Cape Peninsula
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Sustainable waste management in the informal settlement of Hlalani, Port Elizabeth, Eastern Cape

by

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DECLARATION

I, Sibongile Matebese, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed **Date**

ABSTRACT

Waste is a topic that provokes intensive discussions due to the devastating repercussions on humans and the biophysical environment at large (Anand, 2013). The study evaluated Sustainable Waste Management (SWM) in the informal settlements of Hlalani, Port Elizabeth, Eastern Cape. In an effort to achieve the main aim of the research, the following objectives were employed in the study: Identify various waste management plans and practices in the area to solve the problem of waste. Moreover, to find out if the above plans, if any exist, adhere to principles of the waste management hierarchy provided in terms of NEMA: Waste Management Act. Furthermore, to find out whether or not the city council has future strategies to deal with waste in the Hlalani settlement. Lastly, the research seeks to provide recommendations on how waste management plans can improve to benefit the community and the environment.

The study made use of various qualitative and quantitative techniques to collect and analyse data. The primary sources of information used in the study from the qualitative research techniques were in-depth face-to-face and semi-structured interviews with waste officials and the ward councillor. The aforementioned mentioned individuals were interviewed to identify their role in the management of waste in the study area. Interviews were administered to individuals residing in this community to gather data on waste management in the area and whether they felt they are included in the MSWM plan of the Bay. Officials from the Nelson Mandela Bay Municipality (NMBM) and the DEDEA were also interviewed through semi-structured interviews. These government officials act as custodians in the management of waste in the country, so their input was critical in the study. Primary sources of information that were used from the quantitative research methods were surveys and logical observations. The study also made use of various secondary sources that were consulted to answer the research question. Official papers from research documents, papers, and various published government documents were also reviewed. Furthermore, the collection of secondary data collection involved several printed materials, municipal archives, books and journals, which assisted in answering the research question.

The study's significant findings indicate that the municipality has never serviced the area. The study further revealed that occupants in the area had no exposure to proper handling of waste. However, residents in the area don't seem to be playing their part in the management of waste and are instead blaming the government for the dreadful conditions.

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DEDICATION

This thesis is dedicated to my late Grandmother Notiti Gladys Matebese. My biggest motivation in life has always been to make you proud. I would also like to mention my friends and family who have supported me endlessly, this thesis would not have been possible without them.

GLOSSARY

Acronyms

MSW	**Municipal Solid Waste**
NMB	**Nelson Mandela Bay**
SWM	**Sustainable Waste Management**
NEMA	**National Environmental Management Act**
MSWM	**Municipal Solid Waste Management**
PE	**Port Elizabeth**
NMBM	**Nelson Mandela Bay Municipality**
WM	**Waste Management**
DEDEA	**Department of Economic Development and Environmental Affairs**
DSD	**Department of Social Development**

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CHAPTER ONE
INTRODUCTION

1.1 Background of the Research Problem

The primary aim of the study was to investigate Sustainable Waste Management (SWM) practices in the informal settlement of Hlalani in the Eastern Cape, Port Elizabeth. According to Nkosi (2015), waste management was primarily focused around the collection, transfer, removal and handling of waste from a service delivery outlook and this was regarded as traditional waste management. Waste management has evolved from the traditional method to a more sustainable mode of managing waste, which involves communities through informal recycling. Moreover, Davies (2009) reiterates that traditional waste management was subject to local government policy frameworks that were concerned with the collection and disposal of waste without managing the waste from the source. However, this management style resulted in increased generation of waste more especially in urban areas (Moiloa, 2007). This nature of managing waste was highly governmental with less communal involvement. Furthermore, the traditional waste management approach was associated with various environmental and social difficulties such as illegal dumping and the spread of diseases. Therefore, a paradigm shift was needed to a more organized manner of managing waste, founded on modern engineering and technical administration to combat excessive waste generation.

According to Henry et al (2006), Sustainable development emerged during the Earth Summit in 1992 and brought along the pursuit of measures to redress past failures contained in the traditional waste management paradigm that led to the birth of the SWM approach. Sustainable development requires the control of the environment and its subsequent resources to safeguard the needs of forthcoming generations. Furthermore, SWM is a strategy to manage waste from the source and in an environmentally friendly manner (Karani and Jewasikiewitz, 2007). Therefore, SWM is focused around the proficient utilization of material assets to eliminate the quantity of waste created and where it cannot be eliminated, handling it to effectively add to the financial, social and natural objectives of sustainable development (Tembon, 2012). Central to the advancement of SWM is the view that waste ought to be handled as high up as possible in the waste hierarchy. Arguably, all waste disposal practices affect the environment, thus preventing waste from the source is the only way to ensure that no waste is generated. In South Africa (SA), the National Waste Management Strategy (NWMS) was established to address the different challenges the country is confronting in terms of the management of waste. This system expresses that waste should be overseen in a social, financial and environmentally reasonable way (Henry et al, 2006). How SWM can advance waste management on the ground

level is one of the questions the study seeks to answer. The study evaluated the effectiveness of SWM practices in one of the informal settlements in the greater Nelson Mandela Bay Municipality (NMBM) area and whether its implementation is as glorious as the concept.

1.2 Statement of the Research Problem

There has been an increase in the use of resources due to fast population expansion and this has brought about a proliferation of waste generated (Tembon, 2012). The incorporation of sustainable waste management ideas in dealing with waste management issues in informal settlements is a major challenge that faces several municipalities in post-apartheid South Africa. There is also a lack of robust funding for this kind of research. This despite waste nuisance from the dumping of waste increasingly becoming one of the foremost environmental issues besetting these areas, especially in rapidly growing cities. According to Maluleke (2014), there is a rise in Municipal Solid Waste (MSW) to the already limited landfill site as industrial development surges due to urbanization. In response to this problem, Sustainable Waste Management (SWM) which is a strategy to manage waste from the source and in an environmentally friendly manner, was introduced to combat excessive waste generation (Karani and Jewasikiewitz, 2007).The state of waste management in the area or lack thereof is the reason why the study area has been chosen. Literature has shown that the state of waste management in other informal settlements has improved with the effective implementation of sustainable waste management practices. Thus, this study investigated the Sustainable Waste Management (SWM) practices in the informal settlement of Hlalani, in Port Elizabeth, Eastern Cape.

1.3 Rationale

The rationale of strong waste management implementation is principally built around the premise that everyone creates waste and might be influenced promptly if waste isn't appropriately administered (Maluleke, 2014). Waste can be hazardous to the public and the surrounding environment if not effectively managed. Inadequate waste management can also have a detrimental effect on groundwater (Tembon, 2012). Karani and Jewasikiewitz (2007) note that it is evident that communities need to be engaged in the management of waste projects for rational and efficient waste practices. On the contrary, waste can also be a valuable resource that can be recycled and create employment opportunities that can contribute to poverty relief. According to Henry et al (2006), waste management has received great attention over the years and is central to environmental policies in various countries including South Africa.

1.4 Aims and Objectives of the Research

The main aim of the study was to investigate Sustainable Waste Management practices and how they can be used to address solid waste problems in informal settlements. To achieve the main aim of the research, the following objectives were employed in the study:

- To identify various waste management plans and practices in the area.
- To find out if the above plans, if any exist, adhere to principles of the waste management hierarchy provided in terms of NEMA: Waste Management Act.
- If no waste management plans exist, to find out whether the city council has future strategies to deal with waste in Hlalani and surrounding settlements.
- To provide recommendations on how waste management plans can improve to benefit the community and the environment.

1.5 Research Questions

- Does the NMBM have a MSWM plan for the Hlalani Informal Settlement?
- If there is a MSWM plan for the area, does it promote Sustainable Waste Management or adhere to principles provided in NEMA?
- How can the residents of Hlalani be incorporated into the management of waste?

1.6 Location of the Study Area

1.6.1 The study Area

The study area is in the Hlalani informal settlement of the greater Motherwell Township of the NMBM. Hlalani informal settlement is situated in the north of Motherwell (Department of Social Development, 2008). Motherwell is a township situated 18 kilometres outside of the NMBM at GPS coordinates 33.8021 S, 25.5895 E (NMBM, 2009). Motherwell has 12 units with various informal settlements in between and its areal extent is about 92 km2 (NMBM, 2009).

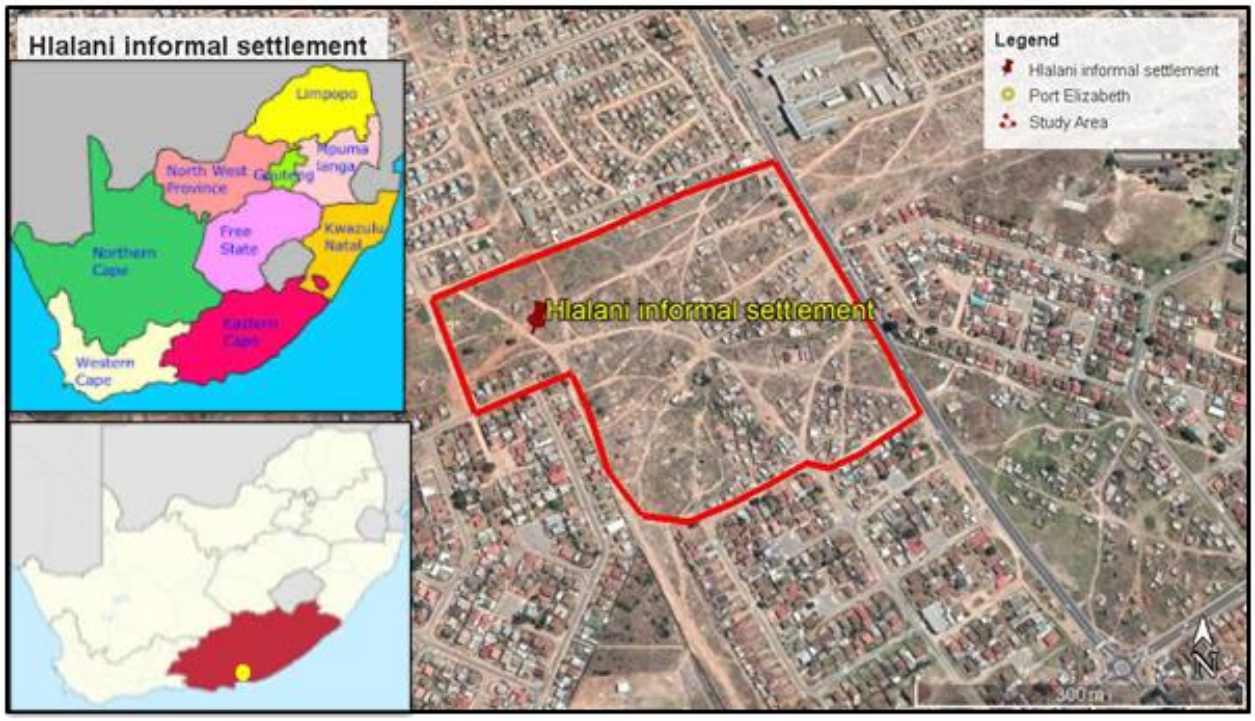

Figure 1.1: Hlalani informal settlement in the Motherwell township (Modified and redrawn from Google Earth, 2017).

1.6.2 Population of the Study Area

In 2008, the population of Motherwell was about 175 748 people (Department of Social Development, 2008). Motherwell varies from low-cost government households to informal settlements, while a 3rd of households (32%) reside in informal residences (NMBM, 2009). The north east part of Motherwell where Hlalani informal settlement lies is impoverished with hardly any proper infrastructure. According to the Department of Social Development (2008), the majority of the population (80%) in Hlalani is unemployed and only about 20% of the population have some form of employment. The residents in the area are black and the majority of the unemployed individuals practice a range of informal commercial activities such as small-scale carpentry, shoe repairs and manufacturing of gates (Department of Social Development, 2008). It can be gathered from the above-mentioned activities that various types of waste will be generated in the area apart from domestic refuse.

1.7 Significance of the Study

The Bill on National Integrated Waste Management was drafted in 2000, hence the need for associated issues to be addressed. The study is essential to address waste management in the area under investigation. This study could contribute meaningfully to improve waste management services and improve the living conditions of communities that were previously ineffectively serviced. Furthermore, the study will improve public awareness about the value

of effective MSWM. The effective application of waste prevention and reduction will improve relations between the private and public sectors.

1.8 Delineation of the Study

The research will be limited to the Hlalani informal settlement in the Motherwell area which is located within the NMBM in the Eastern Cape. The starting point for this study will be the evaluation of MSWM to improve ecological conditions concerning to waste in the area. Thus, the study will be limited to the assessment of MSWM in curbing unlawful discarding as an environmental problem.

1.9 Outline

Chapter 1 introduced and described the purpose of the research while also presenting the research questions. The second chapter is a review of research published by other authors on waste management. Chapter 3 of the dissertation will look at the methodologies used to answer the research questions. The data is presented and analysed in Chapter 4. Chapter 5 discusses the research findings while deducing them according to the study's research questions. Chapter 6 will reflect on the study and draw out conclusions which also includes some recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The purpose of Sustainable waste management is to diminish the consumption of natural resources by ensuring that resources extracted from the environment are recycled while the volume of waste produced is retained to a minimum and treated in an environmentally safe way. The policies put in place by the previous government sidelined black people, which has influenced the establishment of informal settlements in the country (Tshikotshi, 2009). The change in power in the year 1994 brought along fresh economic prospects leading to the relocation of society to urban areas in search of a better life. However, the majority of these individuals had no adequate shelter or other necessities and the democratic government, which had just come into power, was not established to deal with the housing catastrophe (Nkosi, 2015). Subsequently, these individuals end up establishing informal housing structures in areas that are excessively populated and without any municipal services. Pollution and the depletion of non-replenishable natural resources are some of the major issues facing South Africa. According to Tshikotshi (2009), industrial advancement and rapid population growth have caused an increase in the use of natural resources which has resulted in more waste being generated. The government has developed strategies in an attempt to address this problem to ensure environmental protection. These strategies seek to allow organizations such as municipalities that are entrusted with waste disposal to manage their waste accordingly (Nkosi, 2015). The Government is faced with a significant predicament and responsibility to manage waste in the new millennium. A significant challenge presented by a rise in the quantity of waste is the obligation to prioritize public health (Chisadza, 2015). It is essential to discover substitute approaches to managing waste to reduce waste disposed to landfills since accessible land for disposal is shrinking as a result of the growing urban population. There has been an adjustment in waste management approaches to more sustainable alternatives to safeguard sustainability (Nkosi, 2015). Around the globe, several waste management alternative approaches have been established with developed countries promoting social changes directed towards environmental conservation since they have moved beyond meeting the basic waste management needs. According to Tshikotshi (2009), waste management has been governed by several changes in legislation that are intended to guarantee the sustainable management of waste and to preserve the surroundings for the next generation. Hence there is a paradigm shift to a sustainable manner of managing waste to realize waste management targets (Chisadza, 2015). South Africa has taken extensive strides towards advanced waste management through

the formulation of guidelines and legislation in the past few years. The announcement of the National Environmental Management: Waste Act (59 of 2008) which has been revised from the 2011 national Waste management plan signalled South Africa's transition towards sustainable waste management (NMBM, 2009). Local governments are obligated to manage waste to guard human and environmental health under schedule 5B of the constitution of South Africa (Act 108 of 1996). Therefore, waste policies and plans are fundamentally implemented at a local level. As a result, waste designs must receive significant attention at this level as per requirements.

Primarily, the study reviewed literature on solid waste management giving precise devotion to waste management approaches that have been employed to try and combat issues associated with waste in informal settlements. Literature has recognized assorted variety in the manner in which waste is managed in developed and developing countries. Human wellbeing is no longer a momentous catalyst for waste management in most developed countries, the emphasis is on the maximization of waste management practices with an extensive goal of resource preservation (Henry et al, 2006). On the contrary, the administration of waste in third world countries is routinely described by insufficient service inclusion, inadequate operational aspects of administration, restricted usage of recycling practices and deficient landfill disposal (Zurbrugg, 2003). Subsequently, literature on sustainable waste management was reviewed where an unblemished understanding of the concept of Sustainable Development and SWM as a pivotal component in dealing with waste in an eco-friendly mode is provided. The foundation for sustainable waste management in South Africa was laid by the White Paper on Integrated Pollution and Waste Management. This section also provides an unblemished understanding of the pros and cons of the waste hierarchy which is a sustainable waste management approach. Moreover, literature on the principles of sustainable waste management was reviewed. Furthermore, the study compared the sustainable waste management model to the traditional method of handling waste as well as statutes moderating waste in South Africa. Moreover, there is an assessment of the regulation of waste in South Africa with particular reference to the development of waste management legislation in the country. There is also a review of literature on Waste Management Plans which provide the foundation required to attain sustainable waste management. A review of literature that focuses on both national and international knowledge in waste management around the globe also takes place. Finally, there is a review of literature that investigated the problems that arise when municipalities do not have SWM strategies for informal settlements. The notion was to highlight the importance of SWM as an approach to address environmental and general well-being issues facing the country.

2.2 Solid Waste Management

Solid waste management is a significant issue globally in terms of the amount of waste generated due to a change in human lifestyles. Dlamini (2017) states that population growth, economic advancement and human civilization are the premier contributors of waste at present. According to Mohee and Simelane (2015), the environmental impacts related to ill-advised waste management that leads to degradation and the discharge of harmful emissions is becoming a growing concern. Developed countries are frontrunners in the administration of solid waste as they have made solid waste management a priority through the formation of guidelines and sustainable processes regarding the use of solid waste (Khateeb et al., 2011). Monitoring instruments that promote solid waste management have been implemented in developed countries. Hence, vast amounts of wastes are managed in separate ways in harmony with the physical characteristics of the waste generated.

Waste is managed in different ways due to the variation of the physical characteristics of the waste which is generated. Tsydenova et al. (2018) note that the composition of waste in urbanized countries tends to be made up of biodegradable materials. This is down to the simple fact that society tends to prefer packaged products in contrast to developing countries where dependence is high on subsistence farming with restricted post-harvesting and processing of food. Moreover, societies in developing countries lean more towards buying raw material and depending on imported goods thus increasing the fraction of organic wastes (Abdel-Shafy and Mansour, 2018).

Several waste management practices exist in different countries around the world. According to Mohee and Simelane (2015), proper composting, recycling, waste-to-energy technologies and sanitary landfilling for the ultimate disposal of wastes are some of the best practices available. However, cities without adequate means of waste management practices suffer continuously from the indiscriminate dumping of waste and this is intensified by negative demeanours about safe disposal (Gumbi, 2015). Various factors impede positive attitudes in waste management such as insufficient recycling, inadequate waste disposal facilities and the general mistrust residents have in local government officials (Dlamini, 2017). Khateeb et al. (2011) stress that countries with improved waste management practices and infrastructure still face challenges which include the recycling of products that are not recyclables and insufficient waste sorting and recycling.

Solid waste management is one of the methods used for pollution control, however, it comes with various drawbacks just like all the others (Naidoo, 2009). According to Ruhiiga (2014), various pollution control measures have been tried and are available to ease pressure on natural

systems. The natural effects affiliated with waste disposal undertakings are of great concern in the management of solid waste both directly and indirectly. The geographical positions of waste sites are of great significance as they determine the magnitude to which health and the natural setting will be affected (Ruhiiga, 2014). Nkosi (2015) maintains that waste extensively dumped in an environmental media can result in releases of contaminants and possible unfavourable impacts on wellbeing and nature.

Effective solid waste management must be sustainable both ecologically and economically. According to Nkosi (2015), environmentally sustainable solid waste management must extensively decrease the ecological effects of waste including energy consumption, loss of amenity and pollution. On the other hand, economically sustainable solid waste management must function at a cost satisfactory to the community and this includes government, businesses and private citizens (Ruhiiga, 2014). Khateeb (2011) concurs that the operational costs of a powerful strong waste administration framework are subject to existing infrastructure. Bhagwandin (2013) argued that it is virtually impossible to achieve environmental and economic sustainability simultaneously. Therefore, a state of equilibrium must be reached to cut the cumulative natural effects of the waste management framework beyond what many would consider possible inside an appropriate level of expense (Naidoo, 2009). Waste Management (WM) provides practical, operational and ground-breaking solutions to many modern waste issues and is a swiftly evolving multi-disciplinary applied science (Zurbrugg, 2003). Nkosi (2015) outlines that dealing comprehensively with the various factors associated with the management of waste as well as having contributions from a team with general field knowledge is essential. According to Bhagwandin (2013), the aim of waste management is to re-introduce waste back into the environment responsibly.

2.2.1 Liquid Waste Management

According to Pradhikaran (2012), liquid waste is unwanted water such as regular storm water and water polluted by human sources and animals. The contamination of the soil, groundwater and surface water which results in health complications is often caused in part by the inadequate disposal of wastewater (Alemayehu, 2004). Demirbas (2001) notes that in developing countries, wastewater was allowed to drain to the side of the road and thus join small watercourses that flow downstream causing water pollution. Sewage, industrial waste and hazardous liquid waste are the three main divisions of liquid waste (DSEWPC, 2012). Nduthu (2016) highlights that sewage is the principal type of liquid waste that is produced from households. However, other volumes of both harmful and harmless liquid waste can also be produced in households. According to Brice et al. (2006), the disposal of household chemicals such as oils, paints,

pesticides and flammable liquids is the source of hazardous liquid waste generation. Households have also been accredited with the release of liquids within solid food waste or liquid waste foodstuffs such as milk (DSEWPC, 2012). Hatton (2002) emphasizes that most food waste is liable to decay thus producing leachate as it decomposes, however, there is great variety in the liquid content of spoilt solid foodstuffs.

Residents in informal settlements reside in atrocious conditions characterized by a lack of basic services such as sewage systems, water supply and drainage systems (Mswani, 2010). According to Sverdlik (2011), informal households are prone to significant environmental and public health issues. This is due to the congested nature of these informal structures and inadequate sanitation facilities. This is particularly alarming as public health is predominantly compromised since these informal settlements depend on pit latrines as a mode of sanitation (Gudda et al., 2019). DSEWPC (2012) stresses that pit latrines pose a serious health hazard when densities exceed 100- 150 per 10 000 square metres. Domestic activities such as laundry, cooking and sludge irregularly discharged on site may result in liquid waste in the absence of sewage systems.

2.2.2 Gaseous Waste Management

Gadani and Vyas (2011) highlight that chlorofluorocarbons which are greenhouse gases, oxides of carbon, methane, carbon monoxide and oxides of nitrogen are all gaseous wastes. The atmosphere is saturated with gaseous wastes as a result of a rise in factories and trade areas. According to Najjar (2011), the burning of fossil fuels such as coal, gas, oil and wood has a noteworthy effect on the environment. Humans across the globe die annually due to heart and lung diseases from air pollution (Ghorani-Azam et al., 2016). Vekemans and Chaouki (2016) stress that incinerators and electric power plants emit several harmful gases during the burning of fossil fuels which make up 85% of the world's energy. Fog, smog and global warming are formed from the burning of fossil fuels which results in the detriment of natural resources and human health (Najjar, 2011). On peaceful summer days, the dark yellow clouds that accumulate in a big mass of stagnant air while hanging over densely populated areas are termed urban smog (Elsom, 2014). According to Nel (2005), ground-level ozone predominantly makes up smog even though several other synthetic concoctions like carbon monoxide, particulate matter and unstable organic mixtures are present. Ground-level ozone is a contaminant that causes many harmful public health issues and should not be misunderstood for the ozone layer which protects the earth against ultraviolet radiation. Automobiles are the main sources of hydrocarbons and nitrogen oxides. In the presence of the sun on warm summer days, nitrogen oxides and hydrocarbons react to produce ground-level zone (Najjar, 2011). Insignificant amounts of

Sulphur and different other chemicals combine to form fossil fuels. Gadani and Vyas (2011) state that sulphur dioxide which is an air pollutant is formed when sulphur in fuel reacts with oxygen. According to Nel (2005), electric power plants burning high sulphur content coal are the primary source of SO^2. Since small amounts of sulphur are contained in gasoline and diesel, automobiles also contribute to SO^2. Ghorani-Azam et al. (2016) highlight that sulphuric and nitric acids are formed when sulphur and nitric oxides react with water vapour and other chemicals in the sky when it is sunny. Generally, these acids break down in the suspended water beads in the clouds. Moreover, these droplets which are overloaded with acids are washed from the air to the topsoil by precipitation and known as acid rain (Najjar, 2011). According to Vekemans and Chaouki (2016), acid rain renders habitats uninhabitable for plants and animals by altering the composition of soil and water bodies. The burning of municipal waste and refining activities are other means by which sulphur compounds may enter the atmosphere.

2.3 Theory of Sustainable Waste Management

Sustainable development in South Africa is designed at harmonizing the extensive financial and social difficulties of an emerging and inconsistent society guarding ecological capitals. According to Lidster Corporation (2005), "SWM is the use of resource material efficiently to cut down on the amount of waste produced and where waste is generated, deal with it in a manner that actively contributes to the economic, social and environmental goals of sustainable development". DEA (2012) states the waste hierarchy underpins the theoretical outlook to waste management which was inserted into the Country's waste management policy via the White Paper on Integrated Pollution and Waste Management. According to Gupta and Dangayach (2015), the White Paper on Integrated Pollution and Waste Management symbolized a paradigm shift from generating waste and then dealing with it after to waste avoidance. The Waste Management Hierarchy is a strategy to regulate waste more sustainably. The goal is to create zero waste where conceivable, where waste can't be dodged, it is limited with the goal that minimal measure of waste is sent for transfer to a landfill (Lidster Corporation,2005). The lawful directive for the effective operation of the waste hierarchy is provided by the National Environmental Management: Waste Act (Act No. 59, 2008) by providing supplementary measures to protect human wellbeing and the natural setting (Muzenda, 2014). According to Toffel et al (2008) extended producer responsibility in terms of design, composition or packaging is encouraged through the implementation of the hierarchy. Furthermore, there are measures included to encourage clean production, regulation of the volume and composition of packaging together with the duty to ensure that the design of packaged products can be re-used and recycled to promote the concept of cradle to cradle (DEA,2012). According to Muzenda (2014), when a product concludes its lifespan, its elements

are recuperated, re-claimed and recycled thus contributing to the formation of new products under the cradle to cradle management approach. The cycle is rehashed until the least conceivable part of the first product is ultimately discarded (Figure 2.2). On the other hand, the cradle to grave method focused on producer responsibility for the full duration of the product's lifecycle until disposal (DEA, 2012).

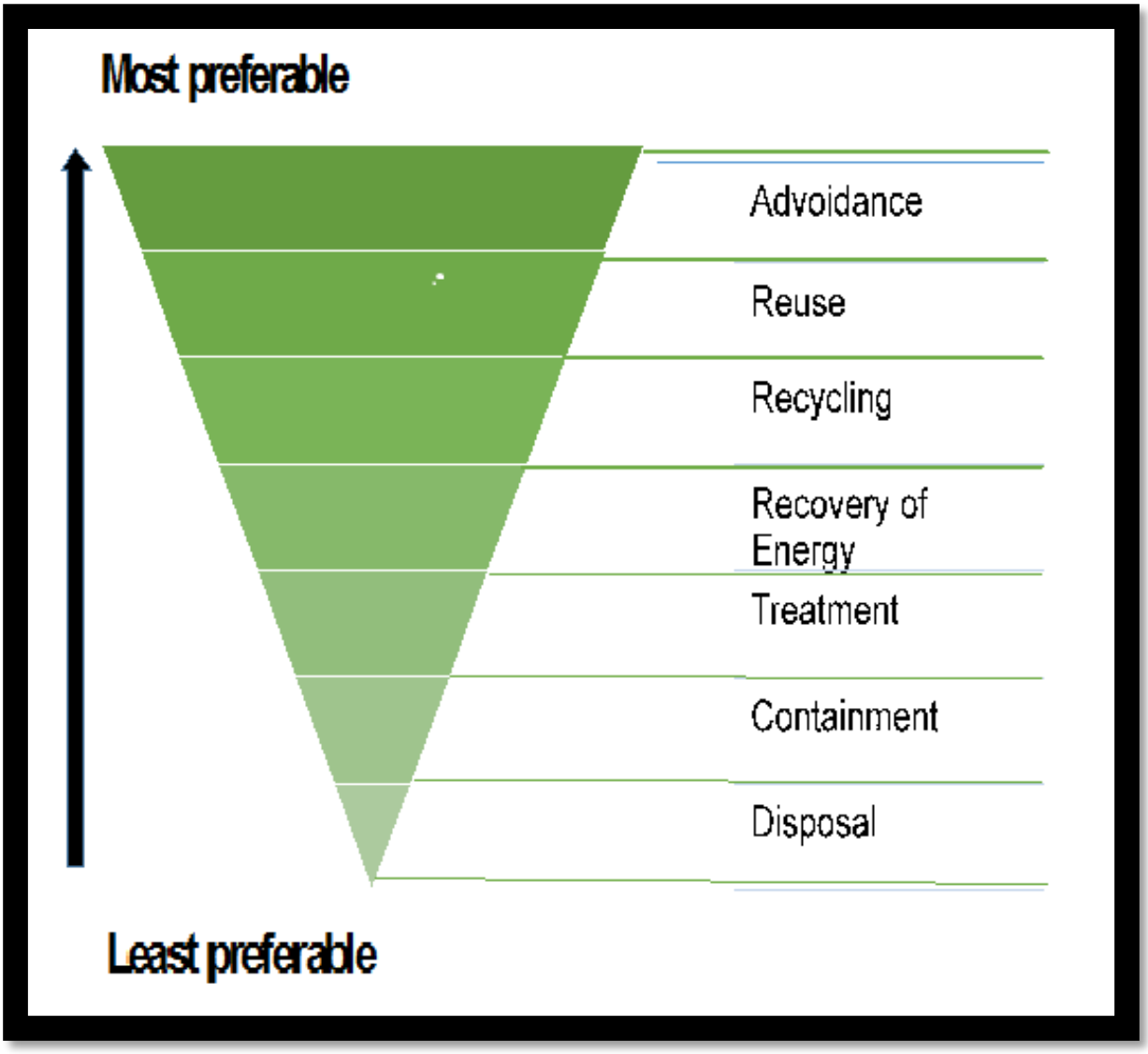

Figure 2.2: Waste Management Hierarchy Redrawn (Nkosi, 2015).

2.3.1 Pros of the Waste Hierarchy

2.3.1.1 Avoidance: The waste hierarchy starts with the most alluring and moves to the least positive option. The principle need is evading and decreasing the production of waste which inspires the public and industries to moderate the sum of virgin materials mined (Gupta and Dangayach, 2015). Avoidance and reduction which are the most supported measures in the management of waste structure the root of the hierarchy. One of the key ideologies vital for sustainable waste management is to manage waste as high up the waste hierarchy as possible

(Akkucuk, 2015). Moreover, Akkucuk (2015) states that all waste removal substitutes have some sort of effect on nature and the best way to avert these is by not generating waste, hence waste avoidance is the highest order of the hierarchy.

2.3.1.2 Reuse: According to Abdul-Rahman and Wright (2014), where avoiding and decreasing waste is beyond the realm of imagination, the subsequent favoured alternative is to re-use the materials moving along without any more handling, staying away from the costs of imperativeness and various resources essential for reusing. The reuse of material results in less demand for virgin material and curbs the pollution of air, water and land while providing an environmentally friendly mode of managing waste (DEA,2012).

2.3.1.3 Recycling: Gupta and Dangayach (2015) highlight that where material cannot be reused, recycling is the next port of call in the hierarchy. According to Akkucuk (2015), the recycling of material moderates the utilization of energy and slows down the depletion of raw materials.

2.3.1.4 Recovery of Energy: Bukhari et al (2018) state the recovery of energy complement's recycling by diverting the valuable post use of material from landfills. Moreover, Abdul-Rahman and Wright (2014) stress that energy recuperation sites can decrease the capacity of waste that goes to the landfill.

2.3.1.5 Treatment: The physical properties of waste are changed to minimize the environmental impact of waste while destroying toxic components of waste (DEA, 2012).

2.3.1.6 Containment: According to the National Research Council (2007), containment is when there is an engineered soil layer known as a liner on which the waste is disposed of. These liners are manufactured such that the contaminants leaching out percolate at a very slow rate (Wuana and Okieimen, 2011). Furthermore, liners are soil layers that come with specific desirable properties meeting the regulations for pollution control (Fuller,2018).

2.3.1.7 Disposal: The waste hierarchy acknowledges that it is impossible to securely reuse certain forms of waste, for example, hazardous synthetics or asbestos and that disposal is the most advisable management alternative (EPA, 2015). The South African waste bill is illuminated by the fundamental components of the waste hierarchy which directs the general key strategy for waste management (DEA, 2012).

2.3.2 Cons of the Waste Hierarchy

2.3.2.1 Avoidance: Preventing waste from being generated means landfilling will not be required. Van Ewijk and Stegemann (2016) maintains the kind of prevention and recycling determines the legitimacy of the hierarchy insofar as the saving of materials.

2.3.2.2 Reuse: Gharfalkar et al (2015) highlight the whole product is prevented from ending up at the landfill site through the reuse of materials that excludes repair waste.

2.3.2.3 Recycling: Abdel-Shafy and Mansour (2018) sustain that recycling only reduces landfill of the processing wastes. A product can be reproduced on several occasions with raw materials only suffering for process waste in the closed loop of recycling (Asif et al, 2012). However, Van Ewijk and Stegemann (2016) states that materials travel from one product life cycle to the next, perhaps triggering significant natural effects past the first item life cycle in closed-loop recycling.

2.3.2.4 Recovery of Energy: Recovery via incineration reduces landfilling of the subsequent ashes (Abdel-Shafy and Mansour,2018).

2.3.2.5 Treatment: According to DEA (2012), the treatment of waste which contains changing the physical properties to destroy toxic components in the waste can be an expensive exercise and thus a challenge for developing countries.

2.3.2.6 Containment: Developing countries may find it difficult for financial reasons to engineer a liner which is a soil layer onto which the waste is disposed of (Wuana and Okieimen, 2011). According to the National Research Council (2007), most developing countries lack regulations for efficient waste management due to weak governance especially in Africa.

2.3.2.7 Disposal: According to Wuana and Okieimen (2011), waste that is disposed of at a landfill may take years before decomposing naturally which may promote the spread of disease. Moreover, efficient landfills require proper planning and operation which may be expensive.

According to Van Ewijk, and Stegemann (2016), other issues with the waste hierarchy include a limited depiction and usage of counteractive action, missing guidelines for choosing among the orders of the hierarchy and the indistinctness concerning open and closed-loop recycling. Moreover, the waste hierarchy just addresses individual needs and does not back choices that influence different divisions (Gharfalkar et al, 2015). The waste hierarchy is exclusively revolved around waste while barring material inputs and financial yields (Van Ewijk and Stegemann, 2016). The life cycle analysis identifies that the waste hierarchy does not hold

particular materials such as biodegradable waste (Heller,2019). In the hierarchy, the regulation of essential material input relies on the highest order of prevention evading essential data sources superior to reuse, recycling and recovery.

2.4 Principles of Sustainable Waste Management

The notion of sustainable development and the term "sustainability" have been increasingly gaining acknowledgment as of late all around the globe (Ben-Eli, 2006). Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). On the other hand, Sustainability can be defined as "a dynamic equilibrium in the processes of interaction between a population and the carrying capacity of an environment such that the population develops to express its full potential without adversely and irreversibly affecting the carrying capacity of the environment upon which it depends" (Ben-Eli, 2006). According to the DEA (2007), the following are Sustainable Waste Management principles that help promote the concept of Sustainable Development.

2.4.1 Polluter Pays Principle: Expresses that whoever is accountable for harm to the environment should endure the costs related (Cordato, 2001). This guideline does not just offer a sound way for managing the individuals who contaminate but is an augmentation of one of the most essential standards of decency and equity. Civilians ought to be considered responsible for their activities and the individuals who cause harm to other individuals or the earth should "pay" for that harm (Cordato, 2001). This appeal to our rationale is the cause of why the principle has come to resound so intensely with both decision-makers and the civilians at large.

2.4.2 Precautionary Principle: Where there is a vulnerability with regards to the presence or the degree of danger to human wellbeing, defensive measures might be taken without delaying until the magnitude of the danger becomes visible (De Sadeleer, 2007). The principle is used by decision-makers to approve optional choices in conditions where there is the likelihood of mischief from settling on a specific choice when across the board consistent comprehension regarding the matter is deficient (Ben-Eli, 2006). Hence, the principle highlights that policymakers have a social obligation to safeguard the general population from any danger when scientific studies have discovered sensible dangers (De Sadeleer, 2007).

2.4.3 Product-Stewardship Principle: This is a product-focused strategy to deal with an ecological assurance that approaches role players in the product life cycle, for example, makers, sellers, clients to split the duties in terms of decreasing the environmental effects of an item (Rose and Cohrssen, 2011). Producers are obligated to prepare for and if necessary, pay for

reusing or disposal of the item after its lifespan. This might be feasible through overhauling products to utilize less hurtful substances, to be progressively strong, reusable and recyclable so that products can be invented from reused material (Lewis, 2006). Rose and Cohrssen (2011), states that retailers and consumers also have to take a functioning part in guaranteeing appropriate disposal or reuse of a product at the end of its lifespan.

2.4.4 Waste Auditing: A waste audit is an analysis of a localized waste stream from a building, household or town (Lewis, 2006). Waste audits provide more individualized attention to waste generators than meetings. Audits provide the necessary information and encouragement needed by generators to better manage their waste (Schwartz and Pratt, 1990). Furthermore, audits identify existing problem areas as well as new opportunities for recycling. Therefore, results from a waste audit enable decision-makers to plan the most efficient methods for handling waste (Goswami and Pati, 2012). When waste is managed efficiently, less is produced, thus less will go to the landfill for disposal. Moreover, audits also launch baseline practices and waste volumes, making it easier to measure progress going forward (Lewis, 2006).

2.5 Sustainable Waste Management versus Traditional Waste Management

An ecologically adequate manner of overseeing metropolitan waste has turned into a worldwide test because of scarce resources, expanding population, urbanization and industrialization (Pokhrel and Viraraghavan, 2005). Sustainable Waste Management has proven to be the most appropriate way to handle waste compared to the mainstream which is considered to be largely unsustainable (Lewis, 2006). Sustainable Waste Management is characterized by changes in perceptions and public participation. According to Puling (2004), public participation and environmental awareness campaigns are subject to one another because the accomplishments of the campaigns depends on the willingness of the public to take part completely to the belief systems featuring in such exercises. Moreover, public support assumes a noteworthy function in the management of waste and co-accountability in safeguarding a hygienic environmental setting (Pokhrel and Viraraghavan, 2005). Communal interest in waste management involves public engagement in exercises such as waste campaigns, recycling ventures and establishment of associations that are headed by the community intended to keep the environment in its pristine state (Puling, 2004). Engaging the community about waste issues and making them an important part of waste management may inspire them to change their negative attitudes (Pokhrel and Viraraghavan, 2005). This will ultimately require them to liaise and assume a positive position in waste management. According to Goswami and Pati (2012), changes in perceptions have also proven invaluable in sustainable waste management as the focus is on reducing waste from the source. The most appropriate manner to minimize waste is to reduce

it from the source (Ben-Eli, 2006). Nkosi (2015) states it is wise to avert waste from being generated than having to administer at a later stage. When waste is managed efficiently, less is produced, thus less will go to the landfill for disposal (Goswami and Pati, 2012).

On the contrary, the traditional manner of handling waste which is synonymous with creating waste and handling it after is characterized by various environmental risks (Puling, 2004). Communities often resort to waste disposal methods that have proven to be damaging to human health and the environment at large such as open dumping and burning (Schwartz and Pratt, 1990). According to Pokhrel and Viraraghavan (2005), landfilling is an unsustainable waste management option owing to the loss of potential resources that could be reclaimed from the waste stream for recycling. Apart from the loss of resources, continued landfilling eventually leads to the loss of space, the risk of groundwater contamination and greenhouse gas emissions (Lewis, 2006). Moreover, the disposal of inert wastes at sea is another form of unsustainable waste management as it has negative impacts on the marine environment. The traditional method of handling waste is focused on disposal and the communities are not involved in solid waste decision making processes or the solid waste management system (Goswami and Pati, 2012). Rose and Cohrssen (2011) state that focusing on waste disposal is problematic in the sense that leachate may be produced as waste decomposes resulting in pollution. It is fundamental to prevent waste from being generated as opposed to disposing and regulating it thereafter.

2.6 Legislation governing waste in South Africa

The Rio Declaration and chapters 21 & 23 of Agenda 21 respectively is where environmentally sound technologies were first introduced to combat challenges related to waste management (Nkosi, 2015). The United Nations Millennium summit in 2000 built up to eight Millennium Development Goals (MDG's) that were proposed to be accomplished by 2015(Goswami and Pati, 2012). Goal 7 was proposed to guarantee natural manageability and empower the consolidation of sustainable development standards into strategies and projects to counter the destruction of natural resources. The Constitution of South Africa, Act 108 of 1996 provides the base for environmental guidelines and approaches in South Africa (NWMS, 2011). According to Section 24 of the Bill of rights (Constitution, 1996) “citizens have a right to an environment that is not harmful to their health or wellbeing and to have the environment protected through reasonable legislative measures”. South Africa’s legislation is supportive of the application of the MDG’s and aims to give successful and productive services to manage waste. Moreover, all legislations in the country need to be allied with the constitution as it is the supreme law in South Africa (Nkosi, 2015). Waste collection and disposal are designated

in part B of schedule 5 of the Constitution as a function of the local government. The principles that govern the control of pollution including the polluter pays, which emphasizes the necessity to take action against individuals that pollute the environment, are included in the National Environmental Management Act (NEMA, no 107 of 1998) (Goswami and Pati, 2012). The life-cycle technique, producer responsibility, precautionary principle and the polluter pays principle represent a portion of the administrative standards brought by NEMA into the South African environmental legislature. Section 28 of NEMA places a duty of care "on any persons who may cause significant pollution or degradation of the environment, requiring them to institute measures to either prevent pollution from occurring or to minimize and rectify the pollution or degradation where it cannot reasonably be avoided" (Nkosi, 2015). Moreover, instruments for integrated waste management are provided in Chapter 5. The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) bolsters the obligation of duty of care by compelling producers of waste to undertake sensible measures to apply the waste management hierarchy (Nkosi, 2015). Regions are requested by the Department of Environmental Affairs and Tourism to formulate waste management plans to regulate and reduce waste in the areas under their control. These waste plans ought to incorporate public awareness, the establishment of waste collection services and administration of disposal sites and the use of valid waste minimization dynamism (Goswami and Pati, 2012). The Waste Act of 2008 ensures that South Africa has an integrated approach to synchronize the management of waste in the country. The waste management hierarchy is adopted in the Waste Act as it exhorts a decrease of waste entering the system and deems disposal as the least favoured option. Moreover, through the supply of supplementary measures to redress polluted land and protect the environment, the Act forms a judicial directive for the employment of the waste hierarchy founded from the National Waste Management Strategy (Waste Act, 2008). Therefore, minimal requisites for waste production, control and refining of authorizations for waste management undertakings have been set by the Act. Moreover, the waste act has a legislative requirement alluded to as the National Waste Management Strategy (NWMS) which pursues to accomplish the aims of the act, characterize its scope and identify its contents (Nkosi, 2015). Thus, structures of the government and affected persons are compelled to give effect to the NWMS.

The strategy affords a blueprint to provide concrete results to the Waste Act and as such strives to warrantee that accountability for waste management is appropriately allocated. The purpose of the NWMS is to restore the past disparities in waste management such as issuing a waste license to a proposed landfill site inside a certain radius of informal settlements (Goswami and Pati, 2012).

2.7 Waste Management Plans

A waste management plan is a record that contains information on present waste production and management approaches for plummeting waste quantities and destruction (Björklund et al, 1999). Waste Management Plans provide the foundation required to attain sustainable waste management. Furthermore, these plans are designed to guarantee that operative procedure is employed for the management, storage, shipping and removal of waste that is produced from undertakings on site. According to NWMS (2011), in the past, waste management in the country was fragmented leading to gaps and inadequate waste management practices. There were several pieces of legislation governed by independent government departments. Björklund et al (1999), notes that the consolidation came in the form of the waste act as it brought about common goals and objectives for managing waste. The three spheres of government must follow the waste hierarchy in developing waste management plans. Back in the day, various municipalities and provinces inaugurated first-generation waste management plans in honour of the National Waste Management Strategy. However, these were on a voluntary basis and thus not mandatory. That could have been the explanation for their limited success as far as implementation is concerned. According to DEA (2007), waste management plans are at present stipulated in the waste act and thus a mandatory requirement. Local authorities are mandated to incorporate their waste management plans into integrated Development Plans under the waste act. Moreover, NWMS (2011) highlights that this is to guarantee that waste management services are up to date with other important basic services such as hygiene and energy. Moreover, this will ensure that equitable funding is set aside for waste management. Subsequently, waste services are budgeted to ensure the sustainability of waste management services. Björklund et al (1999) point out that a municipality needs to determine the currently available financial and human resources required to deliver the municipality's mandate for a successful waste management plan to be implemented.

2.8 History of Waste Management

The desire to guard general health most proficiently fashion and the preservation of the world's capital for coming generations has brought about a paradigm shift in the way that waste is being managed around the globe (Chisadza, 2015). Aginam (2002) states that legislation was first introduced in North America and Europe in the 19th century in response to concerns arising from the outbreak of diseases such as cholera. Municipalities were then established to ensure that waste was removed and that public areas were retained refuse free. According to Snyman and Vorster (2011), the late 90s saw new pieces of legislation being introduced to curb excessive dumping and the destruction of natural capital. The change in legislation was because waste management practices focused primarily on collection. Consequently, what is known

today as the refurbishing of waste management in established countries was birthed (Un-habitat, 2010). According to NWMS (2011), the focus was on climate change and limiting emissions of methane gas from landfill sites in developed countries after the Rio Summit. Muthu et al. (2017) define anaerobic decomposition as the breakdown of perishable waste in the absence of air to produces methane gas. Therefore, the focus around legislation switched to diverting biodegradable municipal waste from landfills, setting goals for recycling, fertilizer and reclamation of waste and landfill bans for recyclable waste. Moreover, alterations logistically, geographically and institutionally also played a significant part in dispiriting the disposal of waste to landfills. The majority of low- and middle-income countries are still battling to phase out open dumps and create controlled disposal even though various high-income countries have shifted their heed towards increased waste management innovation (NWMS, 2011). Logic dictates that strategies that have been successful in industrialized countries may not work in emerging countries that are also facing the same challenges. A case in point, waste technologies that have worked in developed countries with moderately dry waste may not be as successful in dealing with waste from developing countries which tends to contain a higher concentration of organic waste known for being wet waste (Romero-Lankao and Dodman, 2011). According to Kumar et al (2017), while dealing with excessive magnitudes of waste and trying to safeguard the environment by utilizing several control measures, knowledge on the most applicable waste management measures have increased in the past few decades.

According to Chisadza (2015), the result has been that societies have gained valuable insight as to what works and what doesn't. However, it is important to highlight that developed countries underwent a development process where their waste management systems at present developed in terms of their weather, societal settings and wealth. Thus, knowledge gained from their outcomes needs to be designed to be applicable in terms of those developing counties that wish to adopt them (Kumar et al, 2017.

According to Pickin and Randell (2017), in Adelaide, widespread environmentally sensible principles have been developed for the state and industries hence waste management processes are technologically sound and well-structured in Australia. Furthermore, industries in the city have thorough technology and this makes for a system of waste collection that is vastly modernized. Annually about 742 000 000 kg's of waste is generated in the city which has a 100 % waste collection coverage (Un-habitat, 2010). Moreover, Adelaide is continuously pushing to phase out the disposal of waste through a mixture of banning particular materials like plastic bags and backing recycling innovation (Un-habitat, 2010).

One of the lessons that can be learnt from Adelaide is that to effect major policies in waste management, gaining top tier governmental backing is essential. According to Romero-Lankao and Dodman (2011), the government plays an essential role by supporting these policies through operative official structures, applicable administrative capacity and economic mechanisms. Communal cognizance and training also add value to obtaining fixed goals of reducing waste (Un-habitat, 2010). The waste management system in the city ensures the operational use of available technologies and integrates additional facets such as reusing and waste reclamation practices.

According to Un-habitat (2010), in 2009, the official figure for the population of Dhaka in Bangladesh was 7 million and the amount of waste produced per year was 1168000000 kg's. Hossain (2008) highlights that Dhaka is among the significantly inhabited cities in the world at 19 178 persons every square kilometre. The city is plagued by poverty and a destitute standard of living (Romero-Lankao and Dodman, 2011). The human development index in Dhaka is 0.543 and the slums in the city are homes to around 3 million people. One of the challenges facing the city is countering the increasing immigration figures which require the development of appropriate infrastructure to meet the growing demand (Klugman, 2011). The waste in these areas is collected through microenterprise service providers which operate on a door to door basis by collecting the waste at selected transfer points (Romero-Lankao and Dodman, 2011). Training on waste management is provided to the micro-enterprises that collect the waste to guarantee they are appropriately positioned with the city's tributary removal system. These chosen collection points are then serviced by the municipality. Un-habitat (2010) states that there are also ward-based schemes which are headed by communities to promote public awareness on waste management and provide instruments to track the progress of the service providers and support in solving challenges. There is also a multifaceted system of informal and formal cohorts in the public and private sectors where waste that is recovered is sold or reused (Hossain, 2008). This is because there are more than 120 000 waste pickers in the community that ensure that recoverable material is retrieved from the waste before disposal. According to Un-habitat (2010), thus Dhaka manages to counter the effects of a growing population which generates a great amount of waste daily.

In Africa government incentives are no longer the motivation for waste management schemes as individual communities have since taken over that role. According to Godfrey (2007), Public participation in waste management schemes is permitted by Non-Governmental Organizations and Community Based Organizations. Abigo (2016) states that large mobile containers located at chosen points along available highways for the storage of municipal waste by the city

institutions in Nigeria. Therefore, the public must work with the government to achieve efficiency which promotes the shared responsibility approach (Un-habitat, 2010). Moreover, waste generators are obligated to dispose of the waste in the containers at the designated points, the municipality to provide dustbins around the city and collected for disposal. Miraftab (2004), highlights that the containers are allocated for destitute communities since they are unable to pay for waste removal services.

In South Africa, communities have commenced the piloting of waste to energy projects. According to Gumbi (2015), the eThekwini municipality extract gas and generate electricity from the Marian Hill and La Mercy landfill sites. Moreover, flaring gas stations have been installed in four of the landfill sites in the Ekurhuleni metropolitan municipality (Mohee and Simelane, 2015). The City of Johannesburg has established the project to be able to generate energy from incineration waste.

2.9 Consequences of not implementing Sustainable Waste Management in Informal Settlements

Informal settlements assume a very significant position in the dumping of waste. According to Garg and Mashilwane (2015), these informal dwellings which are vulnerable to the dumping of waste and littering as a result of the lethargic circumstances that characterize them have no sufficient waste facilities. As opposed to being an irregular occurrence, these structures have since developed into a more permanent fixture in our towns and cities as a result of excessive population growth. Therefore, municipalities have an imperative function in the provision of essential services such as waste collection to the people of South Africa (Karani and Jewasikiewitz, 2007). The manner in which municipalities conduct their tasks legitimately influences the public and the surroundings in which they reside (Garg and Mashilwane, 2015). According to Fakoya (2014), municipalities have the primary responsibility to manage waste in cities around the country to warrant proficient management of municipal solid waste. However, the majority of municipalities do not practice SWM in informal settlements, hence, the lack of basic services such as refuse collection in these areas (Karani and Jewasikiewitz, 2007). According to Mporetji (2008), the increase in informal settlements in developing countries undermines any efforts of dealing with the challenges of service delivery.

2.9.1 Avoidance: According to the Waste Act (2008), if waste is not avoided and is generated instead, there will be a need for it to be handled, transported, treated and disposed of. However, the generation of waste requires launching and employing operational waste management policies to effectively deal with waste so avoidance is the most feasible option. Furthermore, the management of waste is a significant challenge and has impacts on the environment thus

putting a strain on waste management facilities (Liu et al, 2015). Taiwo et al (2016) state the rapid increase in waste as a result of population growth means there is a shortage of appropriate land for disposing of waste. Excessive waste generation from urban expansion and industrial development increases the intricacy of the waste which affects its management (Malinauskaite et al, 2017).

2.9.2 Reuse: According to NWMS (2011) failure to reuse material means products will have to be disposed of and new products have to be manufactured thus mounting the sum of material that needs to be sent to landfills or recycling facilities. Moreover, the extraction of raw material for manufacture causes pollution of the environment and increases the global energy outflows (Khasreen et al,2009). The disposal of waste is considered to be among the factors contributing to the emission of greenhouse gases. If products are not reused, there will be an increase in the number of greenhouse gases at landfill sites and thus an increase in global warming.

2.9.3 Recycling: Thompson et al (2009) state there would be a greater impact on the environment as a result of anthropogenic activities if materials were not recycled. Moreover, there would be a significant demand for raw materials such as forests, metals and crude oil (Younkin and Stopford, 2009). Ancient forests are on the verge of extinction due to the demand for cardboard and paper. According to Vossberg (2012), the manufacturing of products necessitates significant amounts of energy use and chemicals that pollute the environment during the refining and processing of virgin material which causes destroys habitats.

2.9.4 Recovery of Energy: Owusu and Asumadu-Sarkodie (2016) highlight recovery of energy reduces the reliance on fossil fuels by providing an alternative source for manufacturing processes. This approach prevents plastics at the end of their life span from being discarded to a landfill site. The waste that the energy is recovered from would have been disposed of at a landfill or incinerated in traditional institutions used to burn waste (Malinauskaite et al,2017).

2.9.5 Treatment: Khatri and Tyagi (2015) emphasize that the absence of the treatment phase where toxic components of waste are destroyed would lead to the pollution of water, soil and atmosphere and having a significant bearing on the health of the community. Moreover, failure to treat the waste would result in the degradation of valuable land resources and long-term environmental challenges such as soil infertility (Waste Act, 2008).

2.9.6 Containment: Leachate is a product produced when rainwater infiltrates and interacts with waste when it is disposed of on land (El-Salam and Abu-Zuid,2015). The leachate permeates through the soil and reaches groundwater over a certain time. According to Brice et al (2006), containment liners at landfill sites reduce the volume of the contaminants leaching

out of the waste. Containment is mandatory for ensuring the appropriate control of hazardous wastes from industries and nuclear power stations.

2.9.7 Disposal: According to Mngadi (2016), waste improperly disposed of provides a conducive environment for the infestation of rats which in turn become vectors that spread disease. Improper disposal of waste results in improper practices such as illegal burning which significantly affects the quality of air (Ejaz et al, 2010). Furthermore, NWMS (2011) states waste at the dumping site is not separated therefore dangerous objects such as razor blades, broken glass and chemicals from industries may harm potential scavengers. The quality of life in these communities is negatively impacted due to improper waste dumping (Mabudusha, 2010). The area is likely to be plagued by waste due to the absence of controlled waste disposal.

Moreover, polluted air resulting from fires and obnoxious odours from waste heaps do not only affect the quality of life but also harms the outlook of the area (Garg and Mashilwane, 2015). This is a contravention of human rights as stated in Section 24 of the Constitution, Act 108 of 1996, which entitles everyone to a healthy environment. According to Mporetji (2008), over 600 million people in developing countries are faced with inadequate waste collection. Furthermore, it is projected that approximately 50 % of uncollected waste may be washed away into water resources (Karani and Jewasikiewitz, 2007). Tembon (2012) supports this notion and highlights that waste is not collected in informal settlements around NMBM and thus becomes a site of rodent infestation, fly breeding and bad smells. Therefore, insufficient collection of solid waste in informal settlements does not only affect those affected adversely but also harms the aesthetic nature of cities leading to unhygienic conditions (Lewis, 2006).

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design and Methodology

The purpose of the research design is to plan the stages of the research. The study adopted a mixed-method research design that included field, qualitative and quantitative research methods. Interviews and semi-structured questionnaires were used to collect the data. Questionnaires were given to local respondents from the Hlalani informal settlement. On the other hand, interviews were conducted with the councillor of ward 57, waste officials from the Department of Economic Development and Environmental Affairs and Tourism and the Nelson Mandela Bay Municipality respectively.

3.2 Data Collection Methods

3.2.1 Desktop Study and Field Observations

Primary data collection was achieved through various means such as the conduction of a desktop study and observation of the biophysical environment. Field observations were done by visiting the study area to understand any SWM practices and using a camera to take photographs of waste management operations in the area. One of the data collection methods that has been used throughout the existence of research is observation (Patton & Cochran, 2002). Observation is the use of visual senses to gather data on observable phenomena (Kawulich, 2005). Observing the way that waste in the area is managed, waste heaps from discarded waste and the daily activities in the area is how data collection was conducted through unstructured observation for the study. The desktop study also made use of scientific journal articles, books, municipal and government journals. The importance of secondary data is that it forms an essential component of the literature review and conceptual part of the study. Official papers from research reports and various published government papers were reviewed.

3.2.2 Community Survey

There were semi-structured questionnaires that were given to residents and informal waste pickers on waste management in the area. The purpose of the survey was to gain information from residents in the community on their perceptions and attitudes concerning waste management practices in the area. Furthermore, the objective was to understand how waste management in the area has impacted the environment and the lives of the residents. This afforded the respondents the freewill to give their opinions on issues about the environment in which they are a part of. The researcher was able to capture data practically while observing the emotions and attitudes of the respondents on the issues at hand. A questionnaire was given to the individuals who reside in this community to gather information about the state of waste

management in the area and find out whether they feel they are included in the MSWM plan of the Nelson Mandela Bay Municipality.

3.2.3 Interviews

Interviews are one of the primary data collection methods in qualitative research. In-depth face-to-face interviews with the ward councillor of the Hlalani Informal settlement, Nelson Mandela Bay Municipality waste officials and those from the Department of Economic Development and Environmental Affairs were conducted to achieve the end goals of the research. The interviews focused on participants and decision-makers at the provincial level in SWM. The participants were selected according to their respective roles within the SWMS. Moreover, qualitative data was provided by the respondents regarding the prevailing SWM system as well as the dynamics that may impact the involvement of the public. The interviews aimed at acquiring more information regarding the waste management practices in informal settlements using the Hlalani Informal Settlement.

3.2.4 Sampling

A sample in research terms is a collection of elements that are drawn from a larger population for measurement to establish specifics regarding that population (Field, 2005). Furthermore, samples can be drawn from the population either by non-probability or probability methods thus for this study, both methods were used. Probability sampling is a method in which samples are assembled in a way that offers all the individuals in the population equal opportunities of being selected (Alvi,2016). According to Wagenaar and Babbie (2001), the basic sampling method used to conduct probability sampling is the basic random sample used in statistical techniques and calculations. The random sampling method was used in the study to select households randomly. Another method that can be used is non-probability sampling where samples are collected in a manner that inhibits individuals in the population to gain equal chances of being selected. For the qualitative part of this research, purposive sampling was used to identify those who form part of the management of waste in the city of PE. According to Patton & Cochran (2002), purposive sampling is a non-probability technique that is used depending on the features of a population and the purpose of the study. A simple illustration is the fact that the sample chosen was made up of individuals such as the key informants which were considered to be applicable for the study. This sampling method will be used in conjunction with snowball sampling. A snowball sample is a sociological sampling technique that is employed when the researcher experiences problems in locating the participants of a population (Babbie, 2013). These two sampling techniques are relevant to identify informants or respondents that will give relevant facts to answer the research question. Merriam (1998)

argues that qualitative research methods will thus allow the researcher to study particular subjects in-depth and thoroughly, while the quantitative research method is a conventional, impartial, orderly process in which mathematical data is deployed to acquire information. 30 % of the households in the study area were interviewed to make up the household population survey. The availability and enthusiasm to take part in the study are the two factors that determined the sample size for the study.

3.2.5 Data Analysis

The researcher took the data gathered from the questionnaires collected from the study area and put it on an excel spreadsheet. The researcher had to use coding which is the process of categorizing data from the interviews to establish a foundation for making sense of it (Theron, 2015). Therefore, the researcher assigned codes (numbers) to the respondent's responses to give meaning to them. The responses for each question were organized and the comparisons for the different sets of data were scrutinized. The researcher was then able to use the numbers to distinguish between the individual responses for each of the questions that were asked in the study. Subsequently, the researcher was able to analyze the data from the excel spreadsheet via tables, pie charts, bar and column graphs. Moreover, thematic analysis was also used to summarize the various answers that came out from the open-ended questions. Content and comparative analysis were then employed to make conclusions.

3.3 Limitations to the study

Various challenges that were encountered during the process of data collection by the researcher. Acquiring consent letters from significant stakeholders was one of the challenges which subsequently caused a delay in the overall research process. One of the key stakeholders which also happened to be the one issuing out the consent letter in question was unreachable. Furthermore, there were challenges during the community survey as some members of the community did not want to take part upon hearing that there would not be any employment opportunities brought about by the research.

3.4 Ethical Consideration

The participation of the respondents in the study was voluntary. Furthermore, the purpose of the study was clearly stated to the participants prior to their involvement in the study. The researcher also made it clear to the participants that they may pull-out from the study should they wish to do so. The identity of the participants was never at any given time revealed as the respondents were not required to fill their particulars prior to them taking part in the study. The researcher conveyed the data gathered in the study accurately without any biasedness.

CHAPTER FOUR

DATA ANALYSIS

4.1 Biographical Details of Respondents

4.1.1 Duration of Stay in the study area

The majority of the respondents, 23 which is about 77% answered that they had lived in the Hlalani informal settlement for five years or more (Table 4.1). There were 11 individuals that answered that they had been in the area for 5- 10 years. Furthermore, 7 individuals indicated they had been in the vicinity for 11-15 years as indicated in the table below. Moreover, 5 respondents had been in the Hlalani informal settlement from 16-20 years. These respondents would have a better understanding of the area and how things have been done over the years. On the contrary, 7 respondents which equated to 27% answered that they had been in the area for 4 years or less. Out of the 30 respondents that took part in the study, less than 3 months was the lowest time of residency in the area. On the other hand, 19 years was the longest residence time in the Hlalani informal settlement.

Table 4.1: Duration of stay in the Hlalani Informal Settlement.

Number of Years	**Number**
1 month – 4 years	**7**
5 years – 10 years	11
11 years – 15 years	**7**
16 years – 20 years	**5**

4.1.2 Race

100 % of the respondents that took part in the Hlalani informal settlement survey were of African black ethnic group (Figure 4.1). This was to be expected as Hlalani informal settlement is situated in a location in Motherwell, which is predominantly a black township.

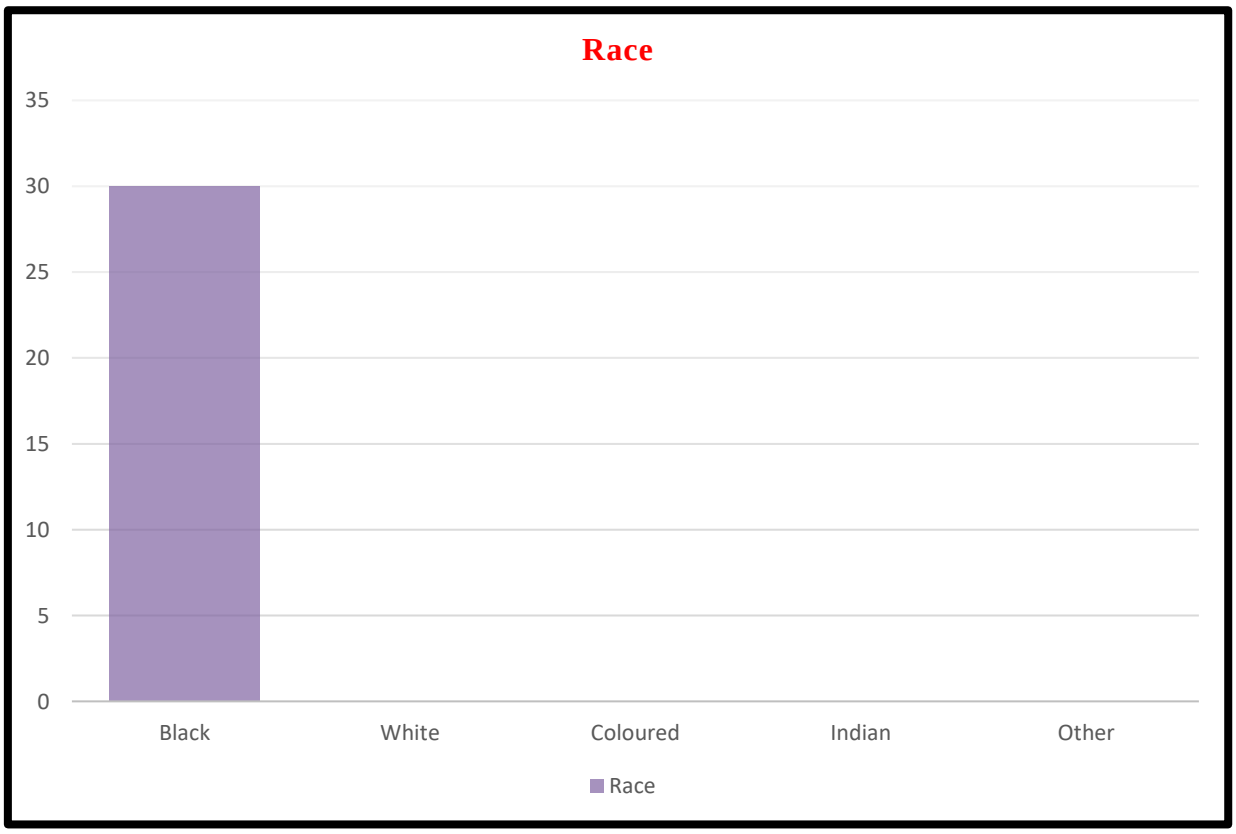

Figure 4.1: Race of the respondents in Hlalani Informal Settlement.

4.1.3 Employment Status

The bulk of the respondents, 24 are unemployed which is 80 % of the sample. This is followed by 5 respondents which equates to 17 % of the sample that is employed. Only 1 respondent which equaled to 3 % of the sample indicated that they were self-employed (Figure 4.2). There is a correlation between the education levels of the respondents and these figures. This is because the majority of individuals in Hlalani have matric or lower levels of education which could have arguably resulted in the high number of unemployment. The high percentage of unemployed individuals in Hlalani is typical of informal settlements around the globe.

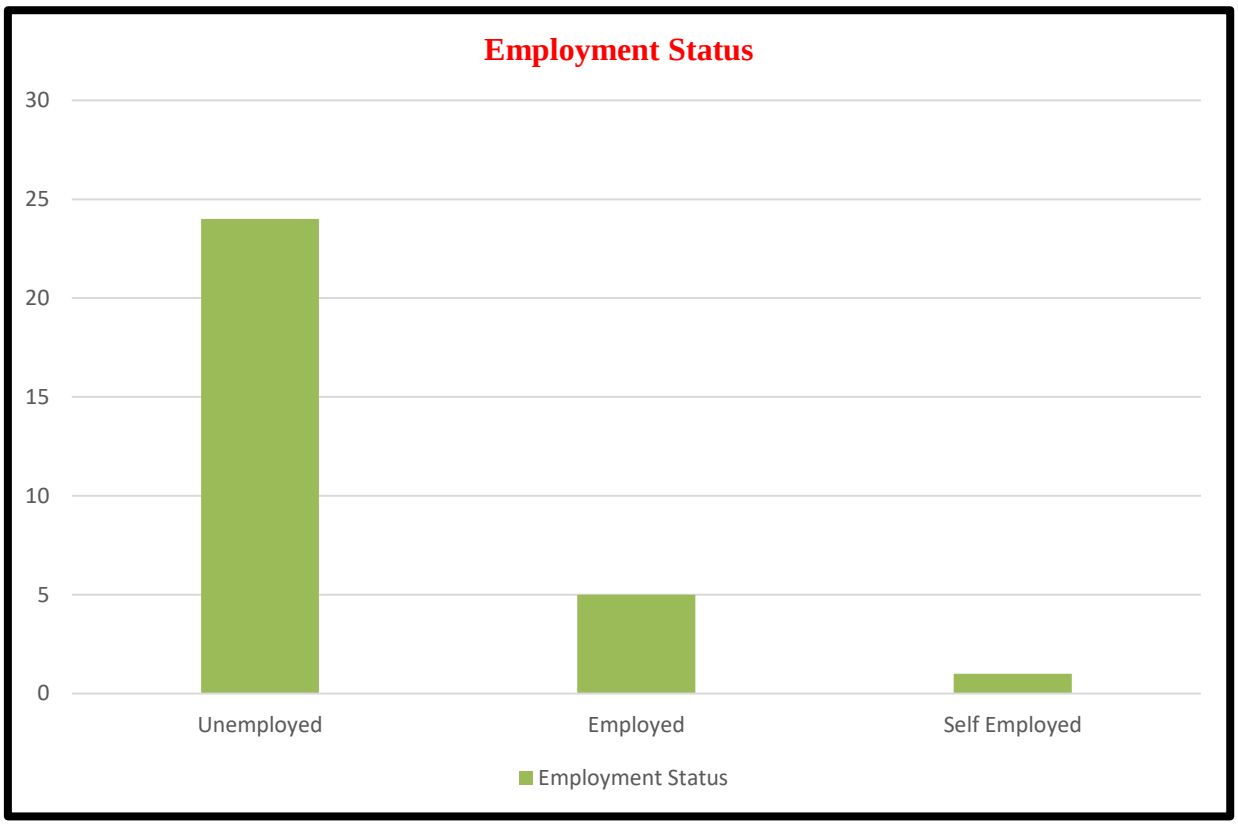

Figure 4.2: Employment statuses of the respondents.

4.1.4 Number of people in a household

Half of the respondents, 15 answered that they had four or more people residing in one household and this was 50 % of the sample. One of these households had up to 9 people which was an indication of the excessive amount of waste that must be generated by that household. Figure 4.3 shows excessive an amount of waste due to populated residences. On the contrary, 15 respondents indicated that their households were occupied by three or fewer people. The lowest number recorded in a single home was 1 person and the mean household size per household is 4 people (Table 4.2).

Table 4.2: Number of people in a household

Number of People	Number of Households
1	1
2	8
3	6
4	6
5	6
6	2
7	N/A

8	N/A
9	1
45	**30**

Figure 4.3: Households with more people produce more waste.

4.1.5 Number of people employed in Households

The majority of the respondent, 16 answered that there were no employed occupants in their households which accounted for 53 % of the sample (Figure 4.4). On the other hand, 14 respondents indicated that at least one individual was employed in the household which equated to 47 % of the sample. In one instance, two people were employed in one household (Figure 4.4).

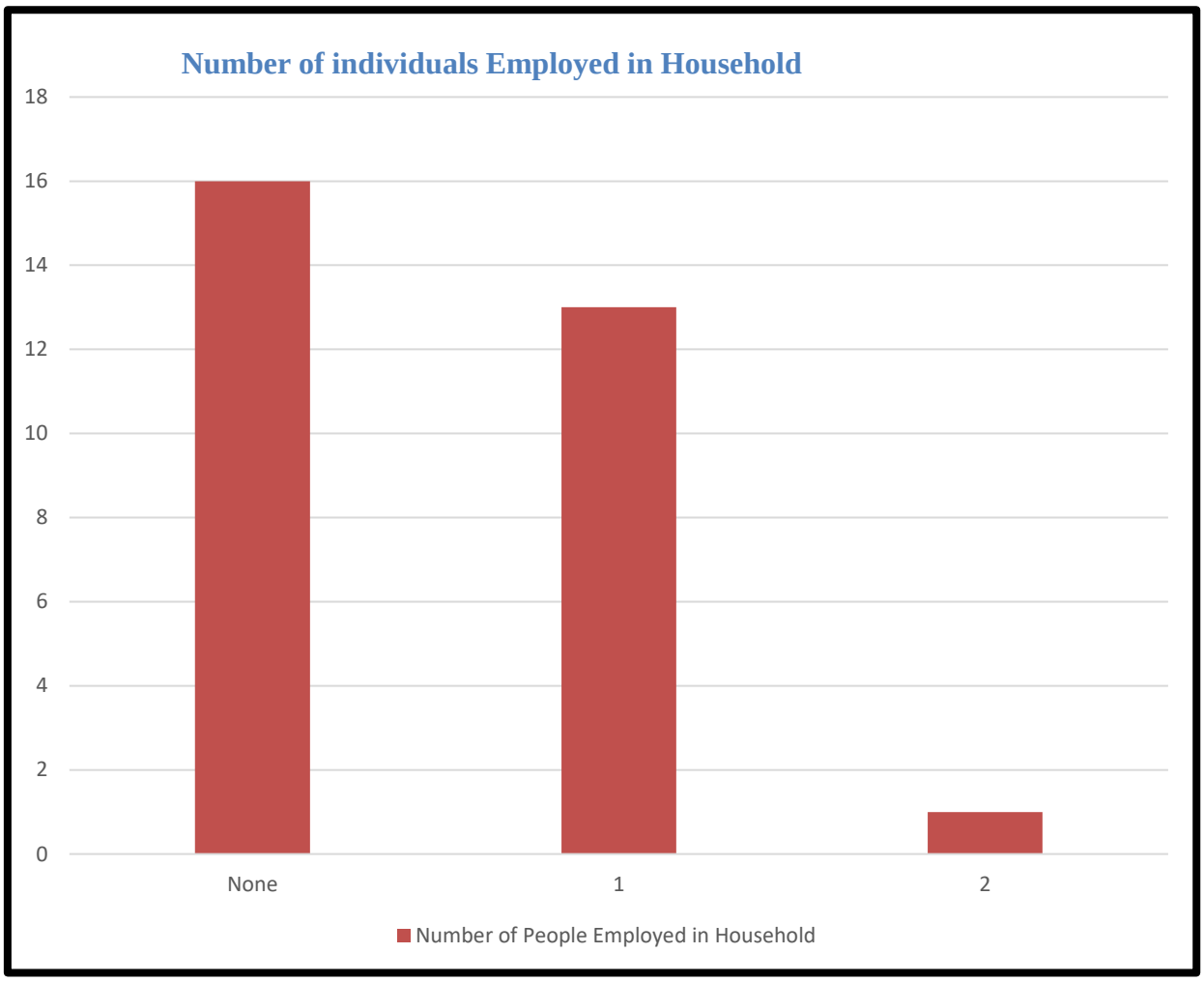

Figure 4.4: Number of individuals employed in a household.

4.1.6 Gender

15 males and 15 females characterize the gender distribution of the respondents from the Hlalani Informal Settlement. Therefore, the gender distribution in the area was balanced at 50 % for males and 50 % for females respectively (Figure 4.5).

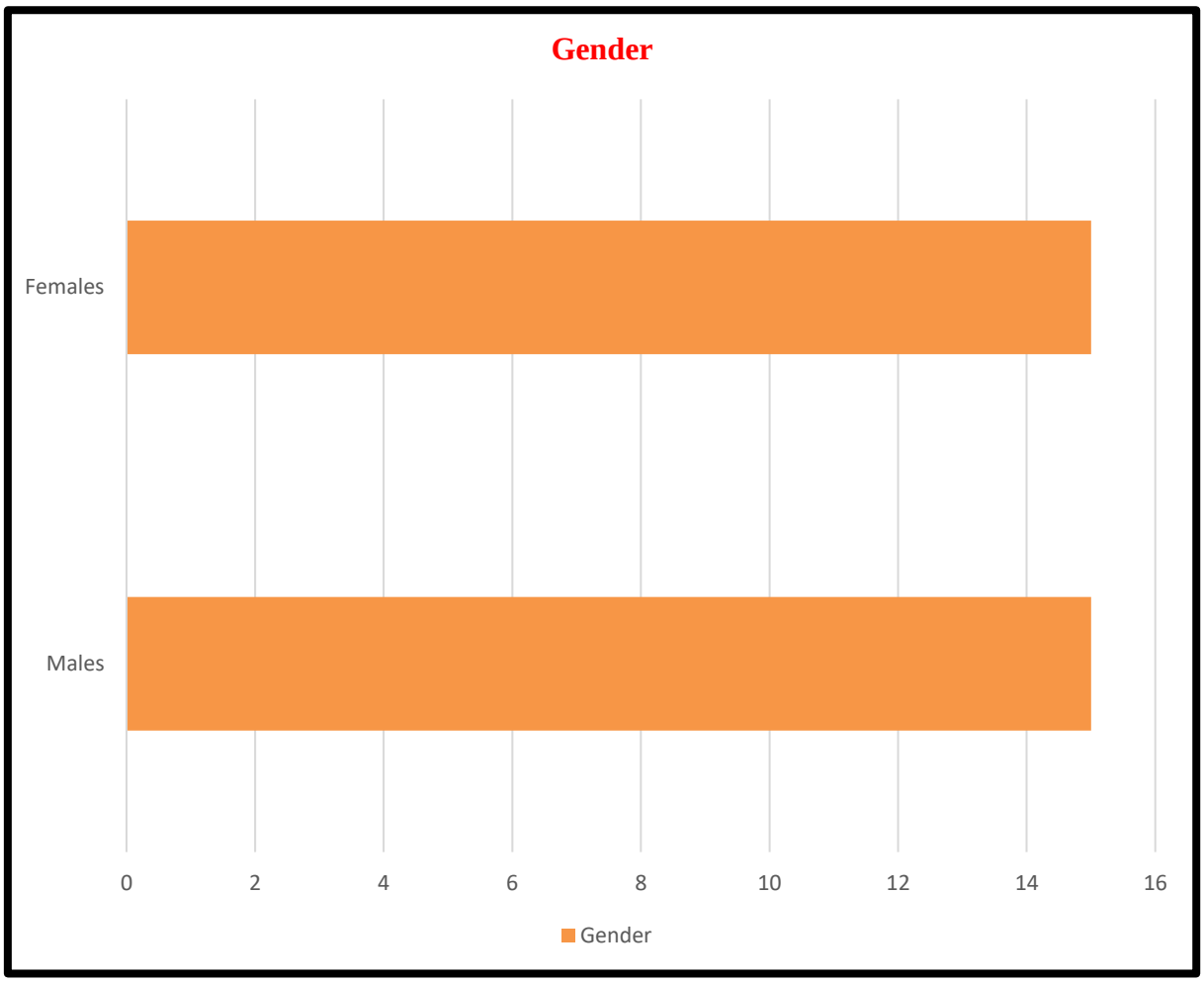

Figure 4.5: Gender distribution of respondents.

4.1.7 Education

The levels of education from the survey of the Hlalani informal settlement reveal that 13 respondents which made up 43 % of the sample had completed matric. This means none of the 13 respondents acquired post-matric education at a formal tertiary institution after completing matric. Only 2 respondents had certificates for courses completed post-matric which equaled to 7 % of the sample. However, there were no respondents with Diplomas or Degrees (Figure 4.6). Furthermore, 50 % of the sample which was made up of 15 respondents had little education or hadn't gone on to complete matric.

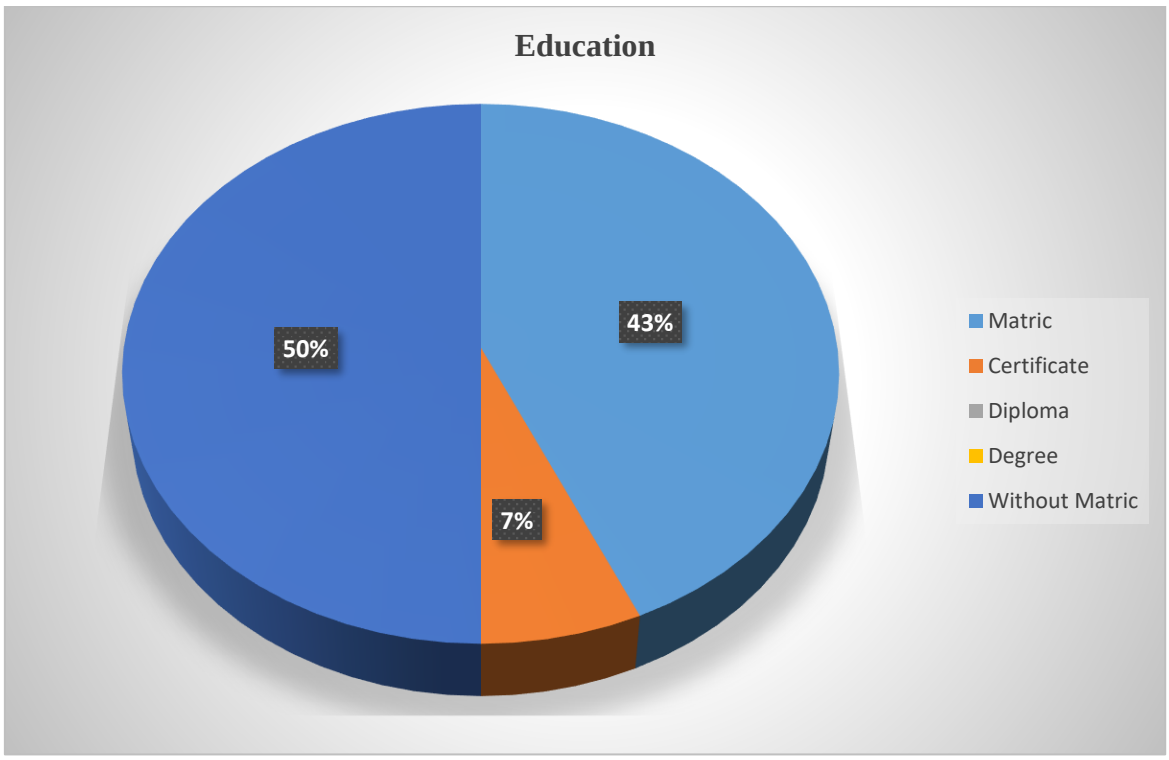

Figure 4.6: Level of education of the respondents.

4.2 Waste Management

4.2.1 Exposure to proper handling of waste

Out of the 30 respondents, all the respondents indicated that they had no exposure to proper handling of waste and this is 100 % of the population (Table 4.3). This could be the reason for the unsustainable waste management habits in the area observed by the researcher. The majority of the respondents answered that they had not heard about recycling before while all 30 respondents answered that they were never exposed to proper handling of waste management (Figure 4.7).

Table 4.3: Exposure of respondents to proper handling of waste.

Exposure to proper handling of waste	**Number**
Yes, a lot	0
Partly	0
No	30

Figure 4.7: Consequences of inadequate exposure of residents to proper handling of waste in the study area.

4.2.2 Types of Solid waste from Households

Out of the 30 respondents in the study, 53 % of the households indicated that their waste consists of paper which equated to 16 respondents (Figure 4.8). Only 9 respondents, which made up 30 % of the sample indicated that tins and cans formed the majority of their waste. The remaining 5 respondents indicated that plastics are the dominant waste from their households which was 17 % of the sample (Figure 4.9).

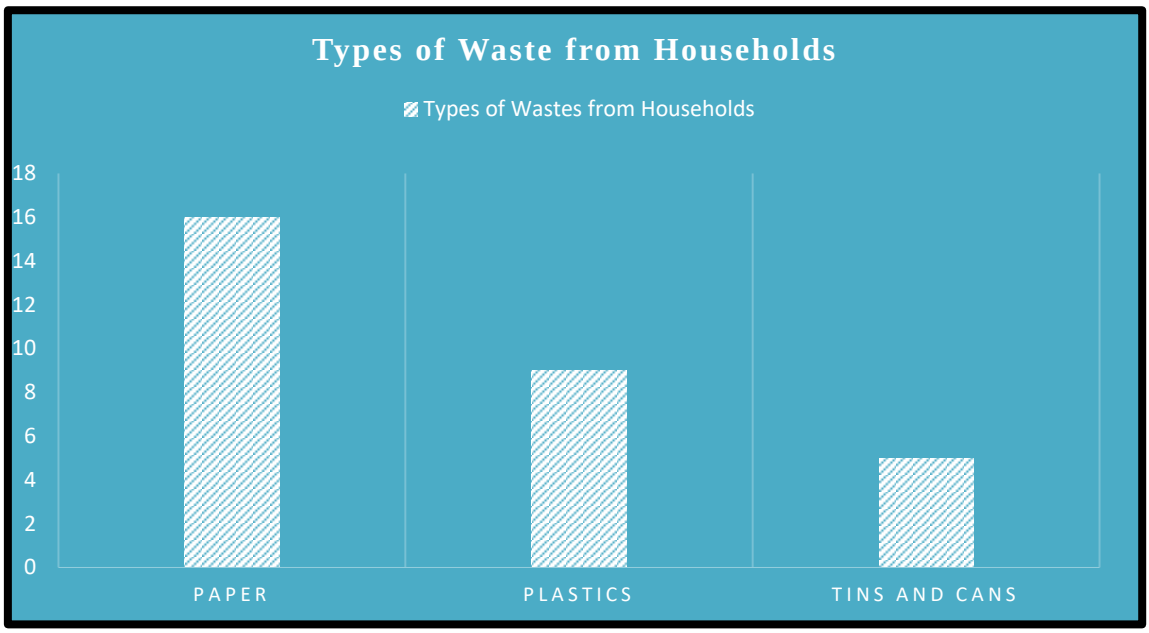

Figure 4.8: Types of waste from households in the study area.

Figure 4.9: Shows the types of wastes in the area in the study.

4.2.3 Access to municipal waste bins

All the respondents 30 indicated that they do not have access to municipal waste bins for the collection of waste in the area (Table 4.4). This is 100 % of the sample which might explain the excess of waste in the area (Figure 4.10).

Table 4.4: Represents respondent's views on their access to municipal waste bins.

Access to dustbins	**Number**
Yes	0
No	30

Figure 4.10: Situations caused by illegal dumping stemming from lack of municipal interventions (waste bins) in the study area.

4.2.4 Municipal waste collection in the study area

29 respondents indicated that the municipality does not collect waste in the area which is 97 % of the sample (Figure 4.12). Only 1 respondent indicated that the municipality sometimes collects waste in the area which equated to 3 % of the sample (Figure 4.11).

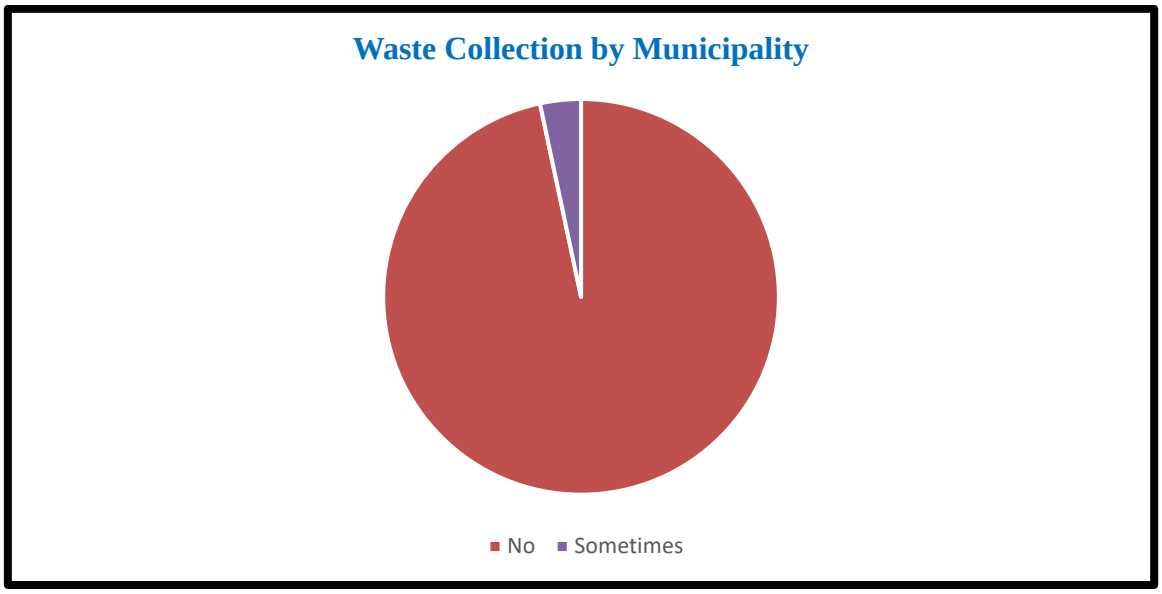

Figure 4.11: Respondents indicate whether Municipality collects waste in the area.

Figure 4.12: Scattered waste in the Hlalani Informal settlement.

4.2.5 Illegal dumping of waste in the study area

All of the 30 respondents answered that they think there are waste management issues in the area such as illegal dumping of waste and this is 100 % of the sample (Figure 4.13). This was to be expected considering that the community does not have access to municipal waste bins for waste disposal (Figure 4.14).

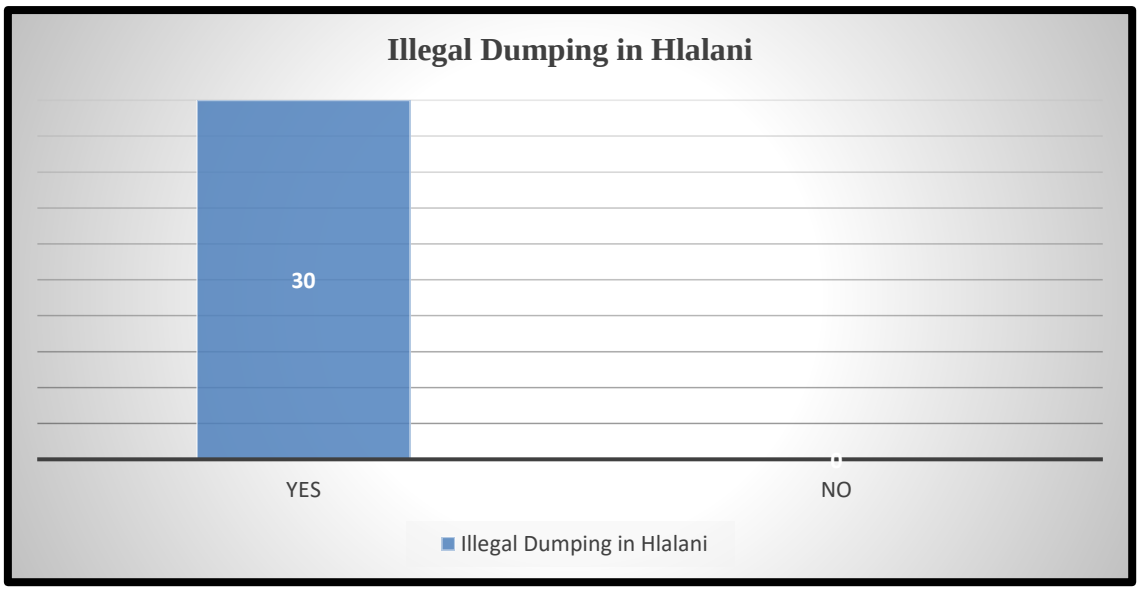

Figure 4.13: Illegal Dumping in Hlalani.

Figure 4.14: Illegal dumping in the Hlalani informal settlement.

4.2.6 Occurrence of Dumping

All of the respondents answered that illegal dumping in the Hlalani area happens more often and that is 100 % of the sample. There are no particular spots were dumping takes place as the residents discard waste wherever they see fit. This is to be expected as this area is not regulated by the municipality as indicated in (Table 4.5).

Table 4.5: Frequency of dumping in the study area.

Frequency of Dumping	**Number of Households**
Once a week	0
Twice a month	0
More often	30

4.2.7 Sources of waste

The majority of respondents, 26 out of the 30 that took part in the study indicated that the waste issues in the Hlalani informal settlement are a result of the resident's inappropriate disposal practices. On the other hand, 2 respondents answered that according to their knowledge the waste in the area is a result of the community members around the informal settlement who dump their waste there at times. It was also interesting to note that 2 more respondents highlighted that the waste in the informal settlement was a result of both the residents of Hlalani and community members from nearby settlements (Table 4.6).

Table 4.6: Respondent's views on the sources of waste in the area.

Respondent	**Theme 1 (Residents)**	**Theme 2 (Community Members)**
R1	**X**	
R2	**X**	
R3	**X**	
R4	**X**	
R5	**X**	
R6	**X**	

R7	**X**	
R8	**X**	
R9		**X**
R10	**X**	
R11	**X**	
R12	**X**	
R13	**X**	
R14	**X**	
R15	**X**	
R16	**X**	
R17	**X**	
R18	**X**	
R19	**X**	
R20	**X**	
R21	**X**	
R22	**X**	
R23		**X**
R24	**X**	
R25	**X**	**X**
R26	**X**	**X**
R27	**X**	
R28	**X**	
R29	**X**	

R30	**X**	

4.2.8 Specific time of the waste dumping

12 respondents answered that illegal dumping in the area took place when its dark around the midnight hours and this equated to 40 % of the sample. On the other hand, 11 respondents which made up 37 % of the sample indicated that illegal dumping took place in the early morning hours. Only 23 % of the respondents which was 7 answered that the illegal dumping of waste took place in the afternoon (Figure 4.15). In other areas, notice boards are erected by the municipality stating that anyone found guilty of illegal dumping shall be prosecuted. The fact that people are aware of the penalties in the form of fines that come with the act of illegal dumping provides a level of control. In Hlalani, the residents take part in acts of illegal dumping without having to worry about any penalties. Testimony to this comes in the form of the respondents that answered that dumping occurs at any time of the day. Furthermore, the residents in Hlalani do not seem to be playing their part in the management of waste and are blaming the government for the situation in the area.

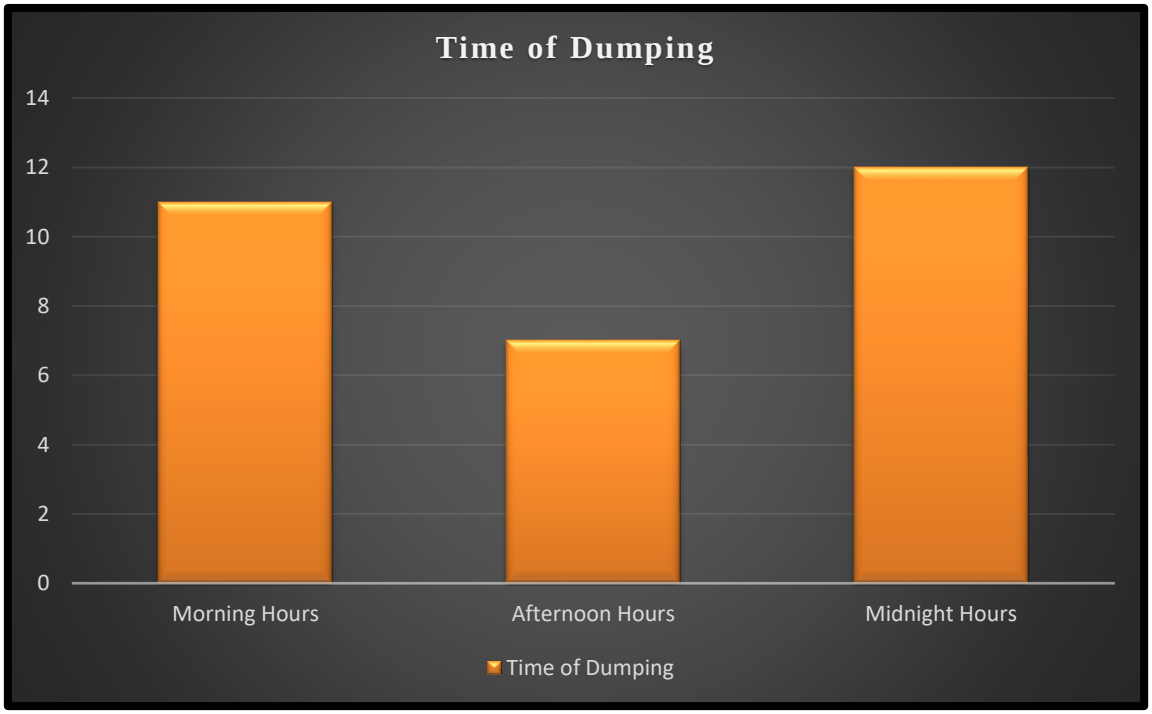

Figure 4.15: Time of dumping of waste in Hlalani.

4.2.9 Waste skips

All of the 30 respondents indicated that there were no waste skips near their households meaning that 100 % of the sample have no access to waste skips in the area (Table 4.7). This is a concern

considering there are no municipal waste bins provided by the municipality for the households in the area.

Table 4.7: Respondent's views on whether there are waste skips near their households.

Waste skips near households	**Number**
Yes	0
No	30

4.2.10 Waste Management in the Area

100 % of the respondents answered that in their opinion waste management was a problem in the area (Figure 4.16). This stems from the fact that the municipality does not provide waste management services in the area.

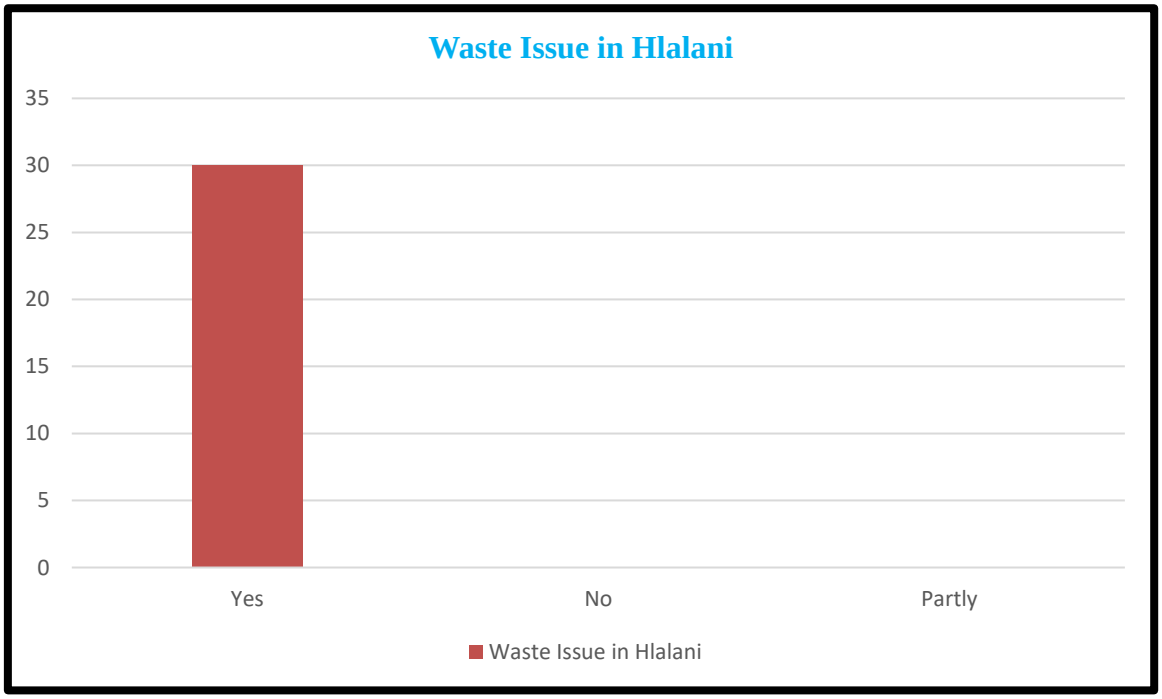

Figure 4.16: Respondent's opinions on waste management in the area.

4.2.11 Waste Management services

30 respondents all answered that they were not satisfied with waste management services or lack thereof from the municipality. A 100 % of the sample that took part in the study felt that they are marginalized and their voices are not heard even though they also vote like all other citizens (Table 4.8). However, there are municipal waste interventions occasionally in the settlement (Figure 4.17).

Table 4.8: Evaluation of Waste Management services from the Municipality.

Satisfaction with Waste Services in the Area	**Number**
Yes	0
No	30
Partly	0

Figure 4.17: Municipal interventions on waste gatherings in the settlement.

4.2.12 Community views on possible solutions

Four major themes that came out of the respondent's views on what needs to be done in the area to improve waste management. Out of the sample of 30 respondents, 11 answered that refuse bags and municipal waste bins could be introduced in the area to effectively manage the waste. Moreover, 9 respondents indicated that the Municipality could provide services such as the collection of waste for residents in the area. On the other hand, 7 respondents highlighted that waste skips could be strategically placed in the area to curb the issue of illegal waste

dumping in the area. 1 respondent suggested the municipality could introduce waste management projects that would be headed by the residence of Hlalani informal settlement (Table 4.9). There were also 2 respondents that indicated that they would like the municipality to provide the residents in the area with waste skips, refuse bags and municipal waste bins so that they could play their part in waste management. The respondents came up with very good suggestions that would assist to manage waste in the interim in Hlalani. The collection of the waste by municipal officials is beyond the control of the residence, however, they seemed determined to improve their living conditions. One respondent (R24) highlighted that the municipality could provide them with refuse bags and have an arrangement with the community where the bags would be put along the main road for municipal trucks to collect.

Table 4.9: Respondent's views on what needs to be done in the area.

Respondents	**Theme 1** **(**Refuse bags and bins)	**Theme 2** **(**Municipal services	**Theme 3** (Waste Skips)	**Theme 4** (Waste Management Project)
R1	**x**			
R2		**X**		
R3	**x**			
R4	**x**			
R5		**X**		
R6	**x**			
R7	**x**		**x**	
R8		**X**		
R9		**X**		
R10			**x**	
R11	**x**			
R12		**X**		

R13	**x**			
R14			**x**	
R15	**x**			
R16			**x**	
R17	**x**			
R18	**x**		**x**	
R19			**x**	
R20			**x**	
R21	**x**			
R22		**X**		
R23			**x**	
R24		**X**		
R25		**X**		
R26	**x**		**x**	
R27		**X**		
R28	**x**			
R29	**x**			
R30				**x**

4.2.13 Recycling

22 respondents specified that they do not know about recycling which formed 73 % of the sample. On the other hand, (8) respondents indicated that they had knowledge of recycling which accounted for 27 % of the sample (Figure 4.18).

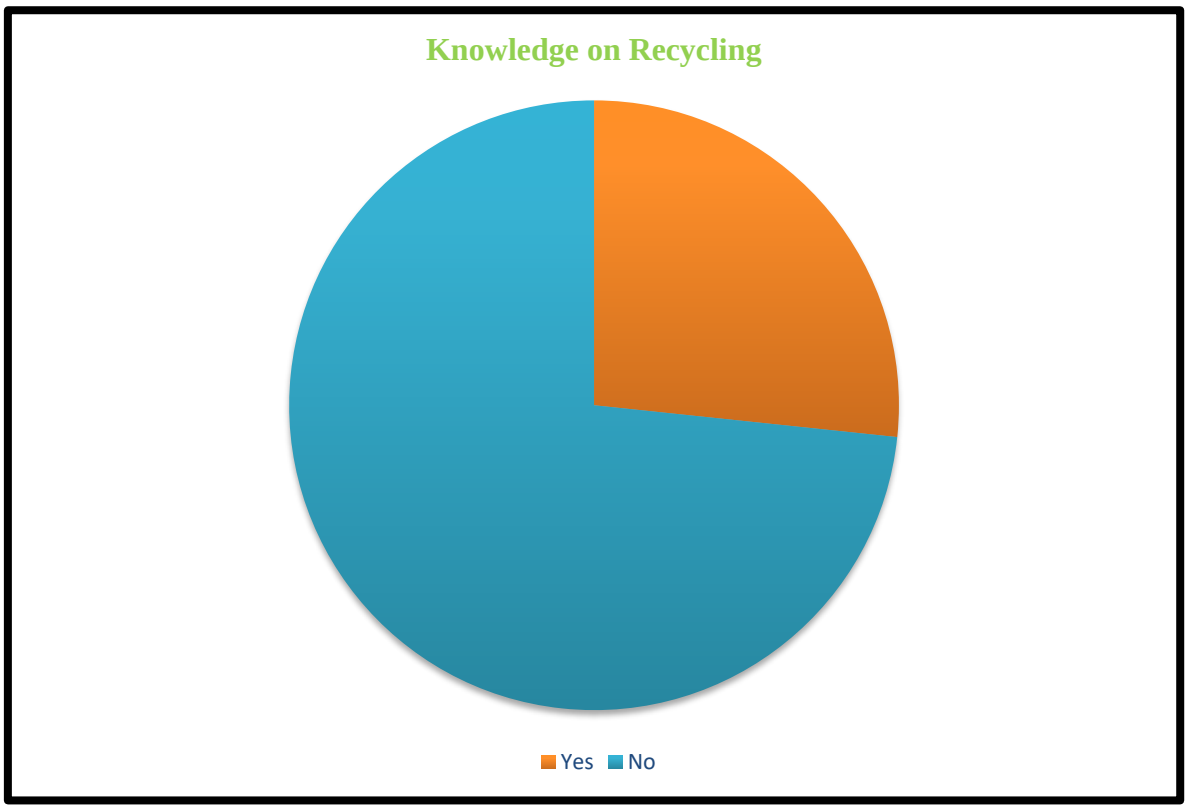

Figure 4.18: Respondent's knowledge of recycling.

4.2.14 Knowledge on the benefits of waste management

28 respondents indicated that they did not know the benefits of waste management which equated to 98 % of the sample. However, this was not surprising considering that most members of the community did not know about recycling. On the contrary, only 2 respondents answered that they had knowledge of the benefits of waste and that minority amounted to 2 % of the sample (Figure 4.19). Residents of Hlalani perceive waste as a commodity that is destined for the landfill site.

Figure 4.19: Respondent's knowledge of the benefits of waste management.

4.2.15 Informal waste recycling in the study area

26 respondents indicated that they did not know anybody that was making a living from recycling in the area. There was only 1 respondent that answered that they knew someone that earned money from recycling material from the waste stream in the area. Furthermore, there were 3 respondents that indicated that there are individuals that collect material to recycle in the area, however, all three of the respondents highlighted that they did not know these individuals personally and which settlement they come from (Table 4.10).

Table 4.10: Respondent's views on informal waste recycling in the study area.

Respondent	**Theme 1 (Yes)**	**Theme 2 (No)**	**Theme 3 (Not Directly)**
R1		**X**	
R2		**X**	
R3		**X**	
R4		**X**	
R5		**X**	
R6		**X**	
R7		**X**	
R8		**X**	
R9		**X**	
R10		**X**	
R11	**x**		
R12		**X**	
R13		**X**	
R14		**X**	
R15		**X**	
R16		**X**	

R17		**X**	
R18		**X**	
R19	**x**		**x**
R20		**X**	
R21		**X**	
R22		**X**	
R23		**X**	
R24		**X**	
R25	**x**		**x**
R26		**X**	
R27	**x**		**x**
R28		**X**	
R29		**X**	
R30		**X**	

4.3 Interviews with ward councillor and waste management officials

4.3.1 Knowledge of ward councillor on waste management

The councillor of ward 57 where the study area is located did not have any knowledge of MSWM plans and therefore could not commit as to whether the NMBM has one or not. As a result of the councillor's lack of knowledge on MSWM plans, she also could not answer if the NMBM waste plans promote sustainable waste management or adhere to the principles provided in NEMA. However, the councillor was able to answer one of the questions which looked at how residents in Hlalani can be incorporated into the management of waste. She suggested that waste skips could be used in the area and have a few community members managing them.

4.3.2 Role of waste officials in the management of waste

The officials from the DEDEA have confirmed that the NMBM has a MSWM plan as they are responsible for overseeing that municipalities formulate these plans as stipulated by the National Environmental Management Waste Act, no 59 of 2008. The officials from the DEDEA also stated that even though the NMBM has a MSWM plan, it would not be area specific. The officials indicated that one way of incorporating communities into the management of waste would be through waste recycling initiatives done with the residents.

On the other hand, municipal waste officials from the Addo depot which is responsible for waste management in the Motherwell area concurred that the NMBM's waste plan is like an umbrella and caters to all areas in the Bay. The officials also mentioned that community-based cooperatives will be used to service informal settlements where municipal services are not provided.

CHAPTER FIVE
DISCUSSIONS

5.1 Introduction

The focus of the research was on sustainable waste management in the informal settlement of Hlalani, Port Elizabeth, Eastern Cape. The purpose of this chapter is to discuss the results as presented in the preceding chapter. The discussion of the chapter is formed from the data gathered from interviews and semi-structured questionnaires. The study seeks to achieve the following aims (1) to identify various waste management plans and practices in the area, (2) to find out if the above plans, if any exist, adhere to the principles of waste management hierarchy provided in terms of NEMA: Waste Management Act, (3) If no waste management plans exist, to find out whether or not the City council has future strategies to deal with waste in the Hlalani settlement and (4) to provide recommendations on how waste management plans can improve to benefit the community and the environment. The discussion of this chapter will also seek to answer the study's research questions. The study's findings will be conferred in greater detail and the literature reviewed in Chapter two will be used to support any arguments or comparisons.

5.1.1 Identification of various waste management plans and practices in the area

The study's first aim was to identify various waste management plans and waste management practices in the Hlalani informal settlement. Informal settlements in South Africa came about as a result of the policies that were put in place by the previous government which marginalized black people (Tshikotshi, 2010). These informal settlements are located in areas that are densely populated and without any municipal services. The government is faced with a significant dilemma and responsibility to manage the excessive amounts of waste in these types of settlements. Local authorities are tasked by the Department of Environmental Affairs and Tourism to establish waste management plans to control and reduce waste in the area under their jurisdiction (DEA, 2007). Bjorklund et al (1999) define a waste management plan as "a document containing information on contemporary waste generation and management strategies for plummeting waste quantities". Goswami and Pati (2012) highlight that these waste management plans should include community awareness, the establishment of waste removal facilities and regulation of disposal sites and the use of applicable waste minimization dynamism. Moreover, waste management plans form the foundation required to attain sustainable waste management. The three spheres of government are obligated to follow the waste management hierarchy when developing waste management plans. According to the DEA (2007), waste management plans are stipulated in the waste act and thus a mandatory

requirement. With regards to the study area, the officials from the DEAT have confirmed that the NMBM has a MSWM plan as they are responsible for overseeing that Municipalities formulate these plans as stipulated by the National Environmental Management Waste Act, no 59 of 2008. The senior official at the Addo waste depot that is responsible for carrying out waste management duties in Motherwell on the behalf of the Metro concurred that the NMBM's MSWM plan is like an umbrella and caters to all areas. The DEA (2007) stresses that municipalities are mandated to incorporate their waste management plans into integrated development plans under the waste act.

Chisadza (2015) states that the challenge with informal settlements is that they do not form part of urban planning and are therefore deprived of services such as refuse collection. According to Puling (2004), waste management in informal settlements is essentially built around the availability of other services such as roads and on-site storage facilities. The majority of waste management issues in informal settlements are anthropological which ultimately destroys natural surroundings. Central to the success of initiatives to protect natural resources and the surrounding environment is environmental education. Failure to provide adequate waste management education to the residents of Hlalani has resulted in negative attitudes and careless waste disposal habits. Freduah (2004) stresses that it is necessary to change the community's beliefs when it comes to the disposal of waste through adequate education of proper waste management handling. The study area is characterized by scattered waste and illegal waste heaps (Figure 4.7). As stated by the respondents in the questionnaire during data collection, the residents do not have access to municipal waste bins and use items such as drums or plastic basins for storing their waste. However, these drums are filled up in a matter of days which is the reason why excess waste can be seen in the surrounding environment in Hlalani. Those that do not have drums or old plastic washing basins to store their waste will use retail bags. The issue with these plastic bags is that they are not durable and are vulnerable to scavenger dogs searching for food. In the absence of municipal waste bins and waste skips, residents of Hlalani resort to incineration and illegal dumping as modes of managing their waste. It must be noted that open dumping was the most popular mode of disposal. The failure of local authorities to supply municipal waste bins to informal settlements derails the participation of these communities in sustainable waste management.

All the respondents in the study emphasized their willingness to play their part in the minimization of waste in the area. However, Freduah (2004) noted that the absence of municipal waste bins and an adequate official recycling system was hindering the primary obstacle preventing residents of informal settlements from sorting their waste. According to Freduah

(2004), informal settlements are at times abandoned by local authorities and are starved of services such as waste collection. Zandamela (2016) concurs that communities in these informal settlements make use of uncontrolled waste dumps which promote the growth of pathogens and endangers health. This highlights the significance of the community's beliefs in terms of waste management. In the absence of waste management services, waste skips should be used and located strategically for effective use by the communities (Puling, 2004). There are no waste skips in the Hlalani informal settlement which causes significant issues for the residents when their containers are filled. Moreover, the issue at Hlalani seems to be that some residents are careless when it comes to the management of their waste. However, Zandamela (2016) argues that even poverty-stricken communities have a right to environmental justice just like everyone has a right to a clean environment and a good quality of life. According to Gumbi (2015), most of the waste produced in developing countries is uncollected and largely accumulates in open spaces bringing along significant health and environmental hazards. Communities residing in informal settlements that are generally densely populated are the most affected since they are not provided with waste collection services. Community members in the study area dispose of their waste into the surrounding environment via open dumping (Figure 4.10). Gumbi (2015) highlights that the ratio of households that dump waste in open spaces is higher in the informal low-income settlements in contrast to the city. The open dumping is a product of inadequate involvement by the government and the inability of municipal trucks to access these areas as there are is no adequate infrastructure such as roads. The researcher discovered that waste disposal practices in the area are unsustainable. Moreover, 97 % of the respondents that took part in the study stated that the municipality does not pick up refuse in the area as shown in (Figure 4.12). As depicted in (Figure 4.17). 3% of the respondents highlighted that the municipality occasionally sends excavators to gather the waste and clear the area.

5.1.2 Waste management plans and principles of the waste management hierarchy

The study's second research question looked to evaluate whether the MSWM plan for the city adhered to principles provided in the NEMA. The Constitution of South Africa, Act 108 of 1996, provides the foundation for environmental legislation in the country. Section 146 of the Constitution which focuses on the environment and pollution control grants National and provincial authorities with equivalent legislative powers. Furthermore, section 24 of the Bill of Rights focuses on the rights to environmental protection and supports the guidelines for environmental law shaped by the National Environmental Management Act, no 107 of 1998. This notion is supported by the (DEA, 2011) which further elaborates that the Constitution grants provincial governments complete judicial powers over refuse removal and disposal of waste in their locality. According to the DEA (2011), the National Environmental Management

Waste Act, no 59 of 2008 forms a cohesive statutory structure that focuses on the waste hierarchy and restructures laws administering waste management. The precautionary and polluter pays principles are some of several supplementary regulating principles that have been brought by the National Waste Management Act 59 of 2008 into South Africa's environmental law. Moreover, NEMWA (2008) states that "any persons that may cause substantial pollution to the environment has a duty of care to reasonably effect measures to prevent or minimize and rectify the pollution where it cannot be avoided". According to the DEA (2011), the Waste Act supports the duty of care notion by asking waste generators to effectively undertake practical measures to apply the waste management hierarchy. According to the DEA (2007), waste management plans are stipulated in the waste act and thus a mandatory requirement.

The researcher has observed that waste management in the Hlalani Informal settlement is unsustainable. All of the population that took part in the study indicated that they had no prior exposure to the proper handling of waste. This could be one of the factors for unsustainable waste management habits in the area. According to Naidoo (2009), the application of waste management in South Africa is influenced by the diverse social-cultural values, which give rise to different beliefs and behaviours. Therefore, failure to provide adequate waste management education to the residents in the study area has resulted in negative attitudes (Figure 4.14). Vital to the success of initiatives to protect natural resources and the surrounding environment is environmental education. According to NEMWA (2008), "Any persons that may cause harm on the environment has a duty of care to reasonably take measures to prevent or minimize and rectify the pollution where it cannot be avoided". It was vividly clear that residents of Hlalani informal settlement do not lead by the duty of care principle. It was either residents didn't care or were simply not informed that there is such a principle. Upon engagements with the residents, it became clear that they were ill-informed about most issues relating to the environment. According to Zandamela (2016), communities in informal settlements produce excessive amounts of waste, however, dealing with the waste in an environmentally friendly manner is the challenge. This is attributed to a lack of adequate services for waste management and the absence of a proper waste disposal heritage on the part of the residents (Puling, 2004). Furthermore, Cordato (2018) states that the polluter pays principle emphasizes that any person liable for harm to the surroundings should bear the expenses associated with it. Therefore, society should be liable for their activities and those who effect harm to others or the environment should pay. However, this is not happening in the Hlalani informal settlement, hence the dire state of waste management in the area (Figure 4.9). According to De Sadeleer (2007), the precautionary principle states that "where there is a doubt as to the existence or the extent of risks to human health, protective measures may be taken without having to wait until

the reality of those risks becomes fully apparent". Therefore, under the precautionary principle, the local authorities have a societal obligation to safeguard the communities under their jurisdiction from detriment. The catastrophic state of the environment in Hlalani suggests that the municipality in which Hlalani is under failed to apply this principle. Garg and Mashilwane (2015) highlight that the way municipalities conduct their tasks affects the community and the environment in which they are a part of. The municipality has a MSWM plan that adheres to the principles of NEMA. However, the implementation and efficiency of these MSWM plan are questionable. The problem with these policies that are put in place is that they are only attractive on paper while their effectiveness on the ground level leaves a lot to be desired.

The senior official at the Addo waste depot stated that certain informal settlements are not serviced because of regulations. According to the official, the municipality also does not service informal settlements such as the study area where it has plans to relocate the residents to another area. However, the official continued to say that ward councillors who these areas are under their jurisdiction are given black refuse bags to distribute to the residents as a temporal service. The official claims upon receiving the bags, the residents are supposed to use them for waste storage and place them at a central area for collection. Yet, upon engaging with the residents, it emerged that they are not provided with refuse bags. Therefore, the relationship between the municipality, ward councillors and communities is dysfunctional. The official from the municipality further went on to say that the problem is bigger than just waste. According to the official, unemployment and a housing backlog are the reasons behind the formation of informal settlements. The waste department is allocated a budget to provide bags and municipal waste bins but the alarming rate at which new informal settlements are formed makes it virtually impossible to cater to residents in these areas. The official further stressed how even formal households are short of municipal waste bins as the last time they were distributed to residents was in 2004. Moreover, Hlalani and other informal settlements are not provided with waste skips because there just isn't any available and those that exist are broken. According to Naidoo (2009), waste management in informal settlements can only be championed when policymakers cater to the poor and provide them with adequate service delivery. The government needs to ensure that policies that are drafted are not only good on paper but are effected on the ground level. Waste is an issue that affects everyone but for the most part, the poor are often neglected in terms of issues relating to waste.

5.2 Future strategies by the city council to deal with waste in informal settlements

The study's third aim was to establish whether the city council has future strategies to deal with waste in the Hlalani settlement. According to Kasinja and Tilley (2018), rapid urban

development has promoted the growth of informal settlements characterized by inadequate basic services in Africa. There is a high regularity of discontent among members of the community regarding waste management issues in the area. However, there are contrasting views about the source of waste in the Hlalani informal settlement. The majority of the residents believe that the waste comes from the residents of Hlalani. However, a smaller percentage argued that the waste was a combination of the residents of Hlalani and the residents of surrounding communities. Traditional systems of waste management have for the most part been unsuccessful in unplanned informal areas that lack infrastructure such as roads for collection trucks. The community members unanimously highlighted their dissatisfaction with the lack of waste management in the study area. Some members of the community have lived in the area for most of their lives and highlighted that things have always been this way. The municipality does not collect waste in the area and the residents don't even have municipal waste bins to store their waste.

Public participation is growing increasingly popular and is legislated in regulations such as the National Environmental Management Act, no 107 of 1998. According to Willis et al (2018), this tool has been used by local authorities to collaborate with communities under their jurisdiction on waste management campaigns. Changing the community's mental state and habits to that of a cleaner environment is the main objective behind these awareness campaigns. Naidoo and Ramphal (2008) stated that collaborations among the public and the private sector have been used in countries such as Ghana and Germany to effectively manage waste. Sustainable waste management is characterized by changes in perceptions and public participation. Pulling (2004) states that community participation and environmental education are interdependent as the accomplishments of the education rest on the will of the civilians to partake in these activities. Examples of instances whereby the municipality can involve the community include recycling projects, waste clean-up campaigns and waste management cooperatives that are tasked with keeping the surroundings clean. According to Kasinja and Tilley (2018), the majority in these informal settlements survive by picking and recycling waste material from dumpsites. Making the community members a significant part of the solution by engaging them in waste related issues may change their attitudes. Therefore, the community would be required to cooperate and play a positive role in the management of waste in their area. The official at the Addo waste depot mentioned that the municipality plans to award contracts to waste management cooperatives made of community members who were previously known as informal waste pickers to service informal settlements such as Hlalani. According to Aga Schioldborg (2014), only about 80 % of the waste produced in developing countries is collected even though 30 – 50 % of their operational budgets are on the management

of waste. Kasinja and Tilley (2018) state municipalities are supposed to provide waste skips in informal settlements. However, in certain areas, these skips are unattended for days on end and eventually overflow. The environmental setting and human well-being at large may be significantly affected by the inadequate disposal of waste. This is where cooperatives could come in to assemble, categorize, process and remodel recyclable material. The use of cooperatives would greatly improve the environment, waste picker's income and social wellbeing. Therefore, formally embracing waste pickers in waste management through waste collection and recycling would help achieve the goals of sustainable development. The formation of waste management cooperatives promotes the three pillars of sustainable development and has been used effectively in countries like Colombia. For the most part developing countries have inadequate recycling programs since their focus is on enhancing the collection and final waste disposal. These cooperatives could help moderate the volume of waste sent to the landfill site while also conserving raw material through recycling. The nature of these informal settlements which are characterized by inadequate roads makes it virtually impossible for municipal trucks to access them for waste collection (Aga Schioldborg, 2014). Therefore, informal settlements are best suited to be serviced by these waste management cooperatives that are headed by waste pickers.

5.3 Improving waste management plans to benefit communities and the environment

The municipality needs to anticipate and improve their waste management planning when it comes to waste management in informal settlements. For instance, the municipality claims that the ward councillor of ward 57 which Hlalani falls under was tasked with distributing refuse bags to the residents in the study area. However, those refuse bags did not reach the intended recipients hence the appalling state of waste management in the study area. Since the study area falls under informal settlements that are not serviced by the municipality, the councillor had a very significant role to play in the management of waste in the area. Another potential stumbling block in the management of waste in areas such as the study area is that ward councillors are elected based on their political affiliations and not on their educational backgrounds. A case in point, the ward councillor of the ward in Hlalani had limited knowledge of waste management. As a result, the councillor was unable to answer most of the waste management related questions when the researcher interviewed her. Instead, she tried to contact individuals she is politically affiliated with at the municipal offices for assistance. Therefore, ward councillors should be responsible and knowledgeable individuals that can act as the municipality's custodians on the ground. Moreover, the municipality must plan and establish routes for waste collection in the informal settlements. Municipal trucks do not have to go into these areas since infrastructure such as roads is inadequate. However, the municipality could announce collection

day/s where trucks could collect waste from informal settlements at a designated location along the nearest main road. Furthermore, waste management plans could improve in terms of financial resources so that municipalities can deliver to the county's citizens. The growth of informal settlements is escalated meaning waste management budgets need to increase to cope with the demands of these areas. Additionally, informal households should be provided with waste skips in the absence of municipal waste bins. The argument from the waste officials was that there aren't enough waste skips available since the waste department is operating on a thin budget. Manpower is also a significant issue as waste skips need to be managed so that waste goes into the skip as opposed to being around it. Therefore, waste management plans need to be tailored to the specific problems that arise in a particular community and not function as an umbrella as they are at present.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This section offers the conclusive statements formed from the discussion of the findings and there will be some recommendations on how waste management can be improved in the informal settlements. The focus of the research was on sustainable waste management in the informal settlement of Hlalani, Port Elizabeth, to understand its scope and impact on the surrounding environment. The study's objectives such as (1) to identify various waste management plans and practices in the area (2) to find out if the above plans, if any exist, adhere to principles of the waste management hierarchy provided in terms of NEMA: Waste Management Act (3) if no waste management plans exist, to find out whether the city council has future strategies to deal with waste in the Hlalani settlement (4) to provide recommendations on how waste management plans can improve to benefit the community and the environment guided the research towards achieving this aim.

6.2 Key Findings

Based on the data that emerged from the community survey, the study's significant findings indicate that the municipality has never serviced the area as far as waste management is concerned.

Data from the community survey further revealed that all the respondents indicated that they had no exposure to proper handling of waste.

All the respondents in the study indicated that they do not have access to municipal waste bins and instead use items such as drums or plastic basins for storing their waste.

All the respondents believe that there are waste management issues in the area such as illegal dumping of waste.

The community was divided when asked about the source of waste in the Hlalani area. The majority believe that the waste issue in the Hlalani informal settlement is a result of the resident's inappropriate disposal practices.

The majority of the respondents claim that illegal dumping in the area took place when its dark around the midnight hours.

All of the respondents indicated that there are no waste skips near their households in the Hlalani Informal settlement.

All of the respondents claimed that they were not satisfied with waste management services or lack thereof from the municipality.

The majority of the community members claimed that they do not know about recycling.

The majority of the respondents indicated that they did not know the benefits of waste. However, this was not surprising considering that most members of the community did not know about recycling. Though in the minority, certain community members claimed that they knew the benefits of waste.

The majority of the members of the community indicated that they did not know anybody that was making a living from recycling in the area.

Even though members of the community are feeling aggrieved when it comes to waste management in the Hlalani informal settlement, the residents believe that including the community in the management of waste would greatly improve the state of the environment in the area.

6.3 Concluding Remarks

Managing waste in informal settlements seems to be a significant challenge for municipalities in the country. Some community members in Hlalani have lived in the area for almost two decades and they have never received attention from the government in terms of waste management. This is an indication of the struggles that face the South African government when it comes to the provision of houses and waste management services to its citizens. The municipality occasionally gathers the scattered waste and takes it away using waste excavators in the area, however, short term solutions have proven fruitless in combating waste management issues in the Hlalani informal settlement. For as long as the municipality cannot provide municipal waste bins for the residence in these areas then efforts to manage waste in the informal settlements will remain barren. Financial constraints are said to be one of the reasons behind the municipality's failure to provide municipal waste bins in informal settlements. However, the municipality provides waste skips for various formal households in Motherwell, yet those households have municipal waste bins at their disposal. On the contrary, informal settlements are not provided with waste skips whereby those are the people that need them the most. If the South African government is serious about curbing waste management related issues and illegal dumping in these informal areas, then it has to step up its efforts. Furthermore, another significant that seems to be compounding the problem in informal settlements is that the residents have not had exposure to proper management of waste. As a result, unsustainable waste management habits and uncontrolled waste heaps characterize informal settlements.

Furthermore, the community also feels disgruntled and marginalized by the government. The discontent from the community members and the absence of a proper waste disposal heritage on the part of the residents is perhaps the reason behind the issue of illegal dumping. The state of waste management or lack thereof in the informal settlements has encouraged residents of surrounding formal households to also practice open dumping in these areas. One can conclude that the residents of Hlalani and surrounding communities take part in acts of illegal dumping without having to worry about any penalties. However, the residents in Hlalani don't seem to be playing their part in the management of waste and are instead blaming the government for the situation in the area. The municipality needs to provide environmental education for the residents in the area and get the public involved in recycling. Ward councillors also need to be educated individuals as education will enable them to have knowledge of the world around them. Moreover, a strong educational background will ensure that ward councillors are knowledgeable leaders that have opinions on critical issues such as waste management. The 3R's otherwise known as reduce, reuse and recycling provide environmentally-friendly means of reducing the negative impacts that come with growing amounts of waste on the natural environment. The notion of reducing the amount of resources consumed which ultimately results in decreased waste production is essential in sustainable waste management. The objective is to reduce the production of waste which inspires the community and industries to moderate the sum of virgin materials mined. One of the key ideologies vital for sustainable waste management is to manage waste as high up the waste hierarchy as possible. Moreover, introducing a culture where items are reused for a different use is essential in the management of waste. The reuse of material results in less demand for virgin material and curbs the pollution of air, water and land while providing an environmentally friendly mode of managing waste. Recycling means that an item will be transformed into a raw material that can be shaped into a new item. Therefore, the recycling of material moderates the utilization of energy and slows down the depletion of raw materials. One can conclude that residents of Hlalani perceive waste as a commodity that is destined for the landfill site since the majority claimed that they had never heard about recycling. Public participation is one of the fundamental principles of sustainable development where the general public gets to voice their opinions on decisions that have an impact on their welfare.

6.4 Recommendations

- The municipality should improve relations with the communities as public participation in the management of waste in the study area is non-existent.

- Provide environmental education to the communities to improve their knowledge of the importance of managing waste sustainably.
- Municipalities should acknowledge that informal settlements exist and thus should provide them municipal services like municipal waste bins.
- Municipal trucks should stand on the main road on certain days so that the residents can bring their waste.
- Encourage the community to reuse items that would, in turn, assist reduce the volume of waste that is disposed to the landfill and involves them in waste management campaigns.
- Provide and manage waste skips in these informal areas to enable residents to at least have a place to dispose of their waste.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR HLALANI INFORMAL SETTLEMENT RESIDENTS

Assessing Sustainable Waste Management in the informal settlements, Case Study of Hlalani Area, Port Elizabeth

Researcher details: Sibongile Matebese – Masters student in the Department of Environmental and Occupational Studies @ CPUT. Email: Sibongile. matebse@gmail.com Tel: 061 174 4350

Supervisor details: Dr Ntokozo Malaza, HOD - Department of Environmental and Occupational Studies @ CPUT. Email: Malazan@cput.ac.za. Tel: 021 4 609040

Co-supervisor details: Dr Vincent Zungu, Senior Lecturer – Department of Environmental and Occupational Studies @ CPUT. Email: Zunguv@cput.ac.za. Tel: 0214609064

NB:

- The questionnaire is purely for the purpose of academics hence your personal details are not required to ensure confidentiality as part of the ethical rule guiding this research study.
- You can withdraw your participation in this study at any time.

1. How long have been staying in this area?

2. Ethnic Group
   - Black
   - White
   - Coloured
   - Indian
   - Other

3. Employment Status
   - Unemployed
   - Employed
   - Self Employed

4. How many people reside in your home?

5. How many people are working?

6. Gender (tick applicable answer)
   - Male
   - Female

7. What is your highest educational level?
   - Matric
   - Certificate
   - Diploma
   - Degree
   - Other

8. Have you been exposed to proper handling of waste?
   - Yes, a lot
   - Partly
   - No

10. What type of solid waste comes out from your household?
    - Plastics
    - Paper
    - Tins and cans
    - fibre and glass
    - Other

11. Do you have dustbins to collect household waste?
    - Yes
    - No

12. Does the municipality collect waste in the area?
    - Yes
    - No
    - Sometimes

13. If so, how many times a month?
    - Once a week
    - Twice a month
    - Other

14. Are there any waste issues in the area such as illegal dumping?
    - Yes
    - No

15. If yes, how regular are these occurring?
    - Once a week
    - Once a month
    - More often

16. Where is this waste coming from, e.g. the community households?

17. Is there a specific time illegal dumping takes place?

- Morning hours
- Afternoon hours
- Midnight hours

18. Are there waste skips near your house?

19.1 If yes, how long does it take you to get there?

19. Do you think waste management is a problem in the area?

- Yes
- No
- Partly

20. Are you satisfied with waste management services by the municipality?

- Yes
- No
- Partly

21. What do you think needs to be done?

22. Have you heard about recycling?

23. Do you know the benefits of waste?

24. Is there anyone that you know that is making money from waste in the area?

APPENDIX B

INTERVIEW QUESTIONS FOR WASTE MANAGEMENT OFFICIALS

Assessing Sustainable Waste Management in the informal settlements, Case Study of Hlalani Area, Port Elizabeth

Researcher details: Sibongile Matebese – Masters student in the Department of Environmental and Occupational Studies @ CPUT. Email: Sibongile. matebse@gmail.com Tel: 061 174 4350

Supervisor details: Dr Ntokozo Malaza, HOD - Department of Environmental and Occupational Studies @ CPUT. Email: Malazan@cput.ac.za. Tel: 021 4 609040

Co-supervisor details: Dr Vincent Zungu, Senior Lecturer – Department of Environmental and Occupational Studies @ CPUT. Email: Zunguv@cput.ac.za. Tel: 0214609064

1. Does the NMBM have a MSWM plan for the Hlalani Informal Settlement?
2. If there is a MSWM plan for the area, does it promote Sustainable Waste Management or adhere to principles provided in NEMA?
3. How can the residents of Hlalani be incorporated in the management of waste?

APPENDIX C

INTERVIEW QUESTIONS FOR WARD COUNCILLOR

Assessing Sustainable Waste Management in the informal settlements, Case Study of Hlalani Area, Port Elizabeth

Researcher details: Sibongile Matebese – Masters student in the Department of Environmental and Occupational Studies @ CPUT. Email: Sibongile. matebse@gmail.com Tel: 061 174 4350

Supervisor details: Dr Ntokozo Malaza, HOD - Department of Environmental and Occupational Studies @ CPUT. Email: Malazan@cput.ac.za. Tel: 021 4 609040

Co-supervisor details: Dr Vincent Zungu, Senior Lecturer – Department of Environmental and Occupational Studies @ CPUT. Email: Zunguv@cput.ac.za. Tel: 0214609064

1. Does the NMBM have a MSWM plan for the Hlalani Informal Settlement?
2. If there is a MSWM plan for the area, does it promote Sustainable Waste Management or adhere to principles provided in NEMA?
3. How can the residents of Hlalani be incorporated in the management of waste?

APPENDIX D

nelson mandela bay
MUNICIPALITY

CORPORATE SERVICES

Your ref:

Our ref:

Date: 03 July 2019

Who deals with this: Ms.T Mdaka

Tel: +27 (0) 41 506 3396

Fax: +27 (0) 41 503 3396

e-Mail: tmdaka@mandelametro.gov.za

CAPE PENINSULA UNIVERSITY OF TECHNOLOGY

Dear Mr.Sibongile Matebese

LETTER OF AUTHORIZATION TO CONDUCT RESEARCH AT THE NELSON MANDELA BAY MUNICIPALITY (NMBM)

This letter serves as authorization for Sibongile Mtebese registered for Masters in Environmental Management conduct a research project titled "Sustainable Waste Management in the informal Settlements in Nelson Mandela Bay Municipality (NMBM).

Upon a review of the letter sent to us by your Institution, we are pleased to offer you an opportunity to conduct the relevant study in our organization. All interviews, filed surveys, observations around the Municipality and the distribution of questionnaires are to be retreated as confidential and will be duly supervised by the Office of the Executive Director: Corporate Services sub-directorate: Skills Development & Employment Equity.

You are welcome to contact Ms.Ntombizandile Booi on 041-506 2894 with enquiries.

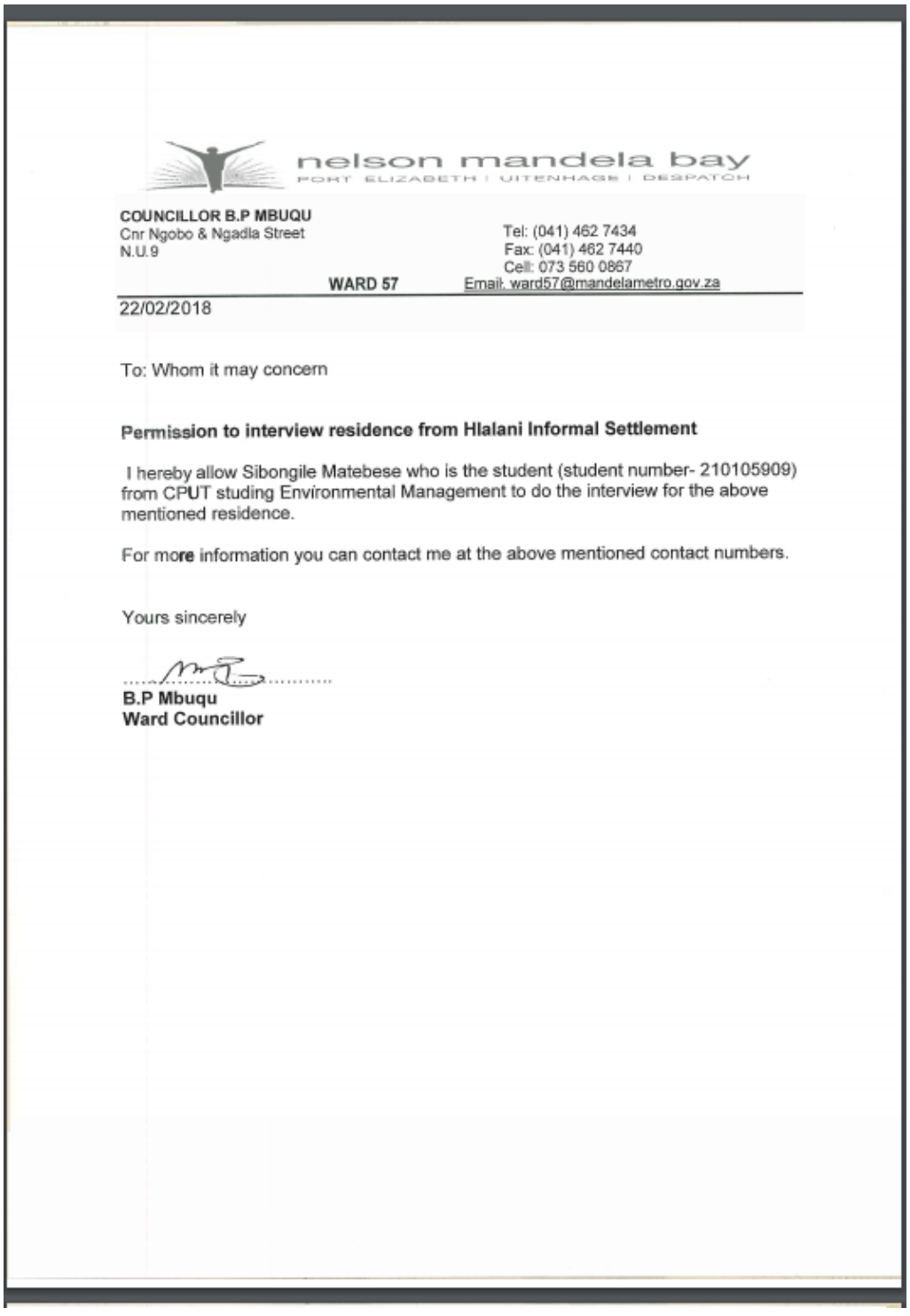
We wish you all the best in your research.

Yours faithfully,

Ms.T Mdaka

Deputy Director: Skills Development and Employment Equity

APPENDIX E



nelson mandela bay
PORT ELIZABETH | UITENHAGE | DESPATCH

COUNCILLOR B.P MBUQU
Cnr Ngobo & Ngadla Street
N.U.9

Tel: (041) 462 7434
Fax: (041) 462 7440
Cell: 073 560 0867
WARD 57 Email: ward57@mandelametro.gov.za

22/02/2018

To: Whom it may concern

Permission to interview residence from Hlalani Informal Settlement

I hereby allow Sibongile Matebese who is the student (student number- 210105909) from CPUT studing Environmental Management to do the interview for the above mentioned residence.

For more information you can contact me at the above mentioned contact numbers.

Yours sincerely

.....

B.P Mbuqu
Ward Councillor

APPENDIX F

Cape Peninsula University of Technology

Statement of Permission

Data/Sample collection permission is required for this study.

Reference no.	**210105909**/08/2019
Surname & name	**Sibongile Matebese**
Student Number	**210105909**
Degree	**MASTER OF ENVIRONMENTAL MANAGEMENT**
Title	Sustainable waste management in the informal settlement of Hlalani, Port Elizabeth, Eastern Cape
Supervisor(s)	Dr Ntokozo Malaza
FRC Signature	A. J
Date	30/8/2019

Cape Peninsula University of Technology

P.O. Box 1906 · Bellville 7535 South Africa ·Tel: +27 21 953 8677 (Bellville), +27 21 460 4213 (Cape Town)

Ethics Certificate **Reference no: 210105909/06/2019**

Office of the Chairperson **Research Ethics Committee**	**Faculty of Applied Sciences**

The Faculty Research Committee, in consultation with the Chair of the Faculty Ethics Committee, has determined that the research proposal of **Sibongile Matebese** for research activities related to a project to be undertaken for a MASTER OF ENVIRONMENTAL MANAGEMENT at the Cape Peninsula University of Technology requires ethical clearance.

Title of project:	Sustainable waste management in the informal settlement of Hlalani, Port Elizabeth, Eastern Cape

Comments (Add any further comments deemed necessary, e.g. permission required)

1. Animal/human subjects are included in the proposed study.
2. This permission is granted for the duration of the study.
3. Research activities are restricted to those detailed in the research proposal.
4. The research team must comply with conditions outlined in AppSci/ASFREC/2015/1.1 v1, CODE OF ETHICS, ETHICAL VALUES AND GUIDELINES FOR RESEARCHERS.

	28/08/2019
Signed: Chairperson: Research Ethics Committee	**Date**