Name : **Ntolo**

Surname : **Molomo**

Student Number : **752048**

Degree : **M.Sc. Environmental Science**

Supervisor : **T Murombo, School of Law**

Title :**Case Study -Municipal Solid Waste Management in Benoni, Ekurhuleni.**

This research report submitted to the Faculty of Science, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Environmental Science

Johannesburg, 2016

Research work and course work

ABSTRACT

The unprecedented population growth, urbanisation and accelerating living standards, significant amounts of solid waste have accumulated all over the world. These changes, therefore, left most municipalities in African countries grappling to find viable solutions to their waste management problems (Özbay 2015). Indeed, studies have shown that the estimated annual growth rate of MSW is 3.2% to 4.5% for developed countries and 2% to 3% for developing countries (Özbay 2015). Notably, continuous increase in accumulation of solid wastes poses risks to not only human health but to the ecological environment (Al-Khatib, Kontogianni, Abu Nabaa, Alshami & Al-Sari 2015; Menikpura, Gheewala & Bonnet 2012). Improper waste management stems from the poor implementations of policies and regulations, to identify the most sustainable approaches to dealing with waste as to meet environmental and socio-economic aspirations, to address waste management efficiently.

The objectives of this research are as follow:

- Locate, consolidate and organise secondary data that is relevant to understanding the specific waste management situation of Benoni, Ekurhuleni.
- Identify the importance of Municipal Solid Waste Management (MSWM).
- Analyse these data and determine how it can be utilised in the case of Benoni.
- Identify and suggest the best strategy implement an effective MSWM system, and
- Discuss the difficulties and challenges faced by Benoni and Ekurhuleni at large, due to ineffective and inefficient MSWM.

The case study area Benoni is a mere example to highlight waste management burdens and challenges, which might be characteristic of most African towns. This research seeks to understand the solid waste collection and proper disposal in informal areas of Benoni and the environmental impacts thereof. In particular, the research assumes that there is yet to be implemented a more rigid and structured approach to waste management in the area which justifies and necessitates the need for research aimed at shedding light on how modern waste management systems can be adapted to the case of the informal settlements in this area. Proper waste management implementation will benefit both the specific community in informal parts of Benoni as well as the global practice of waste management.

This study used the qualitative method to describe, explore, and discover phenomena related to MSWM in Benoni (Creswell, 2003). Qualitative research is typically interpretive, with the researcher using critical analysis for the interpretation of data collected (Shenton & Hay-Gibson, 2009). The quantitative research uses hypotheses in determining the form, quantity, and scope of data to be collected (Morse & Richards 2002). In doing so, the researcher pre-empts alternative ways through which the study questions may be addressed. On the other hand, qualitative investigations are not pre-emptive. In this study of MSWM in Benoni, the form, quantity, and scope of inquiry hinged upon the research questions, the study purpose, and goals, as well as from the data collected (Morse & Richards 2002).

Benoni has reached the dilemma in which adverse health and environmental impacts of ineffective waste management are felt, while the numbers of landfill sites have been decreasing with no planning in evidence for establishing new ones. Because of these, improvements to Benoni's MSWM will entail the cooperation of all tiers of Government as well as industry and the commercial sectors. The EMM will have to restructure the recycling industry with the support of waste management legislation. An option that EMM has is to contemplate upon the outsourcing of the management of sanitary landfill sites to public-private partnerships, based on study findings that these discharges are better managed in South Africa (Naidoo 2009). In the case of Benoni, albeit the EMM has sufficient resources to manage waste effectively, there were numerous gaps related to the challenges that exist within the municipality's waste management sector. For instance, household wastes are not timely collected, and no notices are given when collection dates are changed (Tembon 2012). Apart from these, Benoni has an underdeveloped recycling system perhaps largely because the EMM itself has no comprehensive municipal recycling program and recycling facilities. Somehow, this contradicts the impression being given by providers that they have access to all the necessary resources needed for them to be effective in their work.

This research will discuss an approach to strengthening the capacity to solve the problems that come with MSWM, along with investigating whether modern waste management practices are be present implemented such as; waste diversion from landfills, as well as shifting from incinerators and using unlined landfill sites to more sustainable methods. Based on the combined experiences in the three cases, some recommendations may stand in Benoni Ekurhuleni. First, every member of the community should be empowered with education and skills on waste management to increase their levels of participation in waste sorting at the source of generation. Public involvement will encourage effective recycling that ultimately generates income. This will be particularly useful to Benoni's squatter communities. Benoni has to look into the possibility of providing skills to informal settlers so that they can construct well-planned houses for themselves. With assistance from the national government, the EMM can decide whether this type of housing can be subsidised. Third, it is essential that EMM involves stakeholders from the different sectors of the municipal area in the planning and implementation of waste management strategies. Group leaders from various communities as well as social groups such as church communities should be invited to participate because they are crucial links between the council and the community.

DECLARATION

I, _Ntolo Molomo__, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Environmental Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Ntolo Colette Molomo

Signed at ……

On the …….. day of …… 2017.

Dedication and Acknowledgements

Throughout my life, my parents Mantolo Letta Molomo & Sanku Henry Molomo, along with y two sisters Lisemelo and Mahlape Molomo have been my biggest supporters. My parents who have sacrificed so much for me to be guaranteed to assess to a high-quality education. I would like to thank my husband Morena Mokebe, for the reassurance and support throughout this process. There is no doubt in my mind that without everyone's continued support and counsel I could not have completed this process.

Foremost, I would like to express my sincere gratitude to my supervisor Prof. Tumai Murombo, who has consistently supported me patiently and diligently to complete this dissertation. Without his guidance and persistent help, this dissertation would not have been possible.

Tamelyne Van Tonder for her continuous assistance throughout my Masters, she was patient and willing to help, it was not for both Professor Tumai and Tamelyne I would not have had a smoother road to being able to complete my Masters at the University of Witwatersrand.

Table of Contents

I. Introduction

Materials that are of no use and no economic value to their owners are called waste, and their owners are called waste generators (Pillai & Shah2014). Based on physical properties, waste may be categorised into municipal, medical, hazardous and radioactive wastes. To note, municipal solid waste (MSW) is any waste that comes from households, commercial as well as institutional activities that are not hazardous (Wu, Tsai, Lin, Kuo & Kang 2013). Residential or household waste comes from residential areas such as individual houses, while commercial and institutional waste comes from individually excellent sources, such as malls, hotels, office buildings and schools. Municipal service waste comes from areas like streets and parks, among others.

Due to rapid population growth, urbanisation and accelerating living standards, significant amounts of solid wastes have accumulated all over the world (Özbay 2015). Indeed, studies have shown that the estimated annual growth rate of MSW is 3.2% to 4.5% for developed countries and 2% to 3% for developing countries (Özbay 2015). Notably, continuous increase in accumulation of solid wastes poses risks to human health and the biological environment (Al-Khatib, Kontogianni, Abu Nabaa, Alshami & Al-Sari 2015; Menikpura, Gheewala & Bonnet 2012). Despite the development and implementation of significant technological and regulatory improvements, many countries continue to struggle with inadequate disposal and treatment facilities especially in light of wastes' detrimental effects on health. One of the most important features of society is to have systems that regulate its propensity to produce materials that serve as an obstacle to its sustainability, development and ultimately, survival (Henry, 2006). This statement is true regarding many of society’s aspects, such as its social, political, geological and

physiological dimensions. For example, laws and policies that regulates human behaviour to serve as measures to maintain peace and order regarding the socio- political interactions that occur within a given community. In this regard, laws function as a system of defining acceptable and unacceptable behaviour so that abiding with them will result in a harmonious, united and thus coherent society that can progress and grow with time. Unhealthy practices and unhealthy surroundings, the instances of illnesses and the chance of disease outbreaks increase, threatening the welfare and integrity of both the environment and the humans that inhabit it (Tchobanoglous, 1993).

Municipal Solid Waste Management (MSWM) is primarily concerned with the waste generation, transportation, treatment, and disposal (Yi, Kurisu & Hanaki2011). Therefore, it is a complex process that entails different management options, including, source reduction. The use of information technology, curbside recycling, material recovery, waste-to-energy, sanitary landfilling, and composting, among many others (Bin Guo & Yaxuan 2014; Yang, Zhou & Xu 2015; Ying An, Guangming, Wenqing, Wenzhi & Xiang 2014). Over the years, MSWM has become increasingly challenging especially for municipal authorities not only because of the rapidly increasing waste amount but also because of the need to find solutions to address concerns for environmental pollution, more mixed waste and limited capacity for waste treatment and disposal (Shoou-Yuh, Wanchi & Shu-Liang 2010).

To ensure that MSWM effective and efficient, decision-makers need to study the overall picture from long-term perspectives. For instance, an effective MSWM operates at a reasonable cost so that the maximum amount of solid waste can be efficiently and more treated and disposed of (Yu et al. 2011). The applies in particular for developing countries in which the effective and

efficient MSWM remains critically needed in light of the rapid increase in solid waste caused by urbanisation and industrialisation have been burdening municipalities' infrastructure and the community (Özbay 2015).

In addition to these, the concern regarding environmental pollution and risks have also dramatically increased in recent years, including the contamination of surface water and groundwater from landfill and air pollution from incineration activities of MSWM. Moreover, greenhouse gases (GHG) emissions from MSW treatment and disposal of increasing volumes of MSW have been noted to contribute to global warming and climate change. Here, a challenge for municipal officers looking for strong MSWM solutions is the conflict in objectives between cost and environmental pollution and risks, considering that a good solution for one is inevitably damaging to the other. Hence, the optimal balance between economic efficiency and environmental pollution has been one of the most important measures in determining the efficacy of long-term performance of MSWM systems.

Meanwhile, Benoni is a city on the East Rand in the South African province of Gauteng and falls under the Ekurhuleni Metropolitan Municipality (EMM). It is previously growing mining sector has declined through the years especially since stakeholders had been focusing more on industry and services. Benoni's existence credited to the discovery of gold within the vicinity in 1887 (Ekurhuleni Government 2004). The EMM municipality came to being in 2000, currently one of six metropolitan municipalities in South Africa. It covers approximately 1923km2, with a population of 3.178 million people, three-quarters of which are black. Population densities are high especially in the former "township" and informal residential areas. Approximately 22% of the population resides in informal and adequate housing, according to

Ekurhuleni environmental report (2004). Despite having a large proportion of the people of working age, the unemployment rate is high, around 40%.

Benoni has long struggled with the problem of increasing numbers of informal settlers (EMM 2005). Since 1996, population growth has averaged at 17,000 households per year. Informal settlements remain concentrated in low-income areas that have inadequate MSW services. At the current projected population growth, the EMM requires 5,400 ha of land (developed at 20du/ha). Another issue about Benoni's MSWM is that environmental change in Ekurhuleni, combined with rising numbers of human settlements and overall urbanisation has led to the transformation of the natural land. To further exacerbate the problem, generation of domestic, industrial, mining and medical wastes have drastically increased, while Benoni has been found to be particularly vulnerable to flooding brought about by the effects of climate change (Dit 2010). If not properly managed, accumulated waste can lead to the contamination of water air and soil resources, which in turn, can potentially impact human health (EER, 2004).

1.1 Statement of the Problem

This research seeks to understand the solid waste collection and proper disposal in informal areas of Benoni and the environmental impacts thereof. In particular, the research assumes that there is yet to be implemented a more rigid and structured approach to waste management in the area which justifies and necessitates the need for research aimed at shedding light on how modern waste management systems can be adapted to the case of the informal settlements in this area. Modern waste management systems could include implementation of reducing, reuse and recycling strategies. The municipality could also put colour coded bins in schools to educate the youth; these systems help to manage waste. Several studies have identified many challenges that

affect efforts towards the management of solid waste. These challenges include technical concerns, financial constraints, lack of infrastructure capacity, lack of training and awareness, concerns related to management, corruption, influence stakeholders and poor quality planning (Henry et al. 2006; Pasang et al. 2007; Joseph 2006; Troschinetz and Mihelcic 2009). These challenges are the result of traditional top-down approaches, regulatory approaches and trailing previously adopted in the management of waste, which is largely ineffective in the 21st century (Scheinberg et al. 2004).

Overall, the increased understanding of the effects of sound solid waste management and proper disposal will benefit both the specific community in "informal" areas of Benoni as well as the global practice of waste management. This research will discuss an approach to strengthening the capacity to solve the problems that come with MSWM. This study also investigates whether modern waste management practices are implemented such as; waste diversion from landfills, as well as shifting from incinerators and using unlined landfill sites to more sustainable methods.

1.2 Objectives of the Study

This study seeks to:

- Locate, consolidate and organise secondary data that is relevant to understanding the specific waste management situation of Benoni, Ekurhuleni.
- Identify the importance of Municipal Solid Waste Management (MSWM).
- Analyse these data and determine how it can be utilised in the case of Benoni.
- Identify and suggest the best strategy implement an effective MSWM system, and
- discuss the difficulties and challenges faced by Benoni and Ekurhuleni at large, due to ineffective and inefficient MSWM.

1.3 Research Questions

This study seeks to address these research questions:

- What are the current practices in Benoni, regarding municipal solid waste management?
- What are the gaps between the national policy and local implementation regarding waste management in Benoni?
- How do these practices compare with other South African cities and the United States?
- What are the MSWM problems and their causes in Benoni?
- How can the MSWM system in Benoni improve shortcomings and make it more efficient?

1.4 Significance of the Study

Valuable lessons from this study could extend to other cities in South Africa and globally. Empirical evidence is essential for intervention by planners and policy makers. This study is designed to identify key factors responsible for poor waste management in Benoni, and how these have been impacting the community. Through the identification of and quantifying such risk factors and by suggesting possible recommendations based on detailed findings of the research, it will enable planners and policy makers in Benoni to make appropriate actions that are helpful for improving efficiency in proper waste management in the city. Therefore, this study is significant because it can contribute to the well-being of Benoni residents. It remains anticipated those study findings will help the growing knowledge of waste management implementation in informal settlements in general (Morrissey, 2004).

II. Literature Review

People produce and consume, and whatever remains is considered as waste. Waste management has been a concern for as long as there have been human settlements. Waste management practices run back as The Bronze Age Trojans, who covered their waste with clay to the Old Testament Jerusalem incinerating their waste. In the mid-18th century the rural Americans started digging refuse pits, and the urbanised cities like Philadelphia became crowded, and waste became hard to dispose of, then public street cleaning began (Ayres et at.; Malik al at. 2012). There can be argued to be many different types of waste management paradigms, some of which can be used in certain settings such as in rural or urban places, while others are only applicable in limited scenarios (Tchobanoglous 2002). This literature review presents a discussion of concepts that are relevant to the study.

2.1 Definition of Key Concepts

An oft-cited definition of waste is that of the United States Environmental Protection Agency (EPA) (1990), which based on the Environmental Protection Act 1990. According to this definition, waste is any substance that may be regarded as scrap material, unwanted material or effluent (EPA 2000). Waste is also any material that needs disposal after it has been worn out, broken, spoiled or contaminated. Any material that has already been discarded or disposed of. According to the United Nations (UN) Human Settlements Program (2010), definitions of MSW differ from one country to another. However, the UN defines MSW as wastes that are generated by households, and similar wastes that are produced by (i) commercial and industrial premises, including, institutions such as hospitals, schools, prisons and care homes, and (ii) public spaces such as bus stops, parks, public toilets and gardens (UN 2010). According to the EPA (2000),

MSW encompasses desirable and nondurable goods, containers and packaging, food waste, yard wastes and miscellaneous inorganic waste from residential, commercial, institutional and industrial sources.

The influx of people has resulted in the increase in population in many locations close to the city centres where people believe they can make a decent living. Cities have increased over the past several years in these sites, and the absence of a structured approach to maintaining waste at a manageable level yields more and more waste, which then affect the environment and the aggregate health of the settlers (Obiero 2013; Malik et al. 2012).

The Municipalities subdivision of solid waste's, Drafted Integrated Waste Management By-Law to ensure that the law supports maximum recycling and minimises waste and protects both the environment and the population (Thenga, 2016).

2.2 South African Waste Model

Waste was defined in the Environment Conservation Act 73 of 1989 as "way matter, whether, gaseous, liquid or solid or any combination thereof, or agriculture area identified by the Minister of the Environmental Affairs and Tourism as an undesirable or superfluous by-product, emission, residue or remainder of any process or activity."

This old definition has been replaced by more nuanced conception in the National Environmental Management: Waste Act of 2008 (NEMWA). The NEMWA defines 'waste' as-

"(*a)* any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 to this Act; or

(b) any other substance, material or object that is not included in Schedule 3 that may be defined as a waste by the Minister by notice in the *Gazette*,

But any waste or portion of waste, referred to in paragraphs *(a)* and *(b)*, ceases to be a waste-

(i) once an application for its re-use, recycling or recovery has been approved or, after such approval, once it is, or has been re-used, recycled or recovered;

(ii) where approval is not required, once a waste is, or has been re-used, recycled or recovered;

(iii) where the Minister has, in terms of section 74, exempted any waste or a portion of waste generated by a particular process from the definition of waste; or

(iv) where the Minister has, in the prescribed manner, excluded any waste stream or a portion of a waste stream from the definition of waste".

Waste is seen as a driver of environmental change in that it affects aesthetics, water quality, air clean and land. Ekurhuleni has five landfill sites. Municipal strategic priorities include the provision of refuse removal services in low-income areas to address illegal dumping; and the promotion of waste minimization and recycling initiative (EER, 2004; NEMWA, 2008 & ECA, 1989).

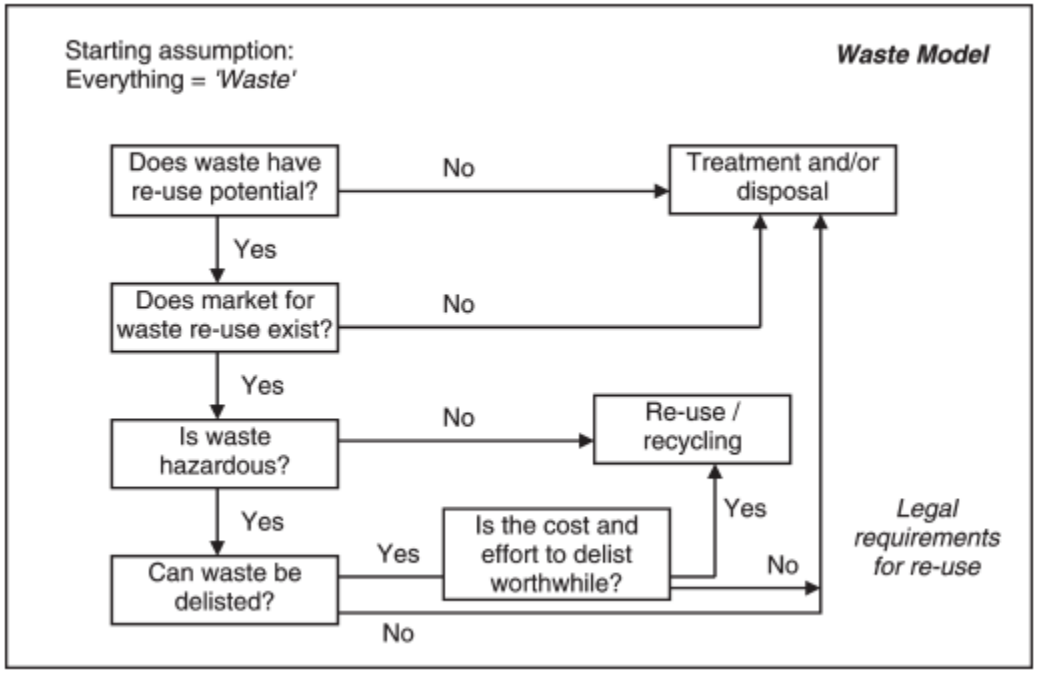
Currently, there are at least two legal definitions of waste in South African legislation. First, the Environment Conservation Act (ECA) defines waste according to a form of a legal notice, which states that it is unwanted or superfluous nature (Oelofse & Godfrey 2008). Because of this definition, the general approach towards waste management in the 1990s had been one of protection considering that the said legislation pertained to environmental conservation. The National Water Act also espouses a similar protection-based approach because its definition of

waste is regarding polluting potential. Due to these all-encompassing legal definitions of waste, waste re-use and recycling facilities in South Africa, remain subjected to similar controls as waste disposal sites.

Meanwhile, based on the Minimum Requirements for Waste Disposal precautionary principle, waste is highly hazardous and toxic unless it is proven otherwise (Oelofse & Godfrey 2008). Here, the burden of proof lies with the waste generator, and because this is not easy to achieve, potential exchange of the material for re-use often constrained. All industrial waste stays considered as hazardous and thus classified as such. If a specific material excluded from the definition of waste, the generator may re-use it or sell (exchanged) for re-use, without having to undergo a bureaucratic process such as delisting. A proposed re-definition of waste has the potential to promote waste reuse and material exchange plans, save natural resources, lessen costs to both the generator and landfill, and protect the environment by long-term waste diversion away from the landfill (Oelofse & Godfrey, 2008).

Notably, this broad albeit highly restrictive, protection-oriented definition of waste remain used in South Africa is perceived by industrial stakeholders as a barrier to the effective implementation of a waste hierarchy (Oelofse & Godfrey, 2008). As Figure 1 below shows, the current approach towards waste management and waste re-use in South Africa is driven primarily by the current legal definition of waste and associated legal requirements.

Figure 1: South Africa Waste Model



(Oelofse & Godfrey, 2008).

2.3 Importance of Solid Waste Management

The management of solid wastes had been a challenge dating back to the earliest societies (Hester & Harrison2002). Centuries ago, and nowadays-in poorer countries, household wastes were simply hauled off to crude dumps to be burned or where animals consumed them. Household waste and other waste streams had to be separated from the human environment to avoid nuisance as well as public health problems (Bortolozo, Rizzi, Serpe & Borba Braga 2014; Ross 2011).

Under these circumstances, the wider environment provided a useful resource for wastes. Since then, population growth combined with societal prosperity, exerted increasing pressures on the environment that, in turn, society increasingly appreciated. As a result, solid waste

management policies and practices in developed countries emerged sometime in the mid-20th century to ensure that public and occupational health risks remained minimised while environmental resources remained protected.

While the protection of human health had originally been the overarching goals of solid waste management, since the 1980s, an added force shaping waste policy had been goals related to sustainability (UNEP 2005). Because of this expanded rationale, waste management approaches had transformed to embrace social, economic and environmental aspects of sustainability. In other words, sustainable waste management has become associated with integrated waste management, which refers to the "judicious application of a range of options to achieve a broadly optimal system of waste management and resource recovery" (Hester & Harrison 2002, p. 2).

2.4 Municipal Solid Waste Management

Local governments are responsible for MSWM, which usually consumes between 20% and 50% of municipal budgets in developing countries (Schubeler, Wehrle & Christen 1996). A defining characteristic of MSWM is complexity, driven by the need for particular organisation and cooperation between households, communities, private enterprises and municipal authorities. As well as “the selection and application of appropriate technical solutions for waste collection, transfer, recycling and disposal” (Schubeler et al., 1996, p. 15). Moreover, waste management is a crucial undertaking that has significant ramifications for “public health and well-being, the quality and sustainability of the urban environment and the efficiency and productivity of the urban economy” (Schubeler et al., 1996, p. 15). The majority of cities in developing countries have inadequate waste management such that a large percentage of the population does not have

access to a waste collection service. Consequently, only a small portion of generated waste fractions collected waste. From the environmental, economic and financial perspectives, the transfer, recycling or disposal of solid waste are often unsatisfactory.

By 2020, more than 50% of the population in sub-Saharan Africa will be living in the cities. This is likely to raise the daily rate of production of waste by as much as1.0kg per capita. The United Nations Environmental Programme (UNEP) estimates that the per capita generation of solid waste is an average of 0.7kg per day in Zimbabwe and 1.0kg per day in Tanzania. South Africa has noted the impact of waste on a big challenge of the twenty-first century in its Integrated Pollution and Waste Management Policy, established by the Department of Environmental Affairs and Forestry. According to the 1999 State of Environmental Report, South Africa generates 42million m3 of SW every year. In 2001, the amount of waste produced was noted as increasing due to population growth, urbanisation and economic growth (Simelane and Mohee, 2012).

2.4.1 Goals and Principles of MSWM

The first goal of MSWM is the protection of public health, especially poor communities that tend to suffer most from poor waste management (Schubeler et al., 1996). Secondly, MSWM seeks to improve environmental conditions through the control of all types of pollution as well as ensure that ecosystems are sustainable. MSWM also supports economic development through the delivery of waste management services and through measures that facilitate the conservation of valuable materials and resources. MSWM seeks to generate employment and incomes in the sector itself.

For these aims to be attainable, it is crucial that sustainable systems of solid waste

management established, so the public needs are met, including, disenfranchised populations such as the poor. The fundamental principles of sustainability demand that waste management systems involve society and its local communities (Schubeler et al., 1996).In other words, these systems should appropriately address the specific circumstances and problems of the city and locality, thereby requiring the employment and development of stakeholder capacities. Notably, waste management should be effective all throughout the entire life cycle of materials, from production to distribution and consumption, waste collection and disposal. Whereas priority should take preference to effective collection and disposal, waste reduction and recycling are just as important, longer-term objectives. Hence, it is notable that the principles of sustainable waste management strategies are to (i) minimise waste generation; (ii) maximise waste recycling and reuse; and (iii) ensure the safe and environmentally sound disposal of waste.

For waste management to be sustainable, collaboration between stakeholders is of utmost importance, because isolated or sectoral approaches simply will not work. To have preferences on sustainable waste disposal, options have to realistically reflect they are entire environmental and economic costs because capital and operational costs of disposal are added on as external costs to the environment (Wheeler, 2013). UNESCAP (2000) reported in this context that in some low-income countries, collection costs represent 80-90% of the MSW budget where most of the waste is sent to open dumps. The collection activities are carried out by labourers and low-level mechanisation, while the collection of the MSW in middle-income countries represents 50-80% of the waste management budget. The latter source also indicated that the collection cost in high-income countries represent less than 10% of the allocated waste management budget, considering that the community participation in these countries reduces costs and increases

options for general administration of the generated waste, mainly by recycling and composting (Albanna 2011; Yohannes 2009).

Municipalities, usually responsible for waste management in the cities, have the challenges to providing an effective and efficient system to the inhabitants- due to living standards accelerating, the influx of people. Management deficiencies often observed in the municipalities. Some researchers that have investigated the institutional factors that affect the system have come to the conclusion that local waste management authorities have a lack of organisational capacities (leadership) and professional knowledge (Guerrero et al. 2013; Sharholy et al. 2008; Pokhrel & Viraraghavan 2005). Supply sufficient financial resources to not limit the safe disposal of waste in well-equipped and engineered landfills and put effective legislation (Pokhrel & Viraraghavan 2005).

The National Environmental Management Waste Act was promulgated in 2008 to address waste management problems and challenges in South Africa specifically. The act highlights some of its objectives, which are to avoid and minimise the generation of waste through reducing, reusing, recycling, recovering and treating. The disposing of waste should be the last resort.

Municipalities are mandated to deliver waste management services, and these services include waste removal, storage and disposal in an accountable manner and by adhering to national and provincial norms and standards. Furthermore, municipalities are required to formulate Integrated Waste Management Plans, bylaws and standards that deal with the management and minimisation of waste within their jurisdiction. The Act was amended in 2013 and 2014 to include the standards that need to be adhered to and implemented during the establishment of the new waste management facilities. Other provisions and terms of the Act

were amended, such as the definition of waste and types (Gumbi 2015).

2.5 Sustainable MSWM

A viable solution does not necessarily represent the highest standards of service and environmental protection, but instead, those services that are durable and thus delivered. Hence, expectations should be managed well. Strategically, MSWM sustainability necessitates the formulation of objectives as well as the development of measures that encompass political, institutional, social, financial, economic, and technical perspectives of waste management. Some waste management models have been developed and adopted through the years. Two of the models that have widely remained used in the context of sustainability are the Waste Hierarchy and the Integrated Solid Waste Management frameworks.

> The Municipal Systems Act (Act 32 of 2002) within Chapter 2, Section 4, states that a "...municipality, within the municipality's financial and administrative capacity and having regard to practical considerations, has the duty to –
>
> a) exercise the municipality's executive and legislative authority and use the resources of the municipality in the best interests of the local community;
> b) provide, without favour or prejudice, democratic and accountable government;
> c) encourage the involvement of the local community;
> d) strive to ensure that municipal services are provided to the local community in a financially and environmentally sustainable manner;
> e) consult the local community about-
>   i. the level, quality, range and impact of municipal services provided by the municipality, either directly or through another service provider; and
>   ii. the available options for service delivery;
> f) give members of the local community equitable access to the municipal services to which they are entitled;

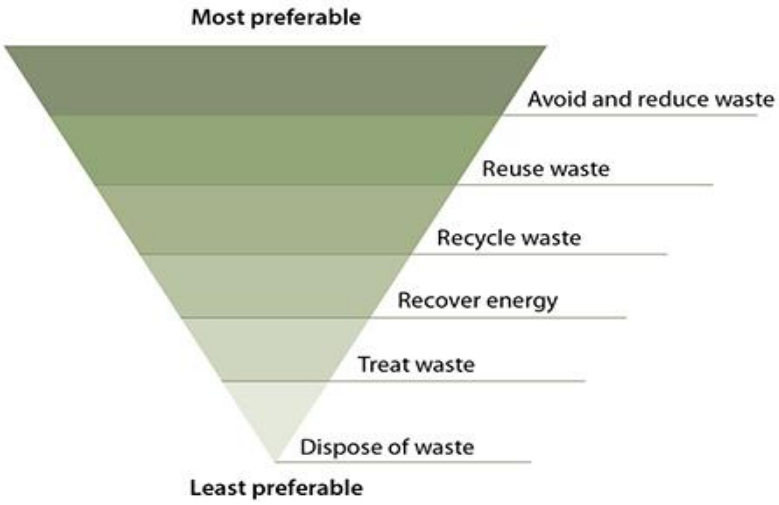
g) promote and undertake development in the municipality;
h) promote gender equity in the exercise of the municipality's executive and legislative authority;
i) promote a safe and healthy environment in the municipality; and
j) contribute, together with other organs of state, to the progressive realisation of the fundamental rights contained in Sections 24, 25, 26, 27 and 29 of the Constitution." (Ekurhuleni Environmental Policy and Implementation Plan, 2012)

Public awareness and education are an important part of sustainable development, involving the community help they understand the environmental impact their actions have. Lack of knowledge can cause environmental degradation and affect human help. Involving community members will bring understanding and regard for the environment and will develop a desire to conserve the surrounding environment (Ekurhuleni Environmental Policy and Implementation Plan, 2013).

2.5.1 Waste Hierarchy

The waste hierarchy is a process featuring an order of preference for action for the reduction and management of waste (Williams, 2015). The waste hierarchy seeks to protect the environment, conserve resources and minimise waste generation. As seen in Figure 2, the waste hierarchy is in the form of an inverted pyramid that prioritises waste prevention but when waste generated, prioritises direct re-use, recycling, recovery methods, and last of all, disposal.

Figure 2: Waste Hierarchy



(Williams, 2015)

The preferred options should always be avoidance and reduction because they are the most efficient in preventing adverse impacts across the entire product lifecycle, including disposal. On the other hand, recovery options should seek to preserve the maximum amount of Embodied Environmental Value (EEV) (Schubeler et al., 1996). Regarding sustainability, waste should be eliminated using closed cycles maximising the value of materials (in both environmental and economic terms) at all times. Meanwhile, in selecting the best recovery option, the broader sustainability impacts of each technology should be considered instead of just their impacts on waste. Other environmental consequences are a GHG generation, water consumption, and waterborne wastes. Social and economic impacts also need to be considered (Gertsakis & Lewis 2003).

Developing and implementing a proper waste management strategy is not an easy task to accomplish. The first challenge pertains to the difficulty in establishing suitable collection and sorting systems for different waste streams (Gertsakis & Lewis 2003). Another challenge pertains to the funding and construction of suitable treatment and disposal facilities as well as the forging

of delivery partnerships. It is also highly challenging to establish systems for data collection and monitoring, enforcement and control of legal frameworks (Williams, 2015).

Having waste disposal options that are sustainable, it is crucial that these choices reflect they are full ecological and economic costs; considering that, the capital and operational costs of the disposal option will add to the external costs to the environment (Wheeler, 2013).

2.5.2 Integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) builds upon the waste hierarchy (Nessi, Rigamonti & Grosso 2013). A concept developed by the UNEP (2009), ISWM emerged out of the dilemma on how solid waste management had become "the most compelling problem of urban environmental degradation" (UNEP 2009, p. 21). In recent years, the quantity of solid waste had dramatically increased, as has its composition. Today, it is not uncommon for MSW to become mixed with other types of construction, medical and even hazardous wastes. The complex nature of MSW these days has led to the involvement of multiple stakeholders who tend to be confused about the fragmented approach to waste management. Consequently, the realisation came that the most effective approach to waste management is an integrated one. In light of these, ISWM stays defined as "a strategic initiative for the sustained management of solid waste through the use of a comprehensively integrated format generated through sustained preventive & consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner" (UNEP 2009, p. 25).

ISWM based on the rationale that all components of a waste management system, technical and non-technical, must be analysed together considering that they are interrelated and

developments in one aspect would most likely impact activities or practices in another area. Hence, the ISWM holds that being able to manage solid waste; the following is the preferred hierarchy of approaches:

- Reduction at the source, which means that tenets of waste management should be applied at every stage of consumption from design, manufacture, purchase, or use of materials to reduce the amount or toxicity of waste generated.
- Environmentally-appropriate reuse and recycling for the purpose of conserving natural resources and energy through systematic segregation, collection and reprocessing (UNEP 2009).

Figure 3 below depicts the concept of ISWM (UNEP, 2009). As can be seen in the depiction, a holistic approach is adopted for all waste streams thereby maximising the synergetic benefits of collecting, recycling, treating and disposing of waste. For ISWM to be effective, resource recovery should be possible at all stages, from generation to final disposal (UNEP, 2009). Aspirations and interests of every stakeholder should be accommodated, from waste generators to waste management and service providers. In addition to these, an effective ISWM facilitates the life cycle view of products such that there is greater efficiency in resource use. Varying response functions are integrated, including, those from the technical, managerial, financial, and policymaking perspectives. Successful ISWMs are targets of more strong local ownership as well as a more robust commitment to responsibilities as motivated by a consultative approach.

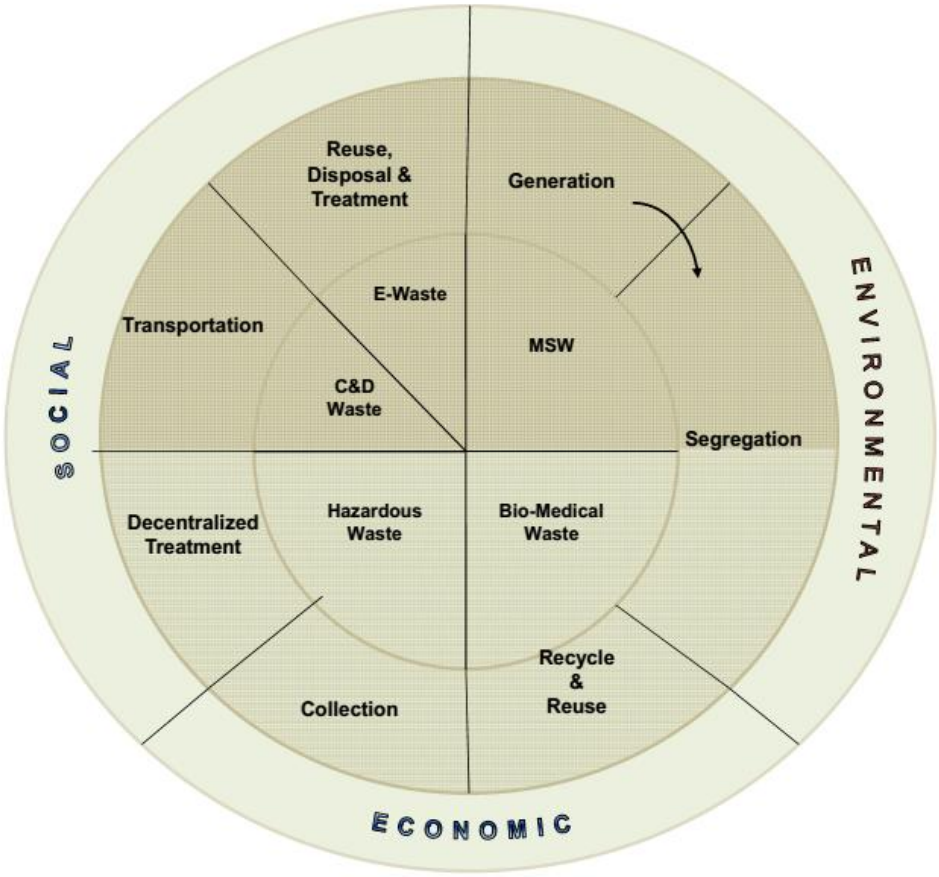


Figure 3. Depiction of the concept of ISWM (UNEP, 2009).

2.6 South Africa's National Waste Management Strategy

In South Africa, waste management exists based on the principles of the White Paper on Integrated Pollution and Waste Management (IP&WM) and the National Waste Management Strategy (NWMS) published by the Department of Environmental Affairs and Tourism (DEAT) in 1999 and 2000. As well as the subsequent amendments to the National Environmental Management: Waste Act of 2008 (NEMWA), the Act No. 59 of 2008.

The National Waste Management Strategy (NWMS) is a legislative requirement of the

Waste Act of 2008 and its overarching purpose is to achieve the objectives of the Waste Act. It is notable that waste management in South Africa remains challenged by many factors. The primary challenge is the country's growing population and economy, which has translated into increased volumes of waste (DEA 2011). These have increased pressure on waste management facilities that have already proven to be inadequate and overly burdened. Another challenge is the increasing complexity of waste streams due to urbanisation and industrialisation (DEA 2011).

This has necessitated an equally complex management system that further called into question by the mixing of hazardous wastes with general waste. Adding to the problem is a historical backlog of waste services for informal settlements in urban areas, tribal areas and formal rural areas. Albeit roughly 61% of all South African households had access to curbside domestic waste collection services in 2007, low-income members of the community remain severely underrepresented in this population (DEA 2011). The reflection is an unfortunate reality because when waste services are inadequate, life could be unpleasant and even miserable due to squalid living conditions or a contaminated, unhealthy environment.

South Africa's policy and regulatory framework do not actively adhere with the waste hierarchy, albeit several local governments claim to do so. Because of this, the inherent cost-efficiency and profitability of the waste management sector have been severely constrained considering that it has an estimated revenue of roughly R10 billion per annum2 (DEA 2011). It is important to note that waste collection and the recycling industry significantly contribute to employment generation and the GOP. From a different perspective, waste management in South Africa is understandably weak because the country does not have the necessary recycling infrastructure that facilitates separation of waste at source as well as the diversion of waste

streams to material recovery and buys back facilities. Instead, what South Africa has an outdated waste management infrastructure, dwindling capital investment rates and increasing maintenance needs.

Pervasive in South Africa's waste management is rampant under pricing, which indicates that consumers and industries do not appreciate the costs of waste management, likely because the preference is for waste disposal of any other options. Options for waste treatment are also severely limited such that they end up costlier than landfill costs (DEA, 2011). In South Africa, it is nearly impossible to safely dispose of all of the waste streams simply because of too few compliant landfills and hazardous waste management facilities. Official estimates of the number of handling facilities in the country are near 20,003, but a large percentage of this figure includes facilities with no permits to operate. In light of these, the Waste Act goals and objectives remain aligned with the waste hierarchy, which is the dominant approach to waste management in South Africa. The NWMS is building upon a framework consisting of eight goals, as shown below in Table 1, along with the targets for each goal that must be attained by 2016.

Table 1: Eight NWMS Goals

	Description	Targets (2016)
Goal 1:	Promote waste minimisation, re-use, recycling and recovery of waste.	• 25% of recyclables diverted from landfill sites for re-use, recycling or recovery. • All metropolitan municipalities, secondary cities and large towns have initiated separation at source programmes. • Achievement of waste reduction and recycling targets set in IndWMPs for paper and packaging, pesticides, lighting (CFLs) and tyres industries.
Goal 2:	Ensure the effective and efficient delivery of waste services.	• 95% of urban households and 75% of rural households have access to adequate levels of waste collection services. • 80% of waste disposal sites have permits.
Goal 3:	Grow the contribution of the waste sector to the green economy.	• 69 000 new jobs created in the waste sector • 2 600 additional SMEs and cooperatives participating in waste service delivery and recycling
Goal 4:	Ensure that people are aware of the impact of waste on their health, well-being and the environment.	• 80% of municipalities running local awareness campaigns. • 80% of schools implementing waste awareness programmes.
Goal 5:	Achieve integrated waste management planning.	• All municipalities have integrated their IWMPs with their IDPs, and have met the targets set in IWMPs. • All waste management facilities required to report to SAWIS have waste quantification systems that report information to WIS.
Goal 6:	Ensure sound budgeting and financial management for waste services.	• All municipalities that provide waste services have conducted full-cost accounting for waste services and have implemented cost reflective tariffs.
Goal 7:	Provide measures to remediate contaminated land.	• Assessment complete for 80% of sites reported to the contaminated land register. • Remediation plans approved for 50% of confirmed contaminated sites.
Goal 8:	Establish effective compliance with and enforcement of the Waste Act.	• 50% increase in the number of successful enforcement actions against non-compliant activities. • 800 EMIs appointed in the three spheres of government to enforce the Waste Act.

Table 1. The NWMS's framework consisting of eight goals (DEA, 2011).

III. Methodology

This study used the qualitative method to describe, explore, and discover phenomena related to MSWM in Benoni (Creswell, 2003). Qualitative research is typically interpretive, with the researcher using critical analysis for the interpretation of data collected (Shenton & Hay-Gibson, 2009). The qualitative researcher seeks to generate findings that provide insight regarding participants' experiences and good thoughts and reflections (Creswell, 2003). In other words, a researcher opts for the qualitative method when he or she is more interested in the meaning of experiences to the subjects, rather than in generalising results to other groups of people. Qualitative studies differ from quantitative investigations that typically seek to test current understanding. In cases such as the latter, the quantitative researcher uses hypotheses in determining the form, quantity, and scope of data to be collected (Morse & Richards 2002). In doing so, the researcher pre-empts alternative ways through which the study questions may be addressed. On the other hand, qualitative investigations are not pre-emptive. In this study of MSWM in Benoni, the form, quantity, and scope of inquiry hinged upon the research questions, the study purpose, and goals, as well as from the data collected (Morse & Richards 2002).

3.1 Philosophical Paradigm

This research study on the Benoni MSWM uses the interpretive philosophical paradigm. Interpretive stays grounded on ontology where reality is subjective, with researchers interpreting and seeking to understand findings through the filters of their belief and value systems. According to the interpretive perspective, there are different types of multiple constructed realities that generalisations are "neither desirable nor possible, that research is value-bound" (Onwuegbuzie, Johnson & Collins 2009, p. 114). In the interpretive inquiry, the researcher is

expected to thoroughly describe and define specific phenomena, so that they can analyse according to themes (Shenton & Hay-Gibson 2009).

3.2 Research Design

This investigation is a qualitative inquiry using the comparative case study design. The case study is a good research design to use when the researcher wants to explore contemporary using real-life contexts, "especially when the boundaries between phenomenon and context are not clearly evident" (Yin 1994, p. 13). For case studies to be robust investigations, they have to use "multiple sources of evidence" (Yin 1994, p. 13). With case studies, the researcher does not manipulate variables mainly because the goal of the investigation is to deeply understand a phenomenon and its contexts (Darke, Shanks & Broadbent 1998).

There are two general types of case studies: single or multiple. Usually, a researcher uses the single case study if the aim is to investigate a critical case with all necessary conditions for testing a theory, when the phenomenon explored is unique or when it is a revelatory case (Yin 2009). At the other end of the spectrum, a researcher opts to use the multiple case study when it is necessary to conduct a cross-case analysis wherein phenomena occurring in different settings need to be compared (Yin 2009). Multiple case studies are warranted when multiple cases have to be compared to (i) predict similar results through replication, or (ii) derive contrasting results for likely reasons thereby achieving theoretical replication (Yin 2009). In other words, comparative case studies remain undertaken so that the researcher can make comparisons for the purpose of advancing propositions, or for replicating findings that have been found to occur in different settings (Mills 2010). In the process, the researcher can discern "cross-case patterns and themes" (Mills 2010, p. 838).

This case study is comparative because the purpose is to make controlled comparisons between several cases about phenomena that closely resemble one another in nearly every aspect (Yin 2009). The advantage of using the comparative case study is that it is equivalent to conducting multiple experiments such that the researcher can find similarities and differences between the cases (Yin 2009). Consequently, a researcher can achieve robustness in the investigation. In this study, three cases will stand deliberation. The Benoni MSWM will be compared with the MSWMs of Cape Town and the United States.

3.3 Sampling

This comparative case study uses purposive sampling through which the cases to be compared with the Benoni MWSM were purposefully selected to determine its effectiveness (Mills 2010, p. 838). With case studies, the sample size determined by the research questions (Mills 2010). Because the research questions pertain to MSWM in South African cities and the United States where MSWM is considered advanced, the cross-case analysis should be in at least four cases: Cape Town, Pretoria and United States MSWM.

3.4 Data Collection

There are two types of data for this comparative case study: primary data and secondary data. The primary data pertain to legislation and policies covering waste management in South Africa, including Benoni, and the United States. Secondary data comprised of extant literature including peer-reviewed sources on relevant concepts that pertain to waste management. The collection of these data enabled by the wealth of articles and empirical studies on the phenomenon being investigated, and which are accessible through electronic databases. In light of these, the sources used for this comparative case study were accessed through electronic databases such as

EBSCOhost, SAGE, Elsevier, and ScienceDirect. Primary data were also collected from government websites and articles from popular albeit credible internet sites.

3.5 Data Analysis

With case studies, data analysis is undertaken through an iterative process. To note, Accurate descriptions of the data, as well as the development of categories in which to place behaviours or process, are important steps in data analysis. The data organised around specific topics, key themes or central questions. Lastly, the data has to be analysed to determine whether they fit or fail to fit expected categories (Yin 2009). In this comparative case study, data analysis required examinations, categorization, tabulation and otherwise recombining qualitative evidence to address the initial propositions of a study. Data analysis equates with searching for patterns in data. As soon as a pattern has been discerned, it is interpreted according to a social theory or the setting in which it occurred. The qualitative researcher then shifts from merely describing the phenomena to a more general interpretation of its meaning. Ultimately, data analysis is needed to "uncover patterns, determine meanings, construct conclusions and build theory" (Patton & Appelbaum 2003, p.67). Yin (2009) explains that with case studies, there are three general analytic strategies for examining case study evidence. The first is by relying on theoretical propositions; the second is by considering competing explanations; and, third, developing a case description.

3.6 Reliability and Validity

To be considered as robust, comparative case studies need to meet the criteria of four tests: construct validity, internal validity, external validity and reliability (Yin 2009). Construct validity was achieved in this study because the investigator used multiple sources of evidence and

information. Cross-case analyses, explanations of study results, clarifications on contradicting or vague explanations all combined to help enhance internal validity (Yin 2009). External validity was achieved through replication logic that, in turn, was enabled by the selection of two comparison cases that generated similar results (Yin 2009). Adhering to case study protocol ensured the attainment of reliability.

3.7 Ethical Implications

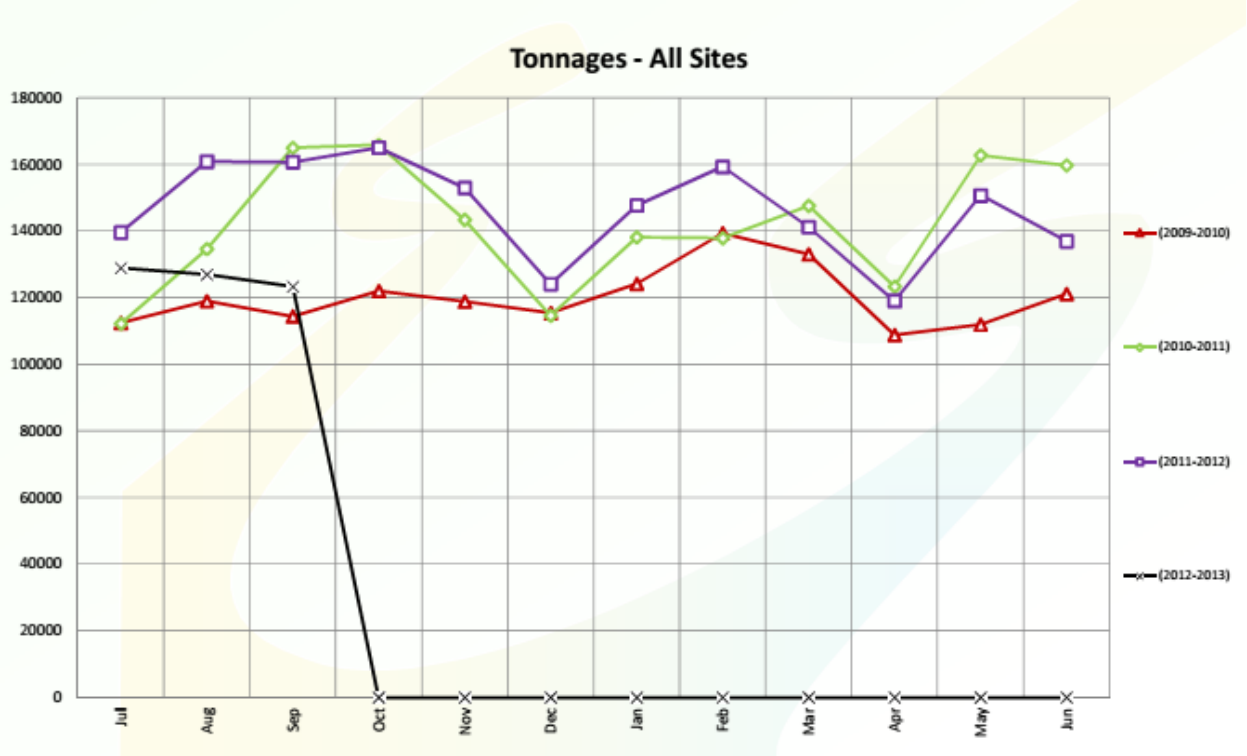
Keeping within case study protocol also helped to make sure that the investigation was conducted according to exemplary ethical standards. Information from primary and secondary sources was presented in as objective as manner as possible. The depiction of the similar cases was value-free, and no variables were manipulated for the purpose of attaining expected results.

This study will look at Benoni; Ekurhuleni's MSWM and will use The City of Cape Town and New York City, as comparative case studies. These two case studies will be discussed in this paper and their implementation of MSWM strategies will be compared to each other, and Benoni. The solid waste management tools used to make the districts efficient and effective will be recommended to Benoni. New York City is situated in a Developed Country and The City of Cape Town and Ekurhuleni are situated in Developing countries. Developing Countries such as The United States of America, has not only introduced tools to decrease unsorted waste at source, it also provided resources to assist households to be able to sort the waste. The choice to study these case studies was to highlight teachings from, The City of Cape Town and New York City for Ekurhuleni on how to effectively and efficiently implement sold waste management strategies.

IV. Case Study 1: Benoni

In 2011 (most recent data available), waste stream volumes in EMM ranged between 115,000 tonnes to 165,000 tonnes, as shown in Figure 4 below (Hlongwane, 2011).

Figure 4: EMM Waste Stream Volumes

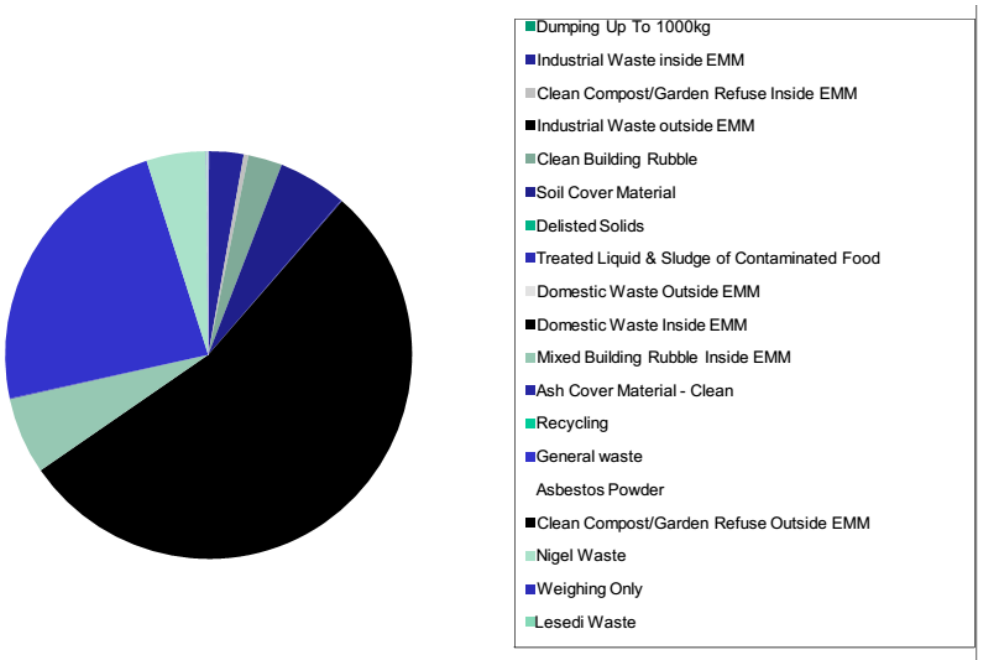


(Hlongwane, 2011).

However, the composition of generated MSW's hard to identify mainly because the EMM Waste Management Services Department (WMSD) does not categorise the waste according to standard definitions. For instance, as seen in Figure 5 below, the WMSD groups together the amount of domestic waste inside the EMM, with fresh compost/garden refuse outside of the EMM (Hlongwane 2011). A type of waste called "general waste" is categorised together with treated liquid and sludge of contaminated food when liquid wastes are supposed to be managed through a fluid waste management approach. As will be shown in this case study, there are other

shortcomings and flaws in waste management in Benoni.

Figure 5: Ambiguous Categorization of MSW



(EMM, 2002).

4.1 Current Practices

Waste handling should be according to waste management proper instructions, rules, and policies or by-laws that establish guidelines for handling. One of the strengths of the EMM waste management system is that by-laws are in place to guide its solid waste management department (EMM, 2002). These by-laws focus on the collection and the removal of business, domestic, garden and industrial refuse within the metropolitan areas of the Municipality (EMM, 2002). Moreover, the by-laws serve as a guideline to the public with regards to their roles in, and personal contributions to, waste management. By-laws do not permit the collection of waste generated by private companies and other persons in the name of profit; instead, individuals may

seek permission of the EMM Council to collect the waste produced by others, including, corporations.

In Benoni, it may be assumed that municipal workers collect waste for disposal. As seen in Figure 5, waste is collected from different sources and mixed. The EMM utilises all of its six landfill sites for the disposal of its waste, and although claims are that it is strategically located, neighbouring communities frequently complain about the foul smell coming from the landfill sites (Tembon 2012). Hence, EMM and its third-party collection companies have to design a systematic waste collection and disposal system that does not cause displeasure or discomfort to community members. The NEMWA specifically states that South African municipalities have an obligation to provide the requirements for the (i) separation of waste at source; (ii) collection of recyclable waste; (iii) communal collection points; and (iv) drop off center for the recyclable wastes, preferably with drive through options (EMM 2001). With regards to its contractors, it is not clear whether EMM measures their performance through effective monitoring strategies. The EMM's weak monitoring function is also evident in how the majority of squatter inhabitants have the propensity of burning their waste in front of their residence either to eliminate unwanted odours or some other rationale. The EMM has increasing volumes of waste that go to the landfill sites or undergo treatment need to be treated in one way or the other (EMF, 2008).

According to the waste hierarchy, minimization and prevention of waste are the most preferred followed by recycling, treatment and lastly disposal. The NEMWA adopts the waste hierarchy as a national approach to waste management, but the community members at the EMM still have the shared propensity to discard their wastes for the landfill instead of having them treated or salvaging them for recycling or re-use (). The waste hierarchy promotes the prevention

and reduction of waste and strongly discourages disposal.

4.2 Waste Management Problems

Based on previous studies, residents of EMM encountered many challenges as a result of a waste management system riddled with shortcomings (Naidoo 2009; Tembon 2012). Residents of informal settlements and high-density areas reported different problems as those who came from the formal high and medium density areas. Study participants from informal settlements disclosed that waste generated from home is not collected regularly (per week). Collection days frequently changed without prior notice to the residents, or, no waste collection occurred during rainy days. The residents find the waste disposal bins too small. Om the other hand, the more affluent respondents also complained about the rare collection, as well as the litres left behind after collection. There are weeks when waste collection ceases altogether. These respondents complained that it is hard to recycle even though they want to because there is no proper recycling facility. Employees are difficult to identify because they do not report for work wearing uniforms.

From the perspectives of the waste management workers, the problem is that the majority of informal settlers are also street vendors. Although they earn a living with suppliers, undisciplined behaviour further worsens the litter and unsanitary solid waste disposal practices in the EMM. Apart from these, many of the poor informal settlers in EMM strive to augment their income by salvaging on landfill sites for items to reuse and scrap metal to sell to recyclers. This activity is one of the main rationales for informally settling in the proximity of landfills (Pantelic et al. 2005; Naidoo 2007).

Landfills in the EMM have a maximum lifespan of about 15 years. To maximise its life,

the landfills are divided into four sections so that one section at a time may be used. However, a persistent problem with regards to this is the reported foul odour either coming from the landfill or the dwellings of the informal settlers, which the waste management workers promptly addressed. The informal settlers have not been permitted to penetrate the landfill site, but searching and subsequently selling recyclable materials from the landfills have become a regular source of income for them. Their scavenging activity is problematic for waste management workers. Not only do they scatter the waste that has been dumped in the landfill, but they also do not wear any protective gear when scavenging such that they are exposed to health risks when they come into contact (and perhaps get wounded) with dirty and broken equipment. Waste management workers, themselves, are guilty of not wearing protecting gear when working in the landfills. The waste collected means are exposed to bacteria, germs, and maggots aside from noxious odours (Naidoo 2009).

Currently, there is considerable pressure on MSWM to expand services such as storage, collection, disposal and even treatment facilities. There are also demands for waste minimization strategies, as well as the demand for facilities that will pose fewer health risks to using as landfill sites, and lack of capacity for effective governance.

V. Case Study 2: Cape Town

Since 1995, Cape Town has made significant progress in local government, including, consolidating local democracy, extending public services, completing the major restructuring and other examples of innovation and good practice (Engeldow 2007). The achievements above may be comparable with other prominent cities; Cape Town still lags behind its peers regarding social and human development outcomes. Consequently, the City has not managed to drive socio-economic trends towards a positive direction.

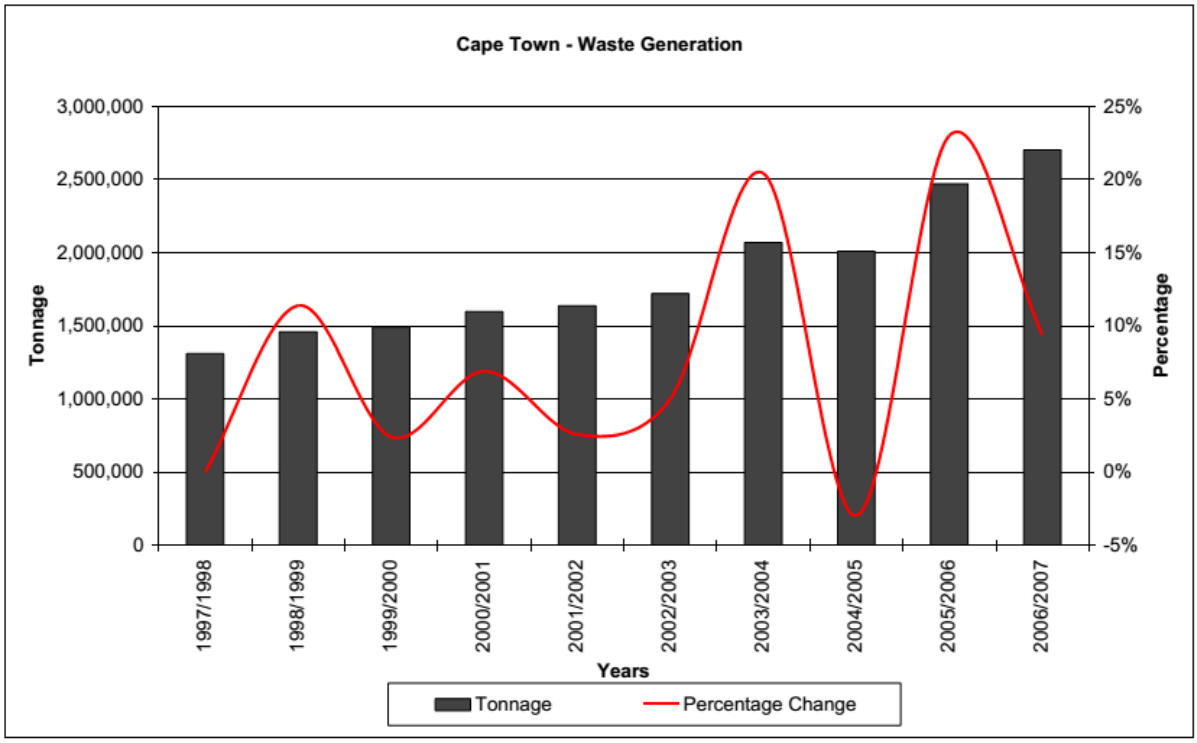
The new Cape Town Council established solid waste services, including, bulk services of the former Cape Metropolitan Council as well as the collection and cleaning functions of the six former Metropolitan Local Council. Cape Town's solid waste management operations used to be highly fragmented, with numerous services and facilities in dire need of upgrades and modernisation. Cape Town's waste management practices and traditions handed down by former officials had been found to be inadequate despite being highly expensive. These shortcomings include massive volumes of tonnes of waste per year, which recently reached 1.7 million (USAID 2004). It is anticipated that this quantity is increasing by an estimated 5.5% per year. Moreover, Cape Town's landfills airspace is rapidly becoming depleted such that disposal has become highly expensive due to new environmental and other legislative requirements.

In 2004, an overhaul of Cape Town's solid waste services was initiated, with an eye towards the development of an IWMP that can holistically address problems related to waste that had been confronting Cape Town from the perspective of sustainability. At that time, the City had been struggling to deal with illegal dumping and littering, while there were no systems in place to ascertain that waste reduction initiatives including reduction, minimizations, and recycling,

were being practised. A review of existing by-laws was undertaken for the purpose of making improvements.

In the Western Cape in 2010, total solid waste generated reached 3,807,765 tonnes per annum1, based on a comparison of four different waste quantification methods (Western Cape Government 2013). On the other hand, Western Cape reached 1,446,500 tonnes. Between 2015 and 2020, it has been projected that the City of Cape will generate waste totalling at least 4.7 million tonnes and a maximum of 5.2 million tonnes per annum (Western Cape Government 2013). Notably, the City of Cape Town represents roughly 70% of the total waste generated in the province, with the Cape Winelands and Eden Districts ranking a distant second and third, as seen in Figure 6 below:

Figure 6: Cape Town Waste Generation (Western Cape Government, 2013).



5.1 Current Practices

Population growth, urbanisation, commercialism, and migration of the population to Urban areas all place increasing pressure on municipalities to improve on waste management services. However, over the past decade, the rate of regular waste removal services has remained the same albeit it improved throughout the province (USAID, 2004). In Cape Town, the percentage remained the same at 94% despite significant population growth. Municipal waste collection services are crucial to the management of solid waste, in particular, domestic waste. Indeed, efficient collection services, combined with services such as street cleansing, ascertain that well-being and healthy environment positively define social conditions in communities. The

waste collection services delivered by private contractors, in particular for the industrial and commercial customers, are also very helpful. It has been estimated that the split in tonnage between municipal waste collection and private companies is 40:60 in the City of Cape Town, including “services such as “pay as you throw,” separation at source and recycling opportunities (USAID 2004).

Just like other South Africans, those in Cape Town also have a preference for outright disposal of wastes. Of the 240 landfills in South Africa, only 193 are operational (USAID 2004). The City of Cape Town has three municipal waste disposal facilities in operation: Coastal Park, Vissershok and Bellville South (USAID 2004). The largest of these is Vissershok at 117 hectares, compared with Coastal Park’s 75 hectares and Bellville South’s 60 hectares.

5.2 Waste Management Problems

Due to the complexity of solid waste management, it cannot be expected that individuals will immediately be satisfied with services being delivered. Solid waste management can be problematic from the perspective of the provider or of other stakeholders. Therefore, one of the problems regarding solid waste management from the view of a tourist destination is the effective provision of waste management services to a growing population, in the context of healthy economic development and tourism increases, but restrained by limited resources and finances. Another problem pertains to the permanent curbing of litter and illegal dumping in inner cities and the ensuing urban decay. Cape Town also struggles in providing adequate landfill airspace for a growing town, by the Department of Water Affairs and Forestry‘s requirements for the legal, safe disposal of waste. For administrators, another problem pertains to how to encourage all stakeholders to participate in minimising the waste to be landfilled through

different waste avoidance, reduction and recycling projects and initiatives. Cape Town also has problems procuring capital funds for the creation of new waste handling and disposal infrastructure.

In light of the socio-historical events that had profoundly impacted Cape Town over the past decade, it may be said that Cape Town *does* have an effective waste management service that covers 96% of all households and businesses while having just embarked on many initiatives to reduce, recover and recycle waste. At this point, Cape Town, the first to have an ISWM plan in South Africa, has waste generation levels that are comparative with both economically developed and economically developing countries, which makes the City an interesting case to study.

It must be stressed that Cape Town's institutional and infrastructural capacity for the management of solid wastes well compared to most developing countries (Engeldow 2007). However, the City does face constraints and challenges especially regarding becoming integrated with six other formerly independent and self-administered municipalities; the long-term impacts of Apartheid as well as unequal service distribution. To further complicate matters, landfill space is direly needed. Rapid urbanisation also exacerbates matters, and when all these are considered, there is resulting pressure on the municipality to find and implement alternative waste management options.

5.3 Causes of the Problems

Cape Town is an urban area that has been undergoing rapid population growth. In 2006, along with dramatic population increase was am accompanying an increase of 23% for a waste generation (Engeldow 2007). Notably, Cape Town's population had increased by 26% already since 1996 (Engeldow 2007). The people in Cape Town has grown 26% since 1996

Census. The increase in a waste generation for the same period is 106%. Partly because of population growth and urbanisation, the City has limited resources, problems with informal settlers who do not have houses built but instead live practically, and litter, in the streets.

VI. Case Study 3: New York City, New York

New York City generates roughly 14 million tonnes of waste and recyclables in a given year (Sylvan 2013). Each day, 50 tonnes of waste are collected in New York, with the Department of Sanitation (DSNY) managing about 25% of it. Private businesses generate the rest (75%) and privately managed. The in-city collection is enabled by more than two thousand city-owned trucks and 4,000 own trucks. Every day, the DSNY disposes 11,000 tonnes of waste, and these activities amount to $1 billion annually on solid waste disposal. These translate into 4.1 pounds of MSW per person per day, or 0.75 tonnes per person per year (NYSDEC 2010). The City estimates that roughly one-third of the residential waste stream is recyclable through its current curbside collection program, it is curbside and containerized recycling diversion rate in 2010 was only 15.7%. Nearly all of the remaining 85% were hauled off to out-of-state landfills. Additionally, the City has made efforts to explore new conversion technologies for waste disposal by soliciting and evaluating a series of proposals for in-city commercial facilities and commissioning feasibility,

6.1 Current Practices

An All-inclusive Solid Waste Management Plan (SWMP), in 2006, was approved by the City Council of New York City. This SWMP aimed to establish a cost-effective, reliable and environmentally sound system for managing the City's waste. The City experienced some changes in recycling policies that resulted in public confusion; this plan worked with City Council to set measurement targets for recycling, improve public education on recycling practices, and create a city office to provide outreach and teaching. The City initially aimed to achieve a 25% diversion rate by 2007. A diversion ratio is the percentage of waste that diverted

from landfills to some form of waste treatment or reuse (DSNY, 2006). As of 2010, waste management in New York was in the form of landfill disposal through the use of long-haul trucks that brought the waste to out-of-state landfills (NYSDEC 2010; Sylvan 2010). When Fresh Kills, New York's largest landfill closed, the City negotiated short-term contracts with different landfills out of town. In recent years, landfill availability in the Northeast and Mid-Atlantic has become severely limited thereby driving disposal prices so high such that the City had to look farther afield for landfill options. In other words, long-haul trucking is the primary method used in transporting MSW from New York to landfills. Roughly 45% of city-collected waste is currently carried in this manner, while 32% of waste remains transported by rail, and 23% travels shorter distances via City collection trucks (Sylvan 2010). Waste that is not taken to out-of-state landfills is being processed at the Newark Resource Recovery Center, a Waste-to-Energy Incineration Plant.

The plan listed a series of initiatives and goals within three areas: recycling, residential waste and commercial waste. In 2011, the New York City's comprehensive sustainability plan incorporated solid waste management into sustainability planning under the PlaNYC.
One of the aims under PlaNYC was to divert 75% of solid waste from landfills by 2030. New York City's Solid Waste Management Plan expects to reduce annual greenhouse gas emissions by 34,000 tonnes while diverting 2,000 tonnes of waste per day from land-based solid waste transfer stations in Brooklyn and Queens to marine transfer stations (City of New York, 2014). New York City is pursuing several different strategies to improve waste management, including increasing recycling capture rates; encouraging residents and businesses to divert organic material from landfills; and overcoming permitting obstacles related to waste-to-energy. The

2014 progress report for PlaNYC determined that the goal of reducing waste sent to landfills by 75% be gradually being reached, with 52% diverted in the previous year (City of New York, 2014).

In April 2015, Mayor Bill de Blasio announced the rebranding of PlaNYC to One NYC, a plan for a strong and just city that includes strategies for growth, sustainability, resiliency and equity. Under this scheme, the city's goal is zero waste by 2030, such that no waste sent to landfills. The goals include the organic program to be able to serve the population of New York, by 2018. Improve curbside recycling to reduce waste, lower the reliance on plastic bags. Implement measures to make schools zero waste (Cohen, Martinez and Schroder, 2015, City of New York, 2015).

6.2 Waste Management Problems

About 20 years after New York State adopted the waste hierarchy, almost 65% of total wastes managed in the state, as well as 80% of the wastes administered by the municipality, were disposed of in landfills (DYSDEC 2010). Despite the fact that landfill is supposed to be the last option according to the waste hierarchy, landfills had become New York's most dominant preference for waste disposal. Here, it must be emphasised that New York has had successes in the area of prevention waste management. However, it is unfortunate that they have been offset by negative developments, such as planned obsolescence, the growth of convenience products and advancing technology. Consequently, these successes did not result in reductions in a waste generation for 20 years.

Meanwhile, it is important to note that New York and its municipalities had made significant progress in the area of recycling initiatives, and attesting to this is the increase in

recycling levels between 1987 and 1997 (NYSDEC 2010). However, progress had not been consistent until the programs all but stalled over the past ten years. New York's well-established recycling industry continues to seek out new markets for secondary materials. About this, practically all municipal recycling programs end up dependent on the recycling industry for the final processing and marketing of recovered materials. Nevertheless, the adoption of source-separation recycling programs has been inconsistent, not only regarding participating communities but also regarding different settings such as schools, businesses, and public spaces.

New York's new MSW plan, called the Beyond Waste Plan, embodies a new approach for New York State, which shifts from focusing on end-of-the-pipe waste management techniques to look towards "upstream" and more comprehensively at how materials that would otherwise become waste can be put to more productive use to gain profitability ultimately. This shift is crucial to the abilities and capacities to respond to constituents' waste management needs. Examples of these requirements are heightening pressure to reduce demand for energy, decrease reliance on disposal, minimise the emission of GHG and generate green jobs (Sylvan 2010). In other words, New York's new plan uses and promotes the waste hierarchy. The new scheme necessitates the participation of key stakeholders in the production and supply chain—product manufacturers, distributors, retailers, consumers, and government. The plan requires considerable investment in initiatives such as recycling and distribution/reverse distribution infrastructure. Ultimately, this will lead to reduced dependence on waste disposal (Sylvan 2010).

The first unresolved management dilemma is the price of long-term disposal and the ambiguity about the accessibility of waste disposal services. Today, the city has agreements with

out-of-state landfills and incinerators to accept the city's waste, but the price of disposal remains to rise, and the supply of disposal sites is not guaranteed (City of New York, 2015).

6.3 Causes of Problems

It is highly possible that New York officials are simply approaching waste management in the traditional manner thereby opting to dispose waste at landfills instead of re-using or recycling. Municipal solid waste landfill continues to dispose of the majority of the nation's municipal solid waste and will continue to be a critical element of sustainable waste management planning and practice shortly. A problem at hand is that landfills have a relatively brief lifespan. Even more, landfills are expected to close down as a result of stricter regulations and for the very reason that it no longer has light. However, it is important to note that new landfills are increasingly hard to find while old facilities are ready to retire. It is also believed that Modern municipal solid waste landfills are coming under increasing scrutiny, and there is a distinct possibility that it will be stricter with the money sometimes in more protective of the environment in future.

In the United States, waste management is dramatically changing. Landfills are in more demand and filling up new sites will take greater effort and will become harder to accomplish. In the process, prices charged may \by expected to skyrocket. In light of these challenges, increasing numbers of communities are seeking out alternative management approaches that do not solely depend on the disposal of waste at landfills. The United States and New York should identify a safe and permanent way to eliminate the gap between waste generation and available capacity in landfills, combustors and secondary materials markets (Sylvan 2010).

Waste generation by individuals exists largely influenced by economic development,

lifestyle and habitat. The use of large amounts of packaging material in distributing goods reflects a community's collective values. Exporting waste is based on a need to avoid the potential environmental insult of treating garbage and on the standards that underlie the "Not in My Back Yard" pattern (NIMBY). This syndrome is not unique to New York; these consumption patterns currently prevail in all modern, developed economies (Cohen, Martinez and Schroder 2015).

VII. Comparative Analysis

Data analysis for the comparative case studies brought to light several surprising yet interesting phenomena. For instance, it was certainly a revelation to learn that New York, one of the most recognised metropolises in the world and associated with notions of modernity and progressiveness, uses a waste management system that has been discredited. Specifically, the bulk of New York's wastes are disposed at landfills. The following subsections present discussions are about the comparative case studies, with the debates according to research questions.

Since the literature review examines waste management and minimization patterns, trends and practices between developed and developing countries, it is imperative firstly to draw a distinction between such countries. Most developing countries tend to have larger fractions of their populations characterised by lower living standards, an underdeveloped industrial base with a low human development index (HDI) about other countries (World Economic Situation and Prospects, 2012).

Developing countries are, in broad, countries that have not achieved a significant degree of industrialisation about their people and have, in most cases, a medium to low standard of

existing. There is also a strong correlation between low income and high population growth (World Economic Situation and Prospects, 2012). On the other hand, developed countries are typically associated with effective public services rendered by governments and the private sector (UNEP, 2000; World Economic Situation and Prospects, 2012; Zhu, 2008). Also, such countries have a high gross domestic product (GDP) per capita and elevated level of industrialisation. The noneconomic factors associated with developed countries are a higher HDI which reflects superior quality of education, literacy, health, high standards of living and public services (Niesel, 2011; Ghana Stats, 2013).

7.1 Current Practices

A surprising similarity between New York and Benoni not only pertains to the preferred choice of waste disposal that contradicts the waste hierarchy but also to the intensity (significance) of the similarity. A commonality among all three cases is that waste handling is consistently informed by proper instructions, rules, and policies or by-laws that establish guidelines for handling. All three cases each have similar laws, policies and by-laws supporting every component of their MSWM or ISWM plan. Notably, for Benoni and Cape Town, the NEMWA 59 of 2008 provides guidelines about the undertakings different municipalities have to incorporate into their systems to achieve efficiency and effectiveness. The Waste Act establishes the prerequisites for the various implementers so that an ISWM would have been accomplished within the given timeframe. The Waste Act also highlights the importance of stakeholder engagement and participation. For New York, the overarching legislation is the Solid Waste Management Law, which establishes administrators, recyclable materials, hazardous wastes and

some other key definitions. Meanwhile, another interesting similarity between Benoni and New York is the focus on the waste-to-energy approach that had been economically beneficial to the two cities (Sylvan 2010).

> Private firms remove the waste from New York City's commercial establishments, but the city's residences, governments and non-profit organisations produce thousands of tonnes of waste each day. Waste that is removed by the City's Department of Sanitation, which must employ thousands of employees to do the work (Cohen, Martinez and Schroder 2015).

The City of Cape Town, efficient collection services, combined with services such as street cleansing; ascertain that well-being and healthy environment positively define social conditions in communities. The waste collection services delivered by private contractors, in particular for the industrial and commercial customers, are also very helpful. It is estimated that the split in tonnage between municipal waste collection and private companies is 40:60 in the City of Cape Town, including "services such as "pay as you throw," separation at source and recycling opportunities (USAID 2004).

Waste management services rendered to most households within EMM and collection was conducted once a week. The weekly collection of waste to households by the municipality is a practice undertaken by most municipalities such as the City of Tshwane (Kamara, 2006), City of Cape Town (Davidson and Swilling, 2010).

The National Environmental Management Act (NEMA) (No. 107 of 1998) is a crucial piece of environmental legislation in South Africa on which subsequent environmental legislation in South Africa binds through. The focal objective of this Act is to provide for co-

operative environmental governance by establishing principles for decision-making on matters affecting the environment. Principles are set out in NEMA for environmental management, which guides organs of state, particularly have an impact on the environment. National and provincial levels are required to prepare an environmental management/ implementation plan(EMIP).The EMIP ensures that all functions that could significantly affect the environment performed in a manner that protects the environment The EMM prepared an EMIP, which holds the Ekurhuleni accountable as stated under Section 28(1), that the municipality needs to prevent or minimise their pollution or degradation to the environment (Ekurhuleni Environmental Policy and Implementation Plan, 2013)

7.2 Gaps between National Policy and Local Policy

In the case of Benoni, albeit the EMM has sufficient resources to manage waste effectively, there were numerous gaps related to the challenges that exist within the municipality's waste management sector. For instance, household wastes are not timely collected, and no notices are given when collection dates are changed (Tembon 2012). Apart from these, Benoni has an underdeveloped recycling system perhaps largely because the EMM itself has no comprehensive municipal recycling program and recycling facilities. Somehow, this contradicts the impression being given by providers that they have access to all the essential resources needed for them to be effective in their work. Meanwhile, when Cape Town created and adopted its IWSM, there was a need to review its by-laws due to the new policies described in the White Paper, National Waste Management Strategy, National Environmental Act, and, National Integrated Waste Management Bill. These laws above should be integrated into the new by-law incentives, taxes,

levies) to help achieve ISWM (Tembon 2012).

The National Waste Management Strategy (NWMS) is a legislative obligation of the National Environmental Management Waste Act (No. 59 of 2008). The purpose of the NWMS is to attain the objectives of the waste act. The organs of state and affected persons are obliged to give effect to NWMS (DEA, 2012). The NWMS emphasises that integrated waste management plans formulated by the municipalities need to be practical and easily be implementable; outcome focused must, include must priorities, objectives and targets and must make provision for a financial arrangement.

The outline of "Pay as you throw", this concept is used to charge residents according to the volume of waste they produce and discard, in The United States of America. The "Pay as you throw" concept encouraged residents to sort their waste from source as it became expensive to dispose of unsorted waste. The waste department within the EMM was not immune to challenges which hindered the effective delivering of waste management services. These challenges ranged from staff shortages, inadequate operational budgets, and non-payment of services by residents to illegal dumping due to the lack of waste management bylaws enforcement. These barriers highlighted above-posted shortcomings for the municipality by cutting the implementation of a full-scale recycling and minimisation programmes (Gumbi 2015).

7.3 Lessons from Comparative Cases

Based on current practices and underlying rationales, it appears that Cape Town's MSWM is the most efficient and consistent with by-laws and the needs of target communities. According to researchers, Cape Town's MWSM covers 96% of all households and businesses. Cape Town also

uses the waste hierarchy paradigm as well as the integrated approach to solid waste management. This is no mean beat considering that from a solid waste management perspective, Cape Town is faced with environmental, economic and social challenges: For example, Cape Town experienced heavy environmental damage due to poorly sited landfill sites with little or no mitigation measures in place, while economic challenges continue to persist because of rising costs related to waste management (Davison 2010).

On the other hand, it seems that the MSWM needing the most improvements is that of Benoni. Notably, waste generation in Benoni is faster than population and economic growth (Naidoo 2007). However, the EMM, just like New York, uses disposal at landfills at its primary method of waste management. Hence, it is imperative that the EMM shift its approach to waste hierarchy, with emphasis on waste minimisation, re-use and recycling strategies to address waste generation. Unfortunately, it does not seem as if the local government can implement such strategies and other sustainable waste management methodologies. Benoni has reached the dilemma in which adverse health and environmental impacts of ineffective waste management are already being felt, while the number of landfill sites has been decreasing with no planning in evidence for the purpose of establishing new ones. Because of these, improvements to Benoni's MSWM will entail the cooperation of all tiers of Government as well as industry and the commercial sectors. The EMM will have to restructure the recycling industry with the support of waste management legislation. An option that EMM has is to contemplate upon the outsourcing of the management of sanitary landfill sites to public-private partnerships, based on study findings that these discharges are better managed in South Africa (Naidoo 2009).

New York has strong similarities with both Benoni and Cape Town. Just like Benoni,

New York has a preference for waste disposal at landfill sites. However, the distance from New York to available landfill sites necessitates trucking services that ultimately contribute to global warming. New York's MWSM seems to be a paradox. New York has long officially adopted reuse and recycling of materials from the City's waste stream. Indeed, New York has had a highly productive recycling sector. However, this productivity has dwindled, and waste authorities appear to have overlooked this practice as a component of actual MSWM. Currently, recycling has become a strong component of the SWSM. New York and Benoni need recycling facilities as well as other resources to manage waste (Tembon 2012 & Naidoo 2009) better.

7.4 Improving Shortcomings

Based on the combined experiences in the three cases, some recommendations can be made to Benoni. First, every member of the community should be empowered with education and skills on waste management to increase their levels of participation in waste sorting at the source of generation. This awareness for the community on waste will encourage effective recycling that ultimately generates income. Community awareness and involvement in waste management will be particularly useful to Benoni's squatter communities. Benoni has to look into the possibility of providing skills to informal settlers so that they can construct well-planned houses for themselves. With assistance from the national government, the EMM can decide whether this type of housing can be subsidised to be gifted. Third, it is essential that EMM involves stakeholders from the different sectors of the municipal area in the planning and implementation of waste management strategies. Group leaders from various communities as well as social groups such as church communities should be called to participate because they are crucial links between the council and the community.

It appears that in the developed countries there is a growing paradigm shift, where waste is no longer regarded as just “waste” but as a resource which can benefit society and the world. There are many wastes to energy projects implemented to provide energy and electricity, in United States of America about 2720 megawatts of total power produced from waste to energy facilities. Overall, the developed countries are doing well regarding addressing waste management and minimization (Gumbi 2015). Cape Town has launched an R400m waste to energy conversion plant, on the 24th of January 2017. Evans stated that the City of Cape Town would generate 20% of renewables.This project is a collaboration between Waste Mart and Clean Energy Africa; this project will be run by New Horizons Energy (Evans, 2017).

“The Growth and Development Strategy (GDS) for EMM which is in development defines the pathway for the Municipality's growth and development, based on the needs of residents and taking into account global, national and provincial trends. The Growth and Development Strategy (GDS) 2055 is Ekurhuleni's long-term plan for service delivery. It is a 20- to 30-year plan that sees to it that services are delivered based on the needs of our people and taking into account the trends globally, nationally and provincially”, described in the Ekurhuleni Environmental Policy and Implementation Plan (2013).

In the GDS there are seven targets named, one of them listed as number 3 is waste management. The concerns surrounding waste management for the municipality, to name a few include landfill airspace requirements, inadequate sanitation and waste services and lack of involvement of communities in waste management, backlogs in service delivery and illegal dumping particularly in the informal areas. “Further to this, the focus on end-of-pipe treatment and little implementation of waste hierarchy is a critical area of interest for future efficient and affordable

waste management option", stated in the Ekurhuleni Environmental Policy and Implementation Plan (2013).

VIII. Conclusion

In waste management, there has been a shift from a collection and disposal dominated waste hierarchy to a waste hierarchy that promotes minimisation and recycling. Currently, the waste management trajectory follows a path from land filling to a blend of recycling and incineration, incrementally substituting the practice of landfilling. Many developed countries have successfully achieved this shift such that the adverse human and environmental effects of waste management had been banned while at the same time gaining economic advantages. This comparative case study has produced interesting findings, not least of which is that an effective MWSM may be found being used in Cape Town while New York needs to improve its own considerably.

The municipalities are accountable for the delivery of efficient and reliable service delivery, while inhabitant is responsible for paying for service provided to them. DEAT has also produced a collection of four strategic papers that outline its strategy on the management of waste, government policy, international conventions, agreements, treaties and protocols relating to integrated pollution and waste management and principles from the Drafts White Paper on environmental management of South Africa. The vision of DEAT is to develop, implement and maintain an integrated pollution and waste management system which contributes to sustainable development. A measurable upgrading in the quality of life through harnessing the energy and duty of all South Africans for the operative prevention, minimisation and regulator of pollution and waste (DEAT, 2007; PDG, 1996)

The aim of this study was to look Benoni's municipal solid waste management and to use The City of Cape Town and New York City as comparative studies. Looking at New York City, which is situated in a developed country and measuring Ekurhuleni and The City of Cape Town, this two found in a developing country. The study showed evidence that New York City developed a tool to not only encourages its citizens to separate waste at source, but also provided resources to equip them to know how to separate waste. Involving the citizens brings awareness and education on waste management. This is one way to involve the population. A commonality among all three cases is that waste handling is consistently informed by proper instructions, rules, and policies or by-laws that establish guidelines for handling. All three cases each have similar laws, policies and by-laws supporting every component of their MSWM or ISWM plan. Notably, for Benoni and Cape Town, the NEMWA 59 of 2008 provides guidelines about the undertakings different municipalities have to incorporate into their systems to achieve efficiency and effectiveness (Sylvan 2010)

In New York City, waste that is not taken to out-of-state landfills is being processed at the Newark Resource Recovery Center, a Waste-to-Energy Incineration Plant. A project took effect on January 2017, to turn waste to renewable energy for the population of Cape Town. It opened in Athlone, Cape Town. Two companies who collaborated were Waste Mart and Clean Energy Africa and will be run by New Horizon Energy. This is evident that developing countries are slowly moving in the right direction when it comes to waste management (City of New York, 2015 & Evan, 2017).

Table2. Breakdown of the three case studies

	Benoni (Ekurhuleni)	The City of Cape Town	New York City
Population	3.2million	3.7million	8.4 million
Area	2000 km'	2444.97km^2	790 km2
Waste generation rate	165 thousand per year	3.8 million tonnes per year	More than 6 million tonnes per year (OneNYC)
Spending on Waste Management	Budget 2016/17 129.75million on waste management	R1.7 to R2 billion on waste management	$2.3 billion annually (2014) DSNY disposes of approximately 11,000 tonnes of waste, and the agency spends roughly $1 billion annually on solid waste disposal.
Government Agencies Responsible for Waste Management	Ekurhuleni Metropolitan Municipality	The City of Cape Town	New York City Department of Sanitation (DSNY)
Major Goals	The Growth and Development Strategy (GDS) 2055 is Ekurhuleni's long-term plan for service delivery	Energy to Waste	Zero waste by 2030 (OneNYC)

(Cohen, Martinez and Schroder, 2015; Western Cape Government, 2013; Hlongwane, 2011; MTREF, 2016, Waste Economy, 2017; Census, 2011)

IX. References

1. Al-Khatib, I, Kontogianni, S, Abu Nabaa, H, Alshami, N, & Al-Sari', M 2015, 'Public perception of hazardousness caused by current trends of municipal solid waste management', Waste Management, 36, pp. 323-330, Applied Science & Technology Source, EBSCOhost, viewed 16 November 2015.
2. Bortolozo, F, Rizzi, J, Serpe, F, & Borba Braga, M 2014, 'Public involvement aiming at the improvement of household solid waste management: a case study', Proceedings Of The International Conference On Waste Technology & Management, pp. 696-712, Environment Complete, EBSCOhost, viewed 16 November 2015.
3. Bin GUO1, 2, & Yaxuan LIU3, l 2014, 'Towards integrated municipal solid waste management: a case of Urumqi, China', Advanced Materials Research, 878, pp. 3-14, Applied Science & Technology Source, EBSCOhost, viewed 16 November 2015.
4. Census 2011 'City of Cape Town' Metropolitan Municipality 199 from Census 2011 [Accessed 1 June 2017] http://census2011.adrianfrith.om/place/199
5. Clarke, MJ, Read, AD & Phillips PS 1999, 'Integrated waste management planning and decision-making in New York City.' Resources, Conservation and Recycling 26, pp. 125-141
6. Cohen, S, Martinez, H, and Schroder A, 2015, 'Waste Management Practices in New York City, Hong Kong and Beijing,' ALEP Waste Management Final, viewed 1 May 2017.
7. Davison, A 2010, Sustaining Cape Town: imagining a liveable city. London: Sustainability Institute.
8. Department of Environmental Affairs (DEA) 2011, 'National waste management strategy.' [Accessed 16 November 2015] http://www.lawsofsouthafrica.up.ac.za/tabledocs/59of2008/GNR344/NWMS%20-%20GNR%20344.pdf
9. Environmental Protection Agency (EPA) 2015, 'The waste hierarchy.' [Accessed 17 November 2015] http://www.epa.nsw.gov.au/wastestrategy/waste-hierarchy.htm
10. Ekurhuleni Metropolitan Municipality (EMM) 2002, 'Solid waste by-laws.' [Accessed 17 November 2015] http://uir.unisa.ac.za/bitstream/handle/10500/8110/dissertation_mbamukunduku%20fayez_t.pdf
11. Ekurhuleni Environmental Policy and Implementation Plan, 2013, 'Environmental Policy and Implementation Plan', Ekurhuleni Metropolitan Municipality Environmental Policy, viewed 5 April 2017.
12. Evan, J, 2017 'Waste-to-energy plant opens in Cape Town', *News24* viewed 1 May 2017, from http://www.news24.com/SouthAfrica/News/waste-to-energy-plant-opens-in-cape-town-20170125

13. Gumbi, S.E., 2015, ‘Current waste management and minimisation patterns and practices: An exploratory study on the Ekurhuleni Metropolitan Municipality in South Africa’, Master’s Degree, Dept. of Environmental Science, University of South Africa.
14. Department of Environmental Affairs and Tourism [internet]. Solid waste management systems Vol. 22 no 12. Pretoria: DEAT; [updated 2003 Jul; cited 2013 Jun 12]. [Accessed 23 April 2017] Available from: www.environment.gov.za/government Digest
15. Dir, T 2010, ‘The vulnerability of the Ekurhuleni Metropolitan Municipality to flash floods and possible future impacts due to climate change.’ [Accessed 17 November 2015] https://sites.google.com/site/witsgeoghonours/the-vulnerability-of-the-ekurhuleni-metropolitan-municipality-to-flash-floods-and-possible-future-impacts-due-to-climate-change
16. Engeldow, SA 2007, 'Integrated analysis solid waste baseline report' [Accessed 18 November 2015] https://www.google.com.ph/
17. Hlongwane, E 2011, ‘Ekurhuleni Metro Municipality waste management services department.’ [Accessed 17 November 2015] https://www.environment.gov.za/sites/default/files/docs/ekurhuleni_metrowaste_energyinitiatives.pdf
18. Gauteng Department of Agriculture, Conservation and Environment (GDACE) 2006, ‘Gauteng Provincial integrated waste management policy.’ [Accessed 17 November 2015] http://www.gdard.gpg.gov.za/Documents1/WASTE%20%20POLICY.pdf
19. Gertsakis, J & Lewis, H 2003, ‘Sustainability and the waste management hierarchy.’ [Accessed 17 November 2015] http://www.helenlewisresearch.com.au/wp-content/uploads/2014/05/TZW_-_Sustainability_and_the_Waste_Hierarchy_2003.pdf
20. Hester, RE & Harrison, RM 2002, Environmental and health impact of solid waste management activities. Cambridge: The Royal Society of Chemistry
21. Menikpura, S, Gheewala, S, & Bonnet, S 2012, 'Sustainability assessment of municipal solid waste management in Sri Lanka: problems and prospects,' Journal of Material Cycles & Waste Management, 14, 3, pp. 181-192, Energy & Power Source, EBSCOhost, viewed 16 November 2015.
22. Medium Term Revenue And Expenditure Framework (MTRE) 2016, Ekurhuleni Metropolitan Municipality - Budget 2016/17 To 2018/2019 [Accessed 22 may 2017] http://www.ekurhuleni.gov.za/2715-annexure-b-final-budget-2016-17/file
23. Naidoo, K 2009, ‘An analysis of municipal solid waste management in South Africa using the Msunduzi Municipality as a case study.’[Accessed 17 November 2015] http://researchspace.ukzn.ac.za/xmlui/bitstream/handle/10413/2164/Naidoo_Kaminee_2009.pdf?sequence=1
24. Nessi, S, Rigamonti, L, & Grosso, M 2013, 'Discussion on methods to include prevention activities in waste management LCA,' International Journal of Life Cycle Assessment, 18, 7, pp. 1358-1373, Environment Complete, EBSCOhost, viewed 16 November 2015.

25. New York State Department of Environmental Conservation (NYSDEC) 2010, ‘Beyond waste
26. New York State Department of Environmental Conservation: a sustainable materials management strategy for New York State.’ [Accessed 18 November 2015] http://www.dec.ny.gov/docs/materials_minerals_pdf/frptbeyondwaste.pdf
27. New York State Solid Waste Management Policy, 2014, ‘Beyond Waste: The Nysdec Solid Waste Management Plan’, *Final Solid Waste Management Plan*, Ontario County.

28. Oelofse, SHH & Godfrey, L 2008, 'Defining waste in South Africa: moving beyond the age of waste.' South African Journal of Science 104, 7-8, pp. 242-246, viewed 16 November 2015.
29. Özbay, İ 2015, 'Evaluation of municipal solid waste management practices for an industrialised city', Polish Journal of Environmental Studies, 24, 2, pp. 637-644, Academic Search Complete, EBSCOhost, viewed 16 November 2015.
30. Pillai, R, & Shah, R 2014, 'Municipal solid waste management: current practices and futuristic approach', SCMS Journal of Indian Management, 11, 4, pp. 72-78, Business Source Alumni Edition, EBSCOhost, viewed 16 November 2015.
31. Ross, DE 2011, 'Safeguarding public health, the core reason for solid waste management,' Waste Management & Research: The Journal of the International Solid Wastes and Public Cleansing Association, ISWA, 29, 8, pp. 779-780, MEDLINE with Full Text, EBSCOhost, viewed 16 November 2015.
32. Schubeler, P, Wehrle, K & Christen, J 1996, ‘Conceptual framework for municipal solid waste management in low-income countries.’ [Accessed 17 November 2015]
33. http://www.worldbank.org/urban/solid_wm/erm/CWG%20folder/conceptualframework.pdf
34. Shoou-Yuh, C, Wanchi, H, & Shu-Liang, L 2010, 'Municipal solid waste management: a comparison between the U.S. and other countries', Journal of Solid Waste Technology & Management, 36, 3, pp. 817-828, Environment Complete, EBSCOhost, viewed 16 November 2015.
35. Simelane, T. and Mohee. R., 2012, Future Directions for Municipal solid waste management in Africa, Policy brief. Held 18 September 2010 at Pretoria: Africa Institute of South Africa.
36. Sylvan, D 2013, ‘Municipal solid waste in New York City: an economic and environmental analysis of disposal options.’ [Accessed 18 November 2015] http://nylcvef.org/wpcontent/uploads/2013/07/Solid-Waste-Background-Paper.pdf
37. The Constitution of the Republic of SA Act 108 of 1996, Pub. L. S. 24-52. RSA; SA Government printers
38. Thenga, M, 2016, ‘Strengthening local government legislative authority in South Africa: Implementation of By-Laws21’, [PowerPoint presentation]. *Strengthening local*

government legislative authority in South Africa: Implementation of By-Laws21. Ekurhuleni Metropolitan Municipality: Solid Waste Management - The relevant content of enforceable and implementable By-Laws. KAS Local Government Conference, Kumkani Country Lodge, Potchefstroom, 21 July 2016. [Accessed 19 May 2017]

39. Pokhrel, D., Viraraghavan, T., 2005. Municipal solid waste management in Nepal: practices and challenges. Journal of Waste Management 25, 555-562.
40. United Nations Environment Program (UNEP) 2009, 'Developing integrated solid waste management plan training manual.' [Accessed 17 November 2015] http://www.unep.org/ietc/Portals/136/Publications/Waste%20Management/ISWMPlan_Vol4.pdf
41. United Nations Human Settlements Program. (2010). Solid waste management in the world's cities: water and sanitation in the world's cities 2010. London: United Nations. Environmental
42. Protection Agency (EPA). (1990). Environmental Protection Act 1990. Retrieved from http://www.rrc.co.uk/nlpdfs/SP2010/LINKS/Environmental%20Protection%20Act%201990.pdf
43. United Nations Environment Program (UNEP). (2005). Solid waste management. Retrieved from http://www.unep.org/ietc/Portals/136/SWM-Vol1-Part1-Chapters1to3.pdf
44. USAID 2004, 'City of Cape Town solid waste management services integrated solid waste management plan.' [Accessed 18 November 2015] http://pdf.usaid.gov/pdf_docs/Pnadd227.pdf
45. WastePlan 2015, 'Ekurhuleni turns waste into power.' [Accessed 17 November 2015] http://www.wasteplan.co.za/ekurhuleni-turns-waste-power
46. Waste Economy 2017, '2017 Market Intelligence Report' [Accessed 29 May 2017] http://www.green-cape.co.za/assets/Uploads/GreenCape-Waste-MIR-2017-electronic-FINAL-v2.pdf
47. Wu, E, Tsai, C, Lin, C, Kuo, S, & Kang, Z 2013, 'Development of a new municipal solid waste management system: multi-objective programming for a merged metropolis', Environmental Engineering Science, 30, 4, pp. 153-160, Applied Science & Technology Source, EBSCOhost, viewed 16 November 2015.
48. Yang, Z, Zhou, X, & Xu, L 2015, 'Eco-efficiency optimisation for municipal solid waste management', Journal of Cleaner Production, 104, pp. 242-249, Business Source Complete, EBSCOhost, viewed 16 November 2015.
49. Yi, S, Kurisu, K, & Hanaki, K 2011, 'Life cycle impact assessment and interpretation of municipal solid waste management scenarios based on the midpoint and endpoint approaches', International Journal of Life Cycle Assessment, 16, 7, pp. 652-668, Environment Complete, EBSCOhost, viewed 16 November 2015.
50. Ying An, A , Guangming Li, Wenqing Wu, Wenzhi He, & Xiang Shi1, S 2014, 'Information technology based municipal solid waste management in Shanghai, China,'

Advanced Materials Research, 1073-1076, pp. 911-914, Applied Science & Technology Source, EBSCOhost, viewed 16 November 2015.

51. Závodská, A, & Benešová, L 2010, 'A tale of two countries -- The Czech Republic and the United States: a comparison of their municipal solid waste', Journal of Solid Waste Technology & Management, 36, 3, pp. 909-917, Environment Complete, EBSCOhost, viewed 17 November 2015.