, and socio-economic problems as some serious concerns associated with mismanagement of solid waste. From an economic perspective, there are a number of variables to be considered in assessing costs of collecting and processing MSW; such as the number of people employed to collect MSW, the salaries, number of vehicles, vehicle storage capacity as well as the compacting ratio (Emery *et al.*, 2006). Shin (2014) stressed that MSWM that in most cases there is no precise account of the exact volume of MSW that ends up in the dumpsites, landfills, recycling, and waste-to-energy of composting facilities. This may cause short comings in effective MSWM planning.

Sankoh *et al.* (2007) also highlighted that there is a need to plan, design, operate management system of MSW quantity and composition as well as streamline MSW management services in order to cope with MSW challenges.

According to Hiriya (2003), the fundamental elements of MSW are:

1) **Waste generation:** This encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal.
2) **Waste handling and separation, storage and processing at the source:** This involves activities associated with management of waste until they are placed in storage container for collection. Handling also encompasses the movement of loaded containers to the point of collection. Separation of waste component is an important step in the handling and storage of solid waste at the source.
3) **Collection:** The fundamental element of collection includes not only the gathering of solid waste and recyclable materials after collection to the location where the collection vehicle is emptied. This location may be a material processing facility, a transfer station or a landfill disposal site. Various ways of collecting MSW identified are such as: House-to-House, Community Bins, Kerb Side Pick-Up, Self-delivered and Contracted or Delegated Services.
4) **Separation and processing, and transformation of solid waste:** The types of methods and facilities that are now used for recovery of waste materials that have been separated at the source including kerb side collection drop off and by back centres.
5) **Transfer and transport:** This element involves two steps: i) the transfer of wastes from smaller collection vehicle to the larger transport equipment; and ii) the subsequent transport of the waste, usually over long distance, to a processing or disposal site.
6) **Disposal:** This refers to the disposal of waste, whether they are residential wastes collected and transported directly to a landfill site, residual materials from materials recovery facilities, residue from the combination of solid waste, compost or other substances from various solid waste processing facilities.

A modern sanitary land is not a dump site; it is an engineering facility used for disposing of solid wastes on land without creating nuisances or hazards to environment and public (Lagbas-Aranas, 2015). This theoretical underpinning will be used as an analytical tool to assess how solid waste is generated; handled; collected; separated; transported and disposed in the Swakopmund municipal area to ensure sustainable waste management. Emery *et al.* (2006) said that it is crucial for waste managers and planners to take financial costs involved in collecting, processing and disposing of MSW into consideration, in order to determine the economic viability of MSW management and disposal.

2.7. Integrated solid waste management

The literature suggested that in order to ensure an efficient and effective SWM process, the system needs to be integrated, which is referred to as Integrated Solid Waste Management (ISWM) (Hoornweg and Bhata-Tata, 2012). Additionally, the use of technology in SWM in modern cities and towns is encouraged. However, the choice of the right technology becomes paramount (Sankoh *et al.,* 2013). In line with this, Hye-Jung (2016) claimed that waste crises are mainly caused by factors such as technological advancement, mass consumption, the change of people practices in consumption; as well as the waste disposal behaviour.

Van de Klundet and Anschütz (2001) pointed out that the effectiveness of the ISWM is determined by factors such as professionalism among solid waste managers, the appreciation of critical roles of the community, as well as employees working with SWM. This was echoed by Hye-Jung (2016) who claimed that the hierarchies of waste management such as reduce, re-use and re-cycle are effective tools to manage municipal solid waste. However, Hye-Jung (2016) acknowledges that we are living in the world of increasing resource scarcity, which makes it very difficult to secure land for landfills or dumpsites. One would get an impression that the Swakopmund Municipality is not immune to the lack of resources. Therefore, there is a need to encourage those who are responsible for waste management within municipalities to select ISWM paths and use the 4Rs that prioritise more on prevention, reduction, recycling and recovering

instead of focusing on waste treatment and disposal only. Furthermore, as has been alluded to, ISWM should be guided by the Integrated Solid Waste Management Plan (ISWMP) (Modak, 2010). In line with this, Hoornweg and Bhata-Tata (2012) suggested what exactly should be included in the ISWMP. Table 2.13 outlines the elements of ISWMP as suggested by Hoornweg and Bhata-Tata (2012:25).

Table 2.13: Elements of an effective Integrated Solid Waste Management Plan

- All municipal policies, aims, objectives, and initiatives related to waste management;
- The character and scale of the city, natural conditions, climate, development and distribution of population;
- Data on all waste generation, including data covering both recent years and projections over the lifetime of the plan (usually 15-25 years). This should include data on MSW composition and other characteristics, such as moisture content and density (dry weight), present and predicted;
- Identify all proposed options (and combination of options) for waste collection, transportation, treatment, and disposal of the defined types and quantities of solid wastes (this must address options for all types of solid waste arising);
- Evaluation of the Best Practical Environmental Option(s), integrating balanced assessments of all technical, environmental, social, and financial issues;
- The proposed plan, specifying the amount, scale, and distribution of collection, transportation, treatment and disposal systems to be developed, with proposed waste mass flows proposed through each;
- Specifications on the proposed on-going monitoring and controls that will be implemented in conjunction with facilities and practices and ways in which this information will be regularly reported;
- Associated institutional reforms and regulatory arrangements needed to support the plan;
- Financial assessment of the plan, including analysis of both investment and recurrent costs associated with the proposed facilities and services, over the lifetime of the plan (or facilities);
- All the sources of finance and revenues associated with developing and operating the plan, including estimated subsidy transfers and user fees;
- The requirements for managing all non-MSW arising, what facilities are required, who will provide them and the related services, and how such facilities and services will be paid for;
- The proposed implementation plan covering a period of at least 5-10 years, with an immediate action plan detailing actions set out for the first 2-3 years;
- Outline of public consultations carried out during preparation of the plan and proposed in future;
- Outline of the detailed program to be used to site key waste management facilities, e.g. landfills, compost plants, and transfer stations.
- An assessment of GHG emissions and the role of MSW in the city's overall urban metabolism.

Source: Hoornweg and Bhada-Tata (2012:25)

According to Hoornweg and Bhata-Tata (2012), all elements mentioned in Table 2.13, should be incorporated into the ISWM plan to get excellent results in integrated waste management endeavours. Omitting one or more elements may result in a poor ISWM plan that may fail in future.

Apart from that, various platforms have stressed the need to have an Integrated Sustainable Waste Management framework in the municipal solid waste management arena. Among others, Wilson, Velis and Rodic (2013:55) defined ISWM framework as an "*integrating across three dimensions – all the elements of the waste hierarchy, all the stakeholders involved and all the 'aspects' of the 'enabling environment' (political, institutional, social, financial, economic and technical) used particularly in developing countries"*. Van de Klundert and Anschütz (2001) explained the meaning of the term 'waste' in an ISWM context, namely that waste has two dimensions; both negative and as useful material that has an income generating potential.

Other authors have attempted to find out if ISWM is indeed useful. Among them is Modak (2010:8), who identified the following ISWM opportunities:

(a) Centralised and decentralised options with effective pollution control systems
(b) Strategically planned waste minimisation and sustainable consumption patterns
(c) Facilitate recycling of valuable resources (i.e. plastic, glass, paper and metal) and recover Refuse Derived Fuel (RDF)
(d) Encourage innovative technology development in recycling, waste to energy and promote green jobs with safer working conditions
(e) Ensure multi-stakeholder participation (i.e. NGOs, Community Based Organisations (CBOs), private sector, residential and commercial communities
(f) Bring waste workers into a formal economy and provide them safe working conditions
(g) Address management of both MSW and other waste streams, like e-waste, construction waste, and scrapped vehicles.

Apart from Modak's (2010) contribution on ISWM, Wilson *et al.* (2013) described the ISWM framework holistically with the following diagram (Figure 2.3).

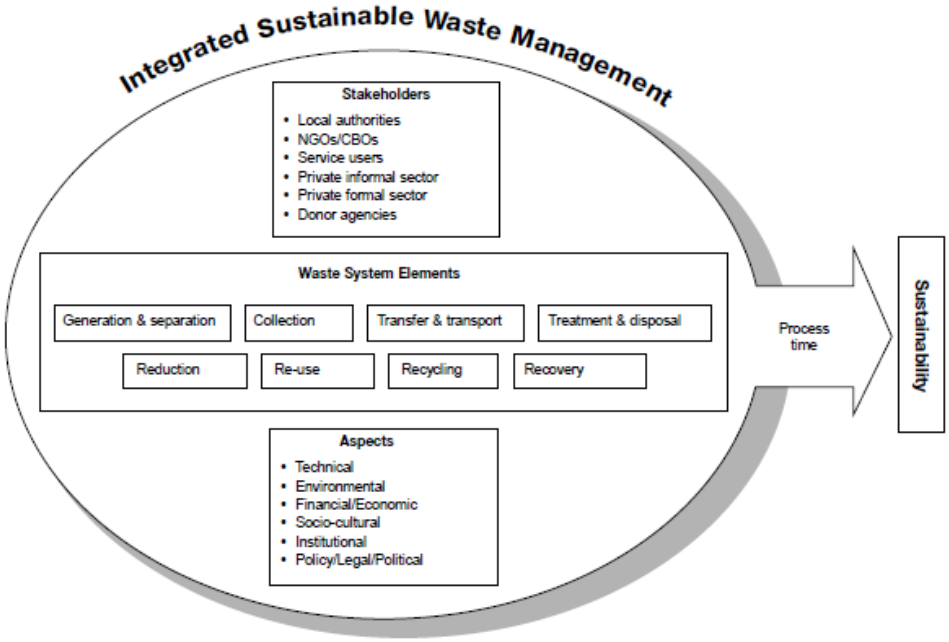

Figure 2.3: ISWM framework

Source: Wilson et al. (2013:57)

In the analysis of Figure 2.3, an ISWM framework should comprise three key drivers for solid waste management which are; stakeholders, elements and aspects working together for the system to attain sustainably (Wilson *et al*., 2013). Van de Klundert and Anschütz, (2001:11) pointed out four basic principles of ISWM:

1. Equity: ensuring all residents are entitled to a proper waste management system for health reasons
2. Effectiveness: apply a waste management model that provides a safe removal of all waste
3. Efficiency: maximise benefits, minimise costs, optimise resource use
4. Sustainability: use waste management system with is suitable to local conditions, yet technical, economic, social, environmental, institutional and political feasible.

This will help to maintain a successful working system in the long run, without depleting the available resources

Furthermore, Van de Klundert and Anschütz, (2001:13-14) also listed six aspects of ISWM as follows:

1. Environmental (Investigate the effects of technology on land, water, air, conservation, pollution control, working conditions for waste workers and public health)
2. Political/legal (set goals and priorities e.g. employment creation, imports reduction, improve environment, determine roles, regulatory framework, legal planning)
3. Institutional (distribution of roles, organisational structures, procedures, methods, planning)
4. Socio-cultural (community involvement, relations between groups and community, ethnicity, social condition of workers, relation between people to people, level of awareness)
5. Financial-economic (budgeting, cost accounting, privatisation, cost recovery, cost reduction, income generation, market place)
6. Technical and performance (practical implementation, maintenance, equipment and facilities)

In summary, the success of drawing up an ISWMP is based on the ability of the municipalities to fully include elements listed in Table 2.13. Among other elements they should furnish their aims, objectives, policies and initiatives that will lead to effective waste management. In addition, the success of an effective waste management depend on demographic and environmental features within the municipalities, therefore these features should be included in the ISWMP. Furthermore, data related to waste generations should be gathered as they are essential for future planning. Equally important, municipalities should ensure financial resources are made available to accomplish the objectives of the ISWMP.

2.8. Circular economy in relation to MSWM

According to The Ministry of Environment-British Columbia (2016) waste management hierarchy supports a circular economy approach that plays a major role in job creation, promote innovation that create a competitive advantage as well as helping secure people and environment. Significantly, various authors and environmental organisations have attempted to define the term and concept of circular economy. Kirchherr *et al.* (2017), defined a circular economy as "*an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equality, to the benefit of current and future generations*".

The research done by Mäkelä, (2017), looked at the concept of circular economy in South Africa, Botswana and Namibia. The researcher gave the background of that concept by stating that a circular economy can be traced back to 1990 in order to provide a solution to environmental issues and resource scarcity. In addition, Lee *et al*., (2017) discovered that reducing, reusing and recycling are the core principles of a circular economy, including the practicality of providing necessary services that support these principles.

In other views, United Nations Industrial Development Organisation (UNIDO) (nd.) describes a circular economy as the new way of creating value and providing ultimate prosperity by efficiently using resources over and over, instead of a once only use. In full support of the concept, UNIDO (nd.) furthermore stated that in a circular economy perspective, the design of products are made in such a way that they are durable, reusable and recyclable; while old products should always produce new products. A circular economy is a cornerstone toward environmental sustainability as the world population grows toward 7.5 billion people (UNIDO, n.d).

Figure 2.4: Circular Economy

Source: UNIDO (n.d:3)

The concept illustrated in the diagram above indicated that waste doesn't really exist because the resources are kept in the economic circle. This means that products are produced and manufactured in the format in which they will be reused, after it has been used for the current purpose. In the circular economy, redundant consumer goods are regarded as input rather than waste, hence providing a lesser environmental footprint by the society (World Economic Forum, 2018). Therefore, municipalities that encourage the 4Rs practice on municipal solid waste, promote green and cleaner production of products, provide better services and collect solid waste are applying and promote the concept of circular economy in their MSWM systems.

The study conducted by Mäkelä (2017) also gave good examples of how the circular economy should function. The researcher outlined examples such as the treatment of biological waste to produce biogas. Furthermore, this researcher mentioned that renewable energy such as solar energy and wind power, biogas should be used to power the circular economy cycle. Apart from that, human labour and material consumption should also be taxed, so that people can reconsider their consumption habit (Andrews, 2015).

Due to current unsustainable methods of production and consumption, many cities and towns have to rethink how they deal with solid waste (Hoornweg and Bhada-Tata, 2012). For example, if producers abide to the production and the use of un-recyclable products that at the end land and rot in landfills and dumpsites without any secondary usage, it means circular economy is not prevailing. Due to this, municipalities could face challenges in applying MSWM systems that ensure environmental and public wellbeing. The intention of a holistic circular economy approach is to allow a natural environment to restore resources and protect it from the negative effects of industrialised waste such as MSW (The Ministry of Environment-British Columbia, 2016). Among others, MSW are considered as main culprit in many environmental issues, decreasing revenue and power generation (Nwofe, 2015). A dirty town/city due to scattered solid waste downgrade the image of that specific place resulting in declined tourism activities and draw back of the economy (Croset, 2014). The theory behind circular economy is that it plays a vital role in mitigating wastefulness of waste resources as well as improving cleanliness in towns and cities which is attributed to a healthy environment. In order to reduce effects of MSW on environment and economy, Saeed *et al*. (2009) suggested that the best strategy is to reduce MSW quantity generated and either to recycle and reuse these waste materials. These are some of the features in the circular economy sphere. In support of Saeed (2009) suggestions, other authors such as Messineo and Panno (2008) highlighted that MSW can also be incinerated to produce energy. This could mean that there is a need to collect MSW and use it to produce new products rather than to collect and store it as waste that is unwanted. This compromise the circular economy objectives mentioned in Figure 2.4.

Most cities and towns in developing economies generates and haul tons of solid waste that are also disposed in undesignated dumping sites consequently leading to clogging of drains, creating feeding grounds for diseases spreading pests, blown by wind and dirtying towns and well as air pollution for decaying solid waste (Nwofe 2015:107). This could also be an indication that the concept of circular economy is applied inadequately. For these reasons Nyarai *et al*. (2016) emphasised that the quantity and compositions of MSW need to be properly managed to reduce environmental footprint. There are

many local authorities/municipalities which provide appropriate SWM services and facilities to the residents such as cleaning of the streets and promptly collection of waste as circular economy concept also entails.

2.9. Legal and Institutional framework for waste management in Namibia

According to Modak (2010) lack of adequate management policy and framework complicate MSWM. Thus, for an effective environmental management and governance, there should be a legal and institutional framework in place to guide these vital practices. Waste management is part of environmental management that fall under the authority of government ministries, municipalities, private companies and individuals. Due to the vulnerability of Namibia's environment, scarce resources, extreme poverty and escalating environmental concerns, all activities that may pose environmental threats are regulated using legal instruments such as environmental laws and policies to benefit the environment and the people (Mapaure, 2011).

Based on the Department of Environmental Affairs (DEA) (2003) prior to independence, Namibia's legal frameworks with regard to the environment were the same as those that have been used in South Africa. As a matter of fact, there has been confusion on what particular legislation can be used to deal with environmental management practices. However, after independence many out-dated legislations, policies and regulations were amended and clarified to suit the practicality of current environmental activities taking place in Namibia (DEA, 2003). Among others, some of the main environmental related laws, policies and legislations existing in Swakopmund and the entire Namibia are defined in the table below.

Table 2.14: Environmental related laws, policies and legislations existing in Swakopmund and the entire Namibia

Framework	Account	Applicability
The Constitution of the Republic of Namibia	Promote and maintain welfare of the people as well as sustainable use of natural resources, provide measures to dumping or recycling of toxic waste	Nationally
The National Solid Waste Management Strategy of 2017	Strengthen solid waste management on institutional, organisational and legal perspective, ensure minimised waste and maximise recycling, ensure formalised solid waste collection, improve municipal waste disposal standards, plan for hazardous waste management	Nationally
Environmental Management Act No. 7 of 2007	Ensure active waste management practices through issuing	Nationally
Local Authority Act 23 of 1992	Provide local authority with an obligation to ensure duties such as waste management, sewage works and drainage system are accomplished with determination	Nationally
Hazardous Substance Ordinance 14 of 1974	To provide control to hazardous substances including their sales, use, manufacture, disposal, dumping, import and export	Nationally
Pollution control and Waste Management Bill of 1999	*Prevent and regulate of air, water and land pollutants; establish appropriate framework for integrated pollution prevention and control, regulate noise, dust and ador, establish system of waste planning and management*	Nationally
Namibia's Pollution Control and Waste Management Policy of 2003	*Improve management and control of all types of waste (hazardous and non-hazardous) in Namibia.*	Nationally
Swakopmund Municipality Waste Management Policy of 2015	*Provide for an improved and efficient waste management agenda to minimise environmental impacts and economic costs involved.*	Locally
Labour Act 15 of 2004	To provide for the precaution against pollution at workplace	Nationally

Atmospheric Pollution Prevention Ordinance 11 of 1976	*To provide for the prevention of the pollution of the atmosphere, and for the matters incidental thereto* (i.e. Regularly monitor air pollution levels caused by industries)	Nationally
Town Planning Ordinance 18 of 1954	*To make provision for the preparation and carrying out of town planning schemes and for matters incidental thereto*	Nationally
Water Resource Management Act 24 of 2004	*Promote the principles of Integrated Water Resource Management, prevent deteriorating water quality and diseases outbreaks*	Nationally
Vision 2013	*Improve country's natural capital to boost ecological and socio-economic wellbeing*	National
Polluter Pays Principle	*Requires waste producers to be accountable for their products from source to disposal.*	Locally
Duty of Care	*Requires waste producers to avoid polluting the environment or causing human health issues from any form of pollution.*	Locally

Apart from existing national laws, Namibia also forms part of international treaties related to environmental issues such waste management and pollution control (DEA, 2003). As given below, these are some of the international agreement that help Namibia to reinforce effective environmental governance and management (DEA, 2003).

They are:

- Montreal Protocol on Substance that Deplete the Ozone Layer, 1987
- Basel Convection on the Control of Trans-Boundary Movement of Hazardous Wastes and their Disposal, 1989
- as well as the Rio Declaration on Environment and Management and Agenda 21
- International Convention on Civil Liability for Oil Pollution Damage, 1969
- International Convention for the Prevention of Pollution from Ships, 1973

- Vienna Convention for the Protection of the Ozone Layer, 1985
- SADC Protocol on Shared Watercourse Systems in the Southern Africa Region,1995
- Cartegena Protocol on Biosafety, 2000
- Framework Convention on Climate Change, 1992
- Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972

It was mentioned earlier that the Namibian legal system on environmental management is governed by an essential national law which is The Namibian Constitution as adopted in 1990 (DEA, 2017). To be specific, article 95 of the Constitution promotes the welfare of the people and the environment. The Constitution states that: "The State shall actively promote and maintain the welfare of the people by adopting, *inter alia*, policies aimed at the following:
(l) maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future; in particular, the Government shall provide measures against the dumping or recycling of foreign nuclear and toxic waste on Namibian territory." In the view of the aforementioned, it is the responsibility of national government, private institutions, individuals as well as local authorities to oversee that waste generated from their activities is managed in an environmental friendly manner, ensure compliance with environmental laws, minimise environmental damage and enhance environmental quality.

From an institutional framework perspective, there are several government institutions that deal with waste management and pollution control in Namibia namely: Ministry of Environment and Tourism (MET) on implementation of NSWM Strategy, Ministry of Health and Social Services (MHSS) on healthcare waste management, Ministry of Fisheries and Marine Resources (MFMR) on marine pollution control, Ministry of Industrialisation and SME Development on supporting SMEs dealing with recycling and other waste management activities, Ministry of Works and Transport on planning

infrastructure among others (DEA, 2017). These institutions play a significant role in environmental management in such a way that they incorporated solid waste, waste water, sewage and sanitation management into their mutual obligation. Apart from that, private institutions and NGOs such as Recycle Forum Namibia, Rent-A-Drum, Enviro-Fill play a significant role towards the realisation of NSWM Strategy (DEA, 2017).

The Ministry of Environment and Tourism (MET) in the year 2017 implemented a National Solid Waste Management Strategy with a vision to make Namibia the leading country in Africa in terms of standards of solid waste management, by 2028. Furthermore, the objectives of this strategy as stipulated by DEA (2017:4) are:

(a) To strengthen the institutional, organisational and legal framework for solid waste management and capacity building
(b) To set up a widespread culture of waste minimisation and expand recycling systems
(c) To implement a formalised solid waste collection and management systems in all populated areas, including under the administration of Regional councils
(d) To enforce improvements in municipal waste disposal standards
(e) To plan and implement feasible options for hazardous waste management.

Apart from that strategy, the DEA (2003), have pointed out other earlier implemented environmental legislations particularly The Pollution Control and Waste management Policy of 2003. The procedures (as indicated) in figure 2.5 below should be followed to ensure that industries have a legal obligation to effectively control pollution and manage waste as per this national policy:

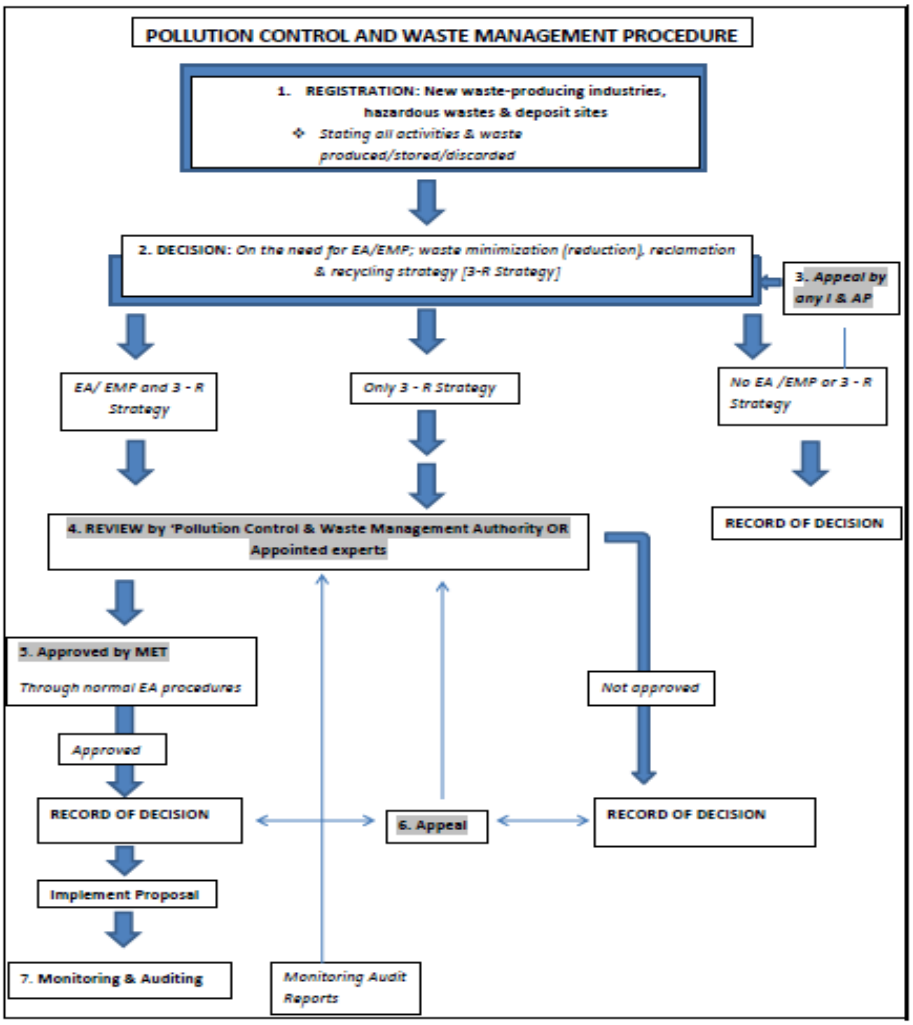

Figure 2.5: Pollution control and waste management procedure in Namibia

Source: DEA, 2003

DEA (2003:19-22) narrated the procedures shown in the diagram by order of seven (7) explained steps, as follows:

1. All industries that produce waste and/or make use of products that are listed in the policy as 'hazardous waste' must be registered by the 'competent authority'. Upon registering, the industries should also propose at least one agency that will be in charge of waste management and pollution control. The nature of activity, waste materials that will be produced as well as products used shall be recorded in the registry. Furthermore, all hazardous waste disposal sites in the country must be registered with the 'COMPETENT AUTHORITY'.

2. Competent Authority shall decide and give feedback to the applicant on whether Environmental Assessment and Environmental Management Plan and/or 4-R Strategy are required.

3. Any decisions by the competent authority with regard to any waste producing activity to undergo an Environmental Assessment (EA), have an Environmental Management Plan (EMP) or 4-R Strategy can be appealed by any Interested and Affected Parties (I&AP) such as companies, individuals or authorities. Such an appeal should provide reliable information to justify the proposed alternative ruling.

4. & 5. The EA and EMP shall be evaluated by responsible authority in the MET directorate of Environmental Affairs. 4-R Strategy shall be evaluated by the 'COMPETENT AUTHORITY' or any other persons or institution appointed by this authority.

6. With reliable justification, any I&AP can appeal a decision of the 'COMPETENT AUTHORITY' with regard to approving or not approving an EA, EMP or 4-R Strategy.
7. Waste producing industry and its waste management agency shall continuously report to the 'COMPETENT AUTHORITY' regarding their 4-R Strategy performance, verification of impact predictions, efficiency of mitigation measures and compliance with all issues raised in the EA and EMP. Periodic independent assessment of all aspects of the development shall also be carried out at all times, as determined by the 'COMPETENT AUTHORITY'.

2.10. Policy and legislation aspects of Swakopmund Municipality

The EU waste policy provides that waste management should consider the following general principles (Hansen *et al.,* 2002:4-5):

1. *Precautionary – states that all activities that may threat human health and environment, precautionary measures should be taken.*
2. *Proximity – states that waste should be disposed close to the source to save time, energy, money and likelihood of accidents*
3. *Polluter Pays Principle – polluters should pay for waste they produce and environmental pollution they caused in production and/or consumption*

These principles correspond with the objectives of the municipal SWM policy. The policy requires the municipality to classify municipal solid waste in terms of waste sources, in order to take precautionary measures in SWM operations. Waste classifications used in Swakopmund are: Building rubble, industrial waste, garden refuse, general waste and cover materials. This is done by a contracted private company Enviro-Fill, which also provides waste classification data to the municipality as per SWM policy.

Apart from that, the Municipality of Swakopmund has a working Municipal Waste Policy of 2015 that was drafted with the guidance of the National Waste Management Policy and other relevant policies. The municipality's waste management administration and regulations are also governed by the national and local legal frameworks indicated in Table 2.14 to reduce negative environmental impacts at all levels. The municipality has also drafted a Municipal Solid Waste Management Plan (MSWMP) in 2015, which is yet to be approved by the council. This means at this point, the municipality does not have an approved action plan to execute MSWM. However, their SWM strategies are based on ISWM framework indicated in Figure 2.3.

Additionally, as per the Swakopmund Municipality Waste Management Policy, the municipality has engaged in on-going council-community programmes aiming to create environmental awareness in the community. According to Mwanangombe, *pers. comm*., (2018) this programme consists of 10 community groups working to together to promote

proper MSWM. Another programme on the cards is the ward cleaning programme which consists of 20 active groups. The programme is focused mainly on the cleaning of open spaces.

Furthermore, the solid waste management section under the Health Department has formed partnerships with other authorities in the municipal waste management sector; including Rent-A-Drum and Enviro Fill. Rent-A-Drum is mainly focused on solid waste collection, disposal and recycling, while Enviro Fill is primarily contracted to control and monitor the Swakopmund solid waste disposal site (Mwanangombe, *pers. comm*., 2018).

The town of Swakopmund keeps growing both in population and in extent, hence waste generation keeps increasing (Mwanangombe, *pers. comm*., 2018). Swakopmund Municipality is operating according to the National and Local laws as stipulated in Table 2.14, to ensure environmental protection and public wellbeing as previously, when all activities that may pose environmental hazards go through the Environmental Impact Assessment processes. As the pressure on the waste disposal facility keeps increasing, it is suggested that the municipality should consider developing the current dumpsite or opt to develop a new sanitary landfill. Last but not least, the respondent emphasised that the council should fast-track the approval of the municipal solid waste management plan, so that further short- and long- term solid waste management plans can be executed. In the same vein, the researcher was interested in the financial aspect with regard to the cost-effectiveness of the MSWM system.

2.11. Stakeholders in MSWM

Local authorities are responsible to oversee and make sure that industries are effectively managing all solid waste they generate. They have prime responsibility to ensure that solid waste materials are collected in urban and peri-urban areas and are disposed at a disposal facility (Breeze, 2012:7). By so doing, they should be aware that stakeholder engagement is a very important in any project, activity, happening in the biophysical environment. It is good to include participants/players in MSWM to ensure a

sustainable solid waste management system. Stakeholders are “key persons, groups or institutions with an interest in a project or programme” (Snel and Ali, 2009:4). In that view, solid waste management programmes are less likely to succeed if local authorities are attempting to do things on their own without involving stakeholders. In most cases, implemented successful waste management strategies are those that involve various stakeholders into waste management programmes. In order to improve efficiency and effectiveness, Modak (2010) suggested that stakeholders in MSWM can involve the community members, private sector, and government institutions, formal and informal sectors. The study conducted by Hasheela (2009) discovered that stakeholders identified in Solid Waste Management in Swakopmund are shown in the table 2.15:

Table 2.15: Stakeholders in SWM around Swakopmund

Stakeholders	Role
Enviro-Fill	Dumpsite operation and monitoring
Refuse Solutions	Refuse removal
West Coast Recyclers	Recycling
Scrap Metals	Recycling
❖ **The bottom two are not mentioned by Hasheela (2009) but actively observed**	
Rent-A-Drum	Recycling, waste collection, skip removers
Residents	Reuse, recycling
Coastal and Marine Pollution Prevention Co-ordinating Committee	Control pollution, public awareness

Sources: Hasheela (2009) and Field Work (2018)

In addition to Modak (2010) ideas, Van de Klundert and Anschütz, (2001), pointed out that other stakeholders in waste management can be dealers who buy, sort and sell waste materials, itinerant waste buyers, informal waste pickers, wholesalers as well as the end-user industries.

2.12. Present and potential impacts of solid waste on Swakopmund environment

According to Mtey (2005), environmental cleanliness influences development of any state, which may sometimes be limited by lack of proper solid waste practices. Korfmacher (1997:477) also mentioned that various developing urban areas suffer large-scale litter problems because there are ineffective and inappropriate ways for residents to dispose of solid waste. It is perceived that generally, Swakopmund is a clean town. However, this does not mean there were never environmental impacts and public health issues recorded. Residents living in informal settlements are highly exposed to an unhygienic environment, due to issues of illegal dumping, and are hence highly susceptible to diseases. Furthermore, informal waste pickers at the dumpsite are also subjected to serious health and safety risks, especially when they lack protective equipment. Previously and in recent years several environmental issues have been reported with regard to public health and environmental quality. The problem of littering is alarming in this region.

Swakopmund being a tourism and recreational town, it is observed that most solid waste is generated regularly by residents, recreational anglers and tourists during recreational activities happening along the shore. Among the most observed solid waste items are: glass bottles, aluminium foils, beer cans, cigarette packages, ropes, fishing reels, plastic bags and bottles. Some of these waste items ended up in the ocean. The amount of litter downgrades the image of the town and has caused a decline in potential investments. Apart from that, air pollution within the vicinity always exists at the dumpsite. The decaying of organic waste materials causes a very bad smell to the ambient environment, and an ideal place for bacteria hence poses a respiratory problem to people living near and those working at the dumpsite (Naidoo, 2009). In addition, the material burning site across in the vicinity also causes air pollution. According to Naidoo (2009:37), factors influencing litter quantity and composition are:

1. Tourism – as more tourists visit the area more garbage is generated
2. Legislation – legislation and policies help to reduce litter, however lack of enforcement facilitates the litter problem

3. Weather pattern – extreme seasonal winds and rain spread litter
4. Natural landscape – more vegetation causes litter from leaves, branches, wood
5. Community initiatives and awareness – the level of community awareness influences litter composition and quantity; communities that are environmentally conscious take part in environmental cleaning up.
6. Industrial development – the more the industrial development, the more litter is produced

According to Hikuafilua, *pers. comm*,. (2018) Swakopmund dumpsite is fenced with a 2 metre high fence. However, the height of dumped solid waste is approximately 4 metres. Solid waste such as plastics and papers were observed blown away by the wind and polluting the desert and the surrounding environment. Apart from that, countless flies are also observed at the dumping site and surrounding environment and this could have an impact on human health. As a result, incidents of solid waste related diseases outbreaks have been reported. In July 2018 the MoHSS confirmed the four (4) cases of hepatitis E outbreak in the DRC informal settlement and suspected cases in other suburbs too (The Namibian, 2018). Apart from that, the region of Erongo in which Swakopmund is located is reported to have the highest HIV prevalence in the country. According to UN-HABITAT (2009) if informal waste pickers operate without protection measures, they are at high risk of contracting HIV when handling solid waste mixed with hospital waste.

In addition The Namibian (2018) also reported the alarming pollution on land as well as at sea, due to high volumes of solid waste dumped ashore and at sea. These diseases are all among those associated with improper MSW collection and disposal and lack of public awareness. Public awareness regarding solid waste management and environmental issues cannot be neglected, because it is very important for sustainable MSWM. Educating members of the public make them potentially ready to solve environmental issues that may arise. The proximity of the dumpsite from residential areas poses high risk to public health and environmental pollution. Diseases carrier insects such as flies can travel several kilometres, therefore easily reaching the

residents. In addition, unpleasant odour that reaches residents causes health hazards and damage quality of life. Apart from that, land and houses/property values may also decline. This may thereby cause a downturn in the economy of the town in general, because unhygienic environment also discourages tourism and potential investors. In terms of litter there is a high possibility of solid waste blown by the wind to reach the sea and affect the entire ecosystem, thus harming marine and terrestrial life. Wildlife such as sea birds, jackals, hyenas, crows as well as domestic animals such as dogs may easily access the dumpsite to feed on waste. Feeding on waste poses a high risk to harm the entire ecosystem as poisonous chemicals enter the food chain.

2.13. Empirical studies on MSWM

Various case studies, case reports and prevalence studies conducted about MSWM in Namibia and around the world unveiled informative information on MSWM point of view. Some empirical studies found that the most common MSW disposal methods of solid waste disposal in Namibia are landfills and dumpsites. The study conducted by Mughal (2014) found out that Windhoek city is the only municipality that uses a landfill for waste disposal and the rest of the municipalities in Namibia use dumpsites. Hence, the current waste management situation cannot be regarded as adequate (Mughul 2014). Ngoc and Schnitzer (2009) described waste as any objects that human or institutions do not have an intention to exploit or goods that are about to be disposed of or already disposed of. That was the authors' definition of the context of waste which is also understood in countries like Namibia, as defined in the GRN's Environmental Management Act (7 of 2007) (GRN, 2007). Ngoc and Schinitzer (2009) also extended their explanation of waste by highlighting that waste items are composed of various aspects ranging from garden refuse, sewage, disposed motor vehicles, domestic garbage, disposed industrial goods, disposed electric and electronic materials, disposed metals, disposed expired paints, disposed bricks and interlocks and many more. In that manner, NACOMA (2016) also highlighted that solid waste incorporated the waste produced by household, industrial, construction, decommissioning and services sectors. In Namibia, it is however evident that the existence of solid waste in cities, towns and

settlements is indeed increasing; with factors such as urban and industrial expansion, economic growth, high population growth among others.

According to Onibokun (1999), municipal solid waste management involved major challenges in many cities and towns in Sub-Saharan Africa because of rapid population growth, social and cultural changes, extreme poverty, weak and inadequate local governance and financial constraints. Due to the current global economic crisis and other factors, various local authorities in Namibia are also going through similar solid waste management challenges pointed out by Onibokun (1999). Similarly, the study conducted by Arzumanyan (2004) also concluded that waste generation is being driven by factors such as economic growth and household income, the awareness level as well as demographic and cultural factors.

The study conducted by Mtey (2005) revealed that actions of irresponsibility and negligence in solid waste disposal are a serious challenge in many countries. This could be the reason why environments polluted by solid waste are visible in many towns and cities I came across. In Swakopmund, residents living in close proximity to the current landfill have been complaining of persistently bad odours, especially on windy days. This could be due to greenhouse gases generated from the landfill as stated by Mtey (2005) that the effects of organic waste dumping in landfills generate greenhouse gases that pollute the air, as well as leachates that pollute ground water sources. This point was also supported by U.S. EPA (2006) by affirming that the world methane emission of estimate of 12% comes from anaerobic decomposition landfills and dumpsites. In the same vein, Croset (2014) also stressed that air and water pollution are some of the major concerns concerning dumpsites.

Apart from that, air is also being polluted by smokes emitted from fires burned by community members who make a living from recovering recyclable materials from the dumpsites. The same situation is also evident in Namibia. Informal landfill workers burn recyclables at various landfills in Namibia, such as wood, electric cables, metals and steel wires so that they can generate energy as well as making these materials suitable for selling or building their dwelling. Sharholy *et al.* (2007) mentioned that communities

living near or working at the dumpsites and landfills are highly affected by respiratory and intestinal issues, due to air and water pollution.

The common ground is that issues associated with municipal solid waste management need to be addressed and mitigated. Henry *et al.* (2006) also support the above common ground by stressing that management of solid waste should be a duty involving public service, and municipal agencies. This is quite crucial because making solid waste management a mutual responsibility can make solid waste management a success due to effective collective effort. Waste management methods may vary in other parts of the world; however landfills and dumpsites as waste management methods are commonly used in Namibia as a developing country.

Nevertheless, Croset (2014) have recorded some other effective methods of waste management used especially in developed countries such as incineration, pyrolysis, gasification, digestion, composting as well as recycling and reuse. The study conducted by Shin (2014) about generation and disposition of MSW in the United States has found that the best method to manage MSW is to reduce the amount of solid waste, the second best methods are recycling and reuse followed by composting, and combustion/gasification. Landfilling is identified as the least best MSW management method. These types of waste management methods may also be successful if adopted by developing countries like Namibia, to reduce issues related to municipal solid waste handling and disposal.

Inappropriate handling of waste can be associated to atmospheric, water and soil pollution which can be harmful to human health (Giusti, 2009). Apart from that, NACOMA (2016) stated that a harmful environment causes detrimental effects to biodiversity as well as to ecosystem services. In order to avoid environmental damage through effective handling and disposal of solid waste, there is a need to segregate waste. The term waste segregation according to Chintan Environmental Research and Action Group (n.d) simply means to separate waste into dry and wet, to make it easier

to handle. Furthermore, Chintan Environmental Research and Action Group (n.d) highlighted the importance of waste segregation as follows:

(a) Improper waste separation results in a mixed up waste in landfills and dumpsites that later form a toxic soup at the bottom which contaminate groundwater and release explosive methane gas,

(b) The release of methane as a greenhouse gas causes climate change, the effect of climate change causes drought and other disasters,

(c) Proper waste separation ensure health of the WM workers, this means using hands to pick up unsegregated waste results into cuts that may cause infections, hence it is important to segregate waste right at the source,

(d) Improper waste separation causes resources wastage, meaning less recycling activities could take place due to difficulty in removing recyclable materials a landfill/dumpsite.

From the above mentioned views, it is should be encouraged that waste segregation begins at waste source/point. The action of segregation of waste at waste generation point is also crucial in a manner that toxic and hazardous pollutants are eliminated at the beginning; this practice also helps to improve the recycling process, composting and restricting the amount of waste to be discarded, a process which is also essential in acquainting people with knowledge of different waste types (Giusti, 2009). This can play a major role in achieving sustainable waste management and improving economic growth in the country. According to Zakianis *et al.* (2017), it is very important for environmental managers to encourage their society to develop waste management variables such waste sorting behaviour, waste handling, knowledge of managing waste, environmental concerns, waste management education and waste management counselling.

Nyarai *et al*. (2016) found that sub-Saharan African states rarely recycle waste; therefore waste ends up being discarded at unregulated landfill or dumpsites and this action contributes to serious health issues. Lack of recycling capital and knowledge may

also be a reason why recycling is low in sub-Saharan Africa. In his study, Kaufman (2008) indicated that shortage of finances is the common factor attributed to poor waste management. In developing countries like Namibia, economic issues are hindering the collection of waste and motivate members of the public to engage in illegal dumping. The searching of municipal waste materials from garbage bins by the poorest members of the communities also contribute to the amount of waste scattered on the surrounding areas (Aiyambo, 2017). This should be addressed through implementation and enforcement of new and existing laws. According to Nyarai *et al*. (2016) there is a need to implement relevant laws, in order to curb illegal dumping and secure effective waste management effectiveness and strategies. The effectiveness of solid waste management can possibly secure publics with a healthy environment and ecosystem services that improve wellbeing, reducing illness and avoiding diseases outbreak.

Hasheela (2009) mentioned that waste management is an essential component of environmental management in Namibia, because waste can have side effects on the environment. In addition, Hasheela also mentioned that Namibia is facing a serious waste problem driven by lack of organisational capacities in handling waste in various towns, issues of financial constraints as well as lack of competence in managing pollution. Of course, the need for preventive action for discarding solid waste remains an immense challenge in Namibia and this situation may hinder the possibility of attaining sustainable economic growth. Aiyambo (2017) argued that several waste management systems in Namibia are ineffective in reducing waste problems and ensuring mitigation of environmental impact as a result of environmental contamination.

The Namibian Coast Conservation and Management, also known as NACOMA (2016) report have stated that waste management in Swakopmund is also a great concern due to ever escalating volumes of waste, littering and illegal dumping. This situation may also be fuelled by very low recycling activities at the source of waste due to lack of incentives and/or disincentives. Hence NACOMA has identified littering from Swakopmund landfill as causing health impacts to domestic and wild animals including seabirds. NACOMA (2016) also stressed that the root course of litter around town is ignorance and poor waste management.

2.14. Theoretical framework

To assist the study in yielding accurate and desired results, a theoretical framework is needed to serve as a lens through which the study is viewed. To this effect, the Waste Management Theory (WMT) was found to be the most appropriate for this study. The Theory of Waste Management represents a more in-depth account of the domain and contains conceptual analyses of waste, the activity upon waste, and a holistic view of the goals of waste management. The WMT is founded on the expectation that waste management is to prevent waste causing harm to human health and the environment (Lagbas–Arams, 2015). It is based on the hypothesis that the way we describe a target prescribes action to achieve it, which implies that sustainable waste management depends greatly upon how it is defined.

According to this theory, the proper definition of waste is crucial to constructing a sustainable agenda of waste management. It is largely the case that current legislation relates to existing waste and not to waste prevention. Definitions emerging from this condition may, however, conflict with the goals of waste prevention, because something that existed already cannot be prevented from arising. When material is assigned the label of ‘waste’, it will be treated as such; consequently despite its explicit wish of waste prevention, implicitly, legislation essentially amasses waste. The inherent philosophical implication of such definitions is that they are not able to facilitate a sustainable waste management system. Therefore, new, dynamic definitions for waste management must be sought, which can explain why waste is created and can offer intrinsic solutions for the problem. A radically new approach, based on object-oriented modelling language, is proposed to define key concepts of waste management (Popov *et al.,* 2004).

To be able to design the most appropriate waste management system, the proper theoretical background had to be established. The WMT embraces the following notions (Popov *et al.,* 2004):

- Waste management is to prevent waste causing harm to human health and the environment.
- The primary aim of waste management is the conservation of resources.

- We shall avoid waste creation, primarily by creating useful objects.
- Waste management is to encompass the goal of turning waste into non-waste.

The practical values of WMT thus are (Popov *et al.* 2004):

- Giving answers to conceptual questions by explaining waste and concepts.
- Providing a guide for choosing waste management options.
- Providing a foundation for how and when to select and integrate waste management options.
- Predicting the outcomes of the use of waste management actions.
- Aiding legislation in how to prescribe activity for/upon waste.

This theory will be used to give an account of an in-depth analysis waste, the activity upon waste, and a holistic view of the functions and goals of waste management.

2.15. Conclusion

This chapter discussed the review of the literature related to this study. The chapter gave an account for definitions of waste and waste management, types of waste, sources of waste, empirical studies related to this study and theoretical framework. These aspects of the literature review were drawn from international best practices and hence used to inform this study. The best practices from the literature were used to formulate recommendations for the practice at Swakopmund municipality. The next chapter will discuss the research design and methodology.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This chapter discusses the research design, methodology and methods used in this study. Mouton (2001) uses the term 'research design' to indicate the 'type' of study that is to be conducted. In other words, the research design captures the conceptualisation, idea, plan or blueprint of the research type. On the other hand, research methodology is the approach, logic or principles that underpin the choice of a broad approach to conduct research such as qualitative, quantitative, and mixed methods. Furthermore, research methods refer to research task-specific choices of methods used for selecting cases, measurement, data collection, and data analysis (Mouton, 2001).

3.2. Research design

Research design is the framework that guides decision about the collection and analysis of data (Anderson, 2013). The most appropriate research design which is employed for this study is evaluation research using a case study approach. Mouton (2001) points out that evaluation research aims to answer the question of whether an intervention (programme, policy or strategy) has been properly implemented; Swakopmund town MSW management and disposal methods and processes in this case. According to Creswell (2014:14) "…case studies are designs of enquiry found in many fields, especially evaluation, in which the researcher develops an in-depth analysis of the case; often a programme, event, activity, process, or one or more individuals". For this study, the case was an assessment of the practice of MSW management in Swakopmund municipality.

The case study research was found to be an appropriate approach to establish an understanding of the phenomenon being studied, that is, MSW by focusing on a specific town instead of being general. In particular, Swakopmund was selected as a case study for this research. Such an approach is aims to assess the phenomenon of interest through obtaining different viewpoints as the researcher interacted with various

participants (Maree, 2008). This approach helped the researcher to develop an understanding of the dynamics of MSW for Swakopmund in particular and in general.

3.3. Research methodology

There are three broad approaches to research, namely qualitative, quantitative, and mixed methods (Creswell, 2014). In this study, a mixed methods approach was employed. Creswell points out that mixed-methods research is an approach to enquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using case study. A case study is an in-depth study in which an individual, group or a particular situation is studied to produce rich descriptive data (Creswell, 2014). In this study, both quantitative and qualitative data were collected to determine the environmental and economic aspects of MSW disposal, in the case of Swakopmund town.

3.3.1. Study area

A selection of study site is a procedure in which a researcher makes changes in an instrument based on feedback from a small number of individuals who completed and evaluated the instrument (Creswell, 2014). This is also done to ensure that both items in the instruments were clear and did not lead to misinterpretation. In this study, the site of the study was the town of Swakopmund, Namibia.

Situated in Southern Africa, Namibia is one of the largest countries in Africa with a surface area of 824,000km^2 (Mfundisi, 2012). It one of the member states of the Southern Africa Development Community (SADC). In terms of the population, Namibia is among the lowest populous countries in southern Africa with 2.1 million people and a population density of 2.55 people/square kilometres (Namibia Statistics agency, 2011). The population concentration is more in the rural northern area as well as in urban areas of Windhoek, Walvis Bay and Swakopmund. Hasheela (2009) cited Gaomab (2005) that Namibia is a middle-income country. The Gross Domestic Product (GDP) is 12, 300 million US$ and GDP per capita of 5, 850 US$ (Mfundisi, 2012). The country is attractive with some notable physical features such as the Namib Desert, Kalahari Semi-Desert and the Southern African Plateau.

Swakopmund was founded in 1892 as the main harbour of the then German South West Africa. Also better known as 'Swakop', it is Namibia's biggest coastal town (Area of 196.3km^2) and famous holiday destination for Namibians and foreigners. The capital of Erongo administrative district, Swakopmund is also regarded as one of the cleanest towns in Namibia. This town is of German origins hence pronounced by beautiful old German Colonial architecture throughout the city. The town is located at the edge of the Namib Desert to the east and Atlantic Ocean to the west and Swakop River to the south. From Windhoek the capital city of Namibia, by road Swakopmund is found on the west coast on the B2 road connecting this city to the neighbouring harbour town of Walvis Bay.

The major economy and infrastructural development primarily depends on mining, tourist, technology, housing and public health. Surrounded by the Namib Desert to the east and cold Atlantic water to the west, the climatic condition varies from time to time and average temperature ranges between 15˚C and 25˚C. The average rainfall received per annum is less than 20mm. However the cold Benguela current is the main source of moisture in the form of fog that reaches up to 140 km inland. The surrounding fauna and flora are highly adapted to this condition and rely on fog as source of moisture. As mentioned earlier, today the town is home to up to 44,725 inhabitants, a population which is continually growing.

Figure 3.1: The location of Swakopmund town in the Erongo Region map

Source: Google maps

3.3.2. Population of the study

According to Gay *et al.* (2011), the population of the study is the general term for the larger group from which the sample will be selected. In this study, the population included all employees dealing with solid waste management at Swakopmund municipality.

3.3.3. Sample and sampling techniques

For the purpose of selecting the study sample, the stratified purposive sampling technique was used. This technique was used because the researcher was motivated to work with participants who are knowledgeable about the waste management system in Swakopmund town (Maree, 2008). According to Creswell (2003), small samples (probably no more than 10 participants) are most suitable for this type of research. Therefore, in this study, a maximum of 10 participants in total from Swakopmund municipality participated in the study. In addition, there is only one landfill in Swakopmund and few illegal dumpsites. All of them were visited for observation of waste handling facilities.

3.3.4. Methods of data collection and instruments

A researcher needs to consider what method(s) can be most appropriate for answering the questions the study would like to want to investigate (Creswell, 2003). As has been alluded to, research methods are research task-specific choices of methods used for selecting cases, measurement, data collection, and data analysis (Mouton, 2001). The qualitative method should be in the form of semi-structured interviews with Swakopmund municipal employees at various levels, dealing with waste management. Quantitative data should be collected through structured questionnaires to be administered to the selected institutions and residents. In addition, quantitative data should also be collected through direct observation using observation checklist. Direct observation assisted by Enviro Fill personnel was carried out at Swakopmund dumpsites/landfill sites, industrial area, sewage treatment plants, commercial properties, areas of sensitive or protected biodiversity to identify and analysing possible environmental issues as well as assesses solid waste management systems and disposal practices in the municipality and identifies the suitable and best practice procedures.

Data were collected using four instruments, namely documentary analyses, interview protocols, questionnaires with structured item, and observation checklists. These instruments were self-designed.

3.4. Data analysis

Quantitative data collected through document analyses, observation and questionnaires were analysed using the Microsoft Excel PivotChart Tools. The data were presented using categories and tabulation and quantitative data are represented using descriptive statistics such as table, means, and frequency distribution. Qualitative data collected from interviews were digitally recorded and manually recorded by the researcher himself. The ATLAS.ti, a computer-assisted qualitative data analysis (CAQDAS), was used to uncover and systematically analyse complex phenomena hidden in unstructured text data from the interviews. Qualitative data were qualitatively analysed, discussed and interpreted in written narrative form as per qualitative research method conventions.

During data presentation and discussion, qualitative and quantitative data were merged and interpreted to give meaning to research findings. The principles of validity and reliability are fundamental cornerstones of the scientific method. To enhance the validity, reliability, and trustworthiness of the findings in this study, the researcher employed consistent measurement procedures for the proposed interpretations and evaluated evidence related to the inferences made. The researcher used triangulation as a way of ensuring validity, reliability and credibility of the findings. Triangulation is defined as a technique that involves using multiple data sources to inform an investigation to produce understanding (Honorene, 2017:91-95)

3.5. Ethical considerations

Anderson (2011) points out that whenever research is conducted on people, the well-being of research participants must be the top priority. The research question is always of secondary importance. This means that if a choice must be made between doing harm to a participant and doing harm to the research, it is the research that is to be sacrificed (Welman and Kruger, 2001). Hult (1995) indicates the following ethical principles when conducting qualitative research. Assuring respondents of critical issues, such as confidentiality and anonymity and how this is adhered to, is imperative for the

success of any study. According to Best and Khan (2014), “ethics in research are important in ensuring the humane treatment of participants”.

This study conformed to research ethics in such a manner that permission was sought from, Swakopmund municipality and participating businesses and individuals. Informed consent was gained from the participants to be interviewed. Ethical clearance was sought from the Research Ethics Committee of Stellenbosch University. Only after the researcher obtained ethical clearance and permission, did the study commence.

The purpose of the study was explained and participants were assured of a high level of confidentiality; and they were informed that their personal information was not going to be disclosed. Participation was on a voluntary basis and informed consent was obtained from each respondent. The anonymity of all respondents was guaranteed and personal information was kept confidential at all times.

3.6. Conclusion

This chapter presented the research design and methodology. The chapter discussed the design and methodology used in this study. The study population, sample and sampling techniques, methods and procedures for data production, ethical consideration, and data analysis were discussed. The next chapter will present data presentation, discussion and interpretation to give meaning to the research findings.

CHAPTER 4: DATA PRESENTATION, DISCUSSION AND INTERPRETATION

4.1. Introduction

This chapter presents an analysis of the current implementation of municipal solid waste management (MSWM) systems in Swakopmund, based on the qualitative and quantitative data collected and direct observation assisted by Enviro Fill personnel. The chapter provides a presentation and interpretation of data on the current municipal solid waste management practices in terms of waste collection and disposal methods, waste composition status, demographic features, solid waste management awareness and community participation, as well as the perception of the community with regard to MSWM.

4.2. The municipal solid waste management system in Swakopmund

Effective management systems are not only technologically based, but also involve environmental, socio-cultural, legal, institutional and economic linkages for the overall system to operate (Guerrero *et al.* 2013:228). In addition, these authors emphasised that a sustainable system includes numerous factors such as skilful and experienced personnel, suitable equipment, right infrastructure, appropriate maintenance and operation as well as efficient financial support. Equally important, the system should be able to provide reliable data essential for planning, evidence-based decision making, policy formulation and to determine areas of improvement (Guerrero *et al.,* 2013). The National Solid Waste Management Strategy (NSWMS) is an important document that provides directions, regulations, funding and action plan to improve solid waste management (DEA, 2017). In addition, the National Solid Waste Management Strategy is connected to the following components (DEA, 2017:7)

1. *High-level commitment at national government to high standards of SWM*
2. *Staff resources and responsibilities for implementation of the strategy*
3. *Legal framework and enforcement*
4. *Capacity development, training, awareness and participation*

5. *Budgets for implementation and financial management*
6. *Monitoring and reporting*
7. *Waste minimisation, reuse and recycling*
8. *Waste collection and transport*
9. *Waste treatment and disposal*

Apart from that, the U.S.EPA (2009) indicated the classes of ISWM as follows:

- Source reduction – this class is ranked number one imperative to manage SW because it has great potential to avoid pollution, minimise resource consumption, minimise system costs, and maximise efficiency.
- Recycling and composting – this class come second in SWM because it involves material collecting, reusing, re-manufacturing of products; however, it will only be successful if source separation is encouraged and maximised.
- Landfilling and combustion – According to the USEPA, these classes are rated the same and at the bottom of the priority listing; however, they are both viable in terms of SWM.
- Sanitary landfill – this is essential to manage non-recyclable and non-combustible waste and is the ultimate waste disposal methodology.

Based at the components of NSWM strategy in conjunction with the classes of ISWM, Swakopmund MSWM strategies are critically analysed to determine whether this is in line with the best practices, as identified in the literature review.

4.2.1 Solid waste generation and separation

The study established that generally, municipal solid waste in Swakopmund is generated from all sources as those outlined by the United Nations ESCAP (2018) in Table 2.3. It is evident that the types of solid waste mentioned in Table 2.3 are found there, except the types of waste from agricultural sources. However it is also evident that there is a lack of effective waste separation practice at household level. Of the total household waste collected, at least 85% is mixed up and dumped into the disposal site (Singhal and Pandey, 2000), who pointed out that generally, at household level, there is

no systematically planned MSW segregation making the effectiveness of waste sorting practically nil. Therefore in most cases, the sorting of waste take place at an informal level, under risky and unsafe conditions. The absence of waste sorting mechanisms minimises appropriate scientific waste disposal (Singhal and Pandey, 2000). Guerrero *et al.* (2012:224) pointed out that waste separation is further hampered by factors such as:

(a) Lack of awareness about the impacts of SWM systems.
(b) Lack of knowledge about good practice and the use of appropriate technology.
(c) Lack of equipment and machinery used to manage and recycle waste.

According to Arzumanyan (2004), waste collection is one of the effective tools that can provide efficient data for present and future use. In addition, Arzumanyan (2004) cited that it is extremely useful to estimate, because it is helpful in minimising uncertainty regarding solid waste composition. According to Hikuafilua, *pers. comm*. (2018) the company that is contracted to monitor the solid waste management facility does not have a mechanism to weigh municipal solid waste and provide the exact figure of waste volume disposal. Hence, data regarding the volume or weight of solid waste entering the dumpsite is based on personal estimation. It was unfortunately impossible to get a calculated actual volume of solid waste entering the dumpsite; but estimated figures were provided. Apart from that, the site visit also provided an ideal platform for the researcher to look at the waste composition in the entire dumping process. Table 4.1 summarises the solid waste composition observed. The volume estimate was done with the assistance of an expert personnel in waste volume estimation from Enviro-Fill waste management company that manage Swakopmund dumpsite.

Table 4.1: Estimated municipal solid waste composition fraction at Swakopmund disposal site by observation

Fractions	Waste components	Occurrence status	% Volume estimate
Organic	Compostable (plant debris), food waste, wood, garden refuse	Abundant	15
Plastics	Hard plastics, clear plastics, carry bag plastics, clear plastic bottles, green plastic bottles, brown plastic bottles, plastic pipes,	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
Grass	Recyclable grass	Common	9
Cans	Metal cans, steel cans, aluminium cans	Common	7
Refuse-Driven Fuel (RDF)	Rubber, tailings	Common	6
Non-ferrous	Aluminium	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	2
Ferrous	Steel packaging	Not common	1
Earth based	Ceramics	Not common	0

Source: Own observation assisted by Enviro Fill personnel

In previous years, several municipalities in Namibia had efficient MSWM systems, due to lower urbanisation and enough resources, but currently, urban populations are growing, thus causing inefficiencies in MSWM systems. Large volumes of mixed types

of MSW are received frequently at the Swakopmund waste disposal site. It is essential to have a theoretical background about the types of MSW generated in Swakopmund to be able to manage these waste appropriately. In Swakopmund, MSW includes the following categories:

- *Biodegradable/organic* (food waste, papers, plants debris, fruits, wood etc.)
- *Non-biodegradable/inert* (concrete, glass, tiles, bricks, some plastics, tyres etc.)
- *Recyclables* (cans bottles, glasses, papers, metals, plastics etc.)
- *Composite* (waste clothing, footwear, tetra packs, plastic toys etc.)
- *Domestic hazardous* (medicines, spray cans, shoe polish, e-waste, pesticide containers, cell phones, light bulbs, PCs, TVs, vacuum cleaners etc.)

Domestic hazardous wastes such as e-waste are also slowly becoming more and more significant, in the solid waste stream. The study conducted by Naidoo, (2009) revealed that e-waste items may contain heavy metals like mercury, lead and cadmium that can be dangerous to the environment. It is unfortunate that some of these items are found at the dumpsite, even though they should not be dumped there. This could be attributed to an increase in the local community's technological advancement. Municipal solid waste disposal facilities are getting full, due to daily increasing waste disposal. As indicated in Table 4.1, waste composition in Swakopmund mainly consists of compostable organic waste, and solid waste of recyclable value such as plastics, boxes, papers, glasses and cans. This indicates that households are major solid waste sources, followed by businesses, industrial and commercial activities. This calls for maximised reduction, reusing, recycling and composting activities, at household, businesses and municipal levels, to reduce resources wastage. There is also a great need to educate the community and encourage them to start implementing the waste management processes at home, so that they can be aware of the role these play in reducing environmental damage by MSW. It is stated in the study conducted by Okot-Okumu (2012) that high income communities generate large solid waste volumes, because they buy many consumable goods. In comparison, lower income communities spend their money on buying mostly food items, which are consumed with a much lower disposal rate.

As mentioned earlier, field work observation gave clear evidence that the Swakopmund solid waste disposal facility has a large fraction of building rubble that is also found in large volumes. However, electronic wastes and earth-made materials like ceramics are not so common in the SW fraction. The researcher's direct observation has estimated that more than 50% of the fraction is made of recyclable waste materials, even though most of the recyclable materials cannot all be retrieved from the waste products. The organic waste, at 15% of the total, makes a higher fraction apart from building rubbles. This data relates positively with the study conducted in Macao, China; where organic waste made up 15% of the total waste generated, while 52% accounted for recyclable waste materials (Jin *et al*., 2006). Building rubble's common availability attracts much attention from the informal waste pickers.

4.2.2 Quantities of Municipal Solid Waste generation and collection in Swakopmund (2016-2018)

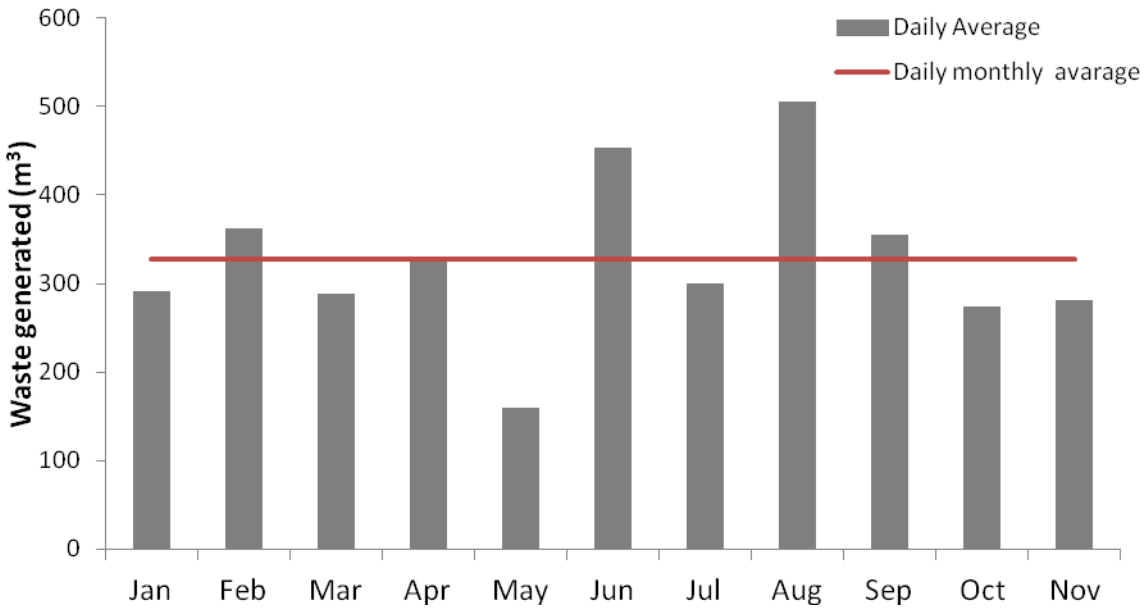

Figure 4.1: Average waste generated per month in 2016

Source: Own analysis based on Enviro Fill data

Figure 4.1 represents the amount of waste generated on average in a day for each month. A large amount of MSW was generated in August with approximately 500m^3 on average followed by June with approximately 460m^3 on average. The months of January, March, July recorded almost a similar trend with nearly 300m^3 on average. May month recorded the least amount of waste generated, with approximately 160m^3 on average. The red line depicts the daily monthly average of waste generated in 2016. This means that on average 327m^3 was produced in a day per month.

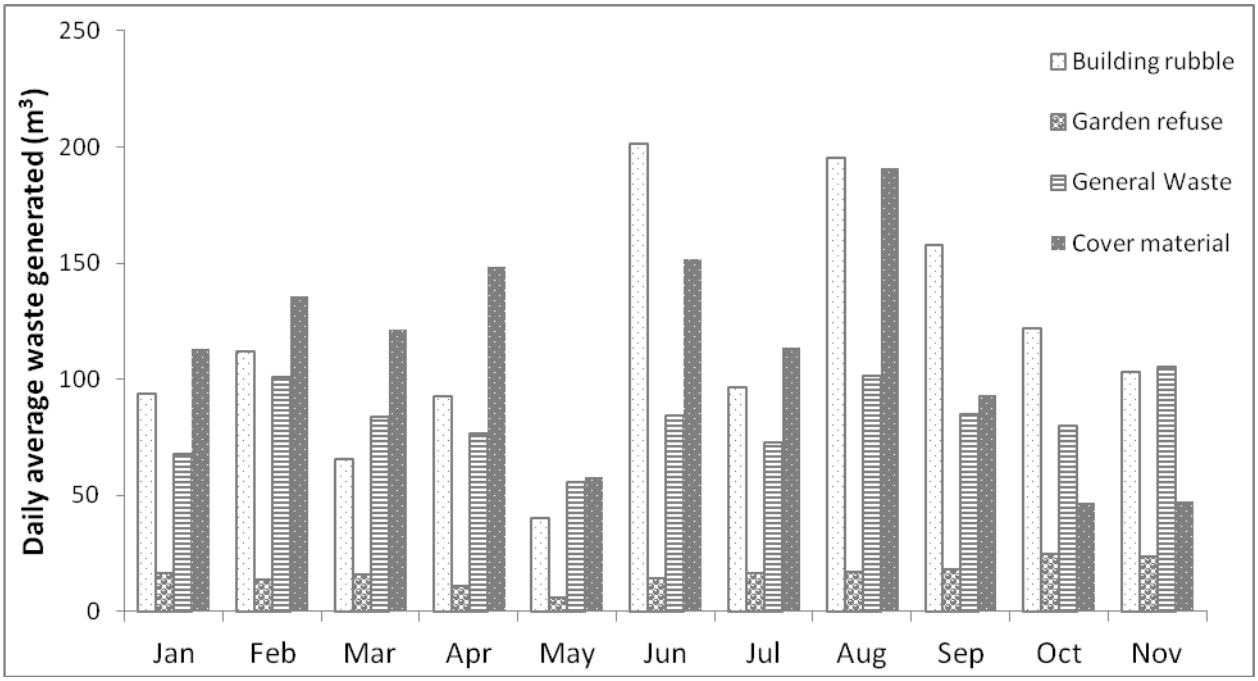

Figure 4.2: Daily average waste generation per waste type/classification for 2016

Source: Own analysis based on Enviro Fill data

In 2016 in January the largest amount of MSW type was cover material; with the daily average of 113m^3 generated, followed by Building rubble with 93m^3 daily average as shown in Figure 4.2. It is indicated that cover materials are the dominating MSW generated in a day every month, except for the months of June and August. Building rubble is the second dominating MSW and highest recorded was in June and August, with 201m^3 and 195m^3 respectively. Daily average general waste recorded was high in February, August and November, with just slightly above 100m^3. Garden refuse recorded the least, with less than 25m^3 a day across all months.

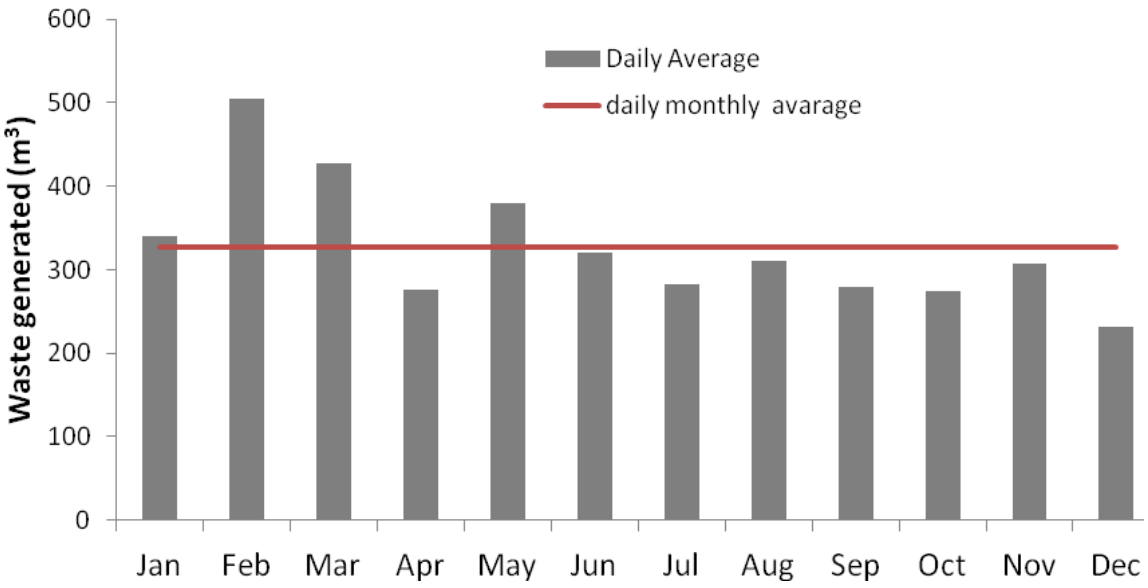

Figure 4.3: Average waste generated per month in 2017

Source: Own analysis based on Enviro Fill data

Figure 4.3 illustrates bars representing the amount of waste generated on average in a day for each month. February recorded the largest amount of MSW with the daily average of 504m^3, generated followed by March, with 427m^3 daily average. April, July and September recorded almost a similar trend with approximately 280m^3 on average per day. December recorded the least, with 232m^3 average waste generated. The red line depicts the daily monthly average of waste generated in 2017; meaning that on average 327m^3 was produced in a day per month.

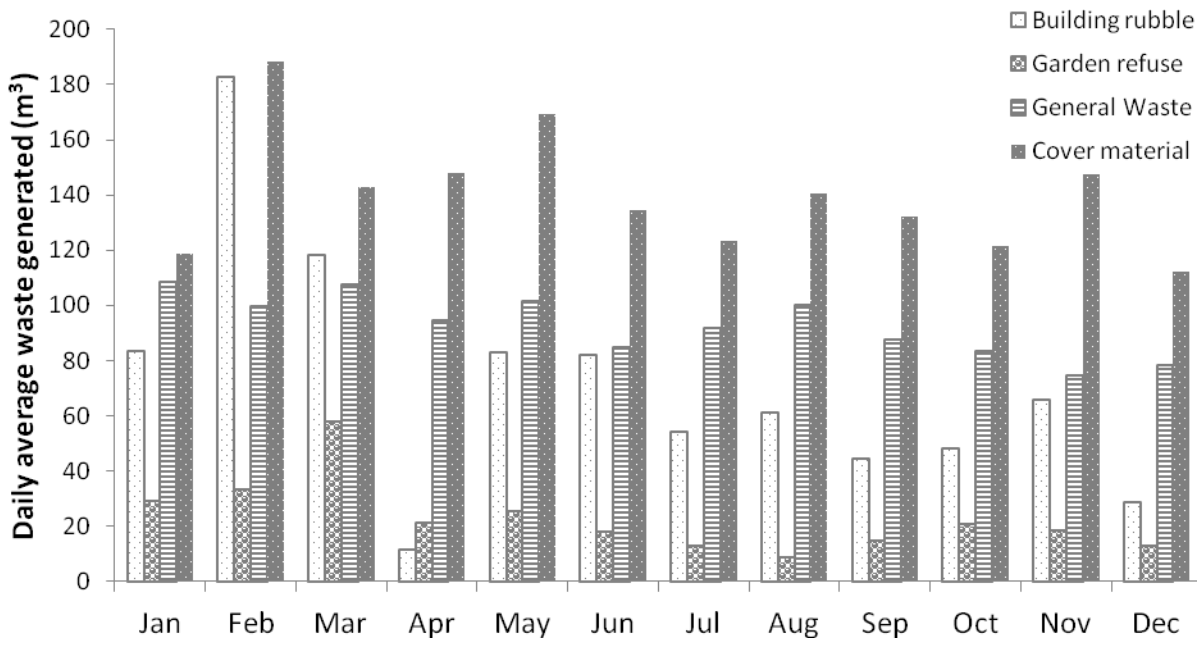

Figure 4.4: Daily average waste generation per waste type/classification for 2017

Source: Own analysis based on Enviro Fill data

Figure 4.4 depicts that, in 2017 the daily average MSW generation per waste type is dominated by Cover materials for all the months with the highest recorded in February and May. Building rubble materials were generated more in February with 182m^3 daily average. General MSW fluctuated in the year but was almost constant in November and December. Garden refuse was the least MSW type generated in 2017, reflecting a daily average below 60m^3 in a day each month.

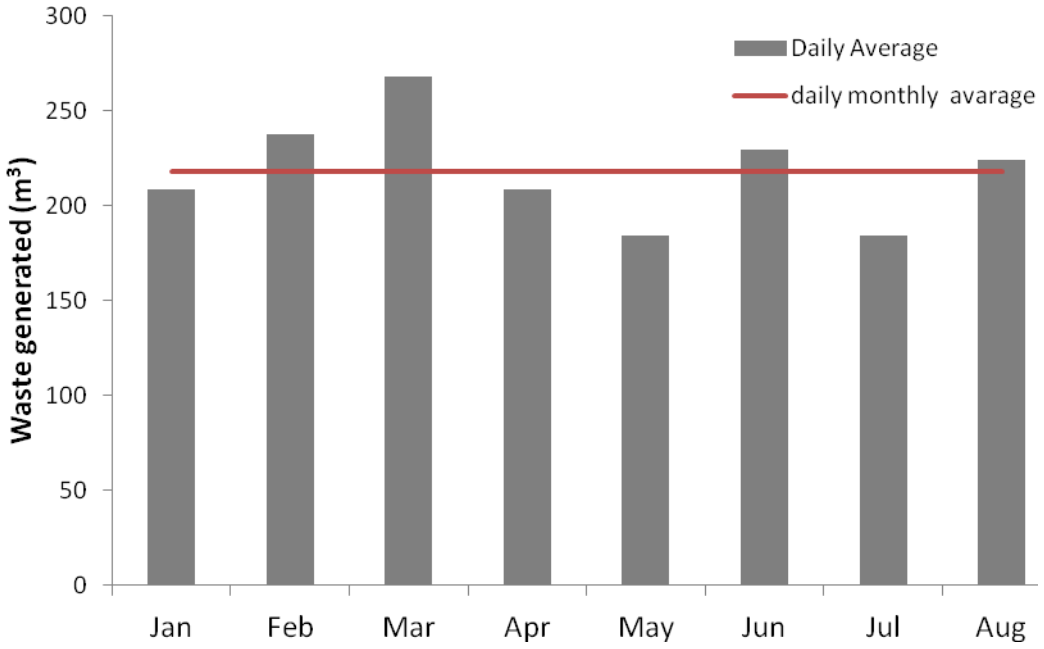

Figure 4.5: Average waste generated per month in 2018

Source: Own analysis based on Enviro Fill data

As indicated in Figure 4.5 the bars represent the amount of waste generated on average in a day for each month. It is observed that a large amount of MSW was generated in February and March with a daily average of 237m^3 and 268m^3 respectively. January and April record equal amounts of waste, with a daily average of 208m^3 each. May and July also recorded an equal amount, though the least amount of waste was generated with 184m^3 each. As in the similar figures of 2016 and 2017, the red line shows the daily monthly average of waste generated and on average 218m^3 was produced in a day per month. However, the data that was provided for 2018 was only from January to August, as reflected below. The lower waste generated monthly average for 2018 may be attributed to the economic situation that has been persisting in the country.

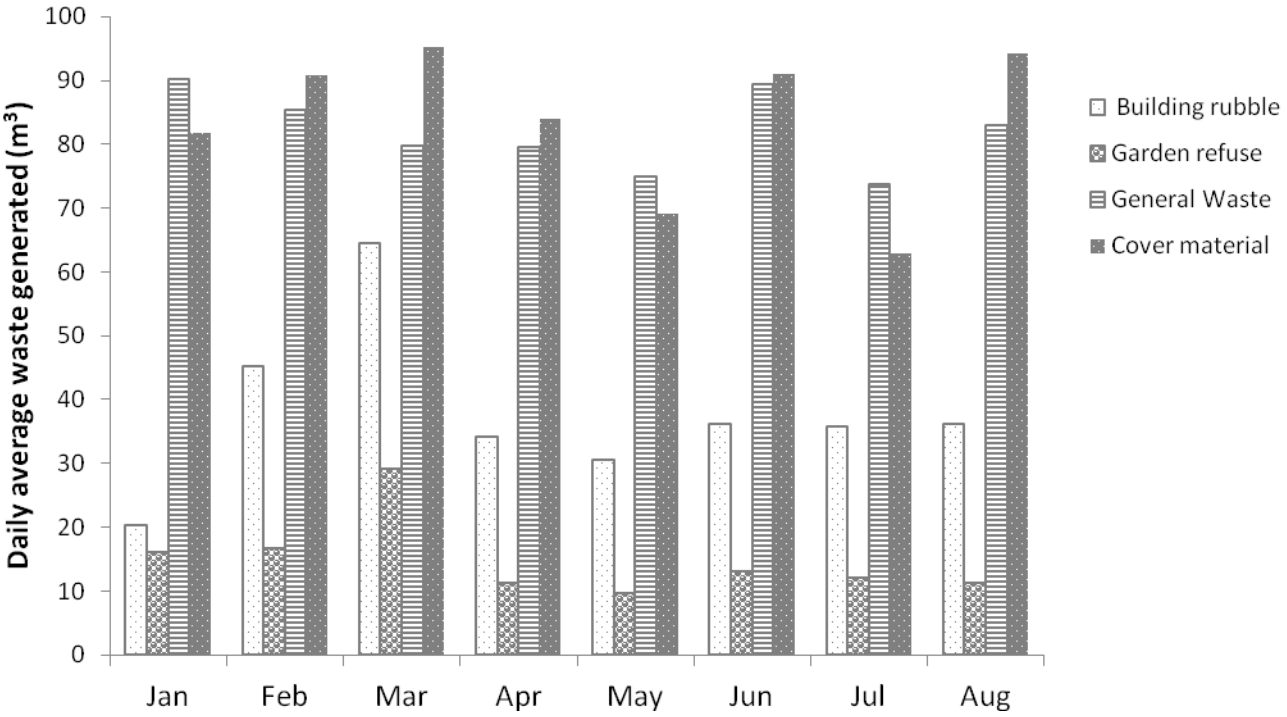

Figure 4.6: Daily average waste generation per waste type/classification for 2018

Source: Own analysis based on Enviro Fill data

Figure 4.6 shows that in the year 2018 from January to August the daily average MSW generation per waste type was dominated by cover materials and the general waste. Daily average for cover materials was very high in March and August, with approximately 95m^3 each. General waste generation was very high in January (90m^3) and June (89m^3). For all months, building rubble and garden refuse recorded the lowest daily average waste generation.

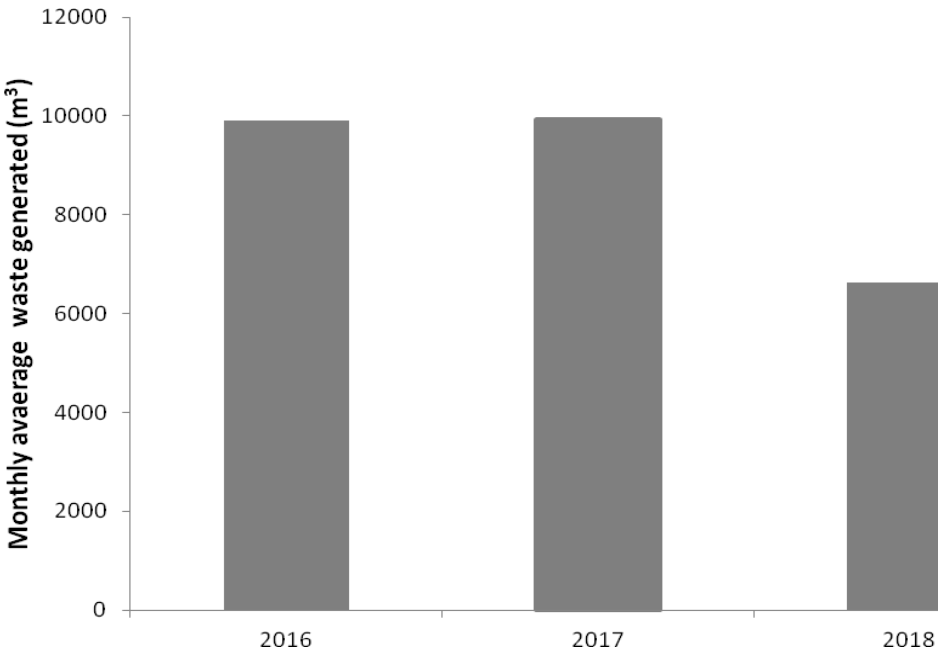

Figure 4.7: The amount of waste produced per year per month

Source: Own analysis based on Enviro Fill data

The rate of waste generation is expected to increase over the years, depending on increase in population, lifestyle change and technology advancement. As shown in Figure 4.7 on average about 10 000m^3 was generated in 2016 and 2017 each month. However, for the year 2018 the data obtained from the municipality were only from January to August. The monthly average waste generated in the 8 months was just above 6000m^3. Based on 2016 and 2017 monthly average waste generated, it is projected that the monthly average waste generation for 2018 is expected to increase by December 2018.

To determine waste generated per day/capita this formula was used: (Monthly average (m^3) times 12 months or 8 months in case of 2018) by 365 days (243 days for 2018) divided by the population. For example, in 2017, in 12 months (365 days) on the monthly average waste generation of 9936.49m^3 × 12 ÷ 365 = 326.67m^3 ÷ by the population of 44727 translates to 0.0073m^3/day/capita in the year 2017.

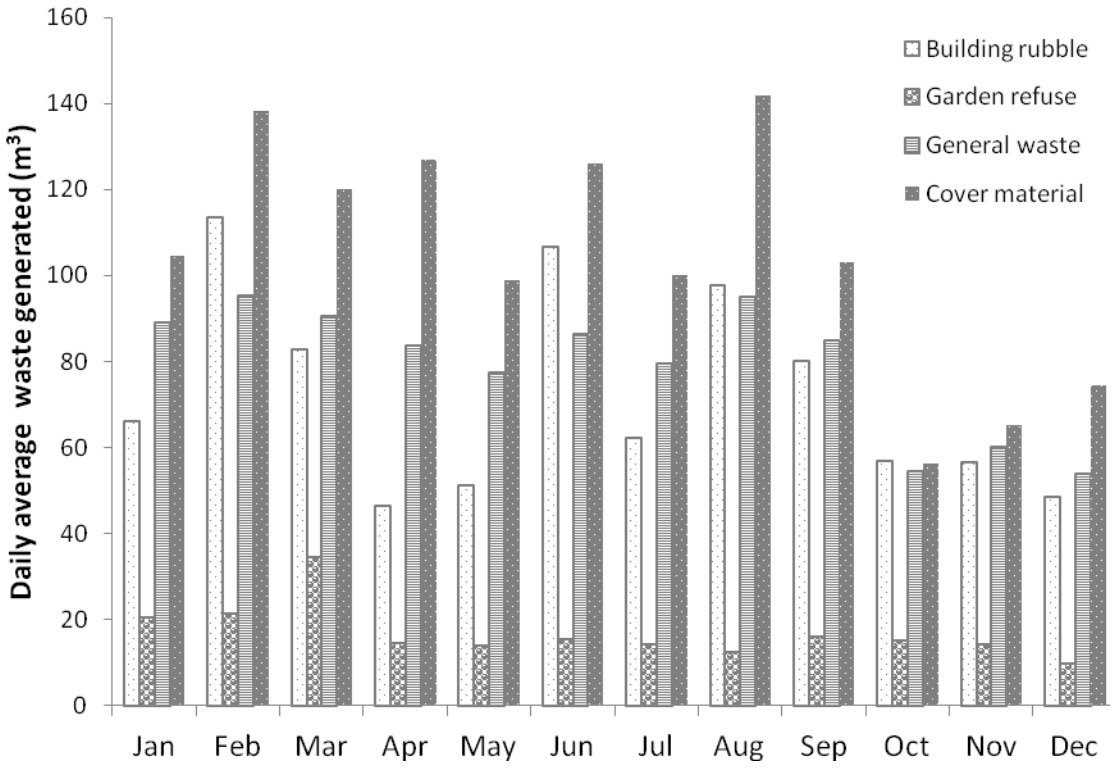

Figure 4.8: Daily average waste production per waste type/classification for combined 3 year time series (2016-2018)

Source: Own analysis based on Enviro Fill data

It is indicated in Figure 4.8 that the daily average waste generated between 2016 to 2018 in January Swakopmund generated 65m^3 of building rubble and more cover materials of about 104m^3. Cover materials were dominating in all months with the highest daily average of 141m^3 recorded in August. General waste daily average varies with the months and the highest recorded was in February and August with 95m^3 each. Garden refuse was the lowest with just below 35m^3 daily waste generation on average. October, November and December shows the lowest daily average because the data for the year 2018 are only from January to August, This means September, October, November, December 2018 daily averages are not represented in this figure.

4.2.3 Formal recycling and composting in Swakopmund

Waste Management Theory (WMT) denotes that producing products that can be reused or recycled shall avoid generating more waste. Therefore, recycling companies such as Rent-A-Drum recycles and produce things that can remain in the recycling circle. It is indicated in Table 4.2 that Rent-A-Drum, a waste management company, recycles approximately 2210.6m^3 of recyclable materials in two years and 9 months at their Swakopmund recycling plant. This translates into close to 850m^3 recycling a year. This volume of recycling is not significant, compared to approximately 10 000m^3 average waste generated per year, in total (see Figure 4.7). The recyclable fraction involves boxes, papers, plastics, glasses, cans, tetra and RDF. Both NSWM strategy and USEPA highlighted that “reduce, reuse, recycling and composting” strategies are some of the best SWM approaches. However, although source reduction is encouraged at municipal level, it is not applied formally; thus a large volume of MSW ended up at the dumpsite. The same applies to the reuse of waste products. The informal sector, however, plays a significant role in material recovery and reuse. Recycling activities are taking place in both the formal and informal sectors; however, it is inefficient due to various factors such as financial, lack of waste segregation at source and lack of information and staff capacity building. The composting approach is not applied in Swakopmund Municipality, though it is one of the viable methods of dealing with the MSW problem. This implies that there are short comings in the municipality to fully implementing the principles of ISWM.

Table 4.2: 2016 - 2018 Yearly recycling (m^3)

Month	2016	2017	2018
Jan	62.2406639	74.27386	80.08299
Feb	85.8921162	60.16598	57.67635
Mar	47.7178423	64.31535	62.24066
April	55.6016598	54.35685	62.24066
May	58.0912863	73.85892	75.93361
June	65.9751037	67.21992	66.39004
July	62.2406639	70.53942	75.10373
Aug	97.0954357	75.51867	71.78423
Sep	49.3775934	77.59336	36.92946
Oct	57.6763485	82.98755	68.85350
Nov	58.9211618	85.89212	-
Dec	60.5809129	74.27386	-
Total (m^3)	**761.410788**	**860.9959**	**588.3817**

Source: Rent-A-Drum (2018)

Table 4.2 also shows the overall formal recycling in Swakopmund from 2016, 2017, and 2018 for all recycling processes, combined. The data provided for the year 2018 was only from January to October. It is indicated in Table 4.2 that the recycling production has increased slightly in the year 2017 however; there is not a significant difference in recycling production in 2016 and 2017. Furthermore, the 2018 recycling rate is expected to increase, provided that the production trend per month does not drop below $60m^3$ in the next three months. Figure 4.9 illustrates what is depicted in Table 4.2.

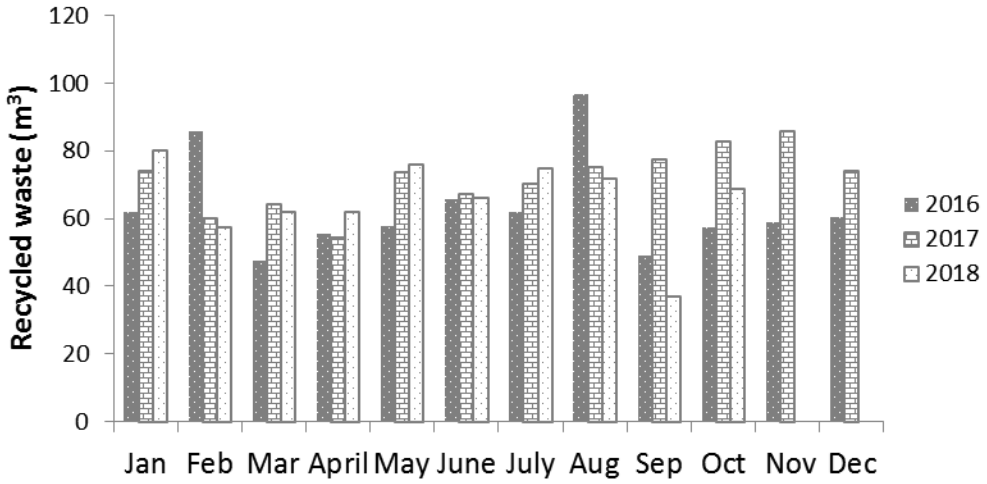

Figure 4.9: Recycled MSW (2016-2018)

Source: Own analysis based on Rent-A-Drum data

It is indicated in Figure 4.9 that January month recorded between 60 and 80m^3 of recycled waste in the years under review. The year 2016 recorded more than 95 m^3 recycling in the month of August than the rest of the months. However, there is not much variation in waste recycled volume in April, June, July for the time frame (2016-2018). However, recycling data for 2018 are only until October month. April and May recorded almost a similar trend in both years. A significant decrease in recycling was also recorded in 2016 in the months of March, April, May, September, and October, when less than 60m^3 of MSW was recycled.

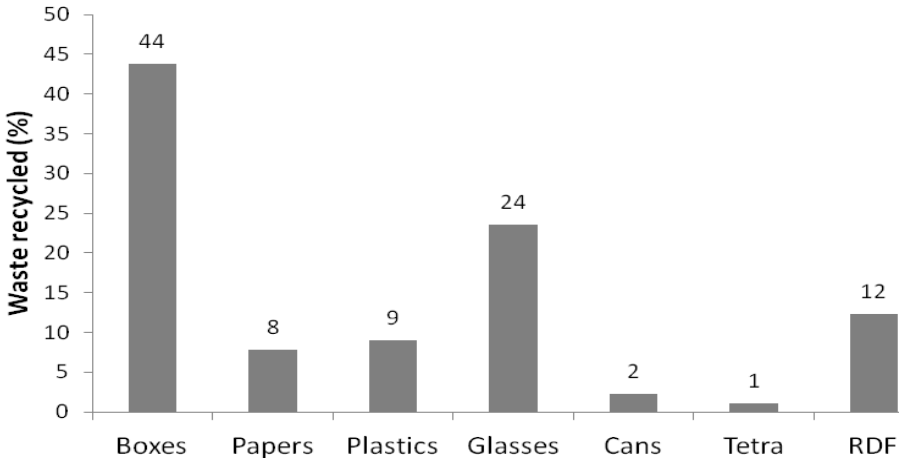

Figure 4.10: Recyclable materials split (1- 30 September 2018)

Source: Rent-A-Drum

As indicated in Figure 4.10, in the month of September 2018 alone, boxes i.e. cardboard, cement/potato bags, beer packaging boxes recycling dominated the production with 44%, followed by glass i.e. bottles (24%), Refuse-driven fuel (RDF) i.e. rubber, tailings (12%) and plastics i.e. clear plastics, carry bag plastics, plastic bottles and caps, plastic pipes, yoghurt, butter, ice-cream cups (9%) respectively on a formal recycling plant. The least recycling production occurred with cans (2%) and tetra (1%).

Activities involving reusing and recycling of materials are evident in Swakopmund, based on the researcher's observations. Apart from formal waste recycling companies such as Rent-A-Drum, more than 50 informal workers were observed at any given point in time collecting reusable and recyclable materials such as bricks, metals, plastics, wires and wood to sell and generate income. During the interview conducted on 10 September 2018, one respondent who happens to be an informal waste picker stated that the standard size brick costs N$1.50 while smaller bricks cost N$1.00. Metals are being sold to a local company called Scrap Metals for reuse and recycling. Apart from that informal waste pickers also recover copper wires that they use to demarcate their residential plots. Informal recyclers are playing a major role in resource recovery and environmental protection; hence they deserve good support from the municipality.

(a) **(b)**

Figure 4.11: (a) Building materials recovered by informal waste pickers, (b) sorting bags filled with recyclable materials

Source: Field Work, 2018

Recovering materials from the dumpsite is a day-to-day job, for some residents. However, most informal waste pickers do not wear proper protective clothes at all or they wear them partially, exposing them to possible health hazards. Even though it is not any easy job to dig through a hump of waste to find suitable material, it pays off at the end of the day because people come and buy bricks (anonymous informal waste picker, *pers. comm*., 2018). This is similar to what Van de Klundet and Anschütz (2001) emphasised earlier, that recycling and reuse helps poor communities in terms of income generation and material availability. These people also use some materials to build their shelters, especially at the informal settlement called DRC. Okot-Okumu (2012) emphasised that it is essential to formalise informal waste pickers so that they can be capacitated to be more effective, to follow health and safety regulations and prevent exploitation of these workers.

4.3. Understanding how the municipal solid waste management system works in Swakopmund

4.3.1. Who is responsible?

Hasheela (2009) mentioned that waste management is a responsibility of all Namibians, including the government, business communities, municipalities and private entities. In Swakopmund, the municipal council of Swakopmund is in charge of MSWM, in terms of funding and collaboration with various stakeholders (Mwanangombe, *pers. comm.,* 2018). In addition, he mentioned that the Department of Health was given the responsibility by the council to lead MSWM operations. According to Mwangombe (*pers. comm.,* 2018) the Council of Swakopmund has successfully achieved various responsibilities with regard to the management of municipal solid waste. Among others, the council implemented relevant by-laws essential in effective MSWM, such as the Swakopmund Municipality Waste Policy of 2015. These laws provide that the public do away with illegal dumping in public spaces, builders ensure building rubble generated is properly disposed of; and accredited waste providers handle, treat or dispose recyclable waste at permitted handling, treatment or disposal facilities.

4.3.2. MSW prevention and reduction

The study established that the municipality ensures preventing the uncontrolled dumping of MSW by providing each formal residential, business, and institution premises are provided with a black waste container “wheelie bin” for depositing domestic waste usually a 240l container is provided. Based on the explanation of how the wheelie bin system works in Swakopmund, the researcher recognised similarity to the wheelie bin system in Windhoek, as explained by Hasheela (2009:86). The similarity includes that the aim of providing these bins is for people to deposit solid waste types such as food waste, domestic waste, and commercial waste. Commonly, black wheelie bins are intended for the purpose of depositing general household waste. According to an anonymous resident from the informal settlement, wheelie bins are not provided to informal households, and that provokes the frequency of illegal dumping, especially in the informal settlements. The municipality also want to reduce the flow of waste materials to be disposed. By so doing the municipality has also proposed a by-law that will require a levy on the usage of plastic bags for shopping. Normally retailers provide plastic bags to their customers free of charge. However, the proposed by-law says in future Swakopmund residents will have to pay a fee on each shopping plastic bag they will use (Engelbrecht, *pers. comm*., 2018). However, public consultations regarding the initiated by-law have yet to be conducted.

Figure 4.12: Solid waste wheelie bins (black and brown for general waste, orange for recyclable materials)

Source: Field work, 2018

Wheelie bins in Figure 4.12 were found at Swakopmund beach. They are three colour bins, of which the orange colour is well-known to be for recycling materials only, while the black and brown colours are for general waste.

In addition to the wheelie bins, the municipality has also provided pedestrian bins that are located along the streets of Swakopmund that are emptied regularly. The municipality also provides street sweeping services to ensure that streets are free of litter. The cleaning of public open spaces is also provided in partnership with the community. Swakopmund Municipality also provides black plastic bags to the community, especially in the informal settlements; and at open spaces where mainly gatherings of people occur. By doing so the municipality is ensuring that general cleaning of open spaces is one of its top priorities. In addition, the municipality also monitors and regulates MSWM services, to ensure that they conform with the country's legal standards and waste compliance processes. To ensure smooth 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. This amount differs from suburb to suburb.

Apart from that, Mwanangombe, *pers. comm*., 2018 mentioned that various public awareness activities have been conducted to encourage residents to minimise waste in all their activities, to ensure minimum waste generation. The municipality provides awareness and encourages residents to reuse and recycle their waste daily. Public awareness and attitude towards waste can affect the people's willingness to cooperate and contribute to effective waste management practices (Zurbrügg, 2003:8).

4.3.3. MSW collection and transportation

Based on the views of Ajayakumar (2006), waste collection involves factors such as collection points, frequencies, storage containers, crew, route, secondary storage, and the transfer station. Furthermore, the MSW collection and transportation system is a cornerstone for good quality waste management services (Guerrero *et al*., 2013). In the

case of Swakopmund, MSW are normally collected from various points, particularly at households, business premises, institutions, and road walk ways. The collection is usually done on a weekly basis. The scheduled days and routes for routine waste collection vary from location to location. Solid waste collection duty is organised by the municipal solid waste management, section whereby compactor assistants attach the wheelie bins onto the compactor trucks where the bin is emptied. The entire crew membership involves the truck driver and the compactor assistants. When the compactor truck is full, solid waste is then transferred to the disposal site. Apart from that, Mwanangombe *pers. comm*., (2018) touched on the solid waste transportation fleet by pointing out that it consists of Compactor trucks (10), Skip trucks (3) and a Lorry (1) to be used for MSW operations. Compactor trucks are engineered with a compactor mechanism, so that the volume of solid waste collected can be maximised (Mwanangombe *pers. comm*., 2018). This also reduces the number of collection trips, fuel consumption and operation costs. Fleet maintenance is done by the municipality engineering department. As mentioned earlier, at municipal level waste collected is not sorted into recyclables and non-recyclables, but is disposed at the dumpsite, where the formal and informal recyclers sort products they want to recycle.

Another solid waste collection mechanism used is the Skip. The Skip is used in case of depositing heavy solid waste materials such as bricks, wood, stones, iron sheets, metals, broken grass, tree branches etc., that require a stronger container than a normal wheelie bin. The municipality is responsible to provide these bigger and stronger steel containers, to cater for heavy solid waste management. These containers are distributed across all settlements (formal and informal), businesses, and industrial areas. When wheelie bins are full, some residents have been observed to deposit their general household waste into the skips.

In the same vein, a contracted waste management company named Rent-A-Drum has also provided each household, business, private and public institutions with an orange wheelie bin (240 litres) to enable residents to deposit recyclable solid waste. It is emphasised by UK Department for Environment, Food and Rural Affairs, (2006) that

recycling is more economic when materials are separated at the source such as at industry, households, offices etc. In addition, waste segregation makes for easy and direct transporting of solid waste to a recycling unit. It is crucial to label the bins, in terms of their intended usage. It was observed that some orange bins are labelled with a sticker on which the word 'Recycling' is written clearly. However, some are not labelled. Some residents are aware that orange bins are intended for recyclable materials; but others are not aware of it. Consequently the unaware residents dispose general waste in the recycling bins as well, making it difficult to segregate recyclable from non-recyclable waste materials. This may result in waste instead of being taken for recycling, ending up in the dumpsite. It is a responsibility of Rent-A-Drum to collect waste from the bins they provided. The company ensures that waste is collected on a weekly basis and disposed of in their recycling facility. Recyclable materials such as papers, boxes, plastics, glass, woven bags, cans, tetra and RDF are mostly found and recycled at the Rent-A-Drum recycling facility. This recycling hub plays a significant role in promoting environmental sustainability and socio-economic development for the community. This was evident at the dumpsite when workers were seen at the disposal site busy separating recyclable waste from non-recyclable. Apart from that, It was reported in the local media, The Namibian (2015) that this waste management specialised and recycling company employed up to 65 residents on a permanent basis in that year.

Figure 4.13: Skip containers

Source: Field work, 2018

The skip containers above were photographed close to one of the entertainment business premises in the settlement called Mondesa. Both skips are observed to be loaded with recycling materials such as boxes, glasses, and plastics.

The following is a summary of the observed MSW collection methods in the vicinity of Swakopmund are supported by Waste Management Theory (WMT) notion of preventing harm to human health and the environment:

1. House-to-House: Municipal waste collectors visit each house with a compactor truck to collect waste once a week. Compactor assistants accompany the truck to hook bins on and pick up waste that is dropping on the ground. Residents normally pay a municipal fee for this service.
2. Skip containers (community bins): these bins are shared with the rest of the community. Usually placed at densely populated areas, and at construction sites. Municipality and Rent-A-Drum trucks or delegated waste collector pick up the bin

on an ad-hoc basis or when they reach the full capacity. Skip containers are usually used to dispose of heavy refuse, garden refuse and building rubble, however some residents deposit general waste.

3. Kerb side Pick-Up: Normally residents leave black garbage plastics directly outside their homes or alongside the roads, based on the garbage pick-up schedule for the municipality.
4. Self-Delivered: Sometimes solid waste generators (members of the community) deliver waste directly to the disposal site or transfer station (normally at the skip container). Sometimes they delegate this job to a hired third party.
5. Contracted or delegated services: Municipality and business hire waste collecting firms on a contract basis (e.g. Rent-A-Drum). Normally the municipality licenses a private firm to carry out the task on their behalf.
6. Street cleaning: Municipal workers sweep the streets to remove solid waste and sand.

Contrary to the observed waste collection methods mentioned, other developing cities also use the non-collection system. According to Korfmacher (1997), in a non-collection system, contractors do not collect garbage; instead residents collect refuse and receive incentives for the garbage they bring to central sites. Furthermore, the author gave an example that the system can work well in squatter settlements where there are no formal municipal solid waste collection services. In view of the aforementioned, this system may also work well in several squatter settlements in Namibia, if a municipality takes this option into consideration. Buying solid waste from residents would also help them generate income. Among other challenges, the MSW collection operations are not always successful; especially when residents do not place wheelie bins at appropriate points of collection (i.e. outside their yard).

4.3.4. MSW treatment

In terms of solid waste treatment, Engelbrecht, *pers. comm*., (2018) mentioned that there is no solid waste treatment activity in Swakopmund, besides sewage waste treatment. General solid waste is disposed at the controlled open dumpsite and

covered with materials that consist of sand and building rubble. On the hazardous waste treatment, handling and disposal perspective, these types of waste are not treated or disposed at Swakopmund waste disposal facility, but they are transferred to a hazardous waste management facility in Walvis Bay (Engelbrecht, *pers. comm*., 2018). According to Tadesse (2004) hazardous wastes are materials that are flammable, corrosive, reactive, toxic, infectious, radioactive and bio-accumulative. Examples of these wastes are batteries, herbicides and pesticides, medical waste. However, various types of hazardous wastes are in liquid form (Tadesse, 2004).

4.3.5. MSW disposal

It was mentioned earlier that the only municipality in Namibia that uses a landfill as a solid waste management and disposal facility is Windhoek. In the case of Swakopmund, one unscientific controlled open dumpsite is used as a waste disposal facility. This type of MSW disposal method is acceptable but unsuitable, considering the environmental impacts this method can pose since it is not a sanitary landfill. According to the satellite measurement on Google earth map, the dumpsite is located about 912m from the residential area to the south, and then 2.15km from residents to the west and 3.93km to the sea. The dumpsite covers approximately 13 hectares of habitable land. Apart from this, there is a solid waste burning site which is less than 500m from the residential area. Burning of plastic coated wires releases toxic carcinogenic compounds in the atmosphere (Naidoo, 2009). It was confirmed by an anonymous solid waste picker that they use the burning site to burn things like insulated copper wires and metals to remove the plastic shields and also to make these materials flexible to use. In the same vein, Mor, Ravindra, Dahiya and Chandra (2006) stated that unscientific dumping practices are the root causes of environmental issues such as water, air, land pollution, due to leachate.

Looking at the distance measurements, it can be concluded that this disposal site is near residential areas and also near the significant wetland for biodiversity importance which is the ocean and may cause land, air and water pollution, pose health risks to the public and a burden to future generations. In brief, the disposal method in

Swakopmund, even though economically affordable and socially acceptable, is environmentally unsustainable because of a lower degree of reduce, reuse, recycling, energy recovery and the highest degree of waste disposal. In addition, waste sorting at source has caused a growing amount of mixed waste at the dumpsite. Furthermore, the close proximity to residential areas, and lack of a solid waste treatment plant in Swakopmund, has caused environmental issues such as air pollution, water pollution, unpleasant odour, and large amount of flies; hence several public health issues were reported in the area.

When MSW reach the land and ocean they can pose a growing problem for terrestrial and marine habitants, biodiversity, human health and the global economy. For example, based on the United Nations Environment Programme (UNEP) about 267 marine species are suffering from entanglement in or ingestion of solid waste debris (UNEP, 2005b). Furthermore, UNEP pointed out that of these 276 species, 86% are sea turtle species, 44% seabird species and 43% sea mammals. Apart from that, when MSW reach the ocean, there is a higher possibility for micro-plastics to enter and accumulate in the food chain and cause health risks to humans. In addition, humans enjoying water by swimming can also get injured when broken bottles and wires enter the ocean. UNEP (2005) also touched on the effect of MSW on the economy by pointing the impact of litter on damaging the aesthetic beauty of the beaches and so reducing economic benefits from tourists. Apart from that, fish caught accidentally by abandoned nets and fishing gear causes economic losses (UNEP, 2005). In addition, litter also causes habitat loss i.e. damage to seaweed and coral reefs that support countless marine species, protect ocean shores from the impact of waves and provide nutrients to the marine ecosystem, (MFMR, 2015).

Figure 4.14: Swakopmund dumpsite

Source: Field work, 2018

Figure 4.14 shows a mixture of solid waste at the Swakopmund dumpsite. It is however displayed that there is some kind of separation between garden refuse and the rest of solid waste, even though it is not intensified.

As mentioned earlier, the municipality has created municipal-private partnerships with external MSWM companies. Waste management companies such as Rent-A-Drum, Remove a mess and Enviro Fill took a MSWM challenge as a business opportunity. These companies are directly involved in offering waste management services around Swakopmund such as collection, segregation, transportation, and recycling; as well as monitoring and control. Enviro Fill is responsible for controlling the solid waste disposal facility and recording solid waste parameters such as the composition and volume (Hikuafilua, *pers. comm*,. 2018). Sold waste volume is measured by estimating the volume of waste entering the disposal facility on a daily basis. Based on the estimation, calculations are made to determine monthly and yearly solid waste generation volume. For the municipalities to plan, design, operate effectively in terms of MSWM systems as well as to make a suitable choice of the best MSWM practice, it is important know the variation in quantity and composition of waste generated (Guangyu, n.d.). Apart from that, it is important to know the concentration of key elements in the waste stream (Diaz *et al.,* 1992). Furthermore, by taking solid waste generation measurements, it is easy to

determine the type and method of waste storage, collection frequency, disposal method, crew size, the degree of waste recovery and budget preparation (Guangyu, n.d). For instance, to get a high degree of accuracy, a portable or a permanent scale should be installed at the disposal site.

On the other hand, Diaz *et al.* (1992) emphasised that waste managers should have a full knowledge of waste composition, to be able to reach the following outcomes:
(a) Choose the appropriate storage and transportation at a given situation,
(b) Determine resource recovery potential,
(c) Select a suitable disposal method, and
(d) Determine environmental impacts expected in case waste is not managed properly.

In view of the aforementioned, Swakopmund municipality records waste generation quantity, to provide data to be used as Diaz *et al*. (1992) highlighted. However, as Guangy (n.d) stated, the issue of data accuracy is a shortcoming in Swakopmund municipality.

Contrary to the formal acceptable solid waste disposal processes, some residents are engaged in illegal waste dumping. By law it is an illegal practice. Purposely littering, unauthorised burning and dumping are the main types of illegal dumping observed in Swakopmund; whereby plastics, papers, bottles and cans, are commonly observed. The main culprits are pedestrians, residential, entertainment squads, vehicle occupants, lack of garbage bins, and a few from waste vegetation. The result of these observations saw the municipality initiating a by-law that set charges on plastic shopping bags in retailers.

4.4. Actors in the municipal solid waste sector

Mwanangombe *pers. comm*., (2018), stated earlier that the municipal section dealing with MSW is under the Department of Health. He also explained the pattern of all stakeholders involved in MSW in various capacities, as illustrated in Figure 4.15. In the formal operational context, the Department of Health spearheads the operation by ensuring that all types of solid waste are collected, transported and disposed of. The

municipality also join forces with contracted MSWM companies and the community members (households). In other words, households are required to dump solid waste into solid waste containers provided by the municipality (Usually 240 litre wheelie bins, 6m^3 skip containers and black plastic bags). On the contrary, members of the community sometimes engage in illegal dumping; including solid waste burning and burying particularly in the informal settlements. From an informal operational perspective, informal waste pickers who make a living from recovering and recycling materials are also notable players in MSW sector. These players embrace the theory of turning waste into non-waste.

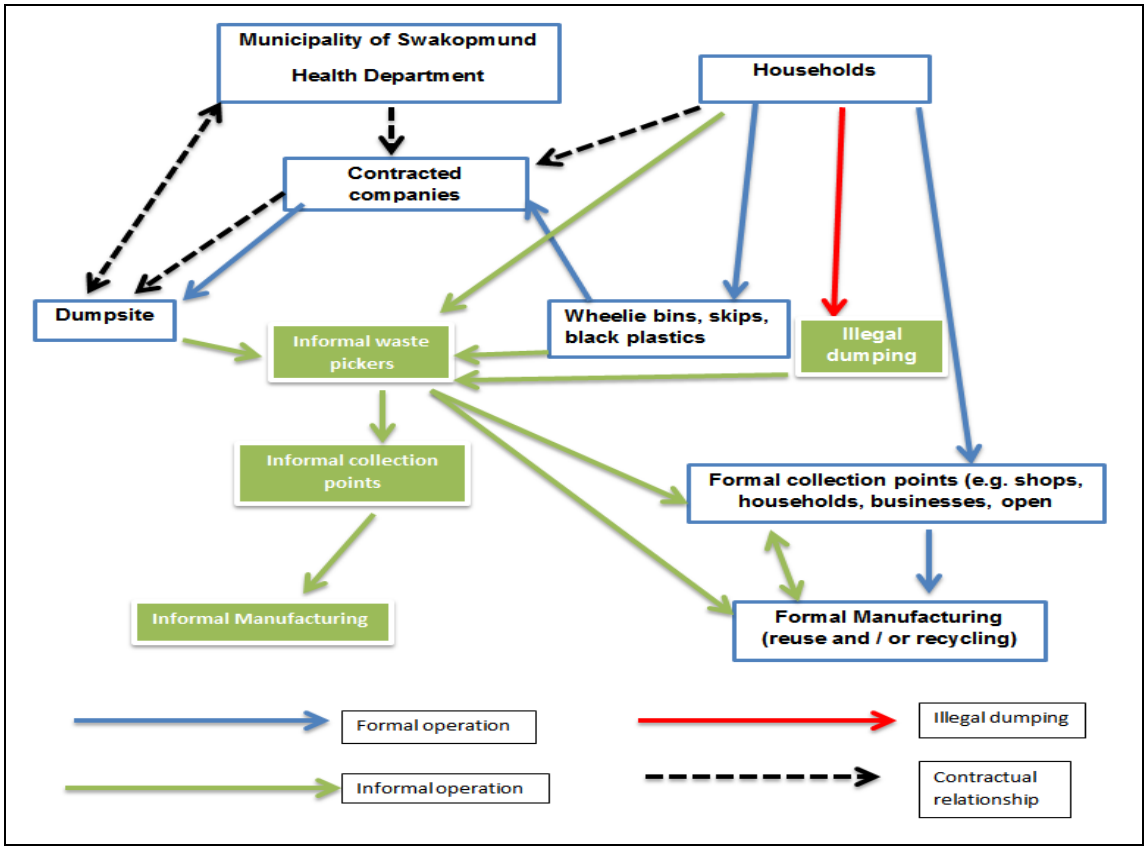

Figure 4.15: Typical solid waste management scheme, Municipality of Swakopmund

Source: Own analysis assisted by Mwanangombe, pers. comm., 2018

As illustrated in Figure 4.15, mainly solid waste is generated from households, but businesses, industries, institutions also generate solid waste. Some solid waste items are dumped illegally and some stored temporarily at source in wheelie bins, skips and plastic bags; at this stage some informal waste pickers are already starting to look for recyclables. After this, they are collected by municipal workers or by contracted private

companies, and then transported to a controlled open dumpsite using compactor trucks or a lorry. At the dumpsite, recycling, reuse, recover is common at formal and informal level. Plastics, glasses, metals, building rubble, papers, boxes, and wires are recycled, reused and recovered.

Mwanangombe *pers. comm.,* (2018) gave an overview of the resources allocated to the municipal solid waste management division. The sector under the supervision of the Head of Solid Waste Management consists of the following personnel: Compactor truck drivers (9), compactor assistants (38), beach cleaners (3), and street cleaners (23). Each worker is provided with a set of protective clothes such as overalls, safety boots, rain coat for the rainy season, and a pair of gloves.

In addition, the head of solid waste division stated that the municipality has registered some solid waste re-claimers who pick solid waste recyclable items to be sold for recycling and reuse purposes. These waste pickers are playing a major role in the waste management stream; however, they get little profit from the products they sell, while the middle men normally secure a big profit. Furthermore, the municipality launched and supports a council-community solid waste management programme that provides a platform to achieve environmental awareness to the public, with consultations, administration and management functions; besides the ward cleaning programmes responsible for cleaning of open spaces. These programmes encourage members of the public to remain actively involved in MSWM. In support of these initiatives, Arzumanyan (2004) stated that environmental awareness is an important factor that influences people's behaviour to reduce the amount of waste they produce, and to encourage reuse and recycling. When all things are considered, the satisfaction level for waste collection at municipal and private sites is at an appropriate status for Swakopmund.

The researcher also engaged with a senior employee in the Municipality of Swakopmund to get an overview of MSWM systems, in terms of policies, legislation, financial aspects and environmental monitoring and control.

4.5. Financial and economic aspects

As mentioned by Aiyambo (2017), financial challenge is one of the factors hindering the effectiveness of proper MSWM systems in developing countries. It is crucial to allocate enough financial resource into MSWM. For the purpose of this study, details about how much of the budget goes to the MSW sector was expected to be provided to the researcher by the municipality. However, there was no amount of money specified; it was noted that SWM sector is served by the Health Department's budget. Apart from that, the municipality also collects revenue from residents, in the form of a fee payable every month per household, for waste management services provided by the municipality. The municipality is also keen to financially support various organisations that wish to venture into composting production and to continue supporting recycling initiatives.

Considering the current population growth, the growth in size of the town, the increasing solid waste volume and the proximity of the current dumpsite to residential areas and to the sea, there is a need to change the waste disposal approach. Taking in account the economic affordability, a sanitary landfill could be a suitable waste disposal method for Swakopmund, due to its minimal construction and operational costs. In addition, this approach also has an acceptable degree of pollution control and monitoring devices, compared to the current open controlled dumpsite. Waste-to-energy and composting could also be viable options, taking into consideration the amount of compostable waste dumped at the dumpsite.

4.6. Environmental monitoring and control

Monitoring and control are crucial parts in environmental management. Wilkinson *et al*. (2016) defined environmental monitoring as the performance and analysis of routine measurements aimed at detecting changes in the environment or health status of the population; and may imply intervention as indicated by monitoring data. The same authors mentioned that control defines the acceptable level of exposure, by setting standards related to environmental levels. The municipal official was asked to evaluate the level of effectiveness when it comes to control and monitor waste (in terms of: high,

satisfactory, low, or does not perform at all). 'Satisfactory' was the answer given in that regard. However on monitoring and control of environmental status, the respondent indicated that there is almost no environmental monitoring and control measurement system at municipal level to confirm the quality of the environment. However, air quality is being monitored by the Ministry of Mines and Energy's advanced air and quality study (Geological Survey of Namibia, 2017). By contrast, the Ministry of Fisheries and Marine Resources and the Namibia Standards Institution (NSI) are responsible for sea water quality monitoring, while NamWater is responsible for portable waste monitoring (personal knowledge). Solid wastes are being monitored and controlled, but volume estimation is done at the disposal site. Solid waste volume data are not so accurate, but can be used to quantify waste generated and to project future waste generation for effective planning. Based on the respondent's comments, at municipal level there was no environmental monitoring activity taking place at the time the interview was conducted. In general, Swakopmund municipality is doing better toward achieving ISWM as indicated by Wilson, *et al.* (2013) in terms of stakeholders engagement, executing waste system elements and deal with various aspects of ISWM. However, there is need to improve on some aspects such as conducting environmental monitoring, provide better working conditions for waste workers both formal and non-formal, mitigate public health issues and pollution. In addition the level of environmental awareness should be enhanced.

4.7. Residents' perception and knowledge toward MSWM

In order to determine the perception of the residents, qualitative data was collected with a questionnaire as a data collection tool. A questionnaire was randomly distributed to 200 respondents above the age of 18, in order to assess if public knowledge and perceptions have an influence on MSWM and disposal practices. The background features of respondents were the sex, age group, marital status, home language, level of education, confirmation of residence and the number of years the respondents have been living in Swakopmund. These factors were used to find out if they influence the level of MSW knowledge and perception, in relation to the current MSWM status of the

municipality. Microsoft Excel was used to compute the data from the questionnaire outcomes. Tables and graphs were made using PivotTables.

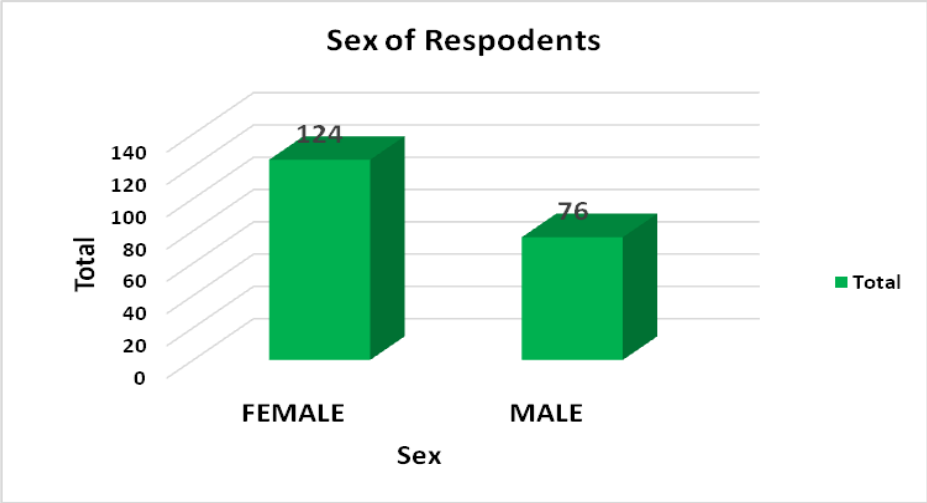

Figure 4.16: Sex of respondents and total numbers

Source: Own analysis

Out of 200 respondents, 124 female and 76 male willingly responded to the questionnaire as indicated in Figure 4.16. This would mean that more females are willing to participate in environmental management studies and support MSWM programmes.

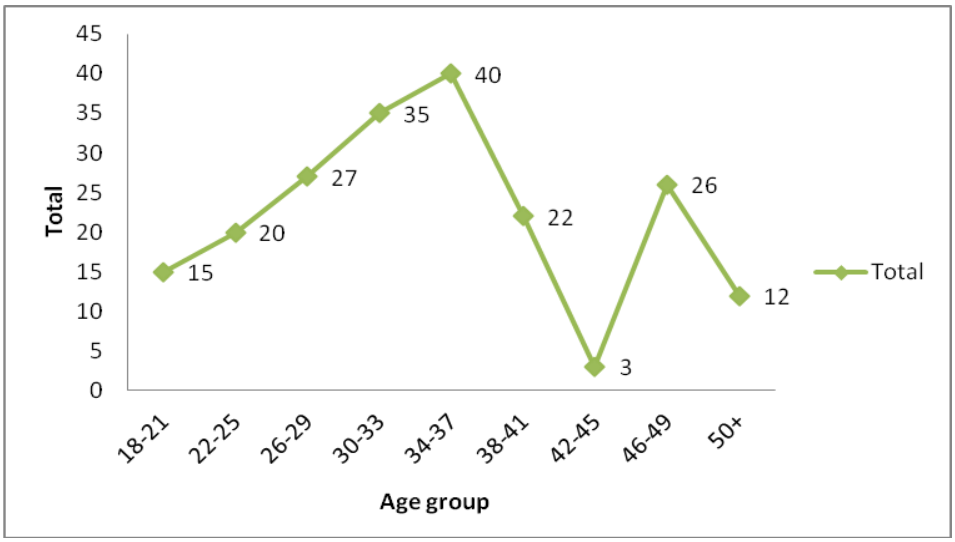

Figure 4.17: Respondents age group

Source: Own analysis

Figure 4.17 shows that age groups of 26-29, 46-49, 30-33 and 34-37 include the large number of people who responded to the questionnaire. The age group of 34-37 reached the peak of 40 participants. All these age groups are regarded as middle age and below the age of 50 year; hence, they are the most economically active group, interacting with waste on a daily basis. Consequently, they understand the need for proper management and handling of wastes.

As suggested by Modak, (2010) public engagement is very important in dealing with MSW. An overwhelming proportion of residents are aware that there is indeed solid waste generated in Swakopmund. Out of 200 respondents, only 2 respondents are not sure if there is any solid waste generated in Swakopmund. This could be attributed to their low level of education as indicated in Figure 4.18 and lack of public awareness. Naidoo (2009) mentioned that the general public environmental knowledge is usually influenced by education level, politics, carrier, social circle and the media.

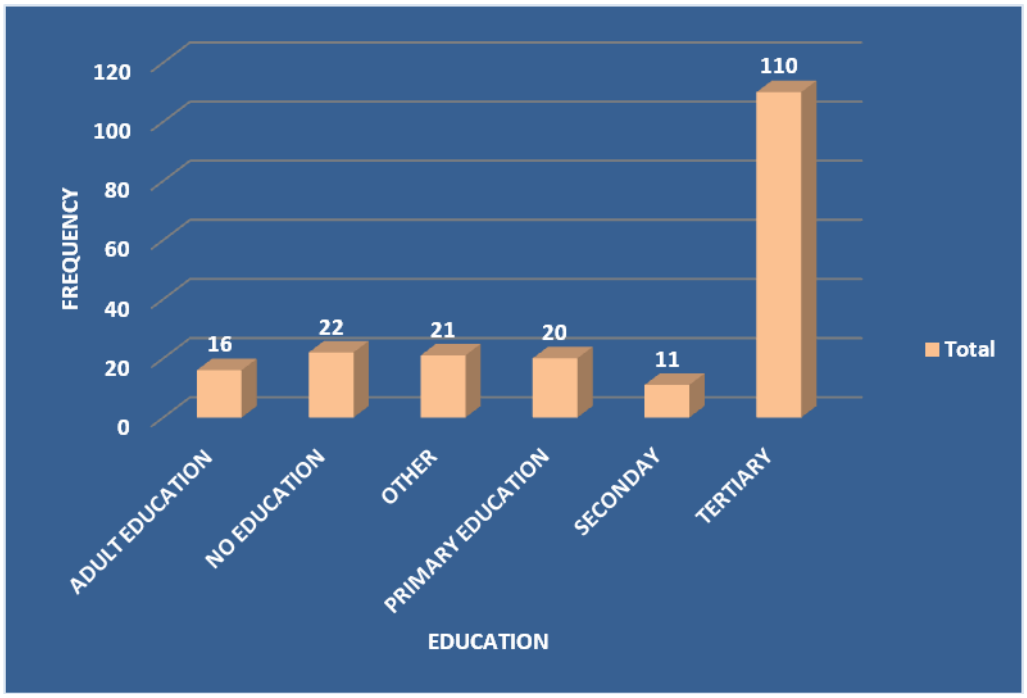

Figure 4.18: Education level of respondents

Source: Own analysis

In order to remedy the situation, it is important to conduct public awareness so that all members of the community knowledgeable and are aware of waste in the environment, regardless of their education level. It was mentioned by Popov, *et al*., 2004 that Waste Management Theory (WMT) influences people to prevent waste that harm them and the environment. Therefore in Swakopmund, public awareness programmes deserve an improvement in terms of the frequency and the content offered. It is indicated in Figure 4.18 that respondents of different educational backgrounds responded to the questionnaire, with tertiary educated people in the majority. Furthermore, it is imperative to include waste management in the curriculum from lower primary school level.

Furthermore, Figure 4.19 and 4.20 touched on the allocation of solid waste bins and bin labelling identifications, respectively.

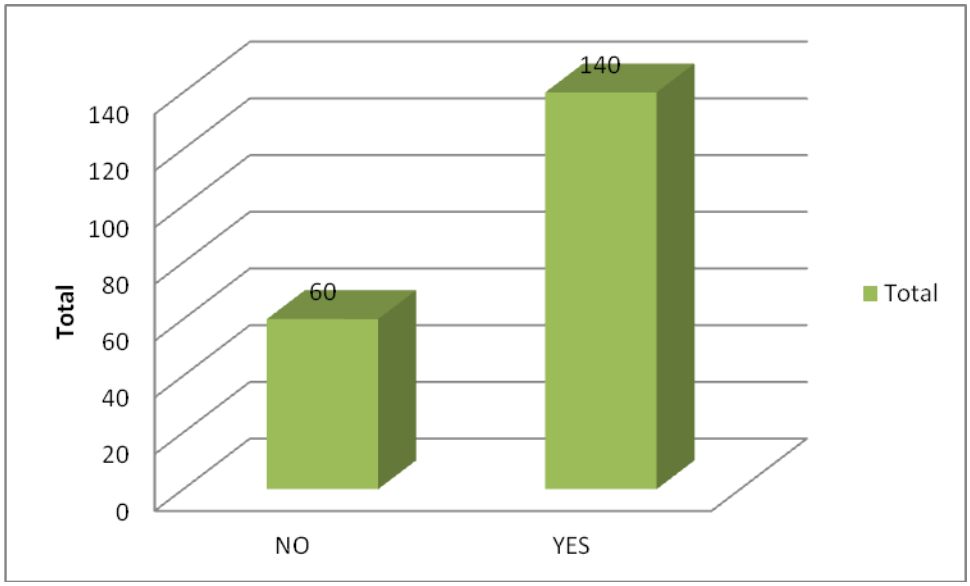

Figure 4.19: Bin allocation to households

Source: Own analysis

A high proportion of 140 respondents as indicated in Figure 4.19 confirmed that there are solid waste bins allocated at each household and business premises. However, 60 respondents indicated that waste bins are not allocated at every household and business premises. Furthermore, these respondents mentioned that perhaps bins are allocated only to formal households and businesses and not to informal households and businesses. The result of this survey saw a large number of people claiming that

particularly informal settlements do not even get waste removal services regularly. Some respondents said that they don't have bins at their homesteads; hence they put their waste in shopping plastic bags and throw them in the nearest skip containers. In respect to the basic principles of ISWM mentioned by Van de Klundert and Anschütz (2001), equity and effective waste management should be met. Based on the study findings from respondents with regard to allocation of waste bins, the researcher discovered that all residents are not entitled to equal and proper waste management system. It is therefore suggested that the municipality should introduce a non-collection system in the hard-to-reach informal settlements. According to Korfmacher (1997), a non-collection system is one of the effective tools to maximise waste collection in informal settlements and has been used in high density populated countries such as Brazil.

It is important to remember that the non-collection system works as an incentive given to community members who are involved in collecting waste from the surrounding environment (Korfmacher, 1997). Some residents justified their response, in that they see waste bins at some businesses such as clubs, bars and tuck-shops but they are not sure if all the businesses are provided with bins.

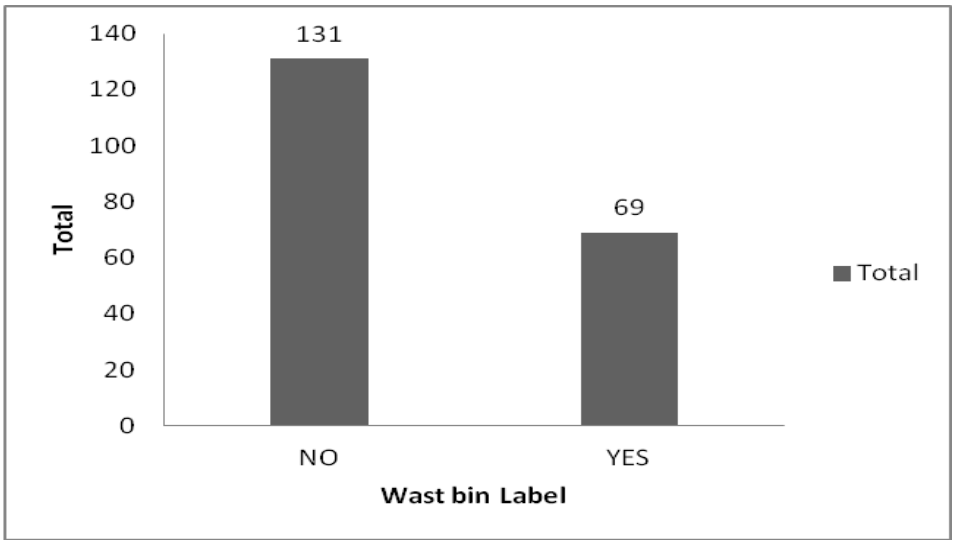

Figure 4.20: Confirmation of waste bin labels

Source: Own analysis

Over 100 respondents as shown in Figure 4.19 confirmed that the bins are not labelled in writing (i.e. wood, plastics, metal, cans, papers etc.) but they are aware of the black and orange colour wheelie bin provided to households and business premises. The consequences of providing non-labelled bins are indicated in Figure 4.21.

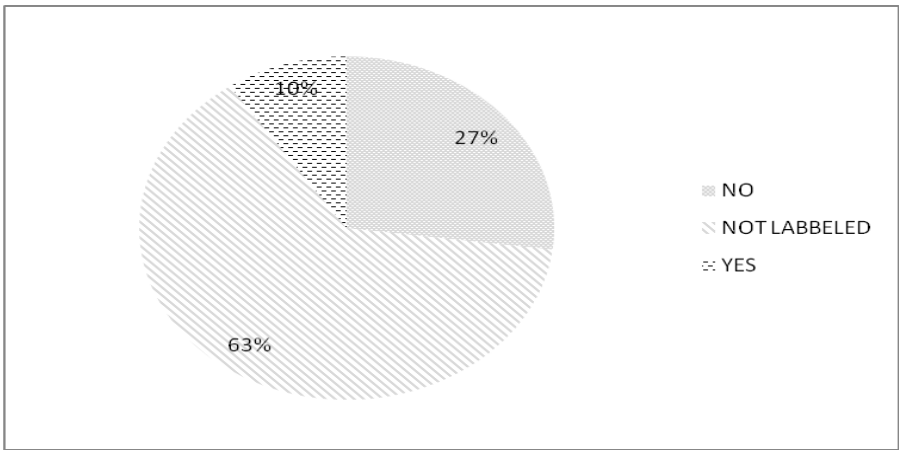

Figure 4.21: Percentage of respondents throwing solid waste in right bin (No. 200)

Source: Own analysis

Figure 4.21 indicates that at least 63% of respondents confirm that they do not throw waste products in the correctly labelled bins, because the bins are not labelled at all; hence they throw their waste in any bin. Through direct observation, the researcher observed and confirmed that not all bins are labelled but there are indeed some labelled orange bins. However, many people do not throw recyclables in the right orange bin but they throw any household waste type without considering the labels on the bin. It is therefore very essential to inform and educate the residents about the importance of appropriately labelled MSW disposal practices.

Table 4.3: (a) Waste recycling activity knowledge, (b) Importance of recycling

(a)

Labels	Count of Questionnaire	Percentage
Not sure	167	83.5
Yes	33	16.5
Grand Total	**200**	**100**

(b)

Row Labels	Count of Questionnaire	Percentage
Not sure	3	1.5
Yes	197	98.5
Grand Total	**200**	**100**

Source: Own analysis

Table 4.3 (a) shows that 83.5% of the respondents are not aware of any recycling activities in Swakopmund. This could be attributed to the recycling activities happening in Swakopmund, because of the few recycling companies present in town. Furthermore, the main recycling plant owned by Rent-A-Drum is located at the dumpsite, and not all people visit that site. In addition, a large number of respondents have an idea of what recycling is, even though they said they did not know how it happens. As indicated in Table 4.3 (b) more than 90% consider recycling as very important for the environment.

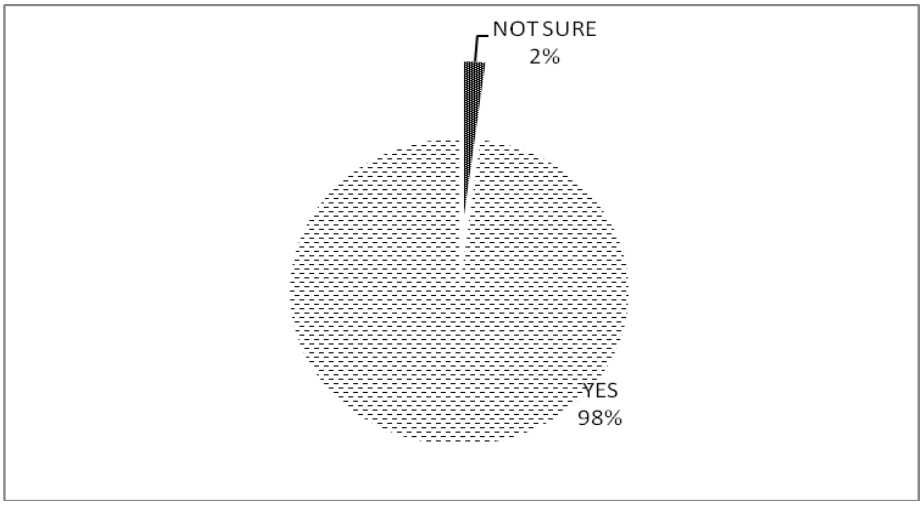

Figure 4.22: Respondents to support ISWM plan

Source: Own analysis

According to Figure 4.22 a large number of respondents are sure they will support the municipality in implementing an integrated waste management plan. This could mean that residents are willing to support the municipality to deal with MSW issues if they are fully engaged in that aspect. Only 2% were not sure if they are willing to support an ISWM plan and its implementation. This is an indication that there is a need to make all residents fully understand the concepts of MSWM.

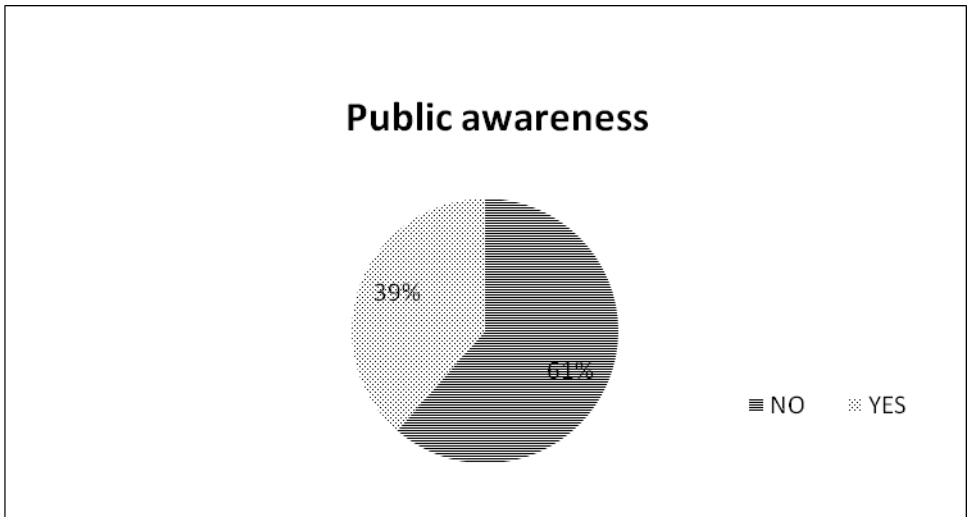

Figure 4.23: Public awareness of waste management

Source: Own analysis

Based on Figure 4.23, close to 61% of public respondents confirmed they have no waste management public awareness; or they can't remember attending any environmental awareness activity in Swakopmund. Close to 39% confirm that they have public awareness in Swakopmund. Respondents that confirmed having public awareness gave examples such as the environmental education and awareness programmes, the marine environmental education and outreach programmes under the MFMR and various workshops involving plastics pollution awareness, usually done with school children and members of the public, during the national cleaning campaign of 2018.

Respondents were also asked to identify any type of waste in the environment. Many of them identified plastics, organic waste (i.e. waste food), papers, wood, building rubble, metals and electronic waste as part of the municipal solid waste stream. This means that a large number of residents are aware of what SW is; and the types of waste in their surroundings are easily identifiable by many. Therefore, if they are informed accordingly on how to sustainably manage these types of waste, environmental issues in the surroundings would positively improve. Moreover, a large number of respondents are aware of the benefits associated with the 3Rs of effective waste management. Below are some of the benefits given by respondents:

1. Help keeping the environment clean,
2. Prevent diseases outbreaks from unhygienic environment,
3. Provide economic benefits such as employment creation,
4. Ensure safety of living organisms including human and animals in case they eat pollutants like plastics,
5. Prevent litter,
6. Conserve landfill space,
7. Attract investors,
8. Save money and energy.

In addition, respondents were asked to give any suggestions on how to improve waste management in Swakopmund. The suggestions made were different from respondent to respondent. Some significant suggestions were that the municipality should intensify environmental awareness programmes in all areas of Swakopmund. They should also provide wheelie bins not just at households but everywhere; and they should provide clearly labelled wheelie bins i.e. plastics, papers, metal and wood. Furthermore, they suggested that the use of posters will be good to educate members of the public about waste management. Some suggested that the municipality should organise monthly clean-up campaigns and educating children at early stage of human development (i.e. pre-primary level) about solid waste management. Others suggested that employing a sufficient number of cleaners could be the best MSWM solution. Many also emphasised the need for waste segregation at household level; and for waste charges to be based on the amount of waste produced to encourage people to use the 3Rs. Plastic production firms should opt to produce biodegradable bags such as paper bags, and to come up with an initiative that give incentives (i.e. in cash or in kind) to members of the public who help to clean up the town on a daily basis. These suggestions deserve to be drawn to the municipality's attention, for consideration by the relevant officials.

4.8. Conclusion

Parallel to the rapidly growing population, the on-going construction and industrial activities have an influence in the increasing volume of MSW generated in Swakopmund. As the local authority responsible for managing solid waste and ensuring the wellbeing of the community and environmental as per constitution of the Republic of Namibia, the challenge faced is that MSW volume generated and disposed is still increasing with the current lack of solid waste treatment facility and insufficient waste segregation at the source. Therefore, MSW could continue affecting the environment under those circumstances. On the other hand, many achievements initiated by the municipality really have to be applauded. The municipality has invested much effort to protect the environment through applying laws and policies to make MSWM an effective practice. However, the absence of a MSWM Plan may reduce the level of system effectiveness. It is worth mentioning that there is a need to fast track approval of the drafted Environmental Management Plan that may address some shortcomings in the system.

It has been evident that MSWM officials have also invested well in acquiring instruments such as the MSWM fleet, providing useful waste collection and disposal tools like wheelie bins, skip containers and providing black garbage plastic bags to maximise solid waste collection and disposal. However, some residents confirmed that some of this essential equipment did not reach everybody particularly in the informal settlements. The partnership between the municipality and private waste management entities in dealing with MSW is another great investment. The status of on-going recycling, however, seems to be inadequate; thus the municipality should be ready to support and encourage more recycling initiatives, particularly at source, which is currently relatively low.

The current solid waste data indicated that the amounts more than 50% of household waste disposed at the landfill are recyclables. Therefore, more waste resources can still be recovered from the disposed SW. Of course, the municipality has invested in keeping the current solid waste disposal site at satisfactory standards by fencing the

dumpsite and covering waste disposed, on a weekly basis. However, a lot still has to be done in ensuring sanitary-hygiene standards to secure the health of people working daily at the dumpsite. It is also worth mentioning that the municipality has invested in human resources by recruiting a satisfactory number of MSWM workforces of different status. Therefore some people perceive Swakopmund town as one of the cleanest in Namibia, even though others indicated their dissatisfaction with waste management services provided by the municipality.

On the local level, it is justified that the level of waste collection is defined as satisfactory, but there is a need fix loopholes in the MSWM system. This is achievable through maximising public awareness programmes to educate the public. This further extends into changing people's mind set with regard to illegal dumping and to cultivate a sense of hygienic environment. The level of waste monitoring and MSWM data needs an urgent improvement to enable accuracy of records, regarding SW quantity generated. Environmental monitoring and control appears to be lacking, and that can be one of the areas of improvement that the municipality should to consider embarking upon. On the other hand, there are also several loopholes in the community development strategy that need to be addressed. The level of public awareness programmes seems to be low. This was justified through public participation in the study, which resulted in close to 61% of respondents confirming they have never had civic awareness; or they can't remember attending an awareness related to MSWM and environmental protection. On the other hand, some residents show gratitude that the municipality is doing well in educating the community about how they should deal with environmental issues that may arise.

Apart from that issues related to public health and environmental quality has been great concerns. Among others, diseases outbreaks and environmental pollution has been reported within Swakopmund jurisdiction. Last but not least, as a developing municipality, there is a need to plan and implement low-cost SWM approaches, enhance public awareness, improve technical SWM knowledge, provide adequate funds, embrace accountability and implement necessary policies and legislation.

CHAPTER 5: SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND PRACTICAL IMPLICATIONS

5.1. Introduction

In general, every citizen has a responsibility to protect the environment and municipalities should fully embrace sustainable SWM systems to provide needed support. MSWM efficiency depends on active participation from the local municipality, as well as the national government and the private sector. It is important to acknowledge the Namibian government for working on ensuring the environment and public wellbeing is protected at national and local levels. Furthermore, it is worth it to acknowledge the Swakopmund municipality for being regarded as a clean town by many; however, that does not mean that the MSWM is adequate. Of course the municipality has applied MSWM systems but they are still inadequate. Countless members of the society could be aware that improper solid waste collection and disposal could end up at a wrong place where it can negatively impact the environment. Through various platforms the government has ensured that local authorities are capacitated to deal with the waste generated in their areas. It is against this background that the government implemented a National Waste Management strategy as an action plan to deal with waste management issues and achieve an integrated SWM approach.

5.2. Summary

Waste generation in Swakopmund is becoming an acute problem due to rapid population growth and urbanisation. On average, close to 10 000m^3 average waste generated in Swakopmund is dumped per year at the Swakopmund disposal facility. Meanwhile, the waste generation per capita is about 0.0073m^3 per day. Different types of wastes are generated from households, businesses, industries and institutions, among other sources. Currently, the Department of Health spearheads MSWM operations, supported by municipal-private partnership, contracted companies and the community. Wastes generated are disposed at the Swakopmund dumpsite which is found to be in close proximity with residential areas; hence posing a wide range of environmental impacts.

The review of the literature revealed that the issue of MSWM is a global phenomenon in both developing and developed countries. However, MSW management systems are more effective in developed countries, compared to developing countries. Namibia as a developing country in general and Swakopmund in particular are not excluded from MSWM challenges. High income countries generate 46% of the global waste volume, followed by lower middle income countries with 29% (Hoornweg and Bhada-Tata, 2012). Therefore, looking at the data and direct observation during this study, Swakopmund generates a lot of waste, and therefore Swakopmund can be regarded as one of the main local waste producers contributing to the waste produced nationally. Swakopmund is one of the fastest growing towns in Namibia, hence MSW generation has increased significantly with the increase in population and economic growth. These dynamics influenced the researcher to conduct the study to investigate the implementation of MSWM systems in the municipality of Swakopmund. The study found that waste management is a burning issue in the Swakopmund municipal area.

The study sought to answer the following two questions:

(a) *What MSWM and disposal systems, policies, processes and methods does the town of Swakopmund have in place?*

The study found that Swakopmund Municipality uses an open controlled dumpsite as a SW disposal method; however the literature suggested that a well-managed sanitary landfill is a suitable waste disposal method that minimises associated environmental impact and public health issues. In addition the study found that MSWM operation in Swakopmund is in accordance with the national policies and legal frameworks related to waste management. This is also strengthened by the council of Swakopmund's waste management policy of 2015 that was drafted with the guidance of the national waste policies and environmental management framework. However, Swakopmund Municipality does not have a waste management plan in place.

MSWM management processes involve waste collection by the municipal solid waste officials and contracted private waste management companies that collect waste on a weekly basis. Waste collection tools such as wheelie bins, skip containers, black plastic

bags, and pedestrian waste bins in the streets are used to deposit MSW. SWM fleet vehicles, such as compactor trucks, skip trucks and a lorry are used to transport MSW to the disposal site and waste is then covered with cover materials consisting of building rubble and sand, using bulldozers. Apart from that, there is no MSW treatment in Swakopmund apart from the recycling activities that are taking place. Sewage waste is the only waste treatment activity at municipal level.

(b) What are the residents' perceptions of MSWM, including environmental impacts?

The study found that the majority of residents are willing to engage in MSWM programmes, even though more females are participating, compared to males. Middle aged residents are actively participating in MSW programmes and initiatives. In addition, the study found that education level and public awareness has a great influence on how people handle and dispose of their MSW. It was also found that solid waste disposal bins are not allocated to all households and business premises, particularly in the informal settlements. Apart from that, many solid waste bins are not labelled to indicate the type of SW to be thrown in, hence people throw SW in any bin available. However, because few bins are labelled, few people throw SW in the right bin.

Several environmental impact and public health issues were reported in Swakopmund. The study found that many residents are not aware that there are recycling activities in Swakopmund; however a large number of residents are aware that recycling could benefit the environment and people in many ways. Most of the residents are also willing to support the municipality in implementing an ISWM plan and other waste management activities. Therefore, public awareness and activities at municipal level should be enhanced. Swakopmund Municipality in general and the Department of Health in particular must consider the participation of the community when designing policies, laws, and making changes in the way they are dealing with waste. Various stakeholders should also be involved in MSWM, especially in the private sector.

Furthermore, the study findings revealed that there is sufficient equipment for collecting MSW, but lack of equipment for sorting and separating waste materials, particularly at household level. Hence, waste separation is conducted manually in both the formal and informal sectors. The study found that the best waste prevention strategy is through public awareness, implementing incentive programmes and enforcing regulations aiming at maximising environmental obligations. Furthermore, it is very crucial for a municipality to have a Solid Waste Management Plan, in terms of which environmental wellbeing, the local economy and public health are highly promoted.

Lack of accurate data prohibits accurate system analysis, particularly data on waste prevention. Data are very important for planning the future waste prevention programmes and determine the most effective policy measures. The study also discovered that effective policies and programmes are effective tools for MSWM. The municipality of Swakopmund was found to comply with the national and local policies related to waste management and environmental protection. The study conducted by Naidoo (2009) stressed that public awareness and environmental education is the key to establish environmental consciousness and conservation. In the context of Swakopmund, public awareness and environmental education on MSWM and recycling techniques are inadequate. This was discovered through qualitative data collected from the Swakopmund residents. Public awareness is an effective tool in MSWM, recycling and general urban hygiene; but their effectiveness depend on support given by the Municipal Council and officials. The ISWM framework can be implemented to facilitate an MSWM approach, since it contains aspects such as stakeholder engagement (i.e. local authorities, NGOs, residents, formal and informal sectors), project elements (i.e. waste generation and segregation, collection, transfer and transport, treatment and disposal, reduction, reuse, recycling and recovery) and managerial aspects (i.e. technical , environment, economic, socio-cultural, institutions, policy/legal and political) all working together to achieve sustainability.

5.3. Conclusions

Based on the findings of the study, the following key conclusions are made:

- There is no sanitary landfill, and the current MSW disposal facility according to literature definitions, is an open controlled landfill and not a sanitary landfill which is needed to reduce environmental impacts.

- Most of the wheelie bins allocated are not labelled, which make waste segregation very difficult to implement.

- Mixtures of biodegradable and non-biodegradable solid waste materials are dumped at the dumpsite on a daily basis; of which organic wastes and recyclables are found in large quantities.

- There is insufficient enforcement of an ISWM approach at municipal level. Accordingly, the 4Rs are not applied efficiently and effectively, despite having some reduce, reuse and recycling activities in the private sector.

- There is low solid waste reduction and low solid waste segregation at source. Generally solid waste sorting at source is very little; and the focus is mainly on waste collection, transportation and disposal.

- There is no appropriate technological solid waste measurement equipment to give accurate solid waste quantity data. In general there is a barrier in providing accurate municipal waste generation quantity data at municipal level, because there is no weigh bridge at the waste disposal site.

- Most respondents indicated that they are not informed of MSM strategies and associated environmental impacts. Therefore, inappropriate MSW disposal, such as illegal dumping, is at an alarming level in Swakopmund.

- There is no municipal solid waste management plan in place. It appears that the municipality has drafted a Municipal Solid Waste Management Plan but this is still to be approved by the Council, hence the Plan finalisation needs to be expedited.

- Environmental impacts associated with inappropriate MSW disposal remain a challenge, despite efforts from the Municipality and various stakeholders involved in MSWM.

- The level of education, socio-economic status and cultural behaviours influence residents' MSW management practices.

5.4. Recommendations

Based on these findings and conclusions of the study, the following recommendations are made:

Recommendations to the Municipality of Swakopmund

- The Swakopmund Municipality needs to invest more in the MSW sector, in terms of constructing a sanitary landfill to replace the current open but controlled dumpsite. Literature suggested that a sanitary landfill is economically viable and environmentally friendly. Taking in account the economic affordability, Namibia as a middle income country, Swakopmund Municipality could afford constructing and operate a sanitary landfill that is a suitable waste disposal method taking environmental wellness and public health into account.

- The Municipality should emulate other progressive cities to consider installing a solid waste quantity measurement station i.e. weighbridge. This is because there is a gap in MSW data accuracy (no accurate data records of solid waste generated at source and volume of waste disposed can be estimated without any

measuring instrument). It is important to note that data accuracy is important in planning and monitoring waste management strategies.

- Solid waste bins should all be clearly and accurately labelled, so that residents will be fully aware of which bin in which to throw recyclables such as papers, grasses, plastics, metals, organic waste etc.

- Swakopmund Municipality should encourage source reduction at all levels. This can be done by a mutual agreement between manufacturing companies and the Municipality so that companies start manufacturing biodegradable materials that pose minimal threat to the environment.

- The public should be encouraged to buy and consume products that are reusable and recyclable, to reduce waste generation quantity.

- Swakopmund Municipality should enforce strict measures for waste segregation at source, as these practices will promote recycling and composting activities in future.

- Promote waste separation at source by providing economic incentives to maximise the waste segregation applicability and efficiency.

- The Municipality should develop environmental awareness programmes on recycling and general MSW management to the public because currently, public awareness programmes are inefficient and there is very scant information available from the public domain.

- Regular clean-up campaigns should be conducted regularly as they would have a positive influence in the community toward changing their attitudes with regard to environmental hygiene.

- There is a need to train informal waste pickers on how to handle solid waste as a resource and provide them with information of safety measures when physically handling MSW.

- Composting and recycling of MSW should be supported by the municipality. Organic waste can be easily converted to fertiliser (organic waste is the main component in daily household waste).

- Swakopmund Municipality should consider using the following forms of municipal solid waste treatment:

  (a) Composting,
  (b) Anaerobic digesters
  (c) Develop more waste-to-energy (WTE) plants
  (d) Incineration with energy recovery,
  provided that all the possible choices are made considering costs of operation and maintenance of the units, minimum installed capacity, the nature of the service provider, the amount of energy generated, logistics, and other information related to each technology. Applying these approaches are economic viable methods of managing MSW.

- There is a need for technical, socioeconomic and environmental evaluation of the technologies for the handling of municipal solid waste, considering the applicability and sustainability based on the quantity and characteristics of the waste generated.

- Swakopmund Municipality should monitor the material producing industries to confirm if all waste generated from their activities is managed properly.

- The Municipality should consider giving a tax concession to companies that produce reusable products.

- Install a loud alarm beep on the MSW collection vehicles with the intention to make residents aware that waste collection operations are underway.

- Swakopmund Municipality should consider formulating legislation pertaining to regular monitoring of leachate, water, ground, and air quality.

- MSWM practices should include environmental monitoring and evaluation to maximise environmental sustainability.

Recommendations to Swakopmund residents

- Residents should at all-time adhere to the municipal waste management policy.

- Residents should support the Municipality and private sector in dealing with MSWM by dropping recyclables in the orange bin instead of dropping recyclable resources in any bin.

- There is a need to adapt a culture of general hygiene and cleanliness as well as to embrace a zero waste mind-set. This will minimise incidence of public health issues such as hepatitis outbreaks.

- Every member of the local society generates waste, regardless of their age and gender, hence they should think of any secondary use solid waste can have, before throwing it in the garbage bin.

- Residents should work together with the municipality in ensuring filled garbage bins are made available during the routine waste collection activity.

Recommendations for Swakopmund waste management policy

- The policies should be reviewed to ensure strict measures are in place that will guarantee transparency in waste recovery, reduction, reuse and recycling.

Recommendations for further research

- There is a need to conduct further studies of MSWM systems in other towns, cities, settlements and villages in Namibia, to ensure generalisation and improving MSWM in the entire country.

5.5. Implications

The study findings and recommendations may be beneficial in terms of guidelines towards improving MSWM systems in various local authorities in the country and beyond. The findings from the study may be useful to inform policy formulation and evidence-based decision for the town of Swakopmund to come up with an efficient and effective waste management plan, benchmarked with the best practices in the world.

5.6. Limitations of the study

Firstly, the study was constrained by both time and a lack of funds, thus making it difficult to expand the scope of key stakeholders in the MSWM sector. This limitation was mitigated by carefully selecting participants in the study through a purposive sampling technique, to ensure that the key stakeholders in MSWM were included.

Secondly, effective and successful collection of data involving people was hindered by the mood and attitude of the participants; hence, the biggest concern was the reliability and validity of the data collected. These limitations were mitigated by explaining to the participants the purpose of the study and assuring them a high degree of confidentiality.

Thirdly, the researcher did not get access to data related to the budget and/or finances allocated to the waste management sector from the municipality as expected. Therefore, the analysis of the economic costs involved in the MSWM in Swakopmund

could not be considered in this study. For future studies the municipality should consider providing financial data so that this limitation can be mitigated.

5.7. Conclusion

This chapter drew conclusions from the study findings and provided a summary of the key findings. Recommendations were also made as well as discussion of the study implications.

References

Abdul-Rahman, F. 2014. *Reduce, reuse, recycle: alternatives for waste management.* College of Agricultural, Consumer and Environmental Sciences: New Mexico State University.

Aiyambo, S.D. 2017. *Evaluating solid waste management challenges at groot-aub settlement.* Unpublished honours dissertation. Pretoria: University of South Africa.

AF Sweden. 2018. *Successful waste-to-energy project in Finland* [Online]. Available: http://www.afconsult.com/en/newsroom/news/news/2017/successful-waste-to-energy-project-in-finland/ [2018, May 21].

Agamuthu, P., Fauziah, S.H. & Khidzir, K. 2009. *Evolution of solid waste management in Malaysia: Impacts and implications of the solid waste Bill 2007.* Paper accepted for journal of Material Cycles and Waste Management.

Ajayakumar, V. 2006. *Status of municipal solid waste generation in Kerela and their characteristics*. Paper. Government of Kerela, India.

Ajith, P.S. 2014. *A study on the effectiveness of solid waste management of Municipalities in Kerala.* Mahatma Gandhi University.

Aljaradin, M. & Person, K.M. 2014.Solid waste management in Jordan. *International Journal of Academic Research in Business and Social Sciences,* 4(11):138-150.

Andrews, D. 2015. The circular economy, design thinking and education for sustainability. *Local Economy*. 30(3), p. 305-315.

Anderson, V. 2013. *Research methods in human resource management: Investing in business issues*. (3rd ed). London: Chartered Institute of Personnel and Development.

Arzumanyan, G. 2004. *Municipal solid waste management in Armenia, current trends and steps forward.* Unpublished Master's dissertation. Lund: The International Institute for Industrial Environmental Economics.

Aziegbe, F.I. 2007. Sediment sources, redistribution and management in Ekpoma, Edo State, *Nigeria Journal of Human Ecology,* 20(4):259-268.

Best, J.W. & Khan, J.V. 2014. *Research in education.* London: Pearson.

Breeze, R. 2012. *Municipal solid waste management in Dar es Salaam*. Draft Baseline Analysis. Toronto, ON , Canada.

Camagni, R., Capello, R. & Nijkamp, P. 1998. Towards sustainable city policy: an economy-environment technology nexus. *Ecological Economics,* 24(1):103-118.

City of Windhoek (CoW). 2008. State of the Environment Report. Volume 1. *Baseline Report*. Windhoek.

City of Windhoek (CoW). 2009. *Solid Waste Management Policy of 2009*. Windhoek.

Chintan Environmental Research and Action Group. (n.d). *Definition of waste segregation* [Online]. Available: http://www.chintan-india.org [2018, August 22].

Coad, A. 2003. *Solid waste collection that benefits the urban poor. Collaborative working group on solid waste management in low-and middle-income countries*. Skat Foundation workshop report, Dar es Salaam, Tanzania.

Conserve Energy Future, 2018. *Reduce, reuse, recycle* [Online]. Available: https://www.conserve-energy-future.com/reduce-reuse-recycle.php/. [2018, July 12].

Council of Swakopmund. 2015. *Waste Management Policy of 2015*. Swakopmund: Health Department.

Creswell, J.W. 2003. *Research design: A qualitative, quantitative, and mixed methods approaches.* (2nd ed.) Thousand Oaks: Sage.

Creswell, J.W. 2014. *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. 4th edition. London: Pearson.

Croset, E. 2014. *Opportunities and challenges of a Sustainable Solid Waste Management in Tsumeb, Namibia. Unpublished Master of Science dissertation*. Stockholm: Royal Institute of Technology.

Department of Environmental Affairs. 2003. *Namibia's pollution control and waste management policy of 2003.* Windhoek: Government Printer.

Department of Environmental Affairs. 2017. *National Solid Waste Management Strategy.* Windhoek: Government Printer.

Department of Environmental Affairs. 2014. *National Solid Waste Management Strategy.* Windhoek: Government Printer.

Dresner, S. (ed.). 2008. *Principles of sustainability*. Sterling: London.

Diaz, L.F., Savage, G.M. & Golueke, C.G. 1992. *Resource recovery from municipal solid wastes: Vol. 1, Primary Processing.* Florida: CRC Publisher.

Diaz, L.F., Savage, G.M. & Golueke, C.G. 1999. Solid Waste management in Africa. *International Fair and Seminar, Solid and Hazardous Waste Integral Management.* CalRecovery, Inc. Concord, California, USA.

Ejaz, N., Akhutar, H., Nisar, A. & Ali-Naeem, U. 2010. *Environmental impacts of improper solid waste management in developing countries: a case study of Rawalpindi City.* Taxila: University of Engineering and Technology.

El-Fadel, M., Findikakis, A.N. & Leckie, J.O. 1997. Environmental Impacts of Solid Waste Landfilling. *Journal of Environmental Management,* 50:1-25.

Emery, A., Davies, A., Griffiths, A. & Williams, K. 2006. Environmental and economic modelling: A case study of municipal solid waste management scenarios in Wales. *Resource, Conservation and Recycling.* 49: 244-263 [Online]. Available: http://www.sciencedirect.com [2018, May 04].

Engelbrecht, P. 2018. Environmental Officer: Health Services Division. Swakopmund Municipality. *Personal interview.* 09 October, Swakopmund.

Enviros Consulting Ltd, & University of Birmigham. (n.d.). *Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes* [Online]. Available: http://www.defra.gov.uk/ [2018, September 10].

Gay, L.R., Mills, G.E. & Airasian, P. 2011. *Educational research competencies for analysis and application.* 10th edition. New Jersey: Pearson.

Geological Survey of Namibia. 2017. Strategic Environmental Management Plan (SEMP) for the Central Namib Uranium Province 2016. Annual Report for the Ministry of Mines and Energy. Windhoek.

Giusti, L. 2009. A review of waste management practices and their impact on human health. *Waste Management*, 29:2227 - 2239.

Goamab, M. 2005. *Private Sector Investment and Socio-economic Transformation and Development.* Namibia Economic Society.

Gogoi, L. 2013. Municipal solid waste disposal: a case study in Guwahati city to mitigate the man-made disaster. *IOSR Journal of Humanities and Social Sciences,* 9(3):55-60*.*

Google Images. 2018. *Swakopmund maps* [Online]. Available: https://www.google.com/search?q+swakopmund-map/. [2018. July 11].

Guangyu, Y. (n.d.). Point sources of pollution: Local effects and its control. *Amount and Composition of Municipal Solid Wastes.* Vol.1.

Guerrero, L.A., Maas, G. & Hogland, W. 2013. Solid waste management challenges for cities in developing countries. *Waste Management*, 33 (2013):220-232.

GRN (Government of the Republic of Namibia). 2007. *Environmental Management Act No. 7 of 2007.* Government Gazette No. 3966. Windhoek: Government Printer.

Hansen, W., Christopher, M. & Verbuecheln, M. 2002. EU Waste Policy and Challenges for Regional and Local Authorities. *Background Paper for the Seminar on Household Waste management "Capacity Building on European Community's Environmental Policy".* Ecologic, Institute for International and European Environmental Policy. Pfalzburger: Berlin.

Hasheela, R. 2009. *Municipal waste management in Namibia: The Windhoek case study*. Unpublished doctoral dissertation. Chalco: Universidad Azteca.

Henry, K.R., Yongsheng, Z. & Jun, D. 2006. Municipal solid waste management challenges in developing countries – Kenyan case study. *Waste Management*, 26: 92-100. DOI:10.1016/j.wasman.2005.03.007.

Hikuafilua, I. 2018. Senior Waste Officer: Enviro-Fill. *Personal communication*. 04 October, Swakopmund.

Hiriya, H. 2003. *Waste containment systems, waste stabilization and landfills.* New York: John Willey and Sons, Inc.

Hoornweg, D. & Bhada-Tata, P. 2012. *What a waste: A global review of solid waste management.* Urban Development & Local Government Unit, World Bank, Washington, DC 20433, U.S.A.

Honorene, J. 2017. Understanding the role of triangulation in research. *Research Scholar, Azam College of Education.* 4:3, 91-95.

Hult, C.A. 1995. *Researching and writing in sciences and technology*. Massachusetts: Ally & Bacon.

Hye-Jung, C. 2016. *The environmental effectiveness of solid waste management: A case study of Oslo, Norway.* Unpublished master thesis. Oslo: University of Oslo.,

Mohammed, B., Wilson, C.D. & Cheeseman, R.C. 2008. Solid waste management in Abuja, Nigeria. *Waste Management*, 28:468 – 472.

Iikela, S. 2018. *Namibia: Coastal environment at risk of degradation.* [Online]. Available: https://allafrica.com/stories/201807130556.html [2018, November 20].

Imam, A., Mohammed, B., Wilson, C. D., & Cheeseman, R. C. (2008). Solid waste management in Abuja, Nigeria. *Waste Management*, 28(1):468–472.

Jha, R., Sharma, K.D. & Singh, V.P. 2003. Critical appraisal of methods for the assessment of environmental flows and their application in two river systems of India. *KSCE J Civil Engineering,* 12(3):213-219.

Jin, J., Wang, Z. & Ran, S. 2006. Solid waste management in Macao: Practices and challenges. *Waste Management,* 26, 1045-1051.

Jofeph, K., Nagendran, R., Thanasekaran, K., Visvanathan, C. & Hogland, W. (n.d.). *Dumpsite rehabilitation manual*. Centre for Environmental Studies. Anna University-Chennai, India.

Kaufman, S.M. 2008. A *new screening metric to benchmark the sustainability of municipal solid waste management system*s. Unpublished doctoral dissertation. New York: Colombia University.

Khan, A. 1994. Environment and health in China: Challenges and opportunities. *Environmental Health Perspective*, 117(12):A530-A531.

Kirchherr, J., Reike, D. & Hekkert, M. 2017. *Conceptualizing the circular economy: An analysis of 114 definitions.* Resources, Conservation & Recycling.

Korfmacher, S.K. 1997. Solid waste collection system in developing urban areas of South Africa: An Overview and Case Study. *Waste Management & Research* 15 : 477-494.

Krista, L., Thyberg, T. & Tonjes, D.J. 2015. *A management framework for municipal solid waste systems and its application to food waste prevention*. New York: Department of Technology and Society, Stony Brook University.

Kurian, D.R., Nagendran, R., Kandasamy, J. & Kandasamy, P. 2018. *Open dumps to sustainable landfills.* Anna University, Chennai. Centre for Environmental Studies [Online]. Available: https://www.researchgate.net/publication/228737059_open dumps_to_sustainable_landfills [2018, June 10].

Lagbas–Aranas, A.G.U. 2015. The theoretical underpinnings of the solid waste management practices: A proposed blueprint towards government action. *European Scientific Journal*, 11(23):1-13.

Lee, G.F. & Jones L.A. 2004. *Flawed technology of subtitle waste*. Report of G. Fred Lee & Associates, El Macero, CA.

Lee, P., Sims, E., Bertham, O., Symington, H., Bell, N., Pfaltzgraff, L., and P, Sjogren. 2017. *Toward circular economy – Waste management in the EU.* Report for Scientific Foresight Unit. European Union, Brussels.

Lee, G.F. & Jones, L.A. 1991. *Municipal solid waste management: Long-term public health and environmental protection.* California: University of California.

LI, L. 1999. A *case study of municipal solid waste management in the municipality of Jingshan, China*. Unpublished master thesis. Sweden: Lund University.

Maluleke, P.H. 2014. *A review of solid waste management practices in Polokwane city.* Unpublished Master of Science dissertation. Pretoria: University of South Africa.

Mapaure, I. 2011. *Environmental law and policy in Namibia*. Windhoek, Namibia

Maree, K. 2008. *First steps in research*. Pretoria: Van Schaik Publishers.

Mäkelä, A. 2017. *Circular economy in South Africa, Botswana and Namibia. Unpublished bachelor degree thesis*. Lahti: Lahti University of Applied Sciences.

McMahon, G.J. & Moreira, S. 2014. *The contribution of the mining sector to socio-economic and human development.* Extractive Industries for Development Series, no. 30, World Bank Group.

Messineo, A. & Panno, D. 2008. Municipal waste management in Sicily: Practices and challenges, *Waste Management*, 28: 1201-1208.

Mfundisi, K.B. 2012. Water Resource Management Act 2004, Namibia: Implementation Status and Challenges. Water Safety Conference 2012, Kampala, Uganda.

Ministry of Environment-British Columbia. 2016. *A guild to solid waste management planning* [Online]. Available: http://www.bclaws.ca/ [2018, October 13].
Ministry of Fisheries and Marine Resources (MFMR). 2015. Annual Report 2015. Swakopmund, Namibia.

Modak, P. 2010. *Municipal solid waste management: Turning waste into resources.* Shanghai Manual-A Guide for Sustainable Urban Development in the 21st Century [Online]. Available: http://www.un.org/ [2018, September 13].

Moningka, L. 2000. *Community participation in solid waste management. Factors favoring the sustainability of community participation.* A literature review. UWEP Occasional Paper. Netherlands.

Mouton, J. 2001. *How to succeed in your master's and doctoral studies: A South African guide and resource book.* Pretoria: Van Schaik.

Mor, S., Ravindra, K., Dahiya, R.P. & Chandra, A. 2006. Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. *Environmental Monitoring and Assessment*, 118, 435-456.

Mtey, J.K. 2005. *Solid waste collection Kawe community development trust.* Unpublished project proposal. Dar es Salaam: The Open University of Tanzania.

Mughal, M.I. 2014. *Waste management in northern towns of Namibia*. Unpublished bachelor's thesis. Tampere: Tampere University of Applied Sciences.

Mwanangombe, K. 2018. Section Head: Solid Waste Management: Health Services Division. Swakopmund Municipality. *Personal communication.* 09 October, Swakopmund.

NACOMA. 2005. *Environmental Management Plan for Namib Coast Biodiversity Conservation and Management (NACOMA) Project*. EnviroScience. Draft February 2005.

Naidoo, K. 2009. An Analysis of Municipal Solid Waste Management in South Africa using the Msunduzi Municipality as a Case Study. Unpublished Master of Science thesis. Pietermaritzburg: University of Natal.

Nahman, A. & Godfrey. L. 2009. Economic instruments for solid waste management in South Africa: Opportunities and constraints. *Resources, Conservation and Recycling,* 54: 521-531.

Namib Times. 2016. *Swakopmund gets waste management policy*. Edited on 14/06/2016.

Namibia Statistics Agency. 2014. *Namibia Populations Projection 2011-2041*. Windhoek, Namibia.

Namibia Statistics Agency. 2011. *Namibia Population and Housing Census 2011*. Windhoek, Namibia.

Ngoc, N.U. & Schnitzer, H. 2009. Sustainable solutions for solid waste management in Southeast Asian countries. *Waste Management*, 29:1982 - 1995.

Nteda, C. & Hauptfleisch, M. 2014. *Turning organic waste into a socio-economic resource: A case study of the City of Windhoek, Namibia.* Polytechnic of Namibia, Windhoek.

Nwofe, P.A. 2015. Management and disposal of municipal solid wastes in Abakaliki Metropolis, Ebonyi State, Nigeria. *International Journal of Scientific Research in Environmental Sciences.* 3: 107-118.

Nyarai, P. M., Willard, Z., Moses, M. & Ngenzile, M. 2016. Challenges of solid waste management in Zimbabwe: a case study of Sakubva high density suburb. *Journal of Environment and Waste Management*, 3(2), 142-155.

Ohorongo Cement. 2017. *Moving towards a zero waste to landfill Namibia.* Media releases [Online]. Available: http://www.ohorongo-cement.com/news-media/article/moving -towards-a-zero-waste-to-landfill-namibia/ [2018, August 14].

Okot-Okumu, J. 2012. Solid waste management in African cities-East Africa. In L.F. Marmolejo Rebellon (Ed.), *Waste management-an integrated vision.* [Online]. Available: http://www.intechopen.com/books/waste-management-an-integrated-vision/solid-waste-management-in-african-cities-east-africa. [2018, July 25].

Onibokun, A.G. 1999. *Governance and waste management in Africa: Managing the Monster.* Ottawa: Canada.

Ouedraogo, F. 2005. *Landfill gas capture opportunity in Sub-Sahara Africa*. Energy sector management assistance program (ESMAP). Technical paper series, no. 074. World Bank, Washington, DC.

Pariathamby, A., Hamid, F.S. & Khidzir, K. 2009. *Solid waste management in Asia and Pacific Islands.* Kuala Lumper: Faculty of Science, University of Malay. [Online]. Available: http://www.scribd.com/documents/31338504/solid-waste-management-pdf [2018, April 10].

Parrot, L., Sotamenou, J. & Dia, B. 2009. *Municipal solid waste management in Africa: Strategies and livelihoods in Yaounde, Cameroon*. *Waste Management,* 29(2): 986-995.

Peprah, K., Amoah, S.T., Thomas, G. & Achana, W. 2015. Assessing '3Rs' Model in Relation to Municipal Solid Waste Management in Wa, Ghana. *World Environment*, 5(3): 112-120.

Popov, V., Itoh, H., Brebbia, C.A. & Kungolos, S. 2004. *Waste management and the environment* [Online]. Available: http://www.witpress.com [2018, June 05].

Ramachandra, T.V. 2006. *Management of municipal solid waste*. TERI Press, The Energy and Resource Institute, New Delhi.

Reddy, S. & Galab, S. 1998. *An integrated economic and environmental assessment of solid waste management in India-the case of Hyderabad, India.* A report, Centre for Economic and Social Studies, Andhra Pradesh.

Reddy, P.J. (ed.). 2011. *Municipal solid waste management.* London: CRC Press. ISBN: 9780203145692.

Rent-A-Drum. 2018. *Swakopmund material recovery facility*. Swakopmund, Namibia.

Saeed, M.O., Hassan, M.N., & Mujeebu, M.A. 2009. Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia. *Waste Management,* 29, 2209-2213.

Sankoh, F.P., Yan, X. & Tran, Q. 2013. Environmental and health impact of solid waste disposal in developing cities: A case study of Granville Brook Dumpsite, Freetown, Sierra Leone. *Journal of Environmental Protection,* 4: 665-670.[

Singal, S. & Pandey, S. 2000. Solid waste management in India: Status and future directions. *TERI Information Monitor on Environmental Sciences*, 6: 1-4.

Sharholy, M., Ahmad, K., Vaishya, C.R. & Gupta, D.R. 2007. Municipal solid waste characteristics and management in Allahabad, India. *Waste Management*, 27, 490 - 496. DOI:10.1016/j.wasman.2006.03.001.

Shen, T.T., Nelson, T.P. & Schmidt, C.E. 1990. Assessment and control of VOC emissions from waste disposal facilities. *CRC Critical Reviews in the Environmental Control*, 20: 43 76.

Shin, D. 2014. *Generation and disposition of municipal solid waste (MSW) in the United States. A national survey.* Unpublished Master of Science dissertation. School of Engineering and Applied Sciences: Columbia University.

Snel, M. & Ali, M. 2009. *Stakeholder analysis in local solid waste management schemes*. London: London School of Hygiene & Tropical Medicine.

Soiferman, L.K. 2010. *Compare and contrast inductive and deductive research approaches*. University of Manitoba.

Srivastava, S. & Singhvi, R. 2013. Impact of solid waste on health and the environment. *International Journal of Science and Research (IJSR),* 4(9):443-445.

Tadesse, T. 2004. *Solid and hazardous waste management*. Environmental Health Science. University of Gondar.

The City of Windhoek. 2009. *Solid Waste Management Policy* [Online]. Available: http://www.windhoekcc.org.na/pdf/infrastructure/SWMPolicy.pdf/ [2018, May 18].

The Namibian. 2008. *Population explosion and nightmare for Swakop*; 24 July:08.

The Namibian. 2010. *Swakopmund municipality landfill eventually fenced*; 09 November:10.

The Namibian. 2015. *Rent-A-Drum employs dumpsite scavengers;* 08 September:15.

The Namibian, 2018. *Hepatitis E outbreak at Swakop;* 04 July:18.

The World Bank. 2015. *Generating electricity from landfill gas in Durban* [Online]. Available: http://www.worldbank.org/en/results/2015/10/21/powering-electricity-landfill-gas-durban/ [2018, July 12].

The World Bank. 2012. *What a waste: A global review of solid waste management*. Urban Development Series-Knowledge Papers, pp. 16-2.

UK Department for Environment, Food & Rural Affairs. 2006. *Key facts about waste and recycling* [Online]. Available: http://www.defra.gove.uk/e [2018, October 15].

United Nations Conference on Environment and Development (UNCED). 1992. *Earth Summit*. [Online]. Available: https://www.unsystem.org/content/united-nations-conference-environment-and-development-unced-1992.

UNEP. 2005. *Marine litter an analytical overview*, Nairobi, Kenya.

UNEP. 2010. *Framework for global partnership on waste management*. Note by Secretariat [Online]. Available: http://www.unep.cr.jp [2018, September 11].

United Nations ESCAP. 2018. *Solid waste management.* SEEA Development in Asia and the Pacific. Bangkok:Thailand.

United Nations Industrial Development Organisation (UNIDO). (n.d). *Circular Economy*. Vienna International Centre, Austria [Online]. Available: http://www.unido.org/ [2018, April 11].

UN-HABITAT. 2009. *Solid waste management in the world's cities.* Pre-Publication Series. UN-HABITAT: Nairobi.

U.S.EPA. 2018. Criteria for the *definition of solid waste and solid and hazardous waste exclusions* [Online]. Available: https://www.epa.gov/ [2018, August 26].
U.S.EPA. 2009. *Waste definitions.* Environmental Protection Authority. EPA 842/09.

U.S.EPA. 2006. *Bio-solids generations, use and disposal in the United States.* [Online]. Available: http://www.cri.dk/wastedataguideline/01_003.htm [2018, October, 01].

Van de Klundet, A. & Anschütz, J. 2001. *Integrated sustainable waste management-the Concept.* Netherlands Agency for International Cooperation (DGIS), Ministry of Foreign Affairs. Netherlands.

Veolia Environmental Services. 2006. *From waste to resource. An abstract of "2006 World Waste Survey"* [Online]. Available from: http://veolines.com/resource.php?id=566. [2018, June 10].

Vergara, S.E. & Tchobanoglous, G. 2012. Municipal solid waste and the environment: A global perspective. *Annual Review of Environment and Resources*, 2012 37:1, 277-309.

Vidal. J. 2014. Smelley, contaminated, full of diseases: the world's open dumpsites are growing. *The Guardian,* October:6.

Von Oertzen, D. 2009. *Green energy in Namibia*. Electricity Control Board. Windhoek, Namibia [Online]. Available: https://www.voconsulting.net/pdf/e [2018, May 11].

Wahengo, N. 2018. *Regional Spotlight*. Vol.1. Issue.1. Windhoek: Namibia Press Agency.

Waste Management World. 2018. *Waste management key to cleaning up oceans* [Online]. Available from: https://waste-management-world.com/ [2018, October 19].

Welman, J.C. & Kruger, S.J. 2001. *Research methodology for the business and administrative sciences.* (2nd ed). Cape Town: Oxford University Press.

Wilkinson, P., Crabe, H. & Crabbe, H. 2016. *Health knowledge: education, CPD and revalidation from Phast.* Public Health Action Support Team (PHAST), Sterling House: England.

Wilson, D.C., Velis, C.A. & Rodic, L. 2013. Integrated sustainable waste management in developing countries. *Proceeding of the Institution of Civil Engineers: Waste and Resource Management,* 166 (2): 52-68

Windhoek Observer. 2017. *Ondangwa set for N$ 300 million waste-to-energy plant*. Paragon Investment Holding, Windhoek, Namibia. 7 November: 2017.

World Economic Forum. 2018. *White Paper on circular economy in cities-evolving the model for a sustainable urban future.* Geneva, Switzerland.

Zakianis, I., Sabarinah, I. & Djaja, I.M. 2017. The importance of waste management knowledge to encourage household waste-sorting behaviour in Indonesia. *International Journal of Waste Resources*, 7: 309.

Zurbrügg, C. 2003. *Urban solid waste management in low-income countries of Asia: How to cope with the garbage crisis*. Scientific Committee on Problems of the Environment (SCOPE), Urban Solid Waste Management Review Session, Durban, South Africa. 1-13.

Appendixes

Appendix 1: Permission to conduct a research project in Swakopmund

MUNICIPALITY OF SWAKOPMUND

(064) 4104502
088 651 9142
53 Swakopmund
NAMIBIA
Web www.swkmun.com.na
lmutenda@swkmun.com.na

Ref No: FI

Enquiries: Ms L N Mutenda

05 June 2018

Mr Timoteus Kadhila
P O Box 6299
Vineta
SWAKOPMUND

Email: tkcibi85@yahoo.com
timkadhila@gmail.com

Sir,

REQUEST TO CONDUCT A RESEARCH PROJECT AT SWAKOPMUND

We acknowledge receipt of your letter dated 24 April 2018 with regard to the above subject matter.

This letter serves to inform you that your request to conduct research in the area of solid waste management at the Swakopmund Municipality for educational purposes to fulfill the study requirement toward obtaining a master degree in Environmental Management at the University of Stellenbosch, South Africa, has been granted.

You are further requested to share the outcome / recommendations of the study with the Municipality of Swakopmund, Health Services Department.

Kindly contact Ms Lydia Mutenda on the above contact details to finalise the arrangements and for any further assistance that you might require in this regard.

Yours faithfully

CL LAWRENCE
GENERAL MANAGER HEALTH SERVICES

General Manager Health Services - 6 JUN 2018 Municipality of Swakopmund

Appendix 2: Waste Composition and Physical characterization of Municipal Solid Wastes (examples of material type and items)

Analysing Municipal Solid Waste Management (MSWM) systems and disposal practices in the municipality as well as determine the solid waste composition and quantity in Swakopmund. This will be done by means of site visits, direct observation and recording to see how waste is collected, transported, treated and recycled. This is the best ways to validate data collected by other means (Hasheela, 2009).

Date:

		Recyclable	Non - recyclable	Transported	Waste treatment	Estimated weight (m^3)
Material type	**Material Items**	✓ (yes)	x (yes)			
1. PAPER						
Newspaper	Newspapers, newspaper like pamphlets					
Magazine/brochures	Magazines (glossy and non-glossy), pamphlets,					
Miscellaneous packaging	Wrapping paper, Labels, Paper packaging (no plastic or wax coating)					
Cardboard	Cardboard with corrugation					
Package Board	Cardboard without corrugation (glossy and non-glossy), cereal boxes, business cards l					
Liquid Paper Containers	Soy milk cartons, some fruit juice cartons, UHT / Long life milk,					
Disposable Paper Product	Hand towels, tissues, coffee cups, paper napkins, paper food bags Sanitary paper					
Printing / writing papers	A4 document paper, writing pads, letters, envelopes, books					
Nappies	Used disposable nappies					
2. ORGANIC (Compostable)						
Food /kitchen	Vegetable scraps, meat scraps, animal food, left-over food.					
OTHER ORGANIC						
Wood / Timber	Milled wood / timber, children's wooden toys, wooden skewers,					
	garden tree (>20mm)					
Textile /Rags /Carpet	Wool, cotton and natural fibre materials					
Leather	Leather clothing, craft leather, some shoes, belts with belt buckle					
Rubber	Rubber bands, rubber toys, shoes, latex gloves					
Oils	Used car oil, motor and other, vegetable, cooking oil					
3. GLASS						
Recyclable Glass	Beer bottles, wine bottles, food and sauce jars other than clear, green or brown					

4. PLASTIC						
Hard Plastics	(Polyethylene) Soft drink bottles, juice bottles, some food					
	containers (e.g. jam and sauce bottles), mouthwash containers,					
	peanut butter jars,					
HDPE # 2 (High Density Polyethylene)	Milk and cream bottles, shampoo and cleaner bottles, Clear cordial and juice bottles, blister packs, plumbing pipes and fittings					
LDPE # 4 (Low Density Polyethylene)	Ice cream container lids, cream bottle lids, squeeze bottles, lids, poly pipe, black mulch film, plant nursery bags, builders black plastic, bread bags, Ice cream containers, drinking straws, plant pots, some bottle					
Plastic Bags	Plastic shopping bags					
10. FERROUS						
Steel Packaging	Food cans, pet food cans, tins, Aerosol cans Empty paint tins, Beer bottle tops jar lids					

7. NON- FERROUS						
Aluminium	Beer and soft drink cans, clean foil					
	Copper / brass / bronze items, other metals (not ferrous /					
	Aluminium					
8. HAZARDOUS						
Paint	Paint (dry or wet)					
Fluorescent Tubes	Fluorescent tubes; compact fluorescent lamps (CFLs)					
Dry Cell Batteries	Common batteries, AAA, AA etc., single use or rechargeable					
Car Batteries	Car batteries					
Household chemicals	Bleach, shampoo, cleaning products, unused medical pills Sharps, human tissue, bulk bodily fluids and blood					
Hazardous Other(please specify)						

9.EARTH BASED						
Ceramics	Cups, bowls, pottery items					
10. E-waste						
Toner Cartridges	Printer and toner cartridges					
Computer Parts	Keyboard, monitor, cables, printers etc.					
	Toaster, radio, IPod, game boys, stereos, speakers, TVs, VCR,					
Other (please specify)						

Appendix 3: To investigate and describe Municipal Solid Waste Management (MSWM) and disposal system, policies and processes implemented by Swakopmund municipality

Target audience: Senior Swakopmund Municipality employees working with municipal solid waste management.

Part A

Organisation: _____

Name/Surname: _____

Contact details: _____

Email address: _____

1. Policy aspects

1.1. What kind of waste management method do you have in Swakopmund?

Types of Practice	
Landfill	
Dumpsite	
Combustion	
Recycling	
Composting	
Plasma gasification	
Others	

1.2. Does Swakopmund municipality classify municipal solid waste?

Yes	No

If your answer is YES, What kind of classification do you use for municipal solid waste? What types of waste considered as municipal solid waste?

_____

_____

1.3. Does Swakopmund municipality have municipal waste management plan?

Yes	No

_____

_____

_____

_____

1.4. Is there a municipal management strategic programme on waste?

Yes	No

If YES what are the main priorities?_____

_____

_____

_____

1.5. Are there main responsible authorities in the municipal waste management sector?

Yes	No

If YES please mention them_____

_____

_____

_____

1.6. Are there any problems regarding to inefficient waste management from your point of view?

Yes	No

If YES please explain_____

_____

_____

_____

1.7. Is there any gaps identified in municipal solid waste management system?

Yes	No

If YES what kind of urgent steps that can be applied to address this gaps?_____

_____

_____

_____

2. Legislation aspect

2.1 What are the main laws and legal acts which regulate the municipal waste sector in the
municipality?_____

_____

_____

_____

_____

2.2 Is there any regulation concerning the limitations of the quantity and quality of waste which should be disposed of?

Yes	No

If YES, what are these
regulations?_____

_____

_____

_____

_____

_____

2.3 From your point of view, does the National Waste Management Policy satisfy the current municipal solid waste management strategy at Swakopmund. municipality?

Yes	No

If yes please explain_____

_____

_____

_____

_____

_____

2.4 Do you think that there should be changes in the current legislative/waste management policies of the municipality?

Yes	No

If YES what are the possible changes that can be done?_____

_____

_____

_____

_____

_____

3. Financial aspect

3.1 Does municipal solid waste management have a portion in the annual budget?

Yes	No

If YES what is the amount of money allocated for the municipal waste (Budget, other sources)_____

_____

_____

_____

_____

_____

3.2 Are there any allocation planned for the development of alternative waste management options (such as composting, recycling, incineration with energy recovery etc.)

Yes	No

If YES please explain_____

_____

_____

3.3 Is there any kind of payment and tax systems are used for waste municipal solid waste disposal?

Yes	No

If YES please explain_____

_____

_____

_____

_____

4. Control and monitoring

4.1 How can you evaluate the effectiveness of the control or monitoring which is performing by the authorities in the waste sector?)

a/ high

b/ satisfactory

c/ low

d/ does not perform at all

please indicate three or four main courses in case if your answer is corresponding to c/ and

d/._____

_____

_____

4.2 Is there existing systems for measurement and identification of quantity and composition of waste collected?

Yes	No

If YES what are these systems?_____

_____

_____

_____

4.3 As it has been stated in a number of sources, the existing dumpsites are not corresponding to the sanitary-hygienic standards. What kind of activities are implemented in that direction?_____

_____

_____

_____

5. Additional data

5.1 Are there any data about illegal dumpsites?

Yes	No

(If YES this data can be helpful to the researcher)

_____

_____

_____

_____

5.2 Are there any data concerning the collection and recycling of waste by private persons or by an informal sector?

Yes	No

(If YES this data can be helpful to the researcher_____

_____

_____

_____

_____

Part B

Please provide the following data (if available)

Population of the Area	**1000 people**	**2016**	**2017**	**2018**
Part of the population which is provided by the MSWM system	%			
Amount of collected waste fees • Per person or • Based on quantity of waste	Swakopmund municipality			
Actual rate of collection	%			
Quantity of bins/ containers located within the area	# of items			

1. Generation of Municipal solid waste	**Unit**	**2016**	**2017**	**2018**
Total amount of generated household/municipal solid waste -including household hazardous	1000 ton			
	1000 ton			
Quantity of solid waste imported into Swakopmund (If data exist)				
Composition of solid waste (Can be shown according to actual classification used)	**%**	**2016**	**2017**	**2018**

• Food residues				
• Paper/ Corrugated cartoons				
• Garden waste				
• Textile				
• Glass residues/bottles				
• Non-ferrous metals				
• Ferrous metals				
• Soil				
• Polymers/Plastics				
• Leather/ Rubber				
• Hazardous substances				
• Others				
2. Amount of collected household waste which is picked up by municipal enterprises in comparison with the total quantity of generated waste	**Unit**	**2016**	**2017**	**2018**
	%			
• Recycling				
• Treatment				
• Incineration				
• Reuse				
• Disposal on dumpsite				
3. Existing Capacities for the waste management and disposal/please point out if such facilities exist, even if they are not in use nowadays	**Unit**	**2016**	**2017**	**2018**
a) Recycling station/plants	#			
Capacity	Tons or m^3/per day			
Actual working capacity (in comparison with total capacity)	%			
Number of employees	# of people			

b) Incineration stations/plants	#			
Total Working Capacity	Tons or m^3/per day			
Actual working capacity (in comparison with total capacity)	%			
Number of employees	# of people			
c) The dumpsites	#			
	Area/hectors			
Capacity	Ton or m^3			
Number of employees	# of people			
d) Transportation facilities	**# of units**			
Dust trucks	#			
Actual operated	#			
Capacity	Ton or m^3			
Type of the fuel and consumption rate	Litre/km			

- Please fill in any available data, if there is no information for the required period of time.
- Please point out if waste composition is calculated according to volume or weight.

Appendix 4: To determine the perceptions and knowledge of the residents towards Municipal Solid Waste Management

Questionnaire Number

Name of the researcher.....

This questionnaire is to be administered to residents of Swakopmund who are in the age groups of 18 years and above, living in Swakopmund. The aim of the study is to provide baseline waste generation data to identify opportunities for integrated waste management and benefit for waste recycling.

Information collected will be purely for research purpose and will be treated as highly confidential and no information will be shared without prior consent.

DEMOGRAPHIC

Please tick or cross or fill in your answer.

1.1 Sex of the respondent

Male	
Female	

1.2 Age group

18-20	
21-23	
24-26	
27-29	
30-34	
35-39	
40-44	
45-44	
45-49	
50+	

1.3 Current Marital Status

Never Married	
Married	
Widowed	
Separated/D	
Other(specify)	

1.4 Home language spoken

English	
Afrikaans	
Damara/Nama	
Oshiwambo	
Otjiherero	
Other specify:	

1.3 What is the highest level of education that you have completed?

No education	
Adult education	
Primary education	
Secondary education	
Tertiary education	
Others	

2.1 Are you a resident of Swakopmund?

Yes	
No	

2.2 If yes to question 2.1 for how long have you been residing in Swakopmund?

≤ 5 years	
≥ 5 years	

2.3. What do you consider as waste in your environment?

……

……

.....

2.4 Do you think there are waste products generated in Swakopmund?

Yes	
No	

2.5 If yes: What types of waste products are disposed in Swakopmund?

Plastics	
Waste food	
Wood	
Papers	
E-waste	
Building rubble	
Others	

2.6 Are there waste bins allocated to each household or business premise?

Yes	
No	

2.7 Are the waste bins labelled? (i.e. wood, papers, plastics, metal etc..)

Yes	
No	

2.8 Do you throw your waste in the right labelled bins?

Yes	
No	
Not labelled	

2.9 If no, can you provide reasons?

……

……

……

3.1 Are waste product being recycled in Swakopmund?

Yes	
No	
Not sure	

3.2 Do you think recycling of waste is an important practice?

Yes	
No	
Not sure	

3.3 How can reduce, reuse and recycling of waste products benefit Swakopmund?

……

……

……

……

……

3.4 Will you support the local authority to implement the integrated waste management plan?

Yes	
No	

3.6 If no, please explain why?

……

……

……

……

3.7 Did you ever have public awareness on waste management in Swakopmund?

.....

.....

.....

3.8 Do you have any suggestion on how to improve waste management in Swakopmund?

.....

.....

.....

.....

THANK YOU VERY MUCH FOR YOUR TIME AND VALUABLE CONTRIBUTION.