Current waste management and minimisation patterns and practices: An exploratory study on the Ekurhuleni Metropolitan Municipality in South Africa

By

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DECLARATION

Student number: **42362407**

I declare that:"**Current waste management and minimisation patterns and practices: An exploratory study on the Ekurhuleni Metropolitan Municipality in South Africa**" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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(Miss SE Gumbi)

ABSTRACT

Growing municipal waste mismanagement and associated environmental impacts is an enormous environmental concern in developing countries such as South Africa. Hence, this study explored current waste management and minimisation patterns and practices in the Ekurhuleni Metropolitan Municipality (EMM), located east of the Gauteng province. The study was undertaken using a mixed method design, particularly the concurrent triangulated design where the quantitative and qualitative data were collected at the same time. The methods employed were desktop surveys, interviews with the participants and use of questionnaires which were designed based on the objectives of the study. The questionnaires were designed for different types of participants (namely, households, informal reclaimers, municipal officials and landfill officials).

All the data collected were stored in Microsoft Excel (2010) spread sheet for statistical analyses. The study has revealed some patterns, practices as well as trends regarding waste management and minimisation within the EMM municipality. At household level, there was some environmental awareness on waste management practices provided by the municipality as well as local recycling options although there are numerous challenges to be resolved before these functions can become effective. With informal recycling, a number of waste materials are being reclaimed at various landfill sites. However, current informal waste picking activities by the so-called scavengers are not sustainable as waste is not separated prior to disposal at various point sources. In addition, informal reclaimers have to travel long distances to reach waste sources. Another concerning constraint hampering the effectiveness of informal waste recovery, has to do with their daily exposure to several environmental and health risks. Furthermore, the study has found out that the EMM is predominantly focused on providing better waste management services rather than balancing this activity with waste minimisation through reclaiming and recycling operations. Thus, the municipality lacks adequate infrastructure to undertake waste minimisation effectively. Also, waste minimisation and awareness campaigns were found to be inadequate and at an infant stage, unlike those carried out by private companies. In view of these findings, a number of recommendations have been made.

KEYWORDS: Waste management; practices and patterns, trends, waste minimisation; surveys, developing countries; South Africa; Ekurhuleni Metropolitan Municipality.

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
CBO	Community Development Organisation
CSIR	Council for Scientific Industrial Research
CBD	Central Business District
CESET	Cebu Environmental Sanitation Enforcement Team
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DEPA	Denmark Environmental Protection Agency
DWAF	Department of Water Affairs and Forestry
EA	Environmental Authorisation
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
EMM	Ekurhuleni Metropolitan Municipality
EU	European Union
GDP	Gross Domestic Product
GDACE	Gauteng Department of Agriculture, Conservation and Environment
GDARD	Gauteng Department of Agriculture and Rural Development
GHG	Green House Gases
GIS	Geographical Information System
GN	Government Notice
HDI	Human Development Index
IDP	Integrated Development Plan
IWMP	Integrated Waste Management Plan
ISWM	Integrated Solid Waste Management
KG	Kilogram
MWH	Megawatt Per Hour
MSW	Municipal Solid Waste
MYSA	Mathare Youth Sports Association
MSWM	Municipal Solid Waste Management
NCC	Nairobi Clean-up Campaign
NEMA	National Environmental Management Act No.107 of 1998
NEMWA	National Environmental Management Waste Act No. 58 of 2008

ABBREVIATION	DESCRIPTION
NGO	Non-Governmental Organisation
NIMBY	Not In My Back Yard
NWMS	National Waste Management Strategy
PET	Polyethylene Terephthalate
PHP	Philippines Peso
PPEs	Personal Protective Equipments
PPP	Public Participation Process
PRASA	Paper Recycling Association of South Africa
SWM	Solid Waste Management
SoER	State of Environment Report
UN	United Nations
UNDP	United Nations Protection Department
UNEP	United Nations Development Programme
UKEPA	United Kingdom Environmental Protection Act
USA	United States of America
SADC	Southern Africa Development Community
SEPA	Scottish Environmental Protection Agency
USEPA	United States of America Environmental Protection Agency
WHO	World Health Organisation
WML	Waste Management Licence
WMS	Waste Management Systems
WSSD	World Summit on Sustainable Development

CHAPTER 1

INTRODUCTION AND RESEARCH BACKGROUND

1.1 INTRODUCTION AND RATIONALE FOR THE RESEARCH

About 1.3 billion tons of municipal waste per annum is generated globally and this constitutes about 3.6 million tons/day, while the average daily rate per capita generation worldwide is 1.2kg (Hoornweg and Tata, 2012). Developed countries tend to generateon average about 2.2kg/capita/day of municipal solid waste (MSW) meanwhile developing countries produce MSW ranging between 0.45-0.95 kg(Hoornweg and Tata, 2012). These trends are expected to double within the next 15 years, from 1.3 billion tons in 2010 to 2.2 billion tons in 2025 (Ayuba, 2013). The greatest contributors to these increases are developing countries due to their rapid urbanisation as well as anticipated economic growths, phenomena associated with unrestrained consumption of goods and services and inevitably large quantities of waste (Ayuba, 2013; Hoornweg and Tata, 2013). The generation rate of MSW is, however, lower in rural areas as residents there are generally poor, thus consuming less goods when compared to urban dwellers (Chalmin and Gaillochet, 2009).

Urban areas in developed countries tend to generate high MSW quantities. However, they are well equipped and have reliable mass and material flow data on waste quantities from a life-cycle perspective (Rand*et al*., 2000; Mendes and Imura, 2004; IPCC, 2006). MSW is managed better in developed countries due to effective waste legislation, policies and strategies as well as the availability of resources and tools to execute waste management. Such resources include adequate finances and provision of waste bins to enable households to separate waste at source and in countries such as Germany, USA and Denmark there are high taxes imposed on households for the disposal of high volumes of mixed waste at landfill facilities(EEA, 2009; ETC/SCP, 2009; USEPA, 2012).

Furthermore, waste generated in urban areas is often disposed off in the outskirts of the cities where most landfill facilities are located. Unfortunately, it is the poor who often reside in the urban periphery and sometimes closerto the landfill sites,thus they suffer from life threatening conditions derived from deficient solid wastemanagement (Lohani, 1984;Zurbrugg, 2002).The effective and efficient waste management of MSW in urban areas is therefore critical.

Municipal solid waste mismanagement is a challenging environmental problem, particularly in the urban areas of developing countriessuch as Nigeria, Philippines and India (Gupta *et al*., 1998; Navarro,2003; Ayuba, 2013), due to increasing urbanisation, lack of funds and managerial skills, poor environmental awareness campaigns and rapidly declining space for the commissioning of new landfill sites (UNEP, 2000; Mcbean, *et al*., 2007; Njoroge*et al.,*2014). The other major challenges experienced by developing countries entail the collection and disposal of waste. One-third of MSW generated remains uncollected at source and the balance of waste uncollected is not disposed at appropriate landfill facilities (Hoornweg and Tata, 2012; Sankoh and Yan, 2013). Consequently, there

is illegal dumping and its potential to pollute ambient air and freshwater resources as well asundermining human health(Mcbean*et al.*, 2007). According to Ayuba (2013), the majority of developing countries have waste management standards, legislation and policiesthat are out-dated and of a poor quality.Lack of proper planning also hinders the implementation of adequate waste management services by waste officials.

1.2 THE RESEARCH PROBLEM

Globally, the increased generation of municipal solid waste is widely recognised due to its negative environmental impacts (Formas, 2004;Akesson, 2004; Shekdar, 2009;Kollikkathara *et al.*, 2009; Demirbas, 2011). Over the past decades, numerous researches have been conducted to identify the impacts caused by waste andassociated mitigation measures proposed to help reduce these impacts (Vidanaarachchia*et al.*, 2006; Sankoh*et al.,*2013; Oke, 2015). However, the solutions implemented successfully in developed countries such as Germany, might not be effective in developing countries due to different geographical contexts and socio-economical dynamics involved(Agunwamba, 1998).

Thus, the mismanagement of solid waste in developing countries is a concerning environmental planning challenge given its improper disposal and detrimental environmental impacts (Mcbean *et al.*, 2007; Ogwueleka, 2009). Municipal solid waste mismanagement is even worse in urban areas where settlements are densely populated in comparison to rural areas (Cointreau, 2006; Sharholy*et al.,* 2008). In such areas, thecontrol of waste management activities is problematic for local authorities because of the rapid influx of people and their attendant households. Inevitably, ineffective disposal of waste will occur, especially in those areas where residents cannot afford to pay for municipal services.

South Africa's natural and human environments are being degraded by litter and illegal dumping found mostly where there are open spacesand human settlements (Moiloa, 2007;Fei-Baffoe,2009). As a result, local authorities have erected billboards and signs (for example: "Illegal dumping is not allowed") within the areas of their jurisdictions. The aim of these signs and billboardsis mainly to discourage and prohibitsuch irresponsible attitudes and behaviour among~~st~~ South Africans.However, such initiatives have not been successful thus far, as there is widespread waste mismanagement in many areas. Therefore, drastic measures and concerted efforts by the provincial, local authorities and the general public need to be undertaken. It must be noted that in the Gauteng province,this is even a greater challenge due to limited space available for the expansion or commissioning of new landfill sites (The CitizenNewspaper, 2011; Joburg IDP, 2013).

The Ekurhuleni Metropolitan Municipality (EMM) is one of the densely populated metropolitan municipalities in the Gauteng province and is home to approximately 2.8 million people as of 2011 (EMM IDP, 2011/2014). This municipality has a higher population density (1400 per km^2) when compared with that of the Gauteng province (596 people per km^2). In fact, the EMM is approximately 135% more densely populated than the entire Gauteng province. Whereas some district municipalities in the Gauteng province and a few other provinces have been investigated in detail regarding their waste management and minimisation patterns and trends (Mnisi, 2008; Bhagwandin,

2013), there is little understanding about this phenomenain the EMM. Given this paucity of scientific knowledge,an exploratory study oncurrent waste management and minimisation patterns and practices in the EMM, which is located in the eastern part of the Gauteng province, became imperative to be conducted.

1.3 RESEARCH AIM AND OBJECTIVES

Given the research problemstated above, the aim of the study was to characterise the status quo of current waste management and minimisation in the EMM municipality. In order to achieve thisaim, the following research objectives were set for the research:

- To identify and analyse existing wastemanagement and minimization activities being undertaken by the municipality, households and the private sector in the selected study area;
- To determine the level of public awareness on waste management and recycling operations in the EMM ;
- To estimate the willingness to participate in waste minimisation and recycling by the different stakeholders;
- To identifyand analyse constraints hindering effective waste minimisation;
- To identify the landfill sites within EMM with a view to paying special attention to aspects:
  - Types and quantities of waste disposed of;
  - Nature of recycling initiatives at landfill sites;
  - Operational permits and management conditions and issuing authority;
  - Types of environmental monitoring conducted;
  - Health and safety of informal recyclers;
  - Waste to energy projects; and
- To recommend possible mitigation measures, best practices and further studies whichmayberequired to assist EMM in the implementation of sustainable integrated waste management.

1.4 STRUCTURE OF THE DISSERTATION

This dissertation has six chapters. Chapter One introduces the study and provides the rationale for the research as well as the research problem, aim and objectives. Chapter Two is mainly literature review,paying specific attention to developed countries (Germany, United States of America, Denmark and Japan) and developing countries (South Africa, Kenya, Philippines and India), and current waste generation. Thestate of waste management and the tools used to minimise waste as well as challenges and successes are also reviewed. Chapter Two further reviewsdifferent methods of managing waste employed in South Africa. Chapter Three describes the research design adopted for this study and different methodologies selected. Chapter Four provides an overview of the study area,Gauteng province and also focuses on the Ekurhuleni Metropolitan Municipality. In addition, the same chapter briefly describes the prevailing biophysical and social environments. Chapter Five presentsand discusses the research results making use of graphs and tables on (1) household waste

management, awareness and challenges; (2) municipal waste management service delivery, staff complement and operations, finances, awareness campaigns, waste minimisation programs and challenges; (3) the role and operation of informal recyclers, health and safety and challenges and lastly;as well as (4) landfill management and challenges. Chapter Six provides conclusions as well as recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides a review of the literature on municipal waste management and minimisation aspects and tools used such as legislation and policies to address waste-related challenges. The literature review is divided into six sections which are (1) terms and concepts on waste management and minimisation; (2)aspects of waste management and minimisation in developed countries; (3) status of waste management and minimisation in developing countries; (4) status of waste management and minimisation in South Africa, legislation and policies devised to assist with effective waste management and the role of local authorities;(5) other methods of waste management which have been implemented successfully and (6) a summary of the findings and gaps needing further research .

2.2 TERMS AND CONCEPTS CONNECTED WITH WASTE MANAGEMENT AND MINIMISATION

2.2.1 Defining Waste

The United Kingdom Environmental Protection Act (UKEPA) (1990) defines waste as:

> *"Any substance which constitutes a scrap material or an effluent or other unwanted surplus substances arising from the application of any process; and as any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled but does not include a substance which is an explosive within the meaning of the Explosive Act 1875."*

Source: United Kingdom Environmental Protection Act (1990:100)

Waste is further classified into groups, namely: origin (household, clinical, urban and industrial and agriculture); form (liquid, solid, gaseous and powder);and properties (toxic, reactive, acidic, alkaline, inert, volatile and carcinogenic).Waste may also be defined according tolegal criteria such as controlled waste, commercial waste and demolition waste (Porteous, 2008;UKEPA, 1990).

2.2.2 Municipal Solid Waste

Municipal solid waste is a classification or term applied to all waste that is being handled by municipalities or local authorities and their sources are households, streets, public places, retail shops, hospitals and commercial offices (Zurbrugg, 2004). Solid waste refers to materials that are not in a liquid form and have no value to the person discarding them away. According to Leton and Omotosho (2004), solid waste is the non-liquid and non-gaseous products of human activities regarded as being useless. In addition, solid waste can also be considered as refuse and garbage. Municipal solid waste (MSW) usually entails wastes generated from households, street pavements, shops, offices and hospitals, and this is the responsibility of local municipality and other governmentspheres (Schübeler*et al*., 1996). In most instances, municipal solid waste is collected by a municipal collection scheme (Marcher, 2005).

2.2.3 Waste Management

Waste management entails the collection, transportation, processing, disposal and monitoring of waste materials. The term usually relates to the management of materials produced by human activity, and the process is generally undertaken so as to prevent or reduce their negative effect on health, the environment or aesthetics (Otchere*et al*., 2014). All waste materials, whether they are solid, liquid, gaseous or radioactive fall within the remit of waste management (Dadson *et al*., 2013). Waste management practices may differ between developed and developing nations, urban and rural areas, and residentialas well as industrial producers (Golush, 2004; Nnorom *et al*.,2009; Magutu and Onsongo, 2011; Chandrappa and Das, 2012;Tacoli, 2012). The management of non-hazardous and residential waste and institutional waste in metropolitan areas is usually the responsibility of local government, while management of non-hazardous commercial and industrial waste is usually the responsibility of the generator, subject to local, national or international laws and regulations (Lewis, 2007).

2.2.4 Waste Minimisation

Waste minimisation is the reduction of waste at source through reuse and recycling. Furthermore, the minimisation of waste is a process that involves reducing the amount of waste produced in society and it helps to eliminate the generation of harmful and persistent wastes, thus supporting efforts to promote a more sustainable society (USEPA, 2012). The minimisation of waste includes 3Rs which can be summarised as reduce, reuse and recycle. The 3Rs have alsobeen used to structure the so-called waste hierarchy (Hawkins and Shaw, 2004; Bernan, 2008; Jones*et al*., 2009; Pires *et al*., 2011; Gin *et al*., 2013).

2.2.4.1 Waste Hierarchy

The waste management hierarchy is an internationally accepted guide for prioritising waste management practices with the objective of achieving optimal benefits from products prior to being discarded as well as reducing the detrimental environmental impacts. The hierarchy sets out the preferred order of waste management practices, from most to least preferred (South Australia Zero Waste Strategy, 2010). The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste which can be disposed to landfill sites (Williams, 2005; Vancouver Waste Management Strategy, 2008; Demirbas, 2011).

The waste management hierarchy comprises of five waste management categories and these are prevention (reduction), re-use, recycling, waste treatment, energy recovery and disposal (USEPA, 2002; DEA, 2007; Matete and Trois, 2008; South Australia Zero Waste Strategy, 2010). The elements of the waste hierarchy are briefly described as follows (1) Waste Prevention: It seeks to prevent waste from being generated. The prevention strategies of waste include using less packaging, designing the product to last longer and reusing the products and material. Waste prevention helps reduce handling, treatment and disposal costs. It further reduces the generation of methane. Regarding (2) Recycling and Composting, the following explanation applies: Recycling is a process that involves collecting, reprocessing and recovering certain waste material (glass, paper, metal, plastic) to make new material or products. Recycling and composting generate environmental and economic benefits (employment, income, a supply of valuable raw materials to industry, the production of oil enhancing compost, a reduction in greenhouse gas emission, a number of landfills and combustion facilities). Furthermore, there is (3) Disposal (Land filling and combustion): These activities are used to manage waste that cannot be prevented or recycled. Properly designed landfills with available technology can be used to generate energy by recovering methane. Combustion facilities produce steam and water as by-products that can be used to generate energy as well (USEPA, 2002; DEA, 2007; Matete and Trois, 2007; South Australia Zero Waste Strategy (2010).

Figure 2:1: Waste Management Hierarchy.
Source: Australia zero waste strategy (2010).

The structure of the waste hierarchy has evolved and taken many shapes over the years since its conception, to address the diversity of waste challenges in respective countries (South Australia Zero Waste Strategy, 2010; USEPA, 2010). The main objective of this tool is the same throughout the world which is sustainable waste management through prevention and reuse (Gauteng Provincial Integrated Waste Management Policy, 2006; EEA, 2013). This tool has been used internationally in addressing waste management issues and has been incorporated in waste management strategies, polices and legislation such as the South African National Environmental Management Act (No.107 of 1998); South African Waste Strategy (2012); United Kingdom Waste Regulations (2011); South Australia Zero Waste Strategy (2010); and the EU Waste Policy (1999).

2.2.5 Developing and Developed Countries

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

development, inadequate housing and public services, poor health, low labour productivity because of the lack of complementary factors, such as capital and the experienced management to raise it.Most developing countries have very high population rates with high birth rates and declining death rates(World Bank, 2013). Developing countries are, in general, countries that have not achieved a significant degree of industrialisation relative to their populations and have, in most cases, a medium to low standard of living. There is also a strong correlation between low income and high population growth (World Economic Situation and Prospects, 2012). On the other hand, developed countries are usually associated with effective public services rendered by governments and the private sector (UNEP, 2000; World Economic Situation and Prospects, 2012;Zhu, 2008). In addition,such countries have a high gross domestic product (GDP) per capita and highlevels of industrialisation. The non-economic factors associated with developed countries are a higher HDI which reflects superior quality of education,literacy, health, high standards of living and public services (Niesel, 2011; Ghana Stats, 2013).

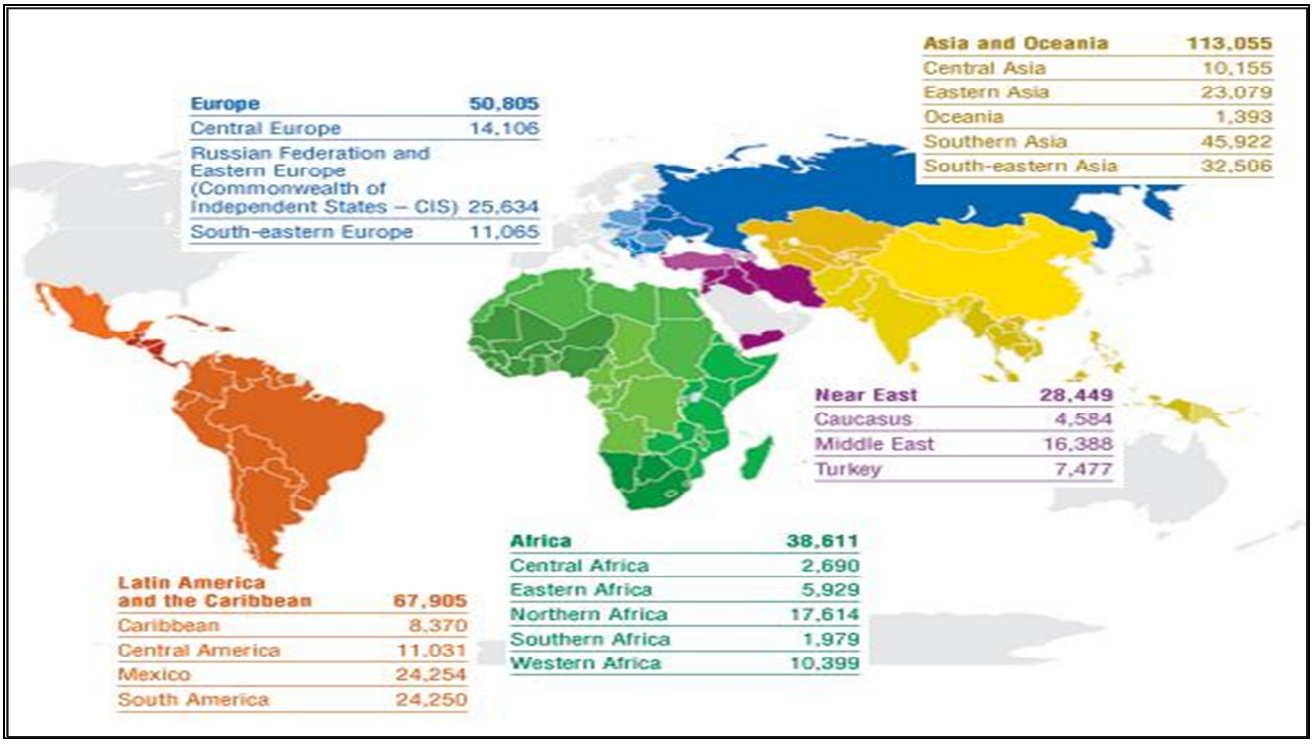

Figure 2:2: List of developing countries.
Source: IFAD (2007).

2.3 WASTE MANAGEMENT AND MINIMISATION IN DEVELOPED COUNTRIES

This section reviews the state of waste management, tools and programmes implemented to deal effectively with waste in developed countries. The countries reviewed are Germany, Denmark, United States of America and Japan.Generally, the more economically prosperous a country is, the more waste is generated per capita (Navarro, 2003). Table 2.1 presents a comparison of municipal waste generation inthree different cities in the world, namely, New York, Hamburg and Rome (World Bank,

2001). Waste production trends for the year 2001 illustrate that New York generated 1.80 kg/capita/day of waste, followed by Hamburg with 0.85kg/capita/day and the city which generated the least amount of waste is Rome with 0.69kg/capita/day. According to Cudecka (2013), Rome generated 535kg/capita of waste in 2011.This translates to 1.46 kg/capita/day which is higher than the amount of waste generated in 2001. In 2010, Hamburg generated 2.90 kg/capita/day of MSW whichis equivalent to 0.79kg/capita/day. This depicts a declining trend over the past nine years of MSW generated in Hamburg. According to the New YorkSolid Waste Management Plan (2010), New York City is planning to reduce its MSW to 0.27kg/capita/day in 2030 from the 1.85kg/capita/day currently being generated. In Germany, new laws and regulations which obliged manufacturers to account for waste generated and enforced restrictions to landfilling of waste were introduced during the early 1990s. These regulatory instruments forced citizens to reduce the amount of waste generated, thus contributingsignificantly in the reduction of waste quantities (EEA, 2009).

Table 2:1: International municipal solid waste generation by city.

City and Country	Generation (Kg/Capita/Day)
Industrialised Countries:	
New York, USA	1.80
Hamburg, Germany	0.85
Rome, Italy	0.69

Source: World Bank (2001).

The world faces immense challenges in not only minimising waste but utilising and reusing it. This will worsen the problem with the global middle class projected to grow to 4.9 billion by 2030 (Infrastructure News, 2013). Internationally, municipalities are challenged by the complexities involved in solid waste management (Zurbrugg, 2004). These complexities include the increasing population, increasing generation of waste, the limited resources available for its management and the lack of responsibility on the part of waste generators which worsens the problem (Zurbrugg, 2004; Omran and Read, 2008). This means that understanding or trying to respond to the improper management of municipal solid waste is a complex process. Waste is generated by different sectors such as commercial establishments (for example, stores, filling stations, and retail offices), educational institutions such as schools and universities, health (hospitals and clinics), recreation (sporting activities and community parks), and tourism (hotels), among others, found mostly in cities and towns (United States International Trade Commission, 2004; Ahmed *et al*., 2011).

2.3.1 Germany

2.3.1.1 Municipal Waste Management

Germany is a Federal Republic consisting of sixteen Federal States (Kesselman*et al*., 2012). The responsibility for waste management and environmental protection is shared between the National

Government, the Federal States and Local Authorities. The National Ministry of Environment sets priorities and participates in the enactment of laws, oversees strategic planning, information and public relations as well as defining requirements of waste facilities (EEA, 2009; Fischer, 2013). Each federal state adopts its own waste management legislationand this may be accompanied by supplementary regulations (EEA, 2009). In Germany, there is no national waste management planning, instead each federal state develops a waste management plan for the area under its jurisdiction (EEA, 2009;Fischer, 2013). In 1990, the German waste association reported that an estimated 50 million tons of commercial and household waste werecollected annually (Integrated Solid Waste Management in Germany, 1995). There were 2,620 landfill sites in 1990, which reflect that the landfill sites were the preferred method of managing household waste (Integrated Solid Waste Management in Germany, 1995).

Germany was the first country in the European Union to introduce producer responsibility for packaging waste regulation in 1991. This means that the producer of a product is responsible for the product when it becomes waste. This regulation is only applicable to some product types such as packaging materials, electronic equipment, vehicle scrap parts,solvents, waste oil and batteries (Rousso and Shah, 1994; EEA, 2009; Kunz *et al*., 2013).

Local authorities are responsible for waste generated at households and their responsibility covers the collection, transportation and also devising measures to promote waste prevention and recovery, planning, construction and operating waste disposal facilities (Sakkai *et al*., 1996; Schwarz-Herion*et al*., 2008). In addition, local authorities subcontract private companies to assist with waste management services (Schwarz-Herion*et al*., 2008). In Germany, there are dedicated waste bins assigned for different types of waste. For an example, the grey lid colour is for residual waste, the red lid colour is for reusable waste and the green lid colour is bio-waste.After collection, waste is transported to different destinations for recycling and composting and other treatments (Schwarz-Herion*et al*., 2008).

Developments of MSW generation per capita in Germany for the period of ten years (2001 to 2010) are briefly reviewed below, and are also illustrated by Figure 2.3. In 2001 to 2010, the average waste produced per capita in the country was approximately 593kg (Eurostats, 2012). According to Eurostats (2012), the highest quantity of waste produced was 632 kg/capita in 2002 and the lowestwas 564kg/capita in 2005 and 2006. There was a steady increase between 2007 and2009. Despite fluctuations in the quantities of MSW generated during this time frame, there was a declining trend between 2001 and 2010 (Figure 2.3) (Eurostats, 2012; Fischer, 2013). In addition, this decrease in waste quantities continued despite the economic recession which occurred between 2008 and 2009 (German Municipal Solid Waste Report, 2006). In 2005, the Government of Germany through the Waste Storage Ordinance enforcedthe cessation of landfilling untreated biodegradable municipal solid waste containing organics. This was implemented throughout the country and the landfill facilities which were not complying with this order were closed down (German Municipal Solid Waste Management Report, 2006). In 1990, the country had 8273 landfill sites and in 2000 there were 333 (German Municipal Solid Waste Management Report, 2006). Thus, there was a drastic

decline in the numbers of the landfills over a period of ten years. The decline was due to the lower volume of waste that was conveyed to the landfill facilities as well as recycling measures implemented in the country (German Municipal Solid Waste Report, 2006).

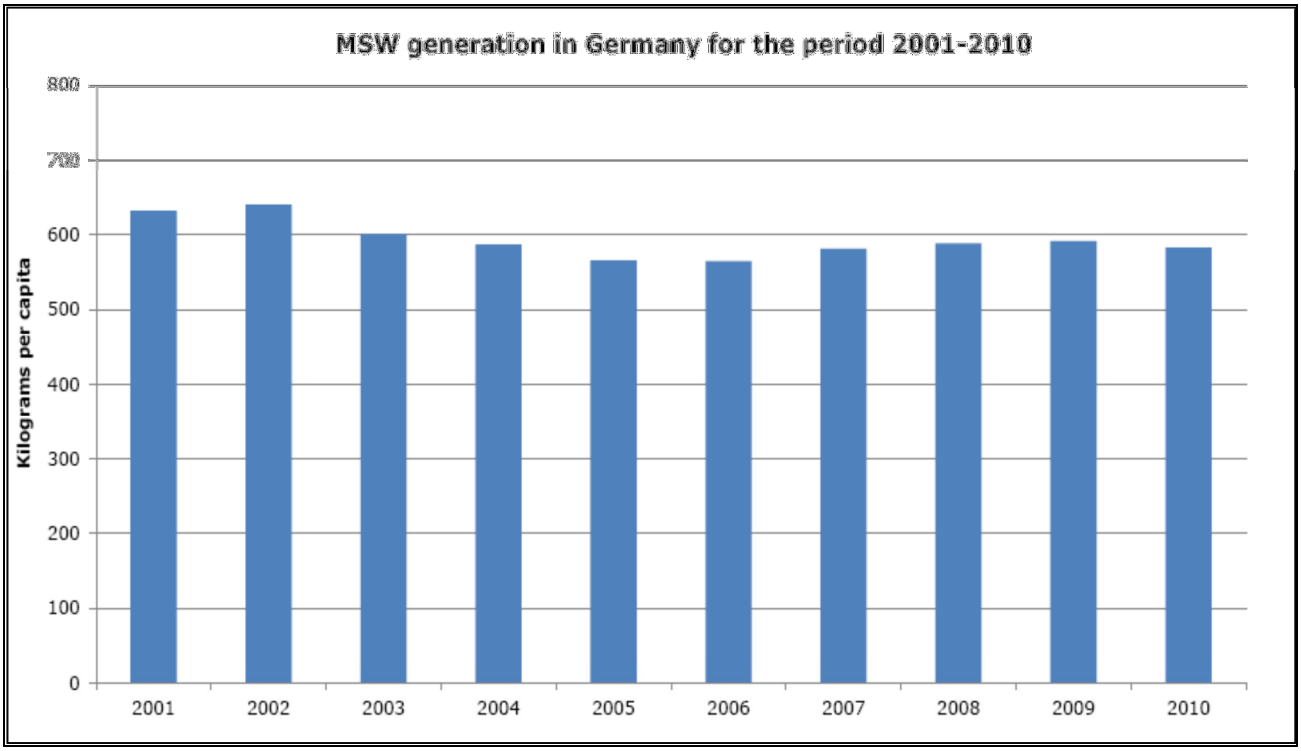

Figure 2:3: MSW generation per capita.
Source: EuroStats(2012).

2.3.1.2 Municipal Waste Minimisation

Germany appears to be leadingin terms of the enforcement and implementation of waste minimisation strategies within the European continent(Sakkai *et al.*, 1996; Hitchens, 2000*et al.*; Clark and Veil, 2009; EEA, 2013). This shows how the waste industry contributes to sustainable economic production and management by saving raw materials and energy resources(EEA, 2013).The European countries have introduced a landfill tax which is aimed at discouraging the disposal of large volumes of MSW at landfill facilities and encouraging the separation of waste at source. In Germany, this form of regulation has never been introduced, although the country has managed to achieve a high recycling rate in comparison to other European countries. Such phenomenal performance regarding recycling rates can be attributed tothe waste minimisation legislation introduced in the early 1990s(EEA, 2009).

The materials which are recycled in Germany include metals, glass, plastic, paper, cardboard and organic materials that are composted.According EuroStats(2012), the lowest recycling rate was in 2001 (48%), the highest recycling rate in 2008 (64%) and the average recycling rate was approximately 59%. Overall, the MSW recycled in the 2001 and 2010 timeframe increased slightly and remained above 60% (EuroStats, 2012) (Figure 2.4). Furthermore, an average of 50% of the

population in Germany collects bio-waste by using bio-bins due to greater public willingness to implementthe principle of waste separation at source (UNDP, 2012).

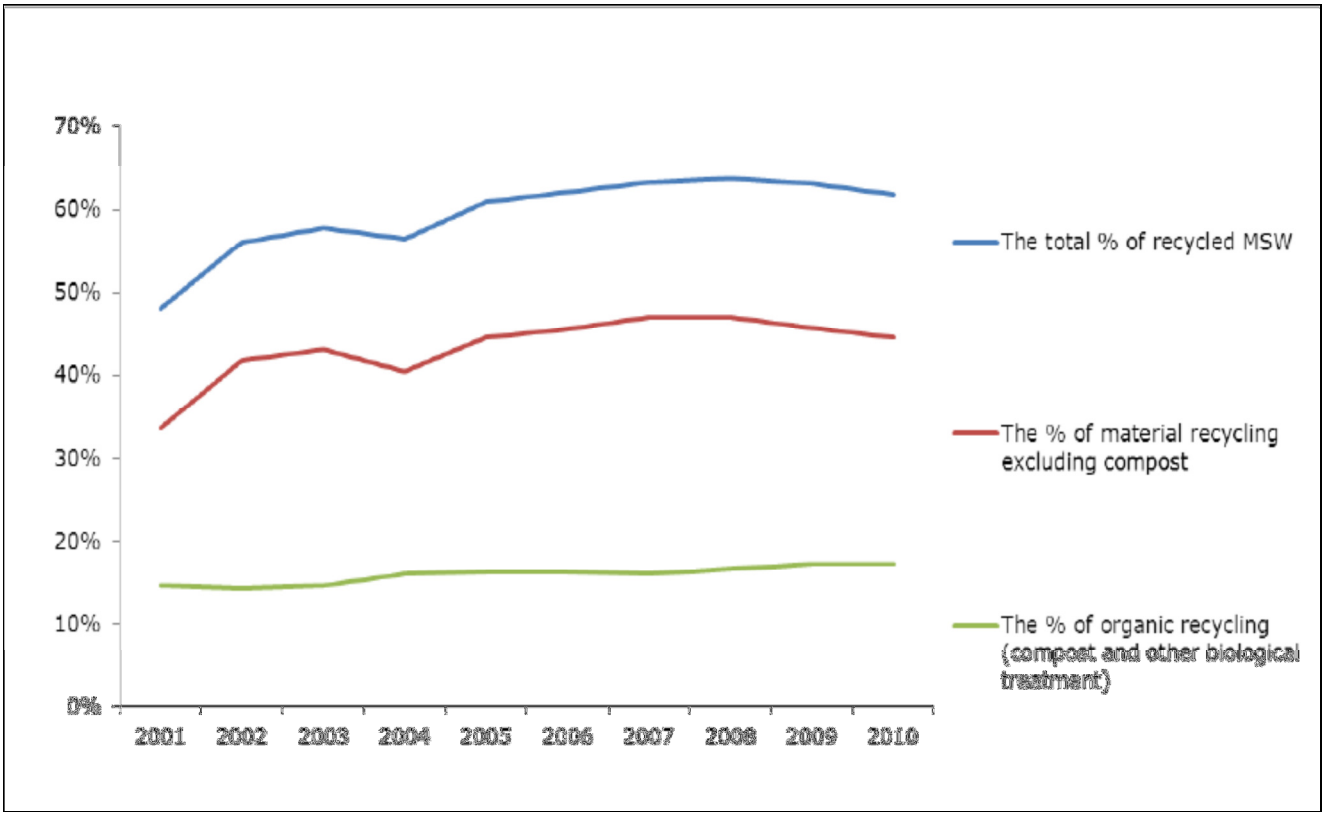

Figure 2:4: Recycling of MSW in Germany.
Source: EuroStats(2012).

Table 2.2 depicts the composition and quantities of MSW material recycled between 2001 and 2010. Trends of each waste material are fluctuating over the years. In 2002, organic waste had a lowest recycling rate (2704 tons) it is however, noted that there is a steady increase in 2010 (3151 tons). Paper and cardboard waste had the highest recycling rate in 2002 (8590 tons) and in 2010 the rate declinedto 8000 tons. Furthermore, paper and cardboard waste compositiondespite its recycling rate declining in 2010;it remains the highest waste composition recycled among other types (EuroStats, 2012).

Table 2:2: Composition of recycled municipal waste in Germany (2002-2010) in tons.

1000 Tonnes	2002	2003	2004	2005	2006	2007	2008	2009	2010
Glass	3106	3289	3100	3572	1929	2233	2480	2442	2523
Paper & Cardboard	8590	8419	7740	7895	8080	8121	8528	8088	8000
Light	5654	4929	4734	4601	4532	4975	4885	5000	5141

1000 Tonnes	2002	2003	2004	2005	2006	2007	2008	2009	2010
packaging									
WEEE	105	104	263	291	409	396	469	605	586
Metal, textile etc.	1313	1204	1333	1274	1570	1685	1842	1607	1730
Green kitchen waste from households	3465	3447	3661	3776	3757	3743	3897	3882	3764
Organic food waste from canteens etc.	485	354	578	476	603	668	535	694	726
Garden and park waste	4163	3845	4172	3924	4044	4509	4421	4607	4964

Source: EuroStats (2012).

- *Regional Differences in MSW Recycling*

In terms of MSW recycling per region within Germany,Trier attained almost 100% recycling rate when compared to Detmold and Niederbayern regions.This attainment is as a result of all waste being sent to municipal biological treatment (EuroStats, 2012; EEA, 2013). The differences in total recycling of MSW are linked to differences in material recycling especially for the period of 2007 to 2008. The differences in total recycling rates within municipalities in Trier of MSW range from 22% (2004), 26% (2006) to about 60% in 2007 and 2008, respectively (Eurostats, 2012).

- *Initiatives Implemented by Germany to Improve Municipal Waste Management*

Germany developed and implemented numerous waste strategies and plans to improve waste management. The plans include: (1) producer responsibility for packaging waste in order to sensitise citizens about sustainable waste management (Rousso and Shah,1994; Magram, 2011); (2) prohibition of landfilling untreated waste (EEA, 2009); (3) separate collection and recycling of secondary raw materials (paper and bio-waste); (4) pre-treatment of mixed household waste in mechanical biological treatment plants and dedicated incineration with energy recovery of mixed household waste (EEA, 2009); and (5) German government committed to recover all municipal waste completely by 2020 by eliminating the land filling of municipal waste so that waste treatment residues would no longer be necessary. This 2020 objective will be achieved through the recovery of waste incineration residues and advanced treatment technologies (EEA, 2009).

2.3.2 Denmark

2.3.2.1 Municipal Waste Management in Denmark

Denmark consists of five states which are also referred to as regions. The mission of the Danish Regions is to safeguard the interests of the regions nationally as well as internationally (Herning, 2013). The public sector (local and regional councils) is tasked to collect, treat waste and ensure high recycling rate as well as dealing with the general administration of waste management. In addition, the public sector is obligated to conduct waste surveys and the compilation of waste management plans as well as the provision and maintenance of the incineration and landfill facilities (DEPA, 2004). About 40 private companies (intermunicipal waste management companies) have been employed by local municipalities countrywide to handle the treatment of waste in an economically viable manner due to the lack of capacity within the municipalities (Renosam and Ramboll, 2006). MSW is separated at source from households. Different containers and bags have been provided to households and assigned for different types of waste: the green bag for organic waste, the black bag for residual waste and containers for paper and cardboard. Glass is disposed offby households in containers that are centrally placed within the municipalities (Kirkeby*et al.*, 2006).

In 2003, Denmark generated a total of 12.7 million tons of waste and of that amount, household waste accounted for 1.5 million tons (Renosam and Ramboll, 2006). In 2004, the amount of waste generated increased from 12.7 million tons to 13 million tons (DEPA, 2004). A similar trend occurred for the household waste which increased from 1.5 million tons to 2.8 million tons (DEPA, 2004). In 2003, about 1 million tons of waste was disposed of in a landfill facility and 3.3 million tons was incinerated and the rest was recycled (Renosam and Ramboll, 2006;Andersen*et al.*, 2011).

In terms of MSW generation per capita, the developments for a ten year period from 2001-2010 are briefly reviewed (Figure 2.5). Denmark produced an average of approximately 709 kg/capita for a period of ten years, the lowest generation of MSW was 650kg/capita in 2001 and the highest was 830kg/ capita in 2008 (Kjaer and Reichel, 2013). There has been an increasing trend in the volumes of waste generated since 2001 to 2008 and the decline in 2009 to 2010 was due to the change of waste regulations which were promulgated in 2010 that changed the definition of MSW (Kjaer andReichel, 2013).

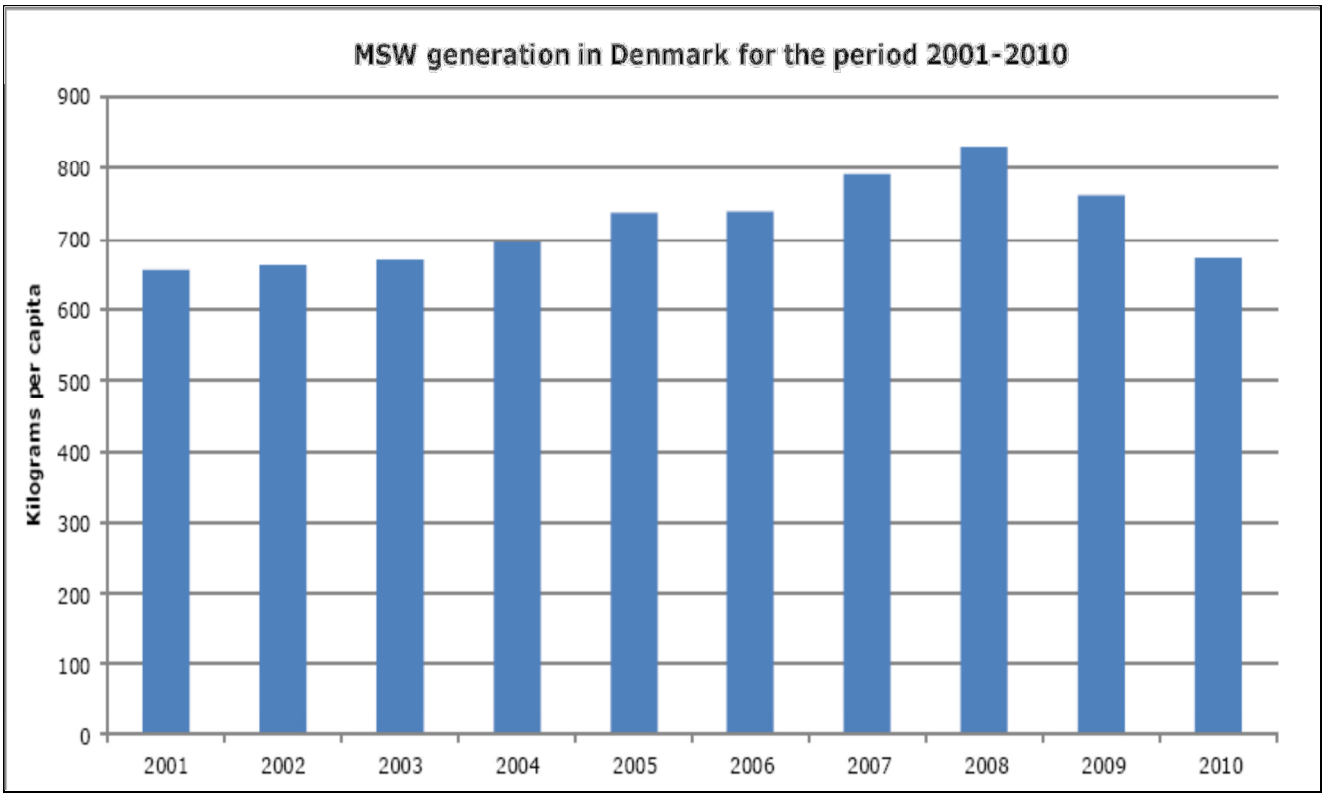

Figure 2:5: MSW generation per capita in Denmark.
Source: Eurostats(2012).

2.3.2.2 Municipal Waste Minimisation in Denmark

Waste hierarchy is a cornerstone of waste minimisation and legislation in Denmark (DEPA, 2004; Schmidta *et al.,* 2007). As alluded to earlier, that in order to incentivise recycling and adequately enforce the waste minimisation strategies in the country, the disposal of waste in landfill facilities was made to be expensive when compared with recycling and incineration as there is a significant amount waste tax associated with the use of landfill facilities (DEPA, 2004). The tax amount paid in 1987 for disposing waste in a landfill was 5.3 Euros and this amount increased several times, so that in 2010 it was 63.3 Euros.

The amount of household waste disposed of in landfill facilities declined significantly from 1985 to 2008 by 77% due to the landfill tax and this was a great achievement for the country. In 2003, about 8.4 million tons of waste was reused and recycled in Denmark (RenoSamand Ramboll, 2006). According toDEPA (2004), municipal waste was currently being recycled at a rate of 15% and the figure which was targeted for the end of 2004 was 30%. This was going to be achieved through increased efforts in the separation of waste at source. It was noticed, however, thatby the end of 2004 the amount of recycled waste was 43% and exceeded the targeted amount (Kjaer andReichel, 2013).

The recycling trends in Denmark are illustrated by Figure 2.6. The highest recycling rate was achieved in 2009 by 49%, the lowest in 2001 by 36% and the average recycling rate for the period of

ten years was approximately 37% (Kjaer and Reichel, 2013). The decline of the recycling rate in 2010 was due to the new regulations being promulgated at that time. There is nevertheless a positive trend of waste recycled in the country (Miljostyrelsen, 2009;Kjaer and Reichel, 2013). In terms of the types of waste recycled, organic waste increased from 14% in 2001 to 19% in 2010. The other recycled waste excluding organic waste has a different trend where the percentage of recycled waste in 2001 (23%) was similar in 2010 (Eurostats, 2012). Table 2.3 outlines the MSW categories which have been collected from households for recycling. There have been some fluctuations on the amount of waste types recycled for the past tenyears. However, a positive trend is observed where 2009 had a successful recycling rate.

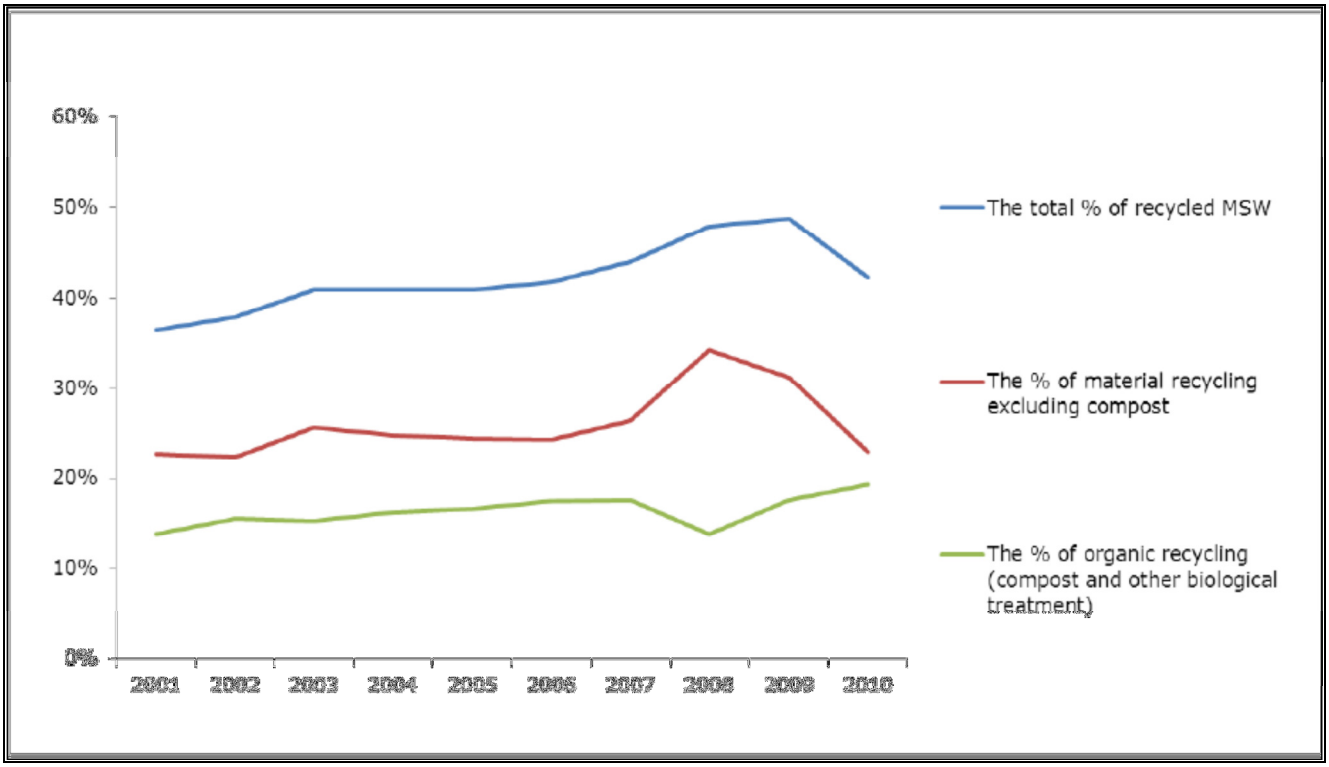

Figure 2:6: Recycling of MSW in Denmark.
Source: Eurostats(2012).

Table 2:3: Household waste collected for recycling in Denmark.

Waste Type	2000	2002	2004	2006	2007	2008	2009
Paper, paper packaging	181	204	221	211	246	207	221
Glass	83	111	88	85	91	65	98
Plastic	2	5	4	4	5	4	5
Metal	17	25	25	31	76	410	313

Waste Type	2000	2002	2004	2006	2007	2008	2009
Green kitchen waste	45	37	53	41	43	38	50
Garden waste	505	512	495	592	640	527	611

Source:Miljostyrelsen (2009).

- *Initiatives undertaken by Denmark to Improve SWM Management*

Denmark formulated the following instruments in improving MSW and they include: (1) the introduction of landfill tax and incineration tax in 1987; (2) prohibition of disposing combustible waste at landfill facilities which came into effect in January 1997 (Andersen *et al*., 2011; Christoffersen and Svendson, 2000; Bartelings and van Buekering, 2005); (3) establishment of separate collection scheme for paper, glass packaging and garden waste which contributed significantly to the increased level of recycling (Kjaer andReichel,2013); (4) promulgation of National Waste Management Plan (NWMP). This plan sets a target of 60% recycling rate for paper and cardboard wastes from households. In addition, municipalities have been obliged to introduce separate containers at each household (Regeringen, 1999). The NWMP was amended in 2005 to include and implement the targets for the packaging of goods set in the European Union Directive to be fulfilled in 2008 (Kjaer and Reichel, 2013). Furthermore, municipalities had to implement collection schemes for metal packaging and certain types of plastic packaging; (5) the expansion of recycling centres for household waste;(6) introduction of a deposit system for one way beverages packing in 2002 to increase the amount of plastic and metal packaging waste and the amount of recycling (DEPA, 2004;Kjaer andReichel, 2013); and (7) Denmark had 29waste to energyfacilities in 2005 (Kleis and Soren, 2004). These facilities treated about 3.5 million tons (26%) of waste. The energy produced by these facilities was used to produce environmentally friendly electricity and district heating that is used by approximately 400 000 households (RenoSamandRamboll, 2006; Magram 2011).

2.3.3 United States of America (USA)

2.3.3.1 Municipal Solid Waste Management in USA

The United States of America (USA) generated about 254 milliontonnes of MSW in 2007 with a major composition of paper (32.7%) followed by garden waste (12.8%)and food waste (12.5%). The lowest amount of waste produced is glass with 5.3% (USEPA, 2010). In 2010, the USA generated about 250 million tons of MSW and over 85 million tons of this material was recycled and composted. In 2011, there was an increase from 250 million tons in the previous year 2010 to 290 million tons (Figure 2.7 and Figure 2.8) (USEPA, 2010).

Per capita, MSW generation increased by 20% over the same period (2010 and 2011) from 3.7 to 4.4 pounds per person each day (USEPA, 2013). The current rate of MSW generation in pounds per

person and per capita in America is 180when compared to 2.8 in Sweden, 3.5 in Germany and 3.2 in United Kingdom (Beede and Bloom 1995; Economic Environmental and Social Fact Sheet, 2013). Packaging, containers and non-durable goods (e.g. Paper, plastic) made up over 50% MSW generation in 2011 (USEPA, 2010). The remainder of MSW is divided between durable goods, garden waste and foods waste (Beede and Bloom, 1995;USDEEIA, 2011). The composition of waste generated in 2011 is depicted in Figure 2.9. Paper and cardboard was the most waste generated (28%) and the least waste generated was glass (4.6%).

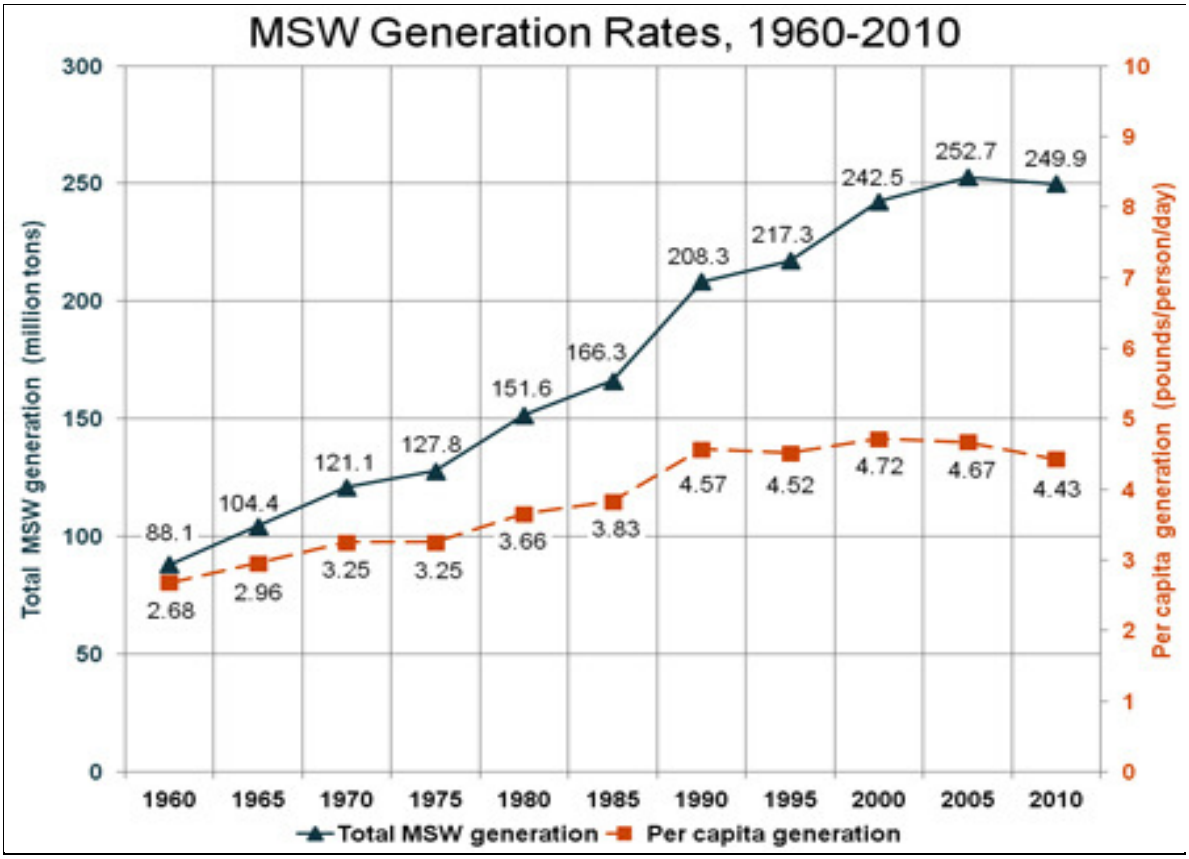

Figure 2:7: United States of America MSW generation rates, 1960-2010.
Source: United States of America Environmental Protection Agency (2010).

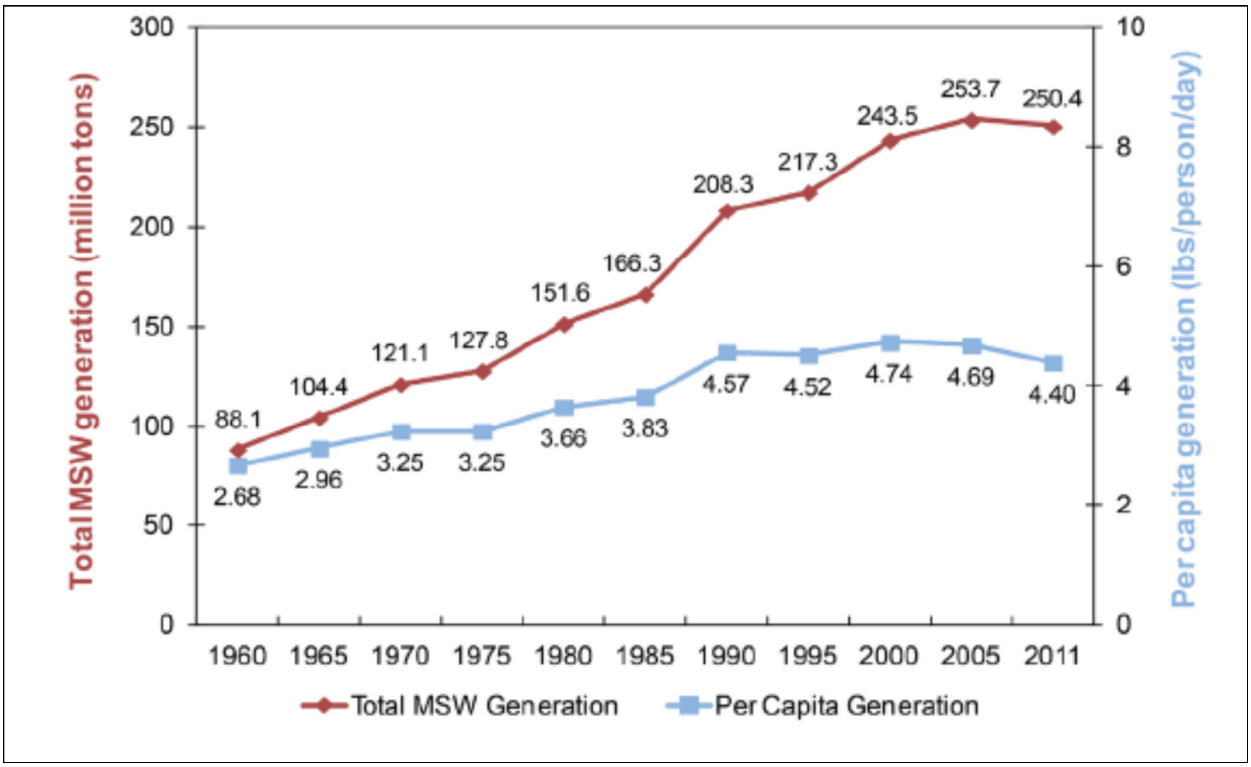

Figure 2:8: United States of America annual MSW generation (1960-2011).
Source: United States Department of Energy, Energy Information Administration (2011).

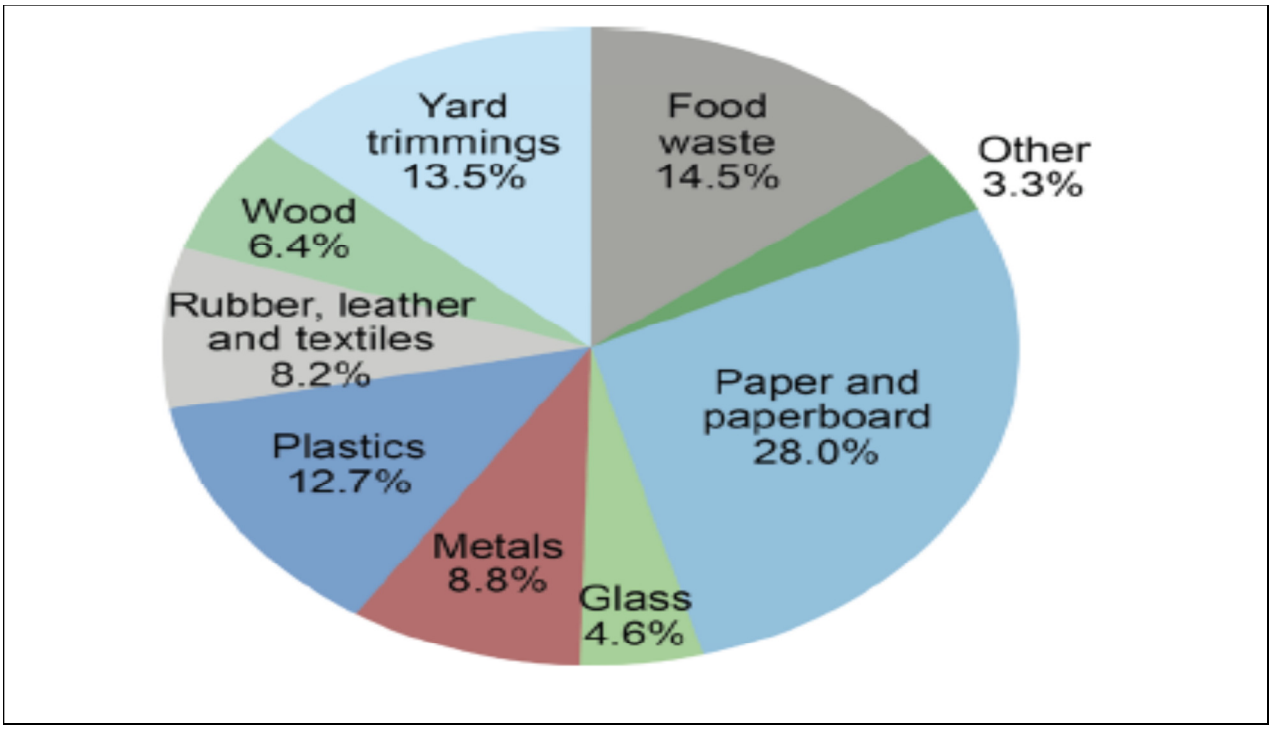

Figure 2:9: United States of America MSW generation composition.
Source: United States of America Environmental Protection Agency (2010).

- *Land filling and Incineration*

According to USEPA (2010), about 53.6% of MSW generated in the USA was disposed of in 1 908 landfills. The total number of landfills in the USA has been declining steadily, while the total capacity of waste increased (Figure 2.10). In 1989, the USA had approximately 7 300 landfills, by 2007 there were 1 800 and the decline of landfills was due to unavailable suitable space to construct new landfills when existing ones expired (USEPA, 2010). The decline in landfill facilitiesavailable for waste disposal has had significant implications for the USA as some cities such as New Jersey and New York transported about 50% and 20%, respectively, of waste generated to nearby cities for disposal (USEPA, 2010). According to USEPA (2010), the USA incinerates about 10% of MSW generated which is significantly lower than that of other developed countries (80%). About 11.7% of MSW generated was disposed of through incineration with energy recovery in 2011. The incinerationreduced waste volumes by approximately 75%, leaving an ash residue which is disposed to landfills (USDEEIA, 2011). In 2010, there were 86 waste to energy facilities operated in the USA with a combined capacity to generate 2 790 megawatt per hour of electricity (Michaels, 2010;US Department of Agriculture, 2013).

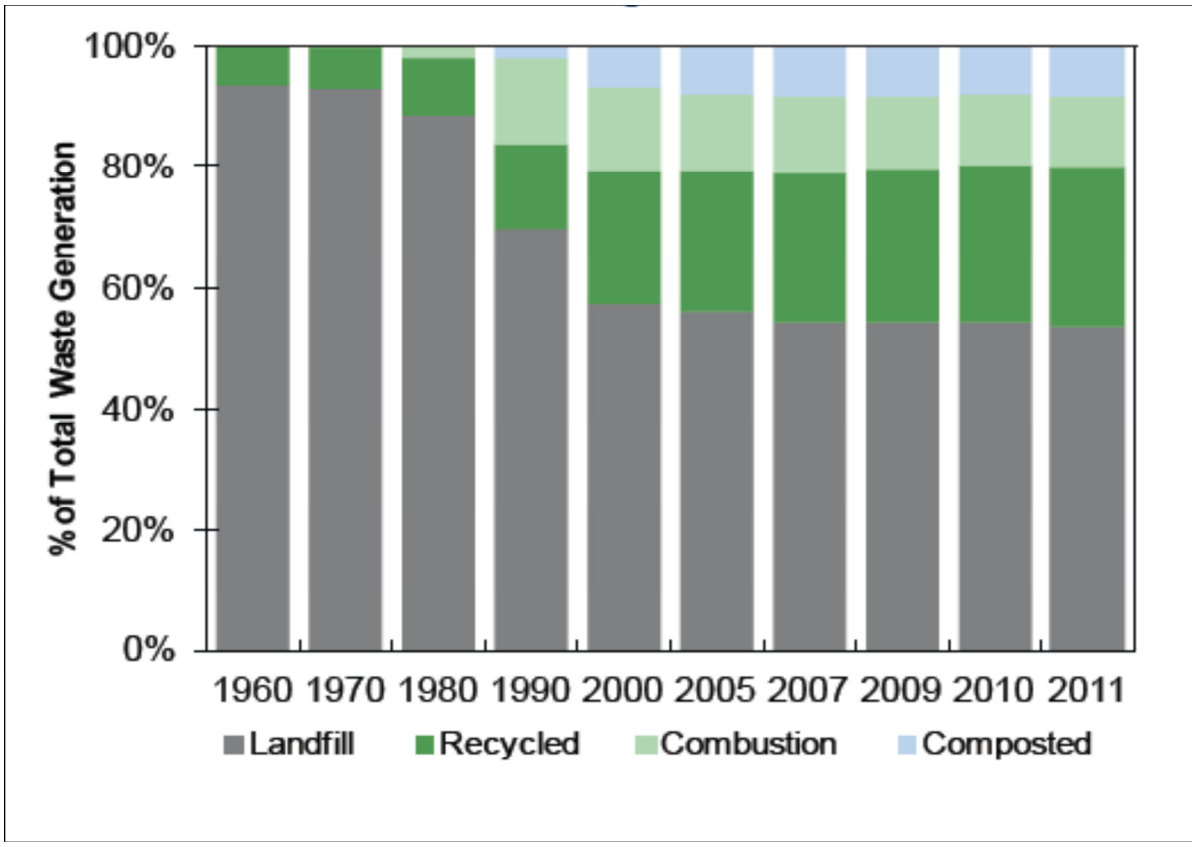

Figure 2:10: MSW management methods.
Source: United States Department of Energy, Energy Information Administration (2011).

2.3.3.2 MSW Minimisation USA

In 2010, the USA recycled and composted about 85 million tons of MSW and this is equivalent to 34.1% recycling rate (Figure 2.11). On average, the USA recycled and composted 1.51 pounds of waste (USEPA, 2010). According to USEPA(2010), the USA recycles about 20% of solid waste generated which is lower when compared with other developed countries which recycle 75%. In 2011, the recycling figure increased slightly to 34.7% and about 87 million tons of materials from landfills and incinerators were diverted for recycling (USDEEIA, 2011). The composting materials represent nearly 25% of all recovered MSW. Curbside recycling programmes currently serve approximately 73% of people. The number of curbside programmes has increased more than three times since 1990, and about 91% of corrugated boxes were recovered for recycling in 2011(USDEEIA, 2011).Other commonly recycled products include lead acid batteries (96%), newspapers (73%), major appliances (64%) and beverage cans (55%). The products with poor recycling rates include carpet (7%), small appliances (7%) and furniture (0.1%) (USEPA, 2013)

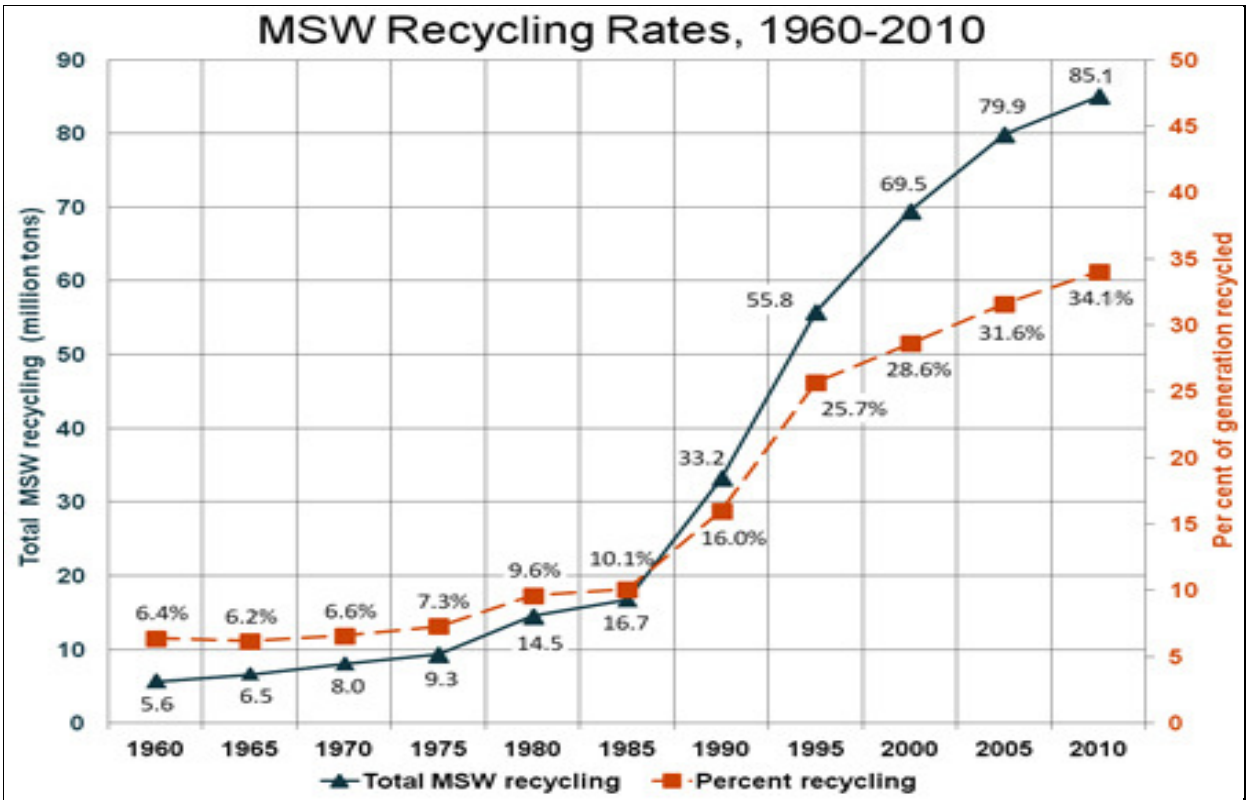

Figure 2:11: United States of America MSW recycling rates.

Source: United States of America Environmental Protection Agency (2010).

- *Initiatives Undertaken by the USA Government to Improve the Management of MSW*

- The ten states (California (CA), Connecticut (CT),Hawaii(HI), Iowa (IA), Maine (ME), Massachusetts (MA),New York (NY) and Vermont (VT)) (1) have deposit laws that encourage the return of empty containers for refunds (USEPA, 2013);
- The Department of Agriculture and Environmental Protection Agency launched the US Food Recovery Challenge in 2013, by donating food to charities which could have been disposed to landfill facilities;
- The composting and generation of electricity with anaerobic digestion of food scraps;
- Communities have implemented programmes such as "Pay As You Throw" designed to limit the volumes of MSW per household by charging residents for waste collection based on the amount they throw away (USEPA, 2010);
- The USA currently has about 87 waste to energy facilities that generated about 2,720 megawatt (0.4 %) of USA total power (William, 2011); and
- Other waste to energy facilities are currently being added in Fort Meyers, Florida, Maryland, Minnesota and Hawaii(Michaels, 2010; William, 2011).

2.3.4 Japan

2.3.4.1 Management of MSW in Japan

Municipal government in Japan like in many other countries, are responsible for the management of municipal solid waste and spent about 2.280 billion Yen in 1993 on general waste services which accounted for approximately 5% of general municipal budget (Japan Waste Management Association, 1999). Of the total budget, approximately 45% is spent on intermediate treatment facilities (incineration plants), 4% is allocated to collection and 6% is allocated to final disposal (Japan Waste Management Association, 1999). The per capita and per ton waste management expenses of municipal government have increased annually (Matsunaga and Themelis, 2009). According to the Japan Waste Management Association (1999), Japanese municipalities have imposed about 35% of charges on waste management services and they have also adopted a fee structure where waste fees increase according to the amount disposed, also known as "Pay As You Throw". Revenue collected from waste management services covered approximately 4% of the total waste management expenses (Japan Waste Management Association, 1999).

In 1998, approximately 49.9 million tons of waste quantities equivalent to 1kg/capita/day were disposed of landfill facilities, about 76.2% of waste produced in 1995 was incinerated, 12% was separated and crushed (Tanaka, 1999). According to Matsunaga and Themelis (2009), the rate of MSW generation in Japan (residential and commercial wastes) in 1999 totalled 53.7 million tons. This translates to a per capita generation of 46.2 tons per year. About 74.5% of the total MSW was

combusted and only 20.3% was land filled, including ash from incineration. The volumes of MSW generated increased within three years to about 65 million tons in 2002 and of this amount 40 million tons was treated thermally, 20% disposed in landfill facilities and the remainder was recycled and composted (Themelis and Mussche, 2013). Japan generated a total amount of 52 million tons annually of municipal waste in 2003 (UNEP, 2010). In 2007, the total amount of MSW generated amounted to 50 830 000 tons and the daily per capita the generation was 1089 grams (UNEP, 2010) (Figure 2.12). There has been a fluctuation in the volumes of waste generated within a period of nine years. However, there is an overall decreasing trend of MSW generation in Japan (UNEP, 2010). In terms of the types of MSW in Japan as illustrated by Table 2.4, paper is the most frequently generated type of waste (36%) with glass representing the lowest amount of waste (0.30%) (Huanga*et al.*, 2012). Japan generated 1.47kg/capita/day of MSW which is lower when compared with that of other Asian countries in 2005 due to the country having a high gross domestic product (US$ 31267) (World Bank, 1999; UNDP, 2007). In addition, to prolong the lifespan of the landfill facility, the municipalities incinerate great quantities of combustible waste (Tanaka, 1999).

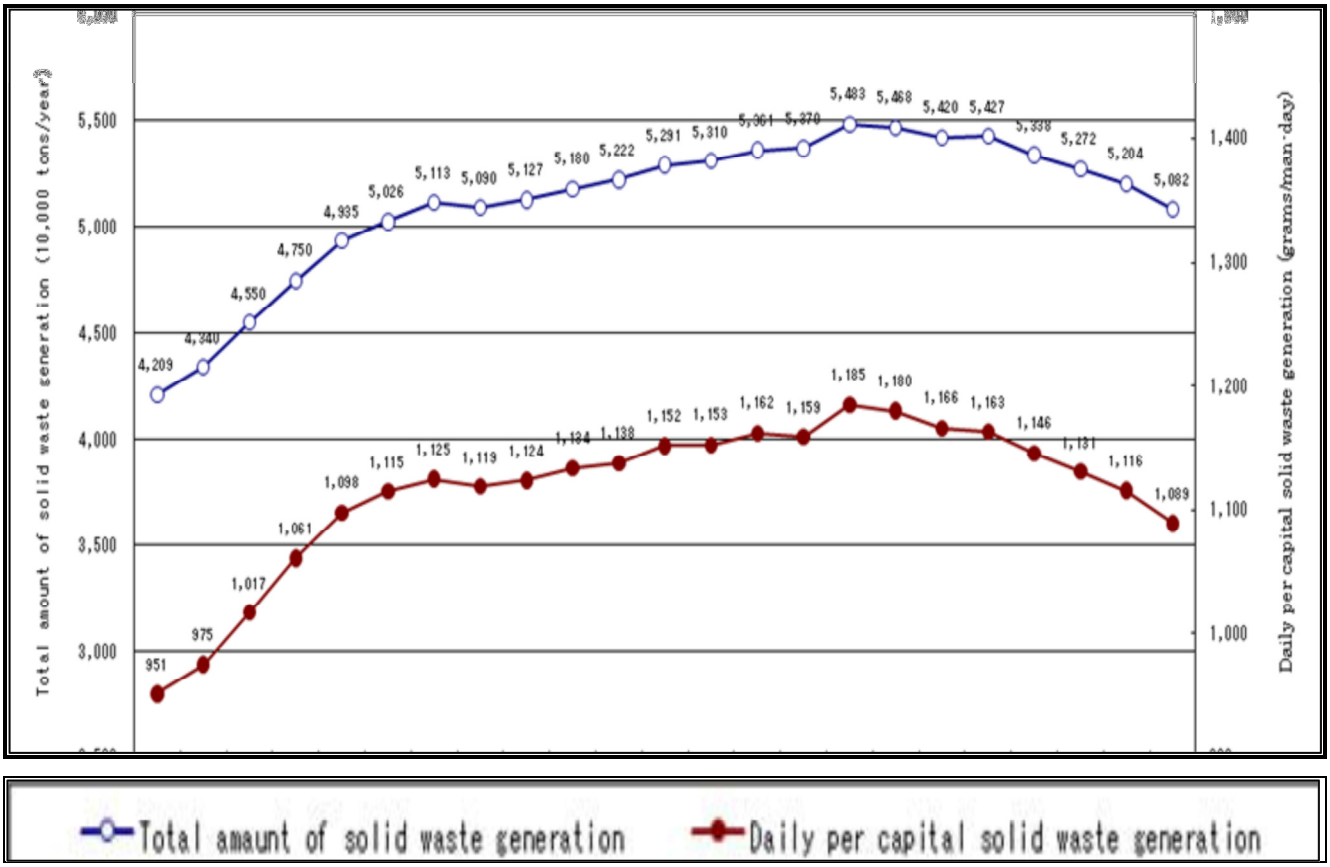

Figure 2:12: Solid waste generation and daily per capital solid waste generation.
Source: UNEP (2010).

Table 2:4: Components of MSW in Japan.

Waste Type	Rate (%)
Food	19.10
Paper	36.00
Plastic	18.30
Textile	9.50
Wood	4.50
Glass	0.30
Metal	0.00
Other	12.30

Source: Huanga*et al.*(2012).

2.3.4.2 Minimisation of MSW in Japan

Japan's approach to waste minimisation is waste reduction, the promotion of recycling, and volume reduction by intermediate treatment (Tanaka, 1999). The material recovery rate of MSW collected by the municipalities in 1996 was 5.6% (Tanaka, 1999). The government of Japan introduced two laws in promoting the recycling and separate collection of waste in 1995 and 1998 and these were Packaging Waste Recycling Law (1995) and Home Electric Appliance Recycling Law (1998). The laws are in line with the extended producer responsibility policy (Tanaka, 1999). The recovery of materials by the municipalities was 2,78 million tons and this led to the decrease of the waste volumes disposed of at landfill facilities from 15.3 million tons in 1992 to 13.6 million tons in 1995 (Tanaka, 1999). According to the (UNEP, 2010), a total of 10 300 000 tons of waste was recycled by the municipalities and the recycling rate was equivalent to 20.3%, which increased by 0.7% from the previous year (2006). In addition, Figure 2.13 illustrates a trend in the recycling of waste over the period of ten years in the country that is increasing by approximately 1% each year.

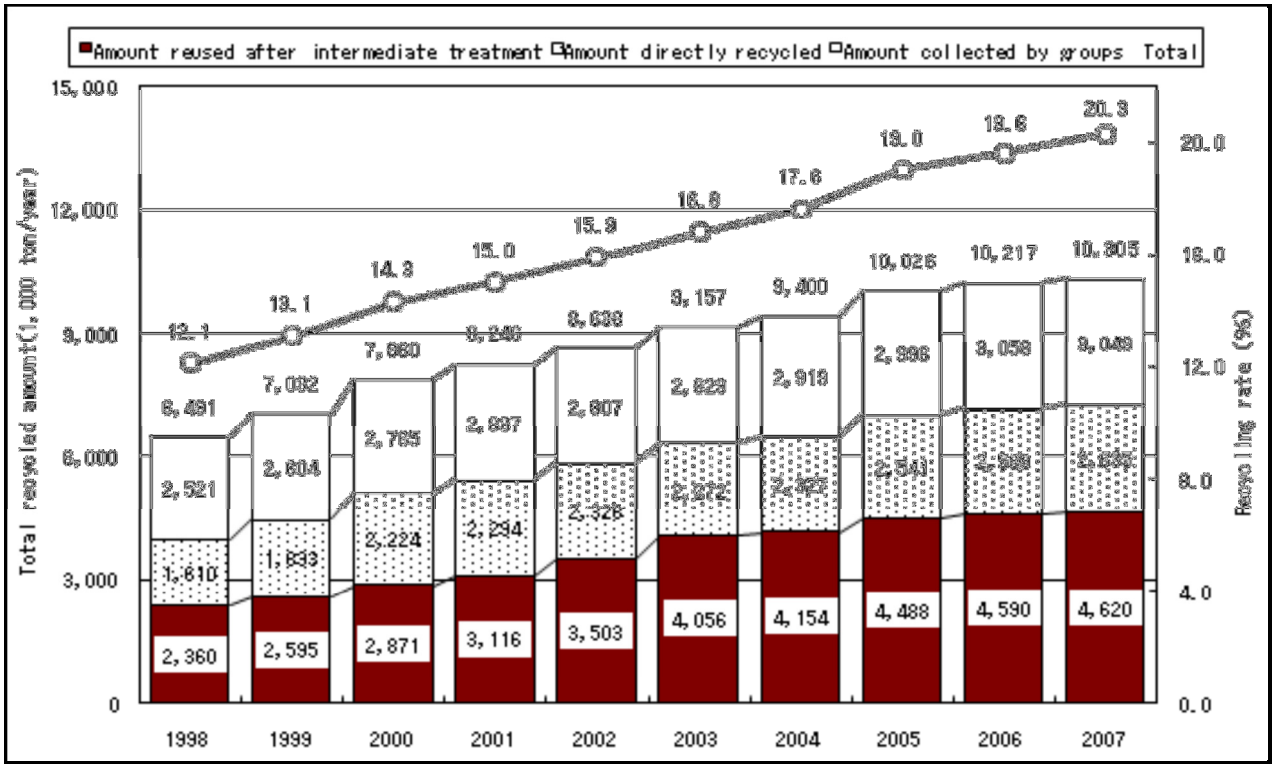

Figure 2:13: Total recycled amount and recycling rate.
Source: UNEP (2010).

Japan can be viewed as a leader in developing and implementing traditional thermal treatment technologies for processing municipal waste (Themelis and Mussche, 2013). Grate (the type of technology); combustion plants are the most frequently used waste to energy technology as they treat 37.8 million tons (84%) of MSW when compared to other technologies available in Japan (Themelis and Mussche, 2013). Eighty percent (80%) of MSW is incinerated in Japan and in 2008-2009, 24.5% of the incineration plants recovered energy from the incineration process with the total electricity output of 1673 megawatt (MW) (Tabata, 2013). The power generation efficiency was low at 11.3% of the national average and incineration plants on average produced 0.2 MWhper ton of waste (Tabata, 2013). Heat is scarcely produced from incineration in Japan, an average of 0.00076mwh/ ton of waste when compared to other developed countries, for example Malmo produces 2.68mwh/ton of waste as heat (Tabata, 2013). The heat produced in Japan is used to heat pool or hot water in public facilities; furthermore, district heating has been implemented in few urban areas (Tabata, 2013).

- *Initiatives Undertaken by the Japanese Government to Improve the Management of MSW*

There are several waste reduction methods undertaken inJapan and they include: (1) the reusing of shopping bags;(2) minimisation of packaging materials; and (3) extending the life of products and the design of products so as to reduce the use of materials (de-materialisation).Recycling is very successful in Japan with regards to some materials. Recycling activities are mostly conducted by the

informal and private sector and the volumes of waste recycled are unknown,thus estimates are made (World Bank, 1999). In 1999, an estimated 55% of paper, 78-83% of metal cans, and 22.8% of PET bottles were recycled. As of April 2001, electronic equipment was recycled for a certain fee(Themelis and Mussche, 2013). The recycling rate of steel cans has been estimated to be 82.9% and that of aluminium at 78.5%. About 7.8% of steel cans are used as drinking containers in European Union, Japan, and South Korea but not in the USA (Tabata, 2013; Themelis andMussche, 2013).

2.4 WASTE MANAGEMENT IN DEVELOPING COUNTRIES

This section focuses on thetrends of waste generation, management, minimisation strategies implemented, challenges and successes in the developing countries. The countries which are examined arePhilippines, Kenya, and India. Solid waste management planning in developing countries does not focus on the concept of resource recognition for example treating waste as an unused resource (Furedy, 1992). The problem of solid waste management in developing countries is acute where economic growth as well as urbanisation is more rapid (Schwarz-Herion*et al.,* 2008). There are many challenges faced by developing countries with regards to waste management and according Zurbrugg (2004)these challenges include inadequate service coverage and operational inefficiencies where the collection schemes in cities only service limited part of the urban population and the low incomes citizens are often not serviced. Such lack of services isdue to insufficient budgets and operational inefficiencies of local municipalities which in turn prevent them from servicing the areas of their jurisdiction adequately. The next challenge is limited utilisation of recycling services, the recycling and recovery of organic materials is a service which is often developed and managed by the informal sector and municipalities seldom support this initiative. The feasibility of municipal waste recycling and composting depends on the market of recycling goods, set up of recycling centres and legislation governing this service. The third issue is inadequate landfill disposal, as municipal solid waste is disposed at landfill facilities and the landfill facilities consume a large space which could have been used for other developments, resulting in negative environmental and health impacts such as hazardous smoke, fires from the methane gas and flies.

Effective management of municipal waste is required; however, local authorities in many developing countries are constrained by limited finances and lack effective instruments such as legislation and policies (van Beukering, 1999; Omran and Read, 2008). The decisions concerning municipal solid waste management are not only capital intensive but also difficult from the environmental and social perspective and there is a need to develop, master and implement a simple but reliable tool that will help the decision makers (Omran and Read, 2008).

2.4.1 Philippines

2.4.1.1 Management of MSW in the Philippines

Like many developing countries waste management is a bigchallenge (Godoy, 1998; Gupta *et al*., 1998). This challenge is exacerbated by rapidly increasing urbanisation (World Bank, 1999; Zurbrugg, 2002). According to Kojima and Machida (2011), in 2005 the Philippines had a population of 82.8 million and of that about 51.8 million (63%) lived in urban areas. It is estimated that by year 2030, the population will be 85 million which equates to a 70% increase (Kojima and Machida, 2011). The increasing urbanisation is accompanied by increasing generation of waste. As of 2005, about 10 million tons of MSW is generated annually and this is equivalent to between 0.3 kg to 0.7 kg per capita per day. This volume is estimated to increase by 40% by the end of the decade (World Bank, 2001b; Antonio, 2010; Kojima and Machida, 2011).

According to Ancog *et al*.(2012), the waste collection services in the city of Cebu located in the south east of Manila are provided 24 hours a day where the employees operating the trucks work three shifts per day (Ligan and Zenaida, 2010; Ancog*et al*., 2012). In addition, there are three waste collection schemes implemented. These waste collection schemes include a communal method where waste is disposed in containers strategically placed for local communities. The second scheme involves a schedule for waste collection at households by trucks. The third scheme entails the building of material recovery facilities at shopping malls where waste is collected and sold by various constituents (Ligan and Zenaida, 2010; Ancog*et al*., 2012). The city of Cibu had one landfill facility which was established in 1998 and its lifespan ended in 2012. A new landfill facility has been established and is located in Consolacion which is a municipality adjacent to the city of Cebu (Ancog, *et al*., 2012). In Asian cities, the expenditure of MSW can reach up to 40% of the municipality's operating budget and of this about 70-90% is spent on waste collection. Metro Manila in the Philippines is reported to be spending about $ 64million dollars on waste collection and disposal (Asian Development Bank, 2004; Boragan, 2010).

Table 2.5 illustrates the estimated MSW generated from the years 2000, 2005 up to 2010 in various regions of the Philippines. The National Capita Region (NCR) generated the highest amount of MSW for the consecutive years (24.60%) in 2000, (24.39%) in 2005 and (23.70%) in 2010. The lowest MSW generator is the region of CAR with 1.11% in 2000, 1.07% in 2005 and 1.4% in 2010, respectively. In addition, Table 2.5 also illustrates an increasing trend in terms of waste generated per day countrywide, where from 2000 to 2005 there was an increase of 4 375 tons and in 2005 to 2010 an increase of 4 816 tons (Kojima and Machida, 2011).

Table 2:5: Estimates of MSW generation in the Philippines.

Region	2000		2005		2010	
	Tons/day	%	Tons/day	%	Tons/day	%
NCR	4 953	24.60%	5 869	24.39%	6 844	23 70%
CAR	223	1.11%	259	1.07%	300	1.04%
Region I	873	4.33%	1 026	4.26%	1 195	4.14%
Region II	271	1.35%	317	1.32%	370	1.28%
Region III	2729	13.56%	3410	14.17%	4188	14.50%
Region IV	3935	19.55%	5126	21.30%	6582	22.79
Region V	654	3.25%	754	3.13%	851	2.95%
Region VI	969	4.81%	1094	4.55%	1245	4.31%
Region VII	1607	7.98%	1962	8.15%	2354	8.15%
Region VIII	336	1.67%	384	1.60%	430	1.49%
Region IX	417	2.07%	493	2.05%	572	1.98%
Region X	748	3.72%	881	3.66%	1017	3.52%
Region XI	986	4.90%	1190	4.94%	1407	4.87%
Region XII	432	2.14%	610	2.54%	706	2.45%
ARMM	253	1.26%	3.25	1.35%	409	1.42%
Caraga	314	1.56%	361	1.50%	406	1.41%
Philippines	**19700**	**100%**	**24059**	**100%**	**28875**	**100%**

Source: Kojima and Machida (2011).

2.4.1.2 Minimisation of MSW in the Philippines

The latest legislation was formulated in 2001 (Republic Act 9003- Ecological Solid Waste Management Act of 2000) also known as RA 9003.This legislation declares the policy of the state to adopt a systematic, comprehensive and ecological solid waste management programme. This latest act is considered to be most comprehensive law on waste management in the country when compared to the previous laws as it considers a holistic approach to the management of waste.In 2004, a National Solid Waste Management Framework was formulated and promulgated. The framework emphasises measures that encourage waste avoidance, reduction and recycling. This is also highlighted by RA, 9003 on the mandatory segregation at source of at least 25% (Acosta*et al.*, 2012). The framework further encourages the composting of biodegradable waste and for local governments to establish material recovery facilities to the resource recovery (Acosta*et al.*, 2012). The second national tool formulated and promulgated is the National Solid Waste Strategy of 2012-2016. The strategy has various components which are aimed at dealing with waste in the country. It is a medium-term tool to address issues and gaps encountered by MSW implementers and to set the

developmental path for the full implementation of the RA, 9003 (Acosta*et al.,*2012).In addition to the national waste legislation, municipalities also have their policies and ordinances which they have formulated and they implement these at a local level, for example, the city of Cebu located in the Cebu province promulgated the following ordinances, namely, Cebu City 1990, Cebu City ordinance 2017, Cebu City ordinance 2031. Cebu City 1990 mandated the municipality of Cebu to establish a garbage collection system and associated collection fees as well as the collection of waste. The Cebu City ordinance 2017 resulted in the formulation of the Solid Waste Management Plan and Strategies which must be implemented by the city. The Cebu city ordinance 2031 focuses in the implementation of solid waste segregation at source with associated penalties for violation and the creation of funds for incentives as well as monitoring and enforcement (Ancog*et al.,*2012).

In terms of recycling companies established in the country, there are about fifty three facilities in Metro Manila, two in Cebu and one in Davao (Ancog*et al.,*2012). These facilities have been registered within the National Solid Waste Management Commission Programmes and Strategies implemented by the Cebu City and they include information and education campaign, cash from trash project and cash from trash initiatives (Ancog*et al.,*2012). These programmes were implemented through the Cebu environmental sanitation enforcement team (CESET), local and international strategies (Ancog*et al.,*2012). The revenue which has been generated through the issuing of penalties to the ordinance violators has amounted to Philippines Peso (PhP) 1.5 million since 2008. This revenue is used as an income for CESET and for the local government (Ancog*et al*., 2012).

- *Initiatives Implemented by the Philippines Government for the Minimisation of Waste*

The initiatives implemented by the Philippines Government include: the implementation of awareness campaigns;the conversion of open dumpsites into ecological waste processing centres (Ancog*et al*., 2012); and the conversion of the informal waste pickers into formal organisations which are known to be official recyclers. In addition, the Barangay Bagumbuhay municipality also have other waste minimisation initiatives, the making of by-products from recycled waste such as plastic paving tiles and reduction trips of waste collection in households within the period of three years resulted in approximately 65% of waste diverted from dumpsites (Atienza, 2008).

2.4.2 Kenya

2.4.2.1 Management of MSW in Kenya

The management of MSW in Kenya is the responsibility of the local authorities as it is in many other countriesand services provided by the local authorities have been on the decline over the past two decades so that the private waste sector had to be involved in the management of MSW (Muniafu and Otiato, 2010). According to Njoroge *et al.*(2014), in Nairobi the city council recruited about 60 private collectors who collected approximately 25% of waste generated in the city. The city has one open dumpsite located about 7.5km away. In 1998 the dumpsite was filled with approximately 1.3

million cubic meters of waste and was not able to handle more waste disposal that is generated by the city which is estimated to be approximately 1200 tons (Muniafu and Otiato, 2010).

Many local authorities in developing countries spend over 30% of their budget on refuse collection and disposal, the revenues collected by urban local councils for waste services is limited and this can be as low as 3% of the total annual local authority budget, which exacerbates the problems associated with waste management services finances (Liyala, 2011). Most dump sites do not meet environmentally safe MSW disposal levels because of a lack of sanitary landfills. At present, MSW is disposed of in open dumps which lack environmental control and monitoring and the local industries operate their own liquid and industrial waste independently from the local authorities (Henryand Yongsheng, 2006).

The growth in the generation of waste has been rapid, while the capacity to collect and safely dispose off waste appropriately has been generally on the decline in Kenya (Henry and Yongsheng, 2006). Figure 2.14 depicts the status of waste management in Nairobi in terms of generation, collection, uncollected waste and the capacity of waste removal vehicles over a period of 22 years. The average amount of MSW generated over the period of 22 years was 552 tons,the lowest volume of MSW generated was 220 tons in 1978 and the highest volume of MSW generated was 500 tons in 2000 (Henry and Yongshen, 2006). This reveals an increasing trend in the amount of waste generated as the years progressed and there is also a similar trend in the case of uncollected waste where, as waste increased, the collection services decreased. The capacity to provide disposal services by Nairobi city declined due to their inability to keep the MSW collection vehicles at full operational capacity (Henry and Yongsheng, 2006).

In 1999, a large portion of the MSW collection vehicles were out of service in the five local authorities examined (Nairobi, Mombasa, Kisumu, Nakuru and Eldorest) due to these being older than 10 years and also without proper maintenance (Kimani, 2001, Mukui, 1994). The uncollected MSW at the middle to lower income levels of society increases when weather conditions are not favourable (rainy season) due to access roads not being maintained (Henry and Yongsheng, 2006). Table 2.6 illustratesthe current state and the demand of waste management vehicles for Nairobi, Mombasa, Kisumu, Nakuru and Eldorest that are in shortage. Currently, the local authorities focus their limited resources to the Central Business Districts (CBD) and the more affluent communities residing adjacent to CBD (Mwangi, 2000; Henry and Yongsheng, 2006).According to Allison and von Blottnitz (2010),Njoroge *et al*., *(*2014), in 2010, Nairobi generated 4016 tons of MSW daily which its collection rate is 33% thus resulting in approximately 2 690 tons being uncollected.Nairobi generates 0.6kg/capita/day of MSW and it is composed of 65% of biowaste, 6% of paper, 12% of plastic, 2% of glass, 1% of metal and 14% of other waste types (Okomu,2012). In terms of collection, about 65% of waste is collected from the source of generation and about 45% of the population pay for waste collection services (Okomu, 2012).

The composition of solid waste in Nairobi has been evolving over the past decades and this is illustrated by Table 2.7. Organic waste has been decreasing while paper, plastic and other types of

wastes were increasing over the years. This increase in the packaging and other waste type trend can be attributed to the changing lifestyle of residents, an increase in the population and urbanisation (Njoroge*et al.*, 2014). The waste dump facilities are located in environmentally sensitive areas, such as wetlands and water bodies, and are not properly designed for example they do not have liners, fences, soil covers and compactors which appear in other landfill facilities designed in developing countries(Republic of South Africa) (Johannessen andBoyer, 1999).

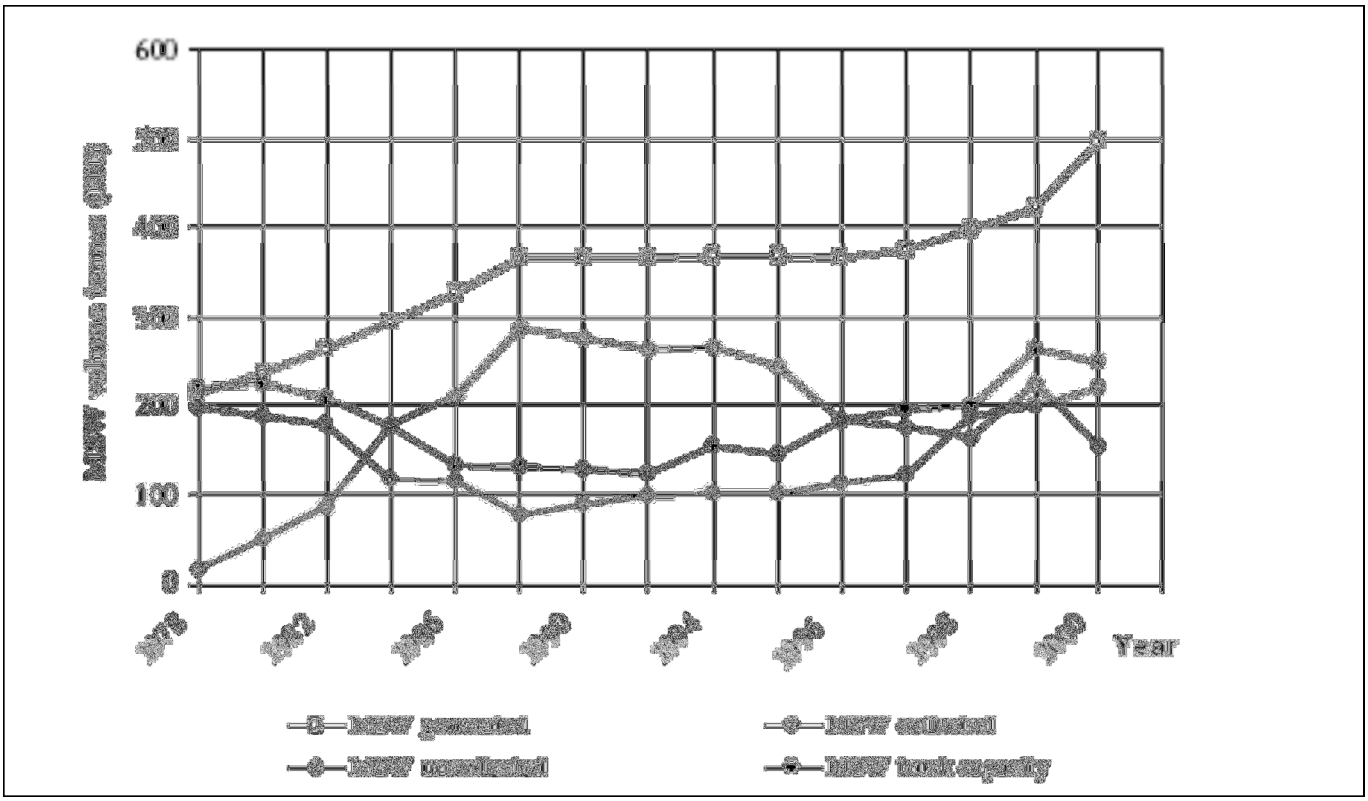

Figure 2:14: MSW generation and collection in Nairobi.
Source: Henryand Yongshen*(*2006).

Table 2:6: Status of MSW collection trucks in local authorities in 1999.

Local Authority	Total Number of MSW Trucks	Number of breakdowns	Average age of trucks (years)	No of trucks in demand	% Waste collection
Nairobi	66	34	12	100	30-45
Mombasa	34	14	9	50	34-50
Kisumu	28	14	12	40	28-48
Nakuru	25	10	15	40	35-58
Eldorest	28	11	15	40	36-54

Source: Henryand Yongsheng (2006).

Table 2:7: Composition of solid waste in Nairobi (%).

Waste type	Molg & FARID (1985) Cited in Kibwage 1996)	JICA, 1998	ITDG, 2004 (Cited in Bahri, 2005)	UNEP/CCN/NTT 2009
Organic	78	58	61.4	50.9
Paper	10.2	17	11.8	17.5
Plastic	4.1	12	20.6	16.1
Glass	3.8	2	0.7	2.0
Metals	1.9	3	0.6	2.0
Other	2	8	4.9	11.4

Source: Solid Waste Management in Nairobi: A Situation Analysis. Report forCity Council of Nairobi (2010).

2.4.2.2 Minimisation of MSW in Kenya

Kenya does not have legislation and policies specifically dealing with waste management. Instead waste has been dealt with by using various legislation and Nairobi CityCouncil by-laws (Njoroge*et al.,*2014). The recycling activities in Nairobi are generally undertaken by private sector such asNGOs, CBOs and ordinary waste reclaimers (Okomu, 2012).

2.4.3 India

2.4.3.1 Management of MSW in India

Municipalities in India spend approximately 500-1500 Rupees per ton of solid waste management and of this amount; (60%) is spent on collection, 20% on transportation and 5% on disposal (Disha and Link, 2001). The city of Ahmedabad, for example, spent about 86% of its solid waste budget on collection, 13% on transportation and 1% on final disposal (World Bank, 1999).

In India, MSW is disposed off in low-lying areas, dump-yards located within the cities or outside without taking proper precautions or operational controls(Kaushal*et al.*, 2012;Strivastava, 2012). Therefore, municipal solid waste management is one of the major environmental problems in Indian megacities.Solid waste management generally involves activities associated with generation, storage and collection, transfer and transport, treatment and disposal of solid wastes (Okyere, 2014). However,according to Kaushal*et al.*(2012), inmost Indian cities, solid waste management system comprises only four activities, namely, waste generation, collection, transportation, and disposal. Poor collection and inadequate transportation both cause the accumulation of MSW in most open spaces, this mismanagement of MSW is problematic, due tothe unavailability of suitable facilities to treat and dispose off larger amounts of MSW generated daily in metropolitan cities (Maudgal,

1995).Household collection of waste has just started in major cities like New Delhi with assistance from non-governmental organisations (NGOs). This has achieved a 72% efficient success rate (Reddy and Galab, 1998; Nema, 2004; Rathi, 2006).

In 1995, MSW generation ranged between 0.2 kg and 0.6 kg /capita /day in the Indian cities amounting to 46 million tons annually (World Bank, 1999; India Infrastructure Report, 2006; Strivastava, 2012).Waste generation per capita in India has slightly increased from 0.44kg/day in 2001 to 0.5kg/day in 2011 this has been exacerbated by the changing lifestyle and increased purchasing power in urban areas (Annepu, 2012). The cities of India generate a total of 86 000 tons per day, which represents 31.5 million per annum MSW at per capita generation rate of 500 grams per day (Annepu, 2012). It is estimated that theMSW generation figure will probably increase in 2030 to 13 750 000 tons/ annually (Gupta, 2004).

According to Annepu (2012), urban areas of India generate about 68.8 million tons of MWS per year which translates to 188 500 tons per day. Furthermore, there has been a 50% increase in the generation rate over the past decade since 2001 (Annepu, 2012). It is projected that, should the generation rate of MSW maintain this trend of increase, by 2041 it will be 160.5 million tons/year, which is equivalent to 440 000 tons/day (Annepu, 2012). The urban population is growing at 2.7 % to 3.5% per annum and it is envisaged that the yearly increase in the quantities of waste generated will be more than 5% within the next few years. As the population growth continues to increase so too does the generation of waste (Tables 2.8 and 2.9) (Akolkar, 2005; India Infrastructure Report, 2006). India generated approximately 30 000 tons/day of MSW in 2000and this volume of waste has continued to increase with increasing population (ARRPET, 2004; Visvanathan*et al.,* 2007). In 2006, MSW in India consisted mainly of biodegradable waste (48%) followed by inert waste (25%) and the least being glass (1%). The generation of high amounts of biodegradable waste is due to high urbanisation with accompanying change in lifestyle and food consumption habits (Sharholy*et al.,* 2008;Strivastava, 2012). According to India (2012), the composition of MSW in urban areas of India is structured as follows: 51% is organic, 17.5% is recyclables (paper, plastic, metal and glass) and 31% inert. In India, the quantity of MSW (t/d/capita) is high in cities where there is high income, for example,New Delhi generates approximately 500 tons/capita/day of MSW in comparison to Gujarat city that generates approximately 250 tons/capita/day (Kaushal*et al*., 2012) .

According to Pappu *et al*.(2007);Annepu(2012), the rateof increase of MSW generated per capita is estimated at between 1 and 1.33% annually and MSW generation rate in India ranges between 0.2 to 0.5 kg/day per capita. In 1991 an estimated 23.86 million tons of waste was generated annually and more than 31 million tons in 2001, this is an increase of approximately 8 million tons in a decade (Annepu, 2012).Waste generation is estimated to exceed 260 million tons by 2047 which will be more than five times the current levels of generation in India (Energy and Resource Institute, 2012).

Table 2:8: Waste generation in Indian cities per capita.

Population Range (Millions)	Average Per Capita Waste Generation (G/Capita/Day)
0.1-0.5	210
0.5-1.0	250
1.0-2.0	270
2.0-5.0	350
5 plus	500

Source: National Environmental Engineering Research Institute, India(1995).

Table 2:9: Waste quantities and generation rates in Indian cities and state capitals.

City	Waste Quantity Generated (Mt/D)	Waste Generation Rate (Kg/D)
Vadodara	157.33	0.12
Kohima	12.48	0.16
Nashik	200	0.19
Lucknow	474.59	0.21
Guwahati	166.25	0.21
Gandhinagar	43.62	0.225
Jabalpur	216.19	0.23
Ranchi	208.27	0.246
Nagpur	503.85	0.25
Dehrandun	131	0.29
Raipur	184.27	0.3
Indore	556.51	0.35
Bhubaneshwar	234.46	0.36
Patna	510.94	0.37
Ahmedabad	1302	0.37
Faridabad	448.01	0.38
Dhanbad	77.12	0.387
Bangalore	1669	0.39
Bhopal	574.07	0.4
Argatala	77.36	0.4
Asansol	206.65	0.425
Daman	15.2	0.43

City	Waste Quantity Generated (Mt/D)	Waste Generation Rate (Kg/D)
Meerut	490	0.46
Agra	653.57	0.49
Allahabad	509.24	0.51
Ludhiana	734.37	0.53
Jamshedpur	387.98	0.59
Visakhapatanam	600	0.62

*Source:*Akolkar (2005).

In terms of MSW disposal trends in India, approximately 65% of MSW was disposed of at open dumps, 18% at landfill facilities, 14% was composted and 5% was incinerated (UNEP, 2002). The big cities collect 70% to 90% of MSW generated whereas smaller cities and towns collect less than 50% (Annepu, 2012). More than 91% of the MSW collected formally is disposed at open spaces and dumps, 2% of uncollected MSW is burnt on streets and about 10% of collected MSW is burnt on streets or at dumpsites (Kumar, 2010). In 2011, India sent to the landfill facilities about 6.7 million tons of MSW which could have been recycled and used as secondary raw material in manufacturing industries. This waste was due to inadequate separation at source (Annepu, 2012). In addition within that same year (2011) about 9.6 million tons of MSW which could have been composted was sent to the landfill facilities due to the lack of source separation and enough composting facilities (Annepu, 2012). The usage of incinerations as a disposal method of MSW is not practised at a full scale due numerous problems such as poor performance. The first large incineration facility was established in 1987 at New Delhi to operate at a capacity of 300 tons/day; however, the operation of the plant lasted six months and was it was shut down (Lal, 1996; Sharholy *et al*., 2008).

2.4.3.2 Minimisation of MSW in India

The separation of household waste at source is not properly organised in India.Instead, this is done by informal recyclers (Annepu, 2012). The volumes of waste recycled by informal recyclers from households are unknown. However, the volumes recycled from landfill facilities and open dumps are estimated to be 21% which can be four times that of the waste collected at households (Annepu, 2012). The unorganised recycling is also not effective as only waste that will result in high monetary return is mostly sorted by informal recyclers (Kaushal *et al*., 2012). The first composting plant was established in 1992 in Mumbai with a capacity of 500 tons/day of MSW. However, the plant can only process 300 tons/day due to various problems and is working very successfully where compost produced is sold at 2 Rupees (Reddy and Galab, 1998; Sharholy*et al.,* 2008). There are numerous composting projects established throughout the country, and the amounts of waste composted are not known and are operating at a low capacity. These composting projects are managed by the private sector through contractual arrangements with the municipalities (India Infrastructure Report, 2006). The compost produced at the composting plants is not marketable, making the operation of

the plants not viable (India Infrastructure Report, 2006). A 5MW Biomethanation power plant was constructed and operated at Lucknow city in India; however, it was closed down due to the non-supply of appropriate quality of MSW to the plant. The organic content in waste supplied to the plant was less that 15%. The operation of biomethanation plants within other cities of the country on asmall scale is continuing, for example Vijayawada city has been successful (Kaushal*et al*., 2012).

The Refuse Derived Fuel (RDF) also known as Pelletisation Projects are at the initial stage of development in India. Pelletisation entails the processing themixed MSW to fuel which is used by thermal processes such as incineration and industrial furnaces. The testing of viability and sustainability of the technology is underway. The pilot pelletisation plants are currently operated at in Delhi and Vijayawada and they have been in operation since November 2003(Sharholy *et al*., 2008). According to Kaushal*et al.*(2012), India does not have legislation that comprehensively addresses the management and minimisation of MSW.

2.5 WASTE MANAGEMENT ISSUES IN SOUTH AFRICA

In South Africa, the impacts of increasing waste generation are evident in various forms which affect the environment and human health in many ways (DEAT, 2000; Almorza and Brebbia, 2000). The negative impacts caused by the mismanagement of waste include:

- Aesthetically unattractive surroundings;
- Loss of land wherenew land must be identified for the development of facilities to manage waste; furthermore, land that could be utilised for other land uses, such as housing or industry, will be lost;
- Increase in the spread of diseases, community health suffers in the vicinity of waste accumulation; waste accumulation can promote the spread of disease vectors and result in specific adverse health effects associated with pollution, such as birth defects, cancer and respiratory illnesses; and
- Air and water pollution; air pollution will occur in the form of dust and hazardous compounds if the landfills are not managed correctly. Water pollution, on ground and surface water, will occur where improper precautions have been taken to prevent leachate (DEAT,2000; Almorza and Brebbia, 2000; Boadi and Kuitunen, 2005; Vasanthi *et al.,*2008).

In many cities such as Cape Town, Durban, Johannesburg and Tshwane, there are institutional frameworks in place to facilitate the management of waste from source to its disposal (DEAT, 2000). However, there is massive accumulation of waste, particularly in poor settlements located outside the urban edge and in townships, where there is a need for attention to support waste management (Frewin, 1997).

2.5.1 Waste Management in South Africa

South Africa generates approximately 42 million cubic metres of solid waste annually and largest portion is generated in Gauteng province (DWAF, 1997; DEAT, 1999; Treasury, 2011; Simelane and Mohee, 2012; Nkosi and Muzenda, 2013). There are numerous studies undertaken in the country attempting to quantify solid waste tonnages generated. The second and third versions of the national baseline study reported that the total amount of solid waste generated in the country increased from 65.4 million tons in 1997 to 108 million tons in 2011 (DEA, 2012). The majority of solid waste was produced in two urban hubs of South Africa which are Gauteng (45%) and Western Cape (20%) provinces in 2011 (DEA, 2012). Of the 108 million tons generated in 2011, about 43.2 million tons was municipal waste and about 97 million tons generated was disposed of at landfill facilities (Kalule and de Wet, 2009; DEA, 2012).

An average amount of waste generated per person in South Africa is 0.7 kg (DEA, 2012a). This is close to the average produced in developed countries, for instance, the United Kingdom produces 0.73 kg and Singapore produces 0.87 kg, in comparison to other developing countries such as Nepal which produce 0.3 kg (DWAF, 1997; Lincon, 2011). According to the third national baseline report, waste generated per capita has increased to an average of 0.96kg per day, with generation rates ranging from 0.19kg in North West province to 2.08kg in Gauteng province (DEA, 2012a; Godfrey, 2012). As seen in Table 2.10, South Africa generated a total of 52 million tons of MSW for the past five years with an average of 10 million per annum. The majority of MSW generated was in 2013 (31,557,618.7) and the least in 2011 (3,925,607.5) (SAWIC, 2014).

Table 2:10: MSW generation in South Africa.

Year	Volumes (Tons)
2013	31,557,618.7
2012	4,750,411.5
2011	3,925,607.5
2010	7,756,623.3
2009	4,164,573.4

Source: SAWIC (2014).

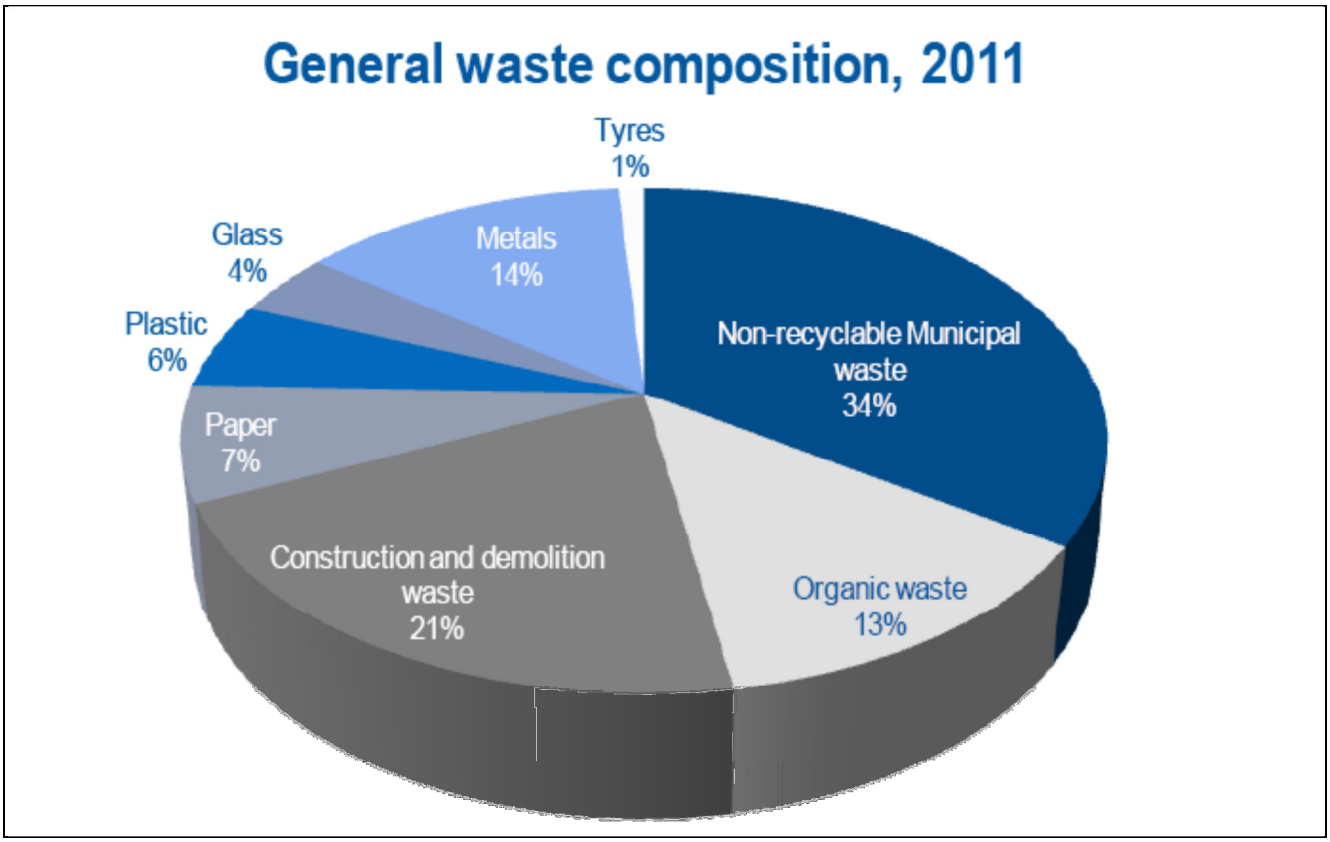

Figure 2:15: Waste composition generated in 2011.
Source: DEA(2012).

In terms of the composition of generated MSW, the highest is non-recyclable municipal waste (34%), followed by construction waste and demolition waste (21%),and the least is tyres (1%) (DEA,2012). South Africa's waste managementrelies mostly on landfill facilitiesfor the disposal of waste where about95%of the waste producedis disposed at landfill facilities(Treasury, 2011). For instance, in Gauteng waste disposed of at landfill facilities has increased to approximately 66% since 2004, while the annual waste generated is at an average of 37% (Treasury, 2011). Waste disposal sites are controlled under Chapter 5 of the National Environmental Management: Waste Act (No. 59 of 2008) with effect from 01 July 2009. Technical guidance on the development, operation and monitoring of waste disposal sites is provided through the Department of Water Affairs and Forestry (DWAF) (1997) Minimum Requirements (SAWIC, 2014). According to (Godfrey, 2004; Treasury, 2011; Oelofse *et al*., 2012), there are approximately 2000 waste handling facilities in the South Africa, and out of the 2000 waste handling facilities only 530 facilities have been licensed (Godfrey, 2004;Treasury, 2011; Oelofse*et al*., 2012). The licensing of land fillfacilitiesis limited in rural areas and secondary cities at 13% and 68% respectively; furthermore, the majority of the landfill facilities that are larger in size and licensed are found in big cities of the country (DEA, 2012). In 2013, the Department of Environmental Affairs in collaboration with the Municipal Infrastructure Support Agency (MISA) advertised a tender for the environmental service providers to conduct waste management licence processing for numerous landfill facilities across the country which were not licensed and those that require formal closure and rehabilitation. This was done in an effort to

expedite the permitting of landfill facilities operation and to assist local municipalities that are struggling to license their landfill facilities.

2.5.2 The Role of Local Authorities in Waste Management Practice

In terms of the South African Constitution (Act No. 108 of 1996), waste management service delivery is a local government function. Municipalities are responsible for the removal, collection and disposal of domestic and commercial waste. Private companies have been contracted by municipalities to assist in the provision of the waste management services, due to capacity constraints. In addition, the municipalities are required by the National Environmental Management Waste Act (No. 59 of 2008) to formulate and implement theIntegrated Waste Management Plans as well as implement the new Waste Management Systems (WMS) created by the Department of Environmental Affairs, but there is a lack of waste awareness by officials and administrators to plan and implement this.There is some progress made by other municipalities where draft Integrated waste management plans has been formulated and these include the Mafikeng local municipality in North West province, the City of Johannesburg municipality in Gauteng province and theeThekwinimetropolitan municipality in KwaZuluNatal province.

2.5.3 Legislation Associated With Waste in South Africa

This section describes the legislation, policies and strategies which were formulated and promulgated by the South African government in response to the waste management problems that were affecting the country and also exercising their mandate to protect South African communities and the environment.

2.5.3.1 South African Constitution Act (Act No. 108 of 1996)

The South African Constitution Act (No.108 of 1996) is an overarching legislation which encompasses various aspects affecting the sustainability of human livelihood. Section 24 of the Act states that everyone has a right to the environment that is not harmful to their health and wellbeing and to have that environment protected for the benefit of the present and future generation through reasonable legislative and other measures that prevents environmental pollution and degradation, promotes conservation and secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development (South African Constitution Act (No. 108 of 1996).

2.5.3.2 National Environmental Management Act (Act No. 107 of 1998)

The Act sets out environmental principles that need to be implemented by all the organs of the state (including local municipalities) in the Republic of South Africa in order to prevent any detrimental environmental impacts. The sustainable development principle requires that waste be avoided, or where it cannot be avoided altogether, it should be minimised and reused or recycled where possible and the responsible disposal should be the last method. Section 16 of the Act states that the municipalities need to adhere to the environmental principles. Section 28 of the Act emphasises the duty of care towards the environment, where anyone who has or is likely to cause harm to the environment must take reasonable measures to protect, minimise and mitigate harm done to the environment. The mismanagement of municipal waste has a potential to result in detrimental environmental impacts, thus the municipalities are required to formulate waste bylaws and management plans to ameliorate waste problems in the environment within their jurisdiction through proper collection, treatment and disposal.

2.5.3.3 National Environmental Management Waste Act (Act No. 59 of 2008)

According to the South African National Environmental Management Waste Act (No. 59 of 2008) as amended in June 2014, waste refers to*(a) any substance, material or object that is unwanted, rejected, abandoned, discarded or disposed of or that is intended or required to be discarded or disposed of by the holder of that substance material or object whether or not that substance can be reused, recycled or recovered and includes all waste as defined in Schedule 3 of this Act. (b) any other substances, materials or object that is not included in Schedule 3 that may be defined as waste by the Minister by notice in the Gazette*

Source: National Environmental Management: Waste Act (Act No. 59 of 2008: 5) as amended in June 2014.

The National Environmental Management Waste Act (Act No.59 of 2008) as amended in June 2014 distinguishes between hazardous and general waste. General waste is defined as waste that does not pose an immediate hazard or threat to human health or environment and that includes domestic, building and demolition, business and inert. Hazardous waste is defined as waste that contains organic or inorganic elements or compounds that are chemical and toxic to the environment or human health and that includes hazardous substances, materials or objects within business waste, residue deposit and residue stockpiles.

The National Environmental Management Waste Act was promulgated in 2008 to specifically address waste management problems and challenges in South Africa. Some of the objectives of the act are to avoid and minimising the generation of waste through reducing, reusing, recycling, recovering and treating. The disposing of waste should be the last resort. Municipalities are provided with a mandate to deliver waste management services and these services include waste removal, storage and disposal in a responsible manner and also by adhering to national and provincial norms and

standards. Furthermore, municipalities are required to formulate Integrated Waste Management Plans, bylaws and standards that deal with the management and minimisation of waste within their jurisdiction. The Act was amended in 2013 and 2014 to include the standards that need to be adhered to and implemented during the establishment of the new waste management facilities. Other provisions and terms within the Act were amended,such as the definition of waste and types.

2.5.3.4 National Waste Information Regulation 2012

The National Waste Information Regulation was published by the Minister of Environmental Affairs in August 2012. The regulations came into effect on 01January 2013. The purpose of the regulations is to regulate the collection of data and information to fulfil the objectives of the national waste information system provided for in Section 61 of National Environmental Management Waste Act (No 59 of 2008). The undertaking of activities listed in Annexure 1 of this regulation needs to be registered on the South African Waste Information System (SAWIS) within the stipulated timeframeswhich includes: (1)any person conducting an existing activity listed in Annexure 1 to the regulations must apply to the Department within 90 days of the regulations coming into effect; (2) any person commencing with an activity listed in Annexure 1 after the regulations come into effect must, within 30 days of commencing such activity, apply to be registered on the SAWIS; (3) If more than one activity on Annexure 1 is undertaken then each activity must be registered on the SAWIS individually; (4)the submission of information to the SAWIS must commence 90 days after the end of the registration period; (5) a registered person conducting an activity listed in Annexure 1 must submit quarterly information as prescribed in Annexure 2 within 60 days of the end of the reporting period;(6) subject to certain exceptions, a registered person (municipalities, private companies etc.)Submitting information on general waste must submit information that is based on an estimation of quantities for a period of 5 years from 1 January 2013, after which the information must be based on actual quantities; (7) a registered person must keep a record of the information submitted to SAWIS for a period of at least 5 years and must be able to make such records available for inspection by a representative of the Department on request ; and (8) if there is reason to believe that the information submitted by a registered person is incorrect then such person may be instructed in writing to, at his/her own costs, submit an audit report conducted by an independent person on the accuracy of the information or conduct a waste quantification survey and submit a waste quantification report prepared by an independent person.

Municipalities are required to report the quantities of municipal waste generated within their jurisdiction as per the procedures stated in the National Waste Information Regulation. The reporting of waste information is to assist the municipalities to gauge themselves over time in determining the improvement in the management of waste and also enable them to identify challenges in order to formulate and develop effective solutions.

2.5.3.5 National Waste Management Strategy 2011

The National Waste Management Strategy (NWMS) is a legislative requirement of the National Environmental Management Waste Act (No. 59 of 2008). The purpose of the NWMS is to achieve the objectives of the waste act. The organs of state and affected persons are obliged to give effect to NWMS (DEA, 2012). Municipalities are tasked to implement the waste hierarchy, conduct waste awareness campaigns to the local communities and lastly, municipalities are required to provide effective and efficient waste management services. The NWMS emphasises that integrated waste management plans formulated by the municipalities need to be practical and easily be implementable; outcome focused must, include must priorities, objectives and targets and must make provision for financial arrangements. The NWMS is structured around a framework of eight goals which are targeted to be met in 2016 and they are: the promotion of waste minimisation through reuse, recycle and recovery of waste; ensuring the effective and efficient delivery of waste services; growing the waste sector to the green economy; ensuring that people are aware of the impact of waste in their health, well-being and environment; achieving intergraded waste management planning; ensuring sound budgeting and financial management of waste for waste services; providing measures to remediate contaminated land; and establishing effective compliance with and enforcement of waste. The above mentioned goals are required to be implemented by local municipalities as authorities mandated to provide waste services.

2.5.3.6 South African Action Plan for Waste Minimisation and Recycling 1999

Action Plan on Waste Minimisation and Recycling is a first generation plan aimed at addressing key the issues, needs and problems currently experienced with waste minimisation and recycling in South Africa. This document represents the optimum approach to the implementation of the activities of the Action Plan in terms of resource allocation, time schedule and responsibilities. Resource constraints may limit the full implementation of the Action Plan in line with the proposed time schedule, thus continual monitoring and adaptation of the Action Plan to accommodate the practical situation will be required. As increased resources become available, additional initiatives can be implemented. Municipal solid waste has a potential to result in negative environmental impacts when controlled inappropriately, thus the implementation of this action plan by municipalities is of vital importance in minimising the environmental impacts.

2.5.3.7 Plastic Bag Regulation R 543

The plastic bag regulation was published by the Minister of Environmental Affairs and Tourism in 2002, to enact section 24d of the Environmental Conservation Act (Act No. 73 of 1989). The purpose of the regulation was to prohibit the manufacturing and commercial distribution of plastic bags with a thickness that is less than 80 micrometres and the paintings marks embedded in the plastic to be approved by the Minister. The Regulation was published as a result of the plastic bags that were degrading the environment and also which were not recyclable. New plastic bags have been

manufactured that meet the standards of the regulation. In addition, the new plastic bags are now sold at retail stores at a cost of approximately 60c whereas prior to the promulgation of the plastic bag regulations they were obtained freely at the retail stores on purchase of goods. This has been done as one of the initiatives to reduce waste and promote reuse or recycling of these bags as they can be used several times before they can tear and be disposed off. Plastic is one of the products classified as MSW when it is no longer in use and incorrect disposal results in aesthetic unattractive impacts, therefore effective control of plastic waste product is important in minimising the negative impacts on the environment. This regulation is relevant to municipalities in terms of waste management as their bylaws can incorporate its objectives and principles in order to enforce and monitor effectively the implementation of bylaws within their jurisdiction.

2.5.4 Waste Minimisation

According to (DEA, 2012), South Africa is reported to recycles about 10% of waste generated in 2011. There is an absence of recycling infrastructure which will enable separation of waste at source and diversion of waste streams to material recovery and buy back facilities. This will reduce the need for air space in municipal landfills and keep the cost of disposal down (Paper Recycling Association of South Africa (PRASA, 2011). The reliance of the country on landfill sites as a method to managing waste has limited the incentives to device alternative methods of dealing with waste. The recycling of waste in the country is still a challenge as there are not many initiatives undertaken to accelerate this waste management method. It is estimated that only 20% of the household waste is recycled in the country (Treasury, 2011). There was an increase in the recycling rates for the period of two years (2007-2009) of different types of waste as seen in Table 2.11 with exception of beverage cans which declined by 1% (National Waste Management Strategy, 2011).

Table 2:11: Recycled waste (2007-2009).

Waste Type	2007(%)	2009 (%)	2007-2009 Trend
Paper	54.50%	56%	↑
Glass	25%	32%	↑
Plastic	22%	26%	↑
Beverage cans	70%	69%	↓

Source: National Waste Management Strategy (2011).

The country has about 18 recycling centres that have been licensed which range from five Buyisa-e-Bag recycling facility in Gauteng to multipurpose facilities which are privately owned (Treasury,2011). In addition there are other recycling activities which are undertaken by informal recyclers in streets, landfills and through sorting the households waste from waste bins on the day of its collection. There are other initiatives undertaken by the local government of South Africa to address waste in the country and these are described below. The involvement of local municipalities in the recycling activities is limited, with few that are involved such as the City of Johannesburg. It is of vital

importance that partnership relations be created by municipalities and the private sector and informal recyclers as they are the most active parties of the recycling sector. This will assist the municipalities in terms of obtaining more information regarding the volumes of waste recycled and being able to report accurate information on the SAWIC as well as being able to plan accordingly for waste management services rendered to communities and commercial sector.

2.5.5 City of Johannesburg's Sisonke (Together) Waste Project

Sisonke is an initiative of the City of Johannesburg, Pikitup and the Department of Science and Technology. The project was launched on the 12 October 2007 where a total of 23 underground bins were installed in various streets of Joubert Park, Hillbrow, Yeoville and the CBD (Figure 2.16). The Sisonke project also entailed the cleaning up of streets in informal settlements located adjacent to the city such as Slovo Park as well as establishing waste recycling centre. However, the recently instituted initiative of underground bin in the Johannesburg City centre to assist in waste management is still not sufficient to control waste as people still discard waste on the floor next to the bins instead of inside the bins (Figure 2.17).

Figure 2:16: An underground dust bin system near Johannesburg Park Station.

Figure 2:17: Depicts the litter around the underground bin.

The City of Johannesburg has also collaborated with the City of Tshwane to establish a clean-up campaign called “Buyisa-ebag” meaning bring it back. Buyisa-e-Bag’s core business is to develop entrepreneurs and create sustainable opportunities in the recycling and waste management sector by setting up multi recycling Buy-Back Centres in South Africa. These business- recycling initiatives are intended to play a vital role in implementing Buyisa-e-Bag’s strategy, which aims to encourage the collection, re-use, and recycling of plastic shopping bags and other recyclable materials that are discarded in the waste stream, as well as making provision for the collection of recyclables from environmentally sensitive areas, including rural areas, hotspots, taxi ranks, tourist areas and high poor density urban areas. The construction of eight new centres commenced in November 2007 where 8 centres were completed in August 2008 and the costs associated with the building each centres was 1.8 million Rands. The centres are aimed at supporting the government in the promotion of recycling and job creation opportunities by making recycling a financially viable and sustainable business. It is important and very critical that sufficient sources of recycling materials are created for Buy Back Centres to ensure expected recovery as these sources will contribute directly in terms of volume recoveries on monthly basis. The required functional resources for the recycling centres are baling machines, electronic weighing scales, collection trolleys, steel containers for plastics and protective clothing (Tshwane Waste Report, 2008).

- *Waste to Energy Projects*

Municipalities have begun to pilot the waste to energy projects. The eThekwinimunicipality is extracting gas and generating electricity from the Marian Hill and La Mercy landfill sites. The recent

project undertaken by the City of Johannesburg is the energy generation from incineration waste. The Ekurhuleni metropolitan municipality has installed flaring gas stations in four of its landfill sites (Weltervreden, Simmer and Jack, Rietfontein and Rooikraal). The energy recovery projects or schemes are incentivised by the potential to generate carbon credits and associated revenues. Eskom has estimated that the energy extracted from landfills could have a capacity that ranges from 20-50 megawatt with a life of the plant of 30 years (Treasury, 2011, Financial and Fiscal Commission, 2012).

2.5.6 Sustainable Waste Management

Sustainable development is a development that meets the current generation needs without compromising or hindering the future generations from meeting their own needs (Sustainable Waste Management Fact Sheet, 2013). Sustainable waste management entails the management of resources in an environmentally sound and economical manner. This management of resources encompasses a cradle to cradle approach where products and goods are designed insuch a manner that they can be easily de-manufactured and dismantled for material recovery and recycling, resulting in the reduction of environmental impacts (Institute of Waste Management in Southern Africa, 2007). The South African government formulated a National Waste Management Strategy in 2011 as referred to above, which outlines goals that need to be achieved by 2016 in effectively addressing waste management. One of the goals is to promote waste minimisation and recovery of waste through the implementation of waste management hierarchy and integrated solid waste management. As mentioned in the above sections, that waste management hierarchy has evolved over the years and is designed according to respective countries' waste management needs and challenges, the hierarchy which has been adopted in South African is depicted below (Figure 2.18). This hierarchy has been aligned with the National Environmental Waste Management Act (No. 59 of 2008) and thus, the National Waste Management Strategy follows the approach of the hierarchy. Waste avoidance and reduction are the first priority in the hierarchy, followed by reuse, recycling, recovery and treatment and disposal which are the least preferred methods.

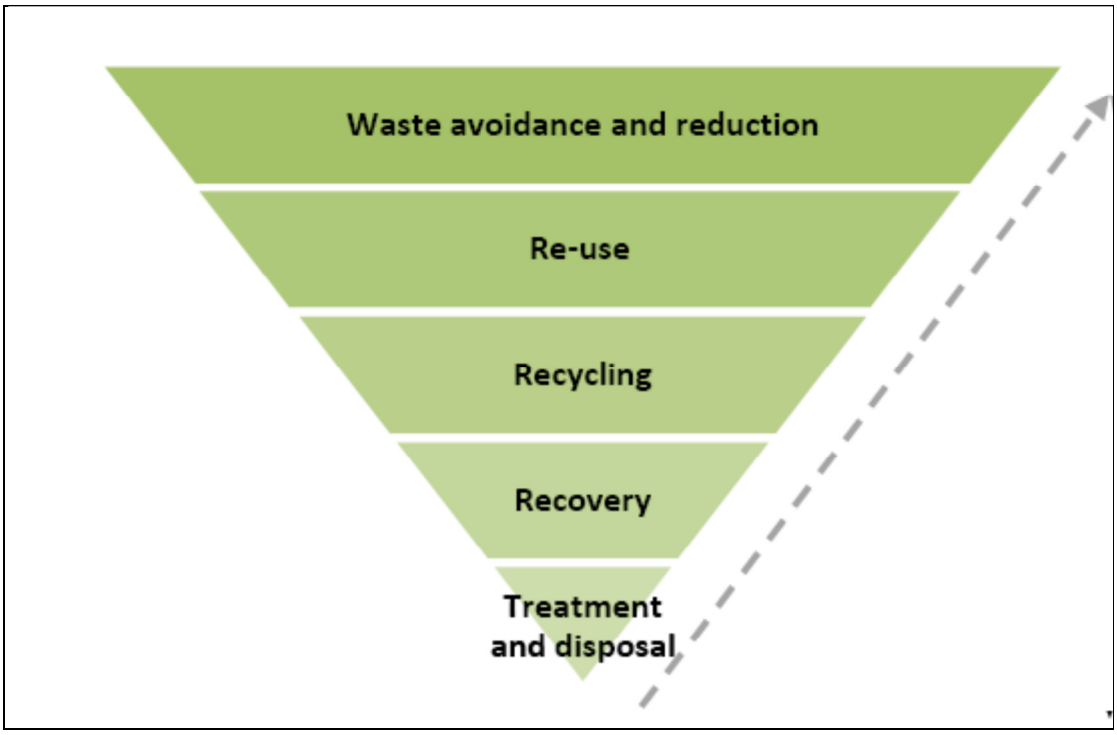

Figure 2:18: Waste management hierarchy.
Source: National Waste Management Strategy (2011).

2.5.7 Waste Information System

The development of thenational waste information system was identified by the South African Government in the late 1990s in order to support the implementation of pollution and waste reduction measures as well as integrated waste management (Republic of South Africa 2000a; Godfrey, 2008).The reporting of reliable waste data for integrated waste planning is vital for the successful implementation of a waste information system in the country as also required by the National Environmental Management Waste Act (No. 59 of 2008). The collection of reliable data is required in order to determine the waste management infrastructure needed in the country and implement this accordingly (DEA, 2012). Section 62 of National Environmental Management: Waste Act (No.59 of 2008) states that the national waste information systems also need to be implemented at the provincial level using the national guidelines. This will ensure appropriate integration of information in order to champion the effectiveness of waste managementin the country. The Waste information system has thus far been implemented nationally where all waste stakeholders report their waste information but the system has not yet implemented provincially. Local municipalities are required to report different types of waste (hazardousand generalMSW) and volumes generated at their respective areas of jurisdiction.

The waste information system is one of the most important tools ever developed in the country, however its implementation is progressing at a slow pace as the waste data collected from various provinces is not comprehensively incorporated. For instance,the number of landfill sites reported for each province and the volumes generated and collected are inconsistent, thus making it making it

difficult to gain a full reflection of waste types generated in South Africa. Such errors need to be corrected in order to meet the objectives waste act of having reliable data (Researcher's Observation).

2.5.8 Land filling as a Form of Municipal Waste Management

Disposal of wastes through landfill is an inevitable element of all solid waste management systems. Even if all activities for reduction, reuse and recycling are implemented, there will always be a need for land disposal of a residual proportion of the waste produced originally (DWAF, 1997). Sanitary landfill is the most common and popular method of solid waste disposal used in many developing and developed countries (DEA, 2012; Simelane and Mohee, 2012). The disposal of MSW at landfill facilities in South Africa remains a predominant means of managing waste due to it being associated with lower costs when compared to other waste management options (recycling) (Treasury , 2011; DEA, 2012; Department of Science and Technology, 2012). The most difficult tasks faced by most waste management authorities in planning solid waste landfill is finding suitable sites for new landfills (Ekurhuleni Metropolitan Municipality SoER, 2004; Western Cape Outlook, 2013). The appropriate site selection for waste disposal is a complicated process because it must combine social, environmental and technical factors (Kontos *et al.*, 2005). However, there are tools in place which can assist in overcoming the challenges faced by waste management authorities and these include a Geographic Information System (GIS) and an Analytical Hierachy Process (AHP) (Allen, 2003; Ball, 2005). GIS has the ability to manage large volumes of spatially distributed data from a variety of sources. It efficiently stores, retrieves and analyses and displays information according to user defined specification;whilst the AHP assists with the ranking of suitable sites for landfill (Allen, 2003; Ball, 2005).

2.5.9 Public Participation Awareness Campaigns

There is a growing increase in the demand of community participation for the development projects due to the past mistreatment of the communities by the developers and authorities when establishing new developments in South Africa (Alli and Emery, 1994). This process has also been legislated in numerous pieces of legislation such the South African National Environmental Management Act (107 of 1998). The public participation process plays a vital role through the comments and concerns that are raised by the different stakeholders and the general public prior the implementation of new projects, which in turn assists the authorities or private developers in making informed decisions during the implementation phase of the developments. Local authorities are now adopting this tool to engage with the local communities within their jurisdictions in relaying certain matters such as waste management and the importance of living in a clean environment through awareness campaigns (CSIR, 2010). The purpose of awareness campaigns in communities is to change people's attitudes and behaviour to ensure a cleaner environment. However, it has been observed that the surrounding environments become littered again few months later after the awareness sessions were held with the communities. This has meant that these awareness campaigns be must designed in a

sustainable manner to ensure the continuity of the clean environment that should be enjoyed by all (Mazinyo, 2009; CSIR, 2010; City of Joburg Integrated Waste Management Plan, 2011; Ludidi, 2013).

The implementation of waste the hierarchy is vital in the effective and efficiency of waste management and as such waste minimisation and separation at source need to be encouraged by the municipalities through the erection of clearly visible billboards and the provision of sufficient properly labelled (e.g.Green label -recyclable waste, red label-non recyclable waste) waste bins and collection thereof in order to improve the reuse and recycling activities. For example the Bitou municipality has clearly marked recycling bins, Saldanha Bay has a 2wise2waste billboards and the City of Tshwane displays the slogans on the transport vehicles. Furthermore, willingness to pay for waste services will also improve with increased awareness (CSIR, 2010).

2.5.10 Other Form of Waste Management

Forming partnerships between the public and private sector can be used as a tool to manage municipal solid waste and has been successful in developed and developing countries such as Germany and Ghana (Ogawa, 2008). One of the promising mechanisms to encourage the effective management of MSW is a public-private-partnership between a municipality and industries. An example of this partnership has been manifested in the City of Cape Town and has been successfully executed,and the replication of this initiative is being investigated for other provinces (DEA, 2007). Other partnerships have been established on a low scale and these include: (1) partnerships of private companies for instance (Kytech and PETCO); PETCO supply recycled PET bottles to Kaytech for the manufacturing of Bidim geotextile used manage groundwater drainage; (2) partnerships between private companies (Polystyrene Council) and schools,schools pupils and teachers in Gauteng are recycling polystyrene material and disposing of the material in special waste bins provided by polystyrene council. The recycling project has become part of the school curriculum (Infrastructure News, 2013).

2.6 SUMMARY OF LITERATURE REVIEW

The reviewson developed countries (Germany, Denmark, Japan and United States of America) have revealed that waste management and minimisation is being carried out effectively when compared with processes indeveloping countries (Philippines, Kenya, India and South Africa).

2.6.1 Summary of Findings Pertaining to Developed Countries

Municipal solid waste generated in developed countries that needs to be disposed at landfill facilities has generallydeclined over thepast decades (2001-2010) in countries such as Germanyand Denmark. The decline has been achieved through the tools which have been implemented such as

the producer responsibility principle, recycling initiatives, legislation and the taxes (landfill and incineration) which have beenincreased with a purpose of discouraging people from disposing off unsorted waste at landfill facilities. The United States of America and Japan introduced tools such as “Pay as you throw”, where residents are charged according to the volume of waste they produce and discard. The tool encouraged residents of each respective country to sort their waste from source as it became expensive to disposeunsorted waste. The municipal officials of each developed countries did not only introduce and enforce these tools to the residents, they also provided resources at household level which enabled the residents to sort waste at source. For example, in Germany, the green label waste lid bin is designated for organic waste, the red label for residual waste and the grey label for other recyclable waste such as paper, plastic. In addition, where waste bins labelled for specific type of waste (glass) are not provided at household level, centrally located communal waste bins are provided for residents (Denmark). The recycling rates have increased tremendously in Germany and Denmark over decades since the introduction of relevant tools (landfill taxes) that discouraged the disposal of unsorted waste. Higher recycling rates have led to the decline of landfill facilitiesinGermany it was reported that they had 333 facilities in 2000 compared to 8273 in 1990. Due to the increase in the recycling and incineration rates, many landfills currently receive less amount of waste, and it is no longer economically viable to keep them fully operational in Denmark. In contrast, the decline of landfill facilities in the United States of America was as a result of land scarcity to develop new landfill facilities and this has resulted in some cities such as New York and New Jersey transporting and disposing of their waste into neighbouring cities. In terms of MSW recycling rates, the United States of America recycled less volumes of waste (34%) when compared to other to other developed countries (75%), and in Japan the recycling rate has been increasing at a 1% rate annually.

It appears that in the developed countries there is a growing paradigm shift, where waste is no longer regarded as just “waste” but as a resource which can benefit society and the world. There are numerous waste to energy projects implemented to provide energy and electricity, in Denmark for instance, the heat produced from waste to energy facilities was distributed to 400 000 households and in United States of America about 2720 megawatts of total power is produced from waste to energy facilities. Japan is considered to be a leader in developing and implementing traditional thermal treatment technologies for processing municipal waste.Overall, the developed countries are doing well in terms of addressing waste management and minimisation. However, waste policy instruments which address the continual waste generation due to the increasing population annually is lacking. This sentiment has been emphasised particularly as the 3Rs need be the cornerstone of waste policy.

2.6.2 Summary of Findings Pertaining to Developing Countries

Waste management in developing countries is still an enormous challenge as the basic instruments such as legislation are lacking or out-dated as in Kenya. The waste services that need to be provided by local municipalities are absent or inadequate and facilities for waste disposal are insufficient. The lack of these instruments results in illegal waste disposal in sensitive environmental areas such as

watercourses, thus causing detrimental environmental and health impacts. The volumes of waste generated in developing countries are very high, equalling to those of developed countries (South Africa, the Philippines 0.7kg/capita versus United Kingdom 0.73kg/capita). The waste collection services are mostly provided in urban areas (Kenya, India) and the records of waste volumes generated in rural areas are unknown due to the waste services not being rendered by municipalities (India, Kenya). The implementation of legislation formulated to deal with waste in other countries, (the Philippines) is a challenge due to the lack of capacity from the officials and proper planning. The budget allocated to waste management services is often not adequate, hindering the local municipalities from providing this service effectively within the areas of their jurisdiction. For example,in India municipalities spend an average of about 60% in waste collection, 20% transportation and 5% in disposal, but can only collect as low as 3% of the total annual local authority budget which exacerbates the problems associated with waste management services finances.

In terms of recycling, this activity is generally undertaken by the private sector (NGO, CBO, private companies) and informal recyclers in developing countries. The volumes of recycled waste are not accurately recorded or they are unknown. The Philippines (Metro Manila) recycled about 28% of waste in 2006 which was higher than the waste recycled the previous years; South Africa was reported to recycle about 10% of annual MSW generated and India recycled approximately 21% from the landfill facilities and this figure is estimated to be four times that of the entire waste recycled in the country. It must be noted that there are several projects undertaken by local municipalities and private sectors in raising awareness on waste management and recycling at community levels. In addition, the recycling initiatives have been undertaken successfully where formal employment was created for local communities at some local municipalities (the Philippines), waste to energy projects have also been implemented at a small scale (India and the Philippines) to meet the energy needs of the respective countries.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter provides a description of the research design, methods and instruments used for data collection, analyses and interpretation. These include qualitative and quantitative methodologies as well as a non-probability sampling framework. The research followed a triangulated research design entailing various data collection methods.

3.2 RESEARCH DESIGN AND METHODS

Quantitative and qualitative research design (mixed method) was adopted in this study. There are many definitions of mixed methods that are available in the literature and for the purposes of this study, a definition by Creswell *et al.,* 2011:165) has been adopted:

"Mixed method study involves the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially, and are given a priority and involve the integration of the data at one or more stages in the process of the research."

In addition, mixed methods have also been differentiated into different types of designs, namely, sequential explanatory, sequential exploratory, sequential transformative, concurrent triangulation, concurrent nested and concurrent transformative versions (Creswell, 2003).

Given the research design selected for this study, it was imperative to make use of both quantitative and qualitative methods. According to Creswell, 2003), using both quantitative and qualitative methodologies minimises the limitation that each method has. Moreover, such a mixed-method approach provides an advantage that each method can inform on the other (Creswell, 2003; Bryman 2006). Furthermore, a concurrent triangulated design was used for this research study where quantitative and qualitative data were collected and analysed at the same time. Concurrent triangulated design is used to validate and confirm the findings within the single study (Greene *et al*., 1989; Steckler *et al*., 1992; Morgan, 1998). This design usually integrates the results of the two methods during the interpretation phase and can result in well validated and substantiated findings (Creswell, 2003). Mixed methods are usually used in social science studies to understand certain dynamics related to social behaviour (Curry *et al*., 2009; Thaler, 2012). It was fitting for this study to adopt this design as the research aim was comprised of social aspects of the EMM municipality that needed to be understood better in order to manage waste effectively.

3.2.1 Development of Questionnaires

Four types of questionnaires were designed for the study and aimed at different target groups, namely, households, informal reclaimers, municipality and landfill facilities. The questionnaires were designed based on the research aim and objectives. It was imperative to have different questionnaires in order to comprehensively understand the waste management and minimisation issues within this municipality. Each questionnaire had different sections dealing with various aspects of waste management and minimisation and these are described below:

- *Household Questionnaire*

This questionnaire had two sections dealing with demographic aspects and waste management awareness aspects (Appendix A).

- *Informal Recyclers Questionnaire*

Three sections were contained in this questionnaire and these are the demographic and recycling aspects as well as environmental health challenges (Appendix B).

- *Municipality Questionnaire*

Municipal demographics, capacity and skills, planning and development, operational challenges and finances, waste minimisation and recycling projects undertaken by the municipality were covered in the different sections of the questionnaire designed for the municipality (Appendix C).

- *Landfill Questionnaire*

The questionnaire contained two sections which cover the demographics involved in the landfill facilities and characteristics of informal waste recyclers (Appendix D).

3.2.2 Quantitative Surveys

Most data collected in quantitative research are measureable and can be analysed making use of statistics and other representations (Poate and Daplyn, 1993). Primary data is firstly generated through field measurements, surveys and various kinds of interviews (Poate and Daplyn, 1993). By contrast, secondary data is collected from existing literature and other secondary sources. In fact, according to Creswell (2003), quantitative data from secondary sources can include numeric data from sources such as existing statistics, census offices and business databases. In the current study, the quantitative methods used involved the collection of primary data through surveys and interviews. The respondents targeted for the study included amongst others: municipal officials and managers dealing with waste management, households, landfill site officials as well as informal waste pickers. The primary data obtained was analysed by means of descriptive statistics. Consequently, the results

obtained from the analysis and interpretation of such data were then summarised and depicted in the form of tables, pie charts, histograms and bar graphs.

These activities were undertaken during the July-November 2013 period. Consequently, this data was collected on the basis of non-probability sampling, which is further explained below.

3.2.2.1 Non-Probability Sampling Framework

According to Leedy and Ormrod (2005), non-probability sampling does not guarantee that each member of the population of the study area will be represented in the sample. There are three types of non-probability sampling, namely, convenience, quota and purposive sampling (Leedy and Ormrod, 2005). A purposive sampling method was adopted for the present study. Purposive sampling method selects a group of people or units of interest for a particular purpose (Coyne, 1997; Leedy and Ormrod, 2005). This sampling framework was chosen to achieve this goal. A sample of households (100), informal recyclers (100) and the municipal officials (36) within the EMM were selected and interviewed verbally and by making use of questionnaires designed specifically to obtain primary data on their attributes. In addition, this sampling framework was selected as it was representative of the study area and research problem.

The primary data collected during quantitative surveys was augmented by secondary data from a desktop survey. Desktop surveys involved gathering data from secondary sources such as existing literature, waste-related documents published in the Government Gazette, or any other relevant material. Such data was then examined, tabulated and analysed statistically in order to reflect further on the problem under investigation, thus assisting in providing a context and background for the study. In addition, data interpreted from such sources also provided a theoretical and a historical basis for the study.

3.2.3 Qualitative Surveys

Qualitative research is used to respond to questions about the complex nature of phenomena and often has the purpose of describing the phenomena from the participant's point of view (Leedy and Ormrod, 2005). In this study, such data was gathered by means of semi-structured and open-ended questionnaires for in-depth interviews. According to Poate and Daplyn (1993), interviews questionnaires may contain open-ended or closed-ended questions, leading questions, multiple questions, ambiguous questions and probing questions. Each of the set questions requires specific skills on the part of the researcher to ensure unbiased responses from research participants (Devos *et al.*, 1998).

Regarding the current study, primary data was obtained by means of questionnaires and face-to-face interviews with various stakeholders involved in waste management or waste minimisation at EMM. In addition, on-site observations were also undertaken. Such a methodological approach has been

used in several studies dealing with the different aspects of waste management and waste minimisation. For instance, in a study carried out by Van der Merwe and Steyl (2005) in the Boland District Municipality in Stellenbosch (South Africa), questionnaires were used to produce the data required in order to help understand the various dimensions of solid waste management in intensively farmed rural areas. Furthermore, in examining the performance of solid waste management in Nigeria, three different sets of questionnaires were designed for the survey of households, businesses and waste policy-makers (Ezeah and Roberts, 2012).

3.2.4 Ethical Research Considerations

Before the study was undertaken, ethical permission to proceed was provided by the relevant College Review Committee at the University of South Africa. At the same time, a prior consent form was designed for the study in order to conform to university ethical research procedures and conduct. Subsequently, the respondents were requested to sign a consent form prior to responding to questionnaires. The consent form explained the purpose and benefits of the study as well as the instruments which were going to be used in obtaining primary data. Certain clauses were also explained to them and included the confidentiality aspect in terms of the views and perceptions shared by the respondents regarding the exploratory study, and the opportunity for withdrawal should the respondents decide not to continue participating in the research. It must be noted that there were no withdrawals by the respondents who gave prior consent to the study and those who were not willing to participate were left alone and not pursued further.

3.2.5 Procedure of Questionnaire Administration

The questionnaires were distributed to the selected respondents where the aim of the research was explained prior to the completion of questionnaires. The distribution period of these questionnaires was five months from July to November 2013.

3.2.5.1 Household Questionnaires

A total of 100 questionnaires were prepared and administered to selected households within the residential areas of the EMM. The household questionnaire was categorised into two sections, namely, biographical details and waste management awareness (Appendix A). Out of the 100 questionnaires administered to respondents, 80 were completed successfully and returned for analysis, thus yielding a response rate of 80%. Household respondents were randomly selected based on their willingness to participate in the study. About 20 questionnaires were returned on the same day of distribution meanwhile the other 60 questionnaires were collected after two weeks of distribution.

3.2.5.2 Informal Waste Reclaimers Questionnaires

One hundred (100) questionnaires were administered to informal waste reclaimers within EMM and of these, 52 respondents gave prior informed consent and went further to complete the questionnaires required for analysis. Thus, there was a 52% response rate. The questionnaire designed for informal waste reclaimers covered three aspects, namely: biographical details, recycling, health and safety aspects (Appendix B). The informal reclaimers who were approached for the study were found near the landfill facilities. The 100 questionnaires were then divided into four batches to cover all landfill facilities. About 25 questionnaires were distributed to 25 informal reclaimers found in each facility. The highest respondent rate (100%) to the questionnaires was from the reclaimers found near the Chloorkop landfill facility who returned all the questionnaires for analysis. Informal reclaimers from Weltervreden and Simmer and Jack landfill site returned only 12, respectively. On the other hand, Rietfontein informal reclaimers had the lowest response rate.

3.2.5.3 Municipal Questionnaires

The second survey undertaken for the study was for municipal officials employed within the Waste Management Department. Out of the 32 questionnaires administered to them, 11 were returned for analysis and this represented a 34% response rate. The municipal questionnaire was categorised into 8 sections which are demographic details, capacity and skills, planning and development, problems encountered in the waste management service delivery, finances within the waste department, minimisation and recycling projects initiatives, the role of buy back centres and the benefits of recycling and minimisation initiatives (Appendix C). The questionnaire was distributed to all waste department employees using an email and a deadline was set for the return of the completed questionnaire for analysis.

3.2.5.4 Landfill Sites Questionnaires

There were four landfill sites selected for the study within the EMM municipality and these included: Chloorkop located in Kempton Park, Weltervreden in Brakpan, Rietfontein in Springs as well as Simmer and Jack in Germiston. Four (4) questionnaires were administered to the landfill managers and these were categorised into two sections, namely, demographic details and informal recycler's characteristics (Appendix D). A 100% response rate was achieved. The landfill sites visited for the study were strategically selected to comprehensively cover the three regions of the EMM, namely, the northern region (Choorkop landfill), easterly region (Weltervreden landfill and Rietfontein landfill) and southerly region (Simmer and Jack landfill).

3.3. DATA ANALYSIS AND INTERPRETATION

All data collected during surveys were stored in the Microsoft Excel (2010) spread sheet. These data sets were then analysed using descriptive statistics. The results were further presented in the form of pie and bar-charts as well as tables. In addition, some of the results were presented by means of photos.

CHAPTER 4

LOCATION OF THE STUDY AREA

4.1 GEOGRAPHICAL BACKGROUND OFGAUTENG PROVINCE

Gauteng is the smallest of the nine provinces in South Africa and densely populated (Figure 4.1 and Table4.2). The mining and processing of underground gold reserves in Gauteng (formerly known as the Pretoria-Witwatersrand-Vaal Region) commenced in the 1800s and the development of urban areas has been shaped by the location of the mines. Over several decades, Gauteng province has become the economic centre of South Africa, contributing nearly 50% of South Africa's economic outputapart from playing a pivotal role in the economy of the Southern AfricaDevelopment Community(SADC) region. Collectively, the Gauteng province is comprised of an urban cluster of cities, town and nodes, and the surrounding rural areas within commuting distance from Gauteng City-Region (Gauteng State of Environmental Report, 2011). According to Statistics South Africa (StatsSA) (2011), this province contains the largest share of the South African population with approximately 12,272,263 and 3,909,022 households. The population density is 680/km² and the density of households is 155.86/km² (StatsSA, 2011).

Table 4:1: Local comparison of population density in the Gauteng region.

Region	People per square kilometre
Ekurhuleni and Johannesburg	2500
Tshwane	2750
Average South African Metropolitan Density	2960

Source: South African Cities Network (2011).

There are three metros which dominate the province and these are the City of Johannesburg, the City of Tshwane and Ekurhuleni Metropolitan Municipality. Furthermore, the province has two district municipalities which are the Sedibeng District and West Rand District (Figure 4.2) (Gauteng State of Environment Report, 2011).

Figure 4:1: South African Provinces.

Source: StatsSA(2001).

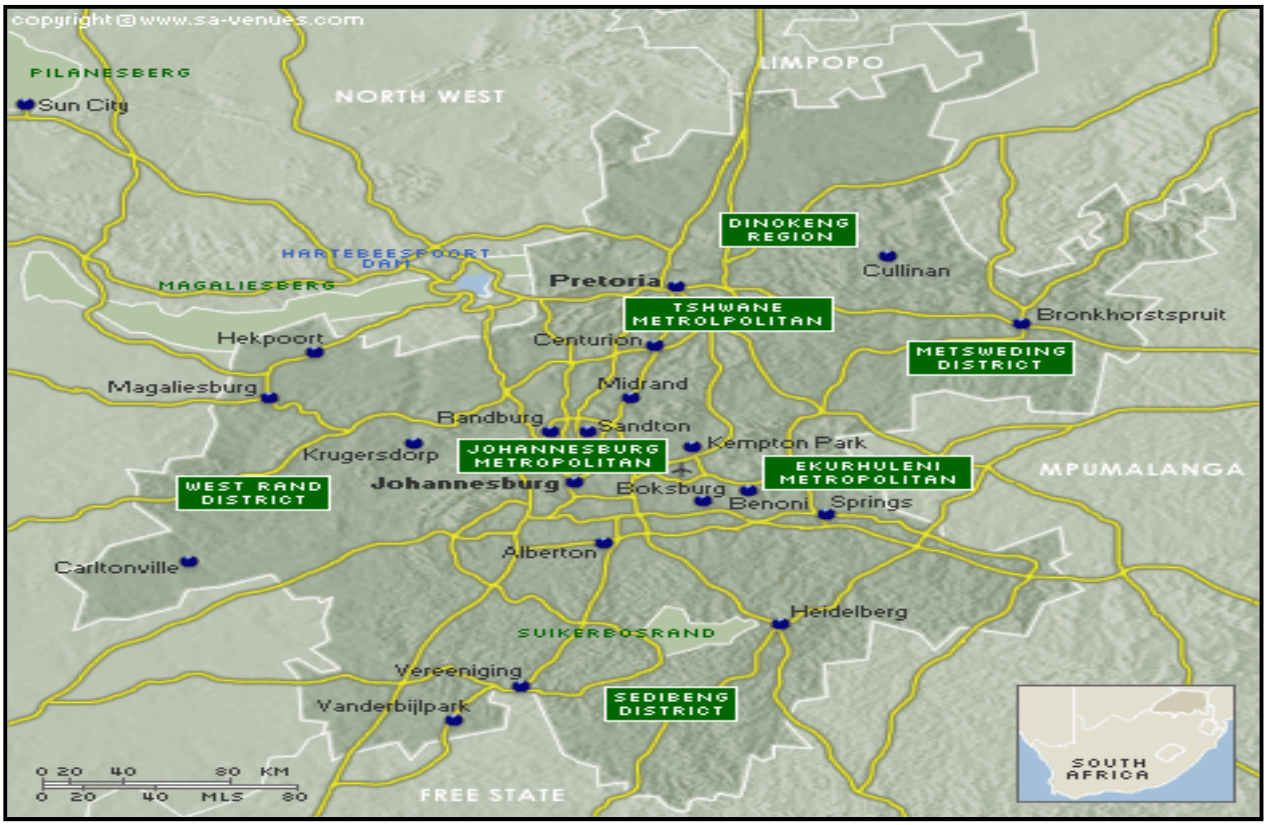

Figure 4:2: Gauteng locality map.

Source: South African Cities Network (2011).

4.2 CLIMATE PATTERNS IN GAUTENG PROVINCE

Gauteng has a mild sub-tropical climate with a distinctive wet summer and dry winter season, significantly influenced by the high altitude of the province (Gauteng State of Environment Report, 2011). The rainy season is concentrated between October and March, and the annual average rainfall varies between 700 mm around Witwatersrand to approximately 600 mm north of the Magaliesberg (Dyson*et al.*, 2009). Official languages spoken in the province are Afrikaans (14.4%), English (12.5%), isiNdebele(1.5%), isiXhosa(7.3%), isiZulu(20.5%), Sepedi (10.7%), Sesotho (13.1%), Setswana (8.4%), siSwati(1.2%),Tshivenda (4.2%) and Xitsonga (5.1%) (StatsSA, 2011).

4.3 HOUSING AND BASIC AMENITIES

According to StatsSA (2011), 56.1% of housing units have a telephone and/or mobile phone, 41.5% have access to a phone nearby and 2.3% have access that is not nearby or no access. Eighty two percent(82%) of households have a flush or chemical toilet. About 84.2% have refuse removed by the municipality at least once a week and 2.6% have no rubbish disposal. Eighty three (83%) percent have running water on their property and 97.5% have access to running water. Seventythree percent (73%) of households use electricity for cooking while 70.4% is for heating, and 80.8% is for lighting. In these households,77% have a radio and 65% a television set. Fifteen percent(15%) own a computer, 62% have a refrigerator and 25.8% of the population aged 15–65 is unemployed (StatsSA, 2011).

4.4 EKURHULENI METROPOLITAN MUNICIPALITY

EMM is made up of former local administrations comprised of nine towns of the East Rand which are Alberton, Benoni, Boksburg, Brakpan, Edenvale, Germiston, Kempton Park, Nigel and Springs which were combined into a new metropolitan municipality (Ekurhuleni State of the Environment Report, 2004). The metropolitan was further divided into three regional service delivery regions, namely, the North Service Delivery Region, the South Service Delivery Region and the East Service Delivery (Figure 4.3). Ekurhuleni (which means *Place of Peace* in the Tsonga language) Metropolitan Municipality has a total land area of approximately 2000 km^2 that accommodates a total of 2.8 million people. This constitutes 5.6% of the national population and 28% of the Gauteng's population. The population density is approximately 1250 people per km^2, making it one of the most densely populated areas in the country and Gauteng province (Ekurhuleni Growth and Development Strategy, 2011).

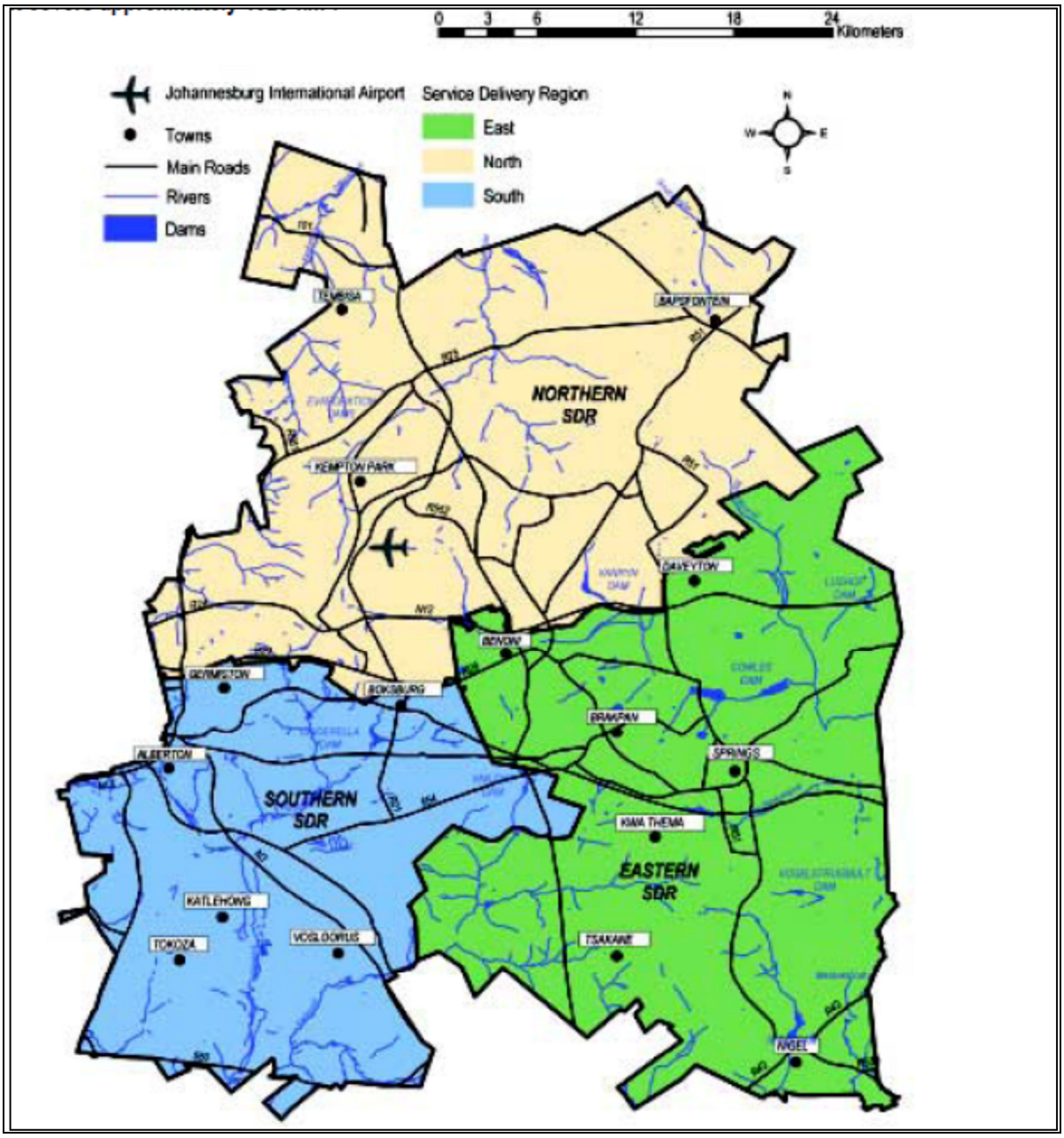

Figure 4:3: Service delivery regions of Ekurhuleni Metropolitan Municipality.
Source: Ekurhuleni State of the Environment Report(2004).

4.4.1 Demographic Profile of EMM

Table 4.2 shows the distribution of languages spoken, population and land area cover of each township located within EMM. The population of EMMas classified by gender consists of 50.7% men and 49.2% women.In addition, the ethnic groups are indicated in Figure 4.4, where Africans are thedominant group (76%) and the smallest group is Indian and Asian (2%)populations, respectively (StatsSA, 2001).

Table 4:2: Population and languages spoken in the study area.

Place	Area (km^2)	Population	Most spoken languages
Alberton	80.45	89,392	Afrikaans 49% English 38%
Bapsfontein	0.31	936	Zulu 34% Pedi 17% Sotho 13%
Bedfordview	15.43	21,294	English 71%
Benoni	187.99	94,341	English 46% Afrikaans 24% Zulu 12%
Boksburg	164.05	158,649	Afrikaans 30% English 22% Zulu 15%
Brakpan	196.35	62,113	Afrikaans 55% English 15% Zulu 13%
Cerutiville	0.41	2,151	Zulu 67% Afrikaans 12% Sotho 12%
Chief Albert Lithuli Park	1.12	2,896	Zulu 44% Pedi 15% Sotho 12% Xhosa 11%
Daveyton	14.17	131,390	Zulu 40% Pedi 16% Xhosa 12% Sotho 11%
Duduza	10.74	71,960	Zulu 63% Sotho 19%
Dukathole	1.07	18,537	Xhosa 26% Zulu 25% Pedi 18% Sotho 11%
Edenvale	20.38	40,624	English 74%
Etwatwa	21.26	124,435	Zulu 47% Pedi 13% Tsonga 11%
Germiston	129.14	139,719	Afrikaans 27% English 26% Zulu 13% Xhosa 10%
Katlehong	61.42	349,866	Zulu 39% Sotho 25% Xhosa 13%
Kempton Park	158.50	117,271	Afrikaans 47% English 28%
KwaThema	13.93	99,517	Zulu 57%
Lindelani Village	1.60	7,514	Zulu 41% Pedi 20%
Midrand	13.41	5,095	Afrikaans 31% Pedi 15% English 12% Zulu 11%
Nigel	129.29	28,706	Afrikaans 51% English 19% Zulu 17%
Reiger Park	5.70	36,004	Afrikaans 48% Pedi 12% Xhosa 11%
Springs	172.18	80,776	Afrikaans 39% English 21% Zulu 14%

Place	Area (km^2)	Population	Most spoken languages
Tembisa	32.44	348,693	Pedi 35% Zulu 25% Tsonga 12%
Thokoza	8.65	85,106	Zulu 39% Sotho 27% Xhosa 20%
Tsakane	29.74	144,289	Zulu 57% Sotho 11%
Vosloorus	28.65	150,277	Zulu 48% Sotho 19%
Wattville	4.78	49,927	Zulu 43% English 16% Sotho 10%
Remainder of the municipality	420.74	18,795	Zulu 26% Pedi 21% Tsonga 14% Sotho 10%

Source: StatsSA(2001).

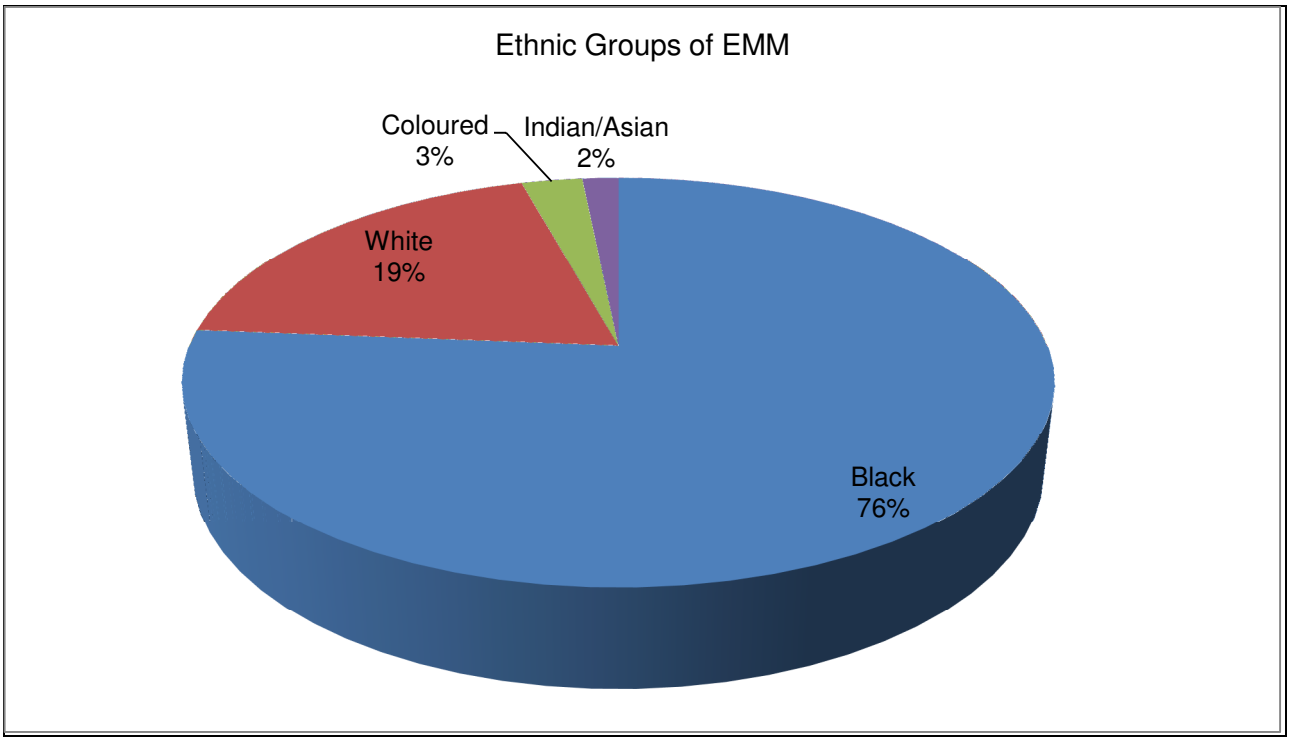

Figure 4:4: Ethnic groups of EMM.
*Source:*StatsSA(2001).

4.4.2 The Economic Statusof EMM

EMM accounts for nearly a quarter of the economy of Gauteng province, which constitutes over one-third of the National Gross Domestic Product (GDP). Manufacturing accounts for 20% of the GDP in Gauteng. It is also known as"Africa's Workshop" because it is home to the largest concentration of industries in South Africa and Africa (Ekurhuleni Metropolitan Municipality IDP, 2011/14). Annual economic growth has increased in the period 1998 to 2003 and has doubled the rate of national manufacturing growth rate. The economically active population is 52% compared to 38% nationally (Ekurhuleni Growth and Development Strategy, 2011). Household income and per capita income exceed the national average by 10% and 33%, respectively. The percentage of people living in

poverty is 29% compared to 49% nationally (Ekurhuleni Growth and Development Strategy, 2011). EMM has an excellent network of roads, airports, rail lines, electricity grids and telecommunication that are competing with those of Europe and America (Ekurhuleni Growth and Development Strategy, 2011).

4.4.3 Description of the Baseline Receiving Environment

4.4.3.1 Climate

EMM receives Highveld summer rainfall. The average annual rainfall ranges between 715mm to 735mm between October to April. The annual average temperatures range between below freezing point during the winter months up to 30°c in summer months. During winter and spring EMM experienced north and north westerly winds and north easterly winds during summer (Ekurhuleni Biodiversity Strategy, 2009).

4.4.3.2 Geology

EMM is situated between the Batholithformations on its western border to the formations comprised of the Witwatersrand and Transvaal supergroup that is dominated by dolomites overlain by sediments of the Karoo Super group. The dominant formations are described below and also (Figure 4.5) (Ekurhuleni Biodiversity Strategy, 2009):

- Granite-gneiss which is found north-west of Tembisa and west of Clayville;
- Dolomites dominate in the northern area between Clayville in the west and Bapsfontein in the east and along the eastern boundary of the area towards Putfontein, Strubenvale as south as KwaThemaand Dunnotar as well as an extensive area of dolomite in the south west and south of Elspark and Withok estate;
- Quartzite dominates in the north south central area from the west of Clayville in the north through Kaalfontein, to the east of OR Tambo Airport and in Broadband from west to the east from Germiston to Springs as well as north of Bapsfontein;
- Surface shale is found in the west, south of Bapsfontein and in the east, south of OR Tambo Airport towards Germiston; and
- Amphibolites occur in the area around Edenvale east of Kempton Park and OR Tambo Airport. A small area of surface dolorite occurs in the extreme south between Duduza and Vosloorus.

4.4.3.3 Topography

EMM is located on flat terrain with the following topographical features (Figure 4.6) (Ekurhuleni State of the Environment Report, 2004):

- Plains with pans;
- Undulating plains with pans;
- Strongly undulating plains;
- Superimposed river valley (Blesbokspruit) on plains with pans ; and

- Ridges.

4.4.3.4 Hydrology

Karst, integranular and fractured aquifersare the dominant hydrological types in EMM (Figure 4.7). Boreholes with the highest yield are found in the dolomites that occur from Wadeville to south of Vosloorus. Yields of more than 10 litres per second are common. The underground water flow supports high yielding springs at an impermeable boundary. The groundwater within EMM is acceptable for any use. The main drainage systems within EMM include Blesbokspruit, Klip River and itstributaries, Kaalspruit or Olifantspruit, the Jukskei River tributaries, Bronkhorstspruit and the Rietvlei River (Ekurhuleni Biodiversity Strategy, 2009).

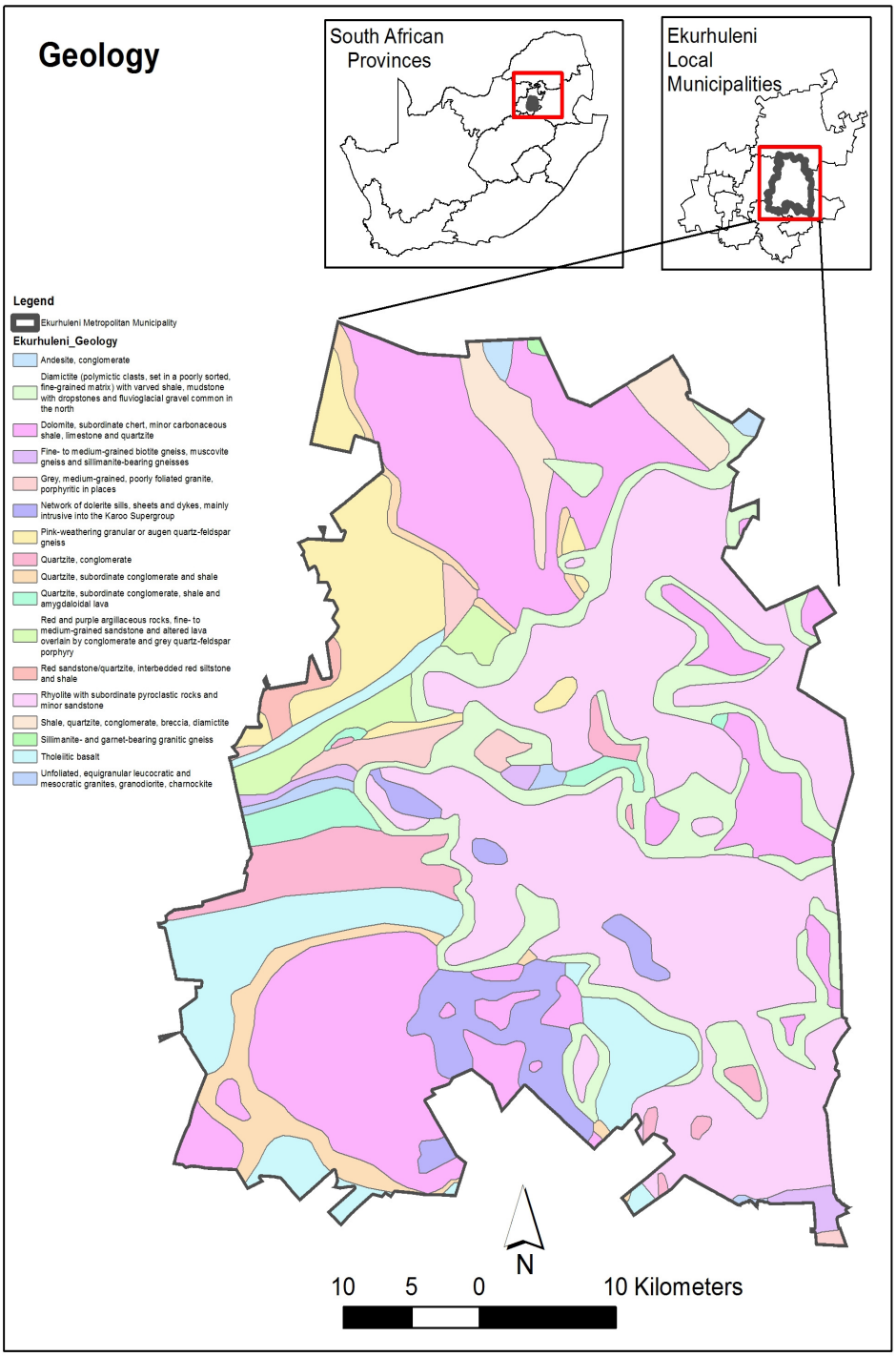

Figure 4:5: Geology of Ekurhuleni metropolitan municipality.

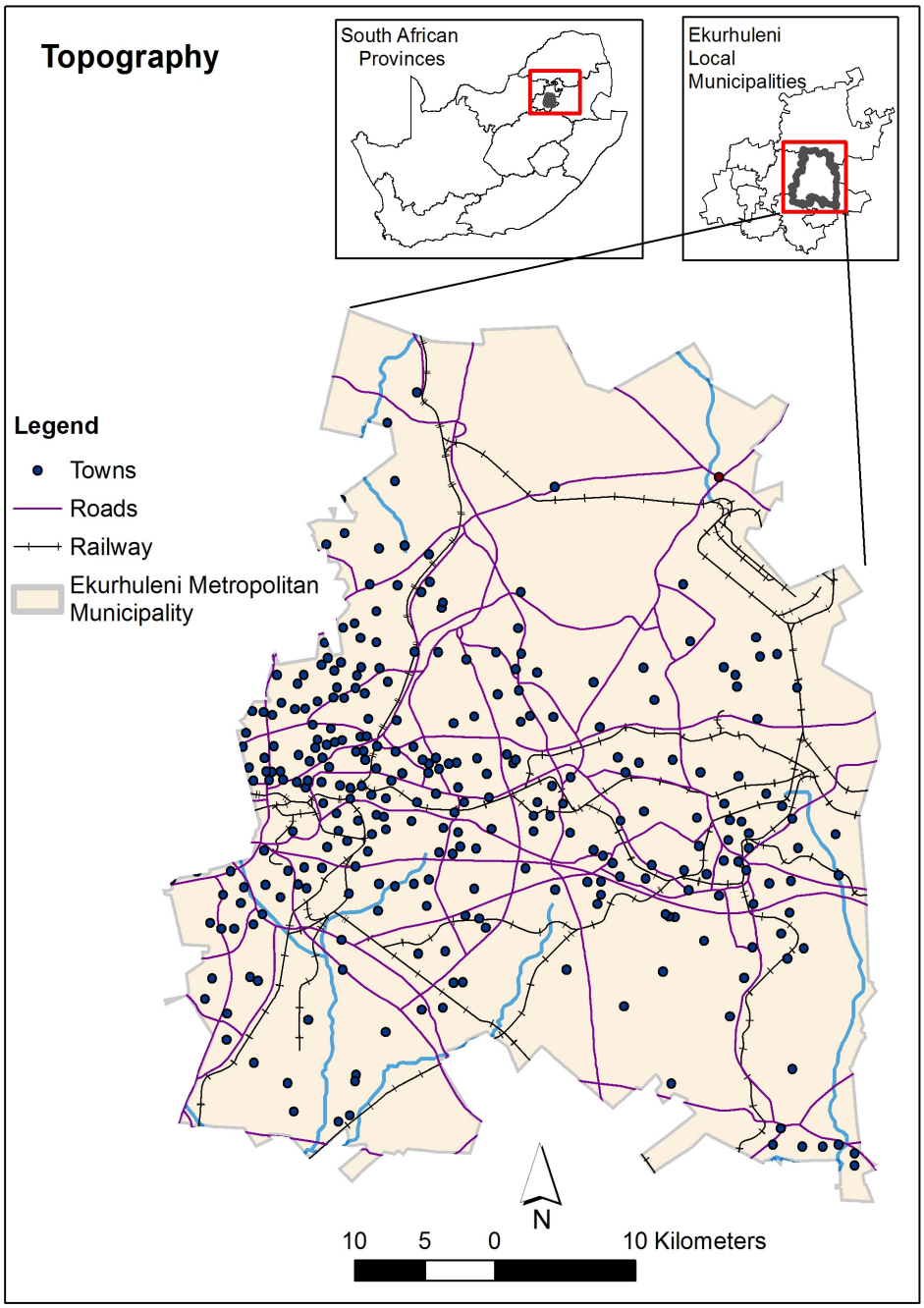

Figure 4:6: Topography of Ekurhuleni metropolitan municipality.

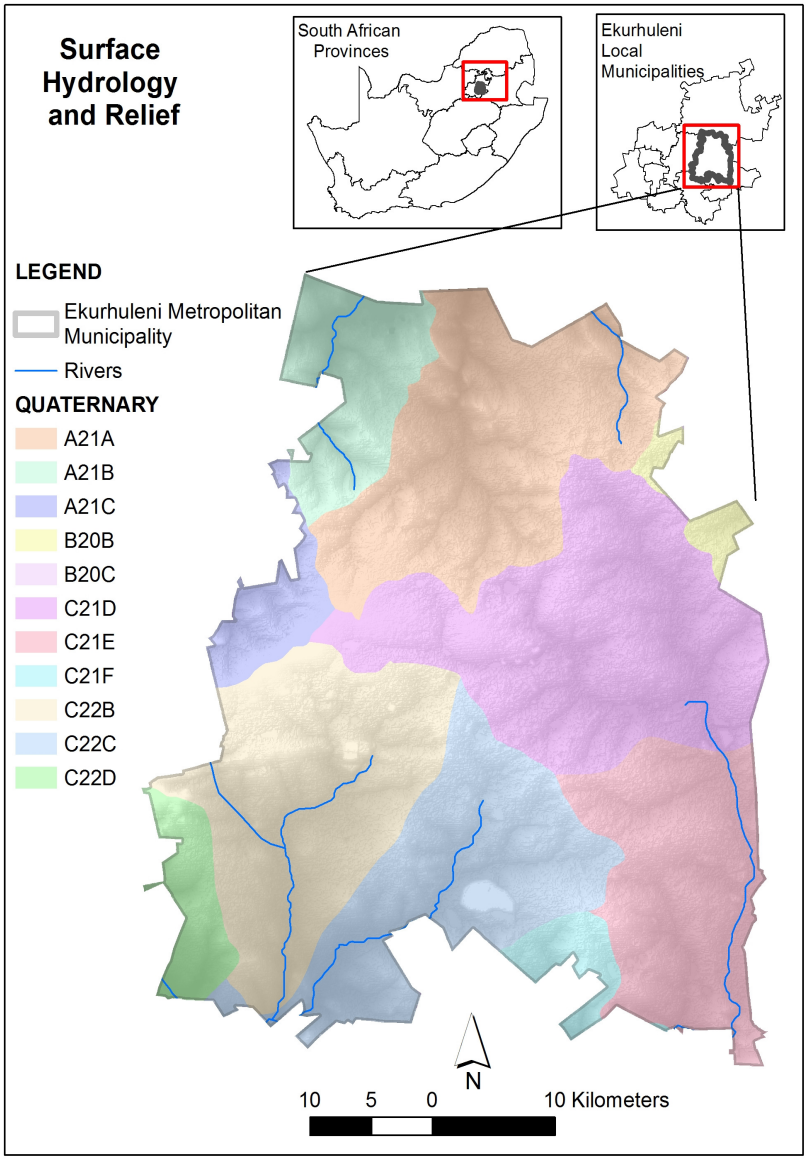

Figure 4:7: Hydrology of Ekurhuleni metropolitan municipality.

4.4.3.5 Vegetation and Habitat

EMM falls within the Grassland Biome where grass dominates with abundant geophytes (Figure 4.8). However there are few areas with natural grassland remaining due to the transformation and developments that have occurred over the past decades. Red grass (*Themenda Triandra*) is the

most dominant grass within EMM and it grows on sandstone and shales with deep sandy loam soil (Ekurhuleni Biodiversity strategy,2009).

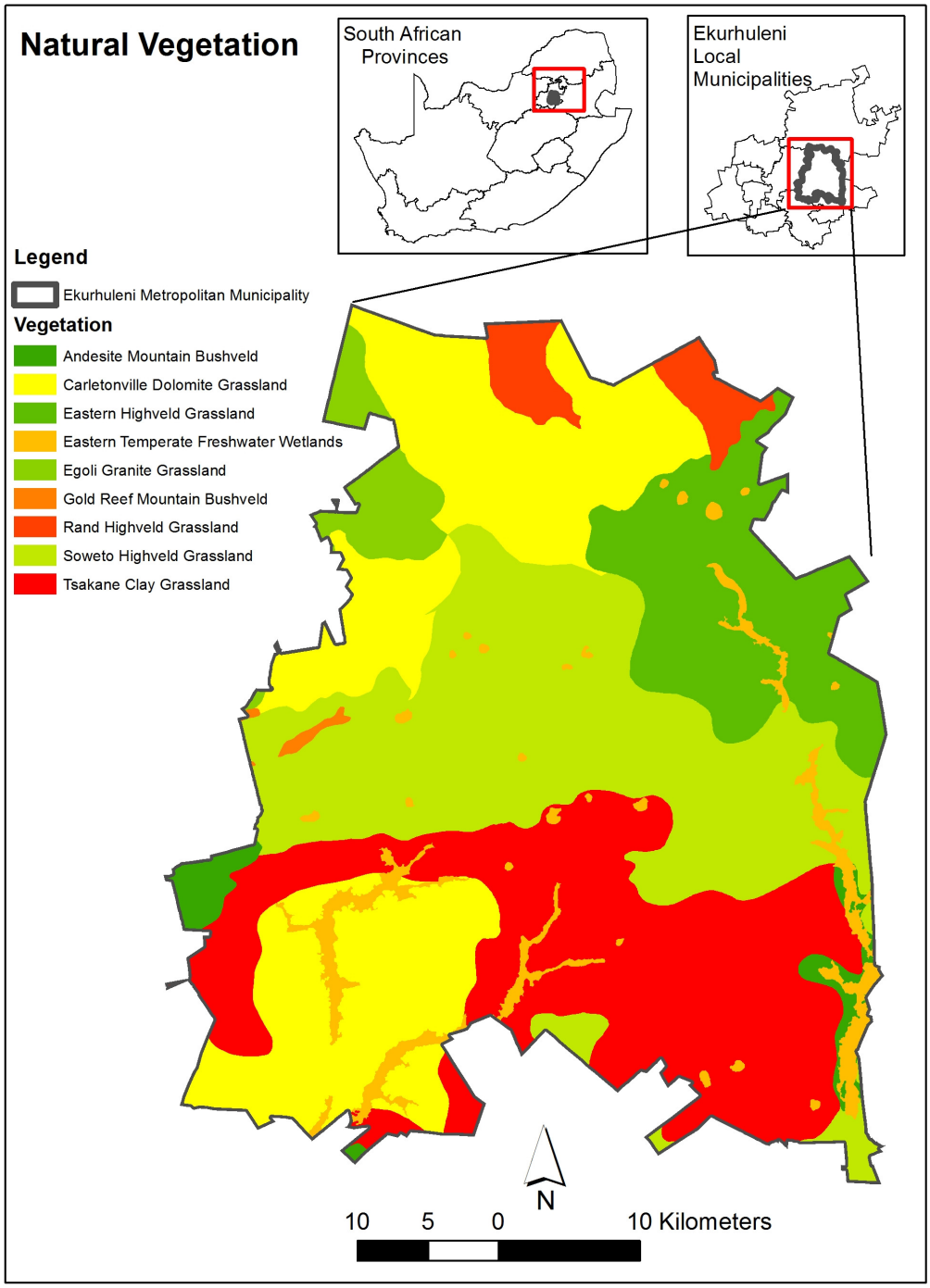

Figure 4:8: Vegetation cover of Ekurhuleni metropolitan municipality.

4.4.3.6 Impacts on Natural Streams

Natural streamsin EMM are filled with waste from sewage works and mining sector. According to the Ekurhuleni State of Environment Report (2004), the water quality of the Natalspruit, Klip River and Blesbokspruit is in a poor state due to the drainage of mine water into freshwater systems. However, the wetlands in EMM are fulfilling a vital geohydrological and purification function due to their capability to regulate water releases and filtrate toxins. Furthermore, these wetlands present a transition between aquatic and terrestrial systems (Ekurhuleni Biodiversity Strategy, 2009).

4.4.3.7 Socio-economic Status

According to the Ekurhuleni Growth Development Strategy (2011), nearly one-third of the 2.5 million population of EMM is living in poverty and the majority of these are Africans. The unemployment rate is approximately 40% and the majority of people live in peri-urban areas far away from job opportunities and urban amenities. There are approximately 112 formal settlements although there are 170 000 informal units without basic services. Most of the informal settlements are situated closer to waste dumps, rivers, spruits and flood lines. Thus, the EMM is facing challenges of finding appropriate land and financial resources for providing subsidy-linked housing that is close to the urban core in order to provide formal housing and eradicate informal settlements (Ekurhuleni Growth Development Strategy (2011).

CHAPTER 5

RESEARCH FINDINGS AND DISCUSSION

5.1 INTRODUCTION

The research findings obtained in this study are presented and discussed in this chapter. Firstly, waste management and its minimisation aspects are presented and discussed at household level. Secondly, the role of informal recyclers is examinedmeanwhile the barriers constraining informal recycling activities are highlighted. Thirdly, the role ofthe EMM municipality in managing and minimising waste production is also explained.

5.2 WASTE MANAGEMENT AND MINIMISATION AT HOUSEHOLD LEVEL

5.2.1 Demographic Profile of Respondents

The results related to the demographic attributes of respondents at Ekurhuleni Metropolitan Municipality (EMM) are depicted in Figures 5.1 to 5.5. In terms of gender, 80% of the respondents are men and20% are women. Sixty nine percent (69%) of the respondents were marriedmeanwhile31% of them were unmarried. The average age ofrespondents that were interviewed was 40 years. The majority (60%) of the respondents were between the ages of 30-40 years, 20% were 40-50 years old, 10% were between 20-30 years and the smallest(8%) age group was between 50-60 yearsold(Figure 5.1).

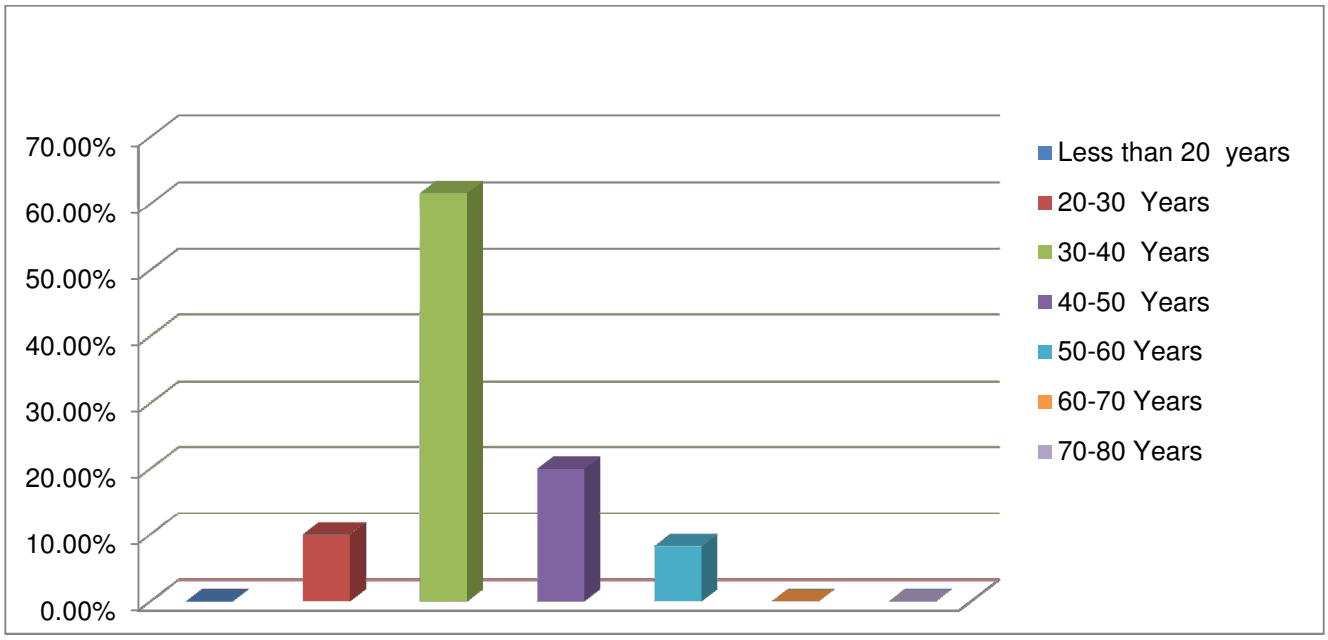

Figure 5:1: Respondent's age.

Regarding the educational status of respondents, the majority (56%) of the respondents completed high school while only 12% had university level education. Only 10% of respondents have completed a qualification in a technikon or college. By contrast, 5% of respondents never attended school (Figure 5.2).

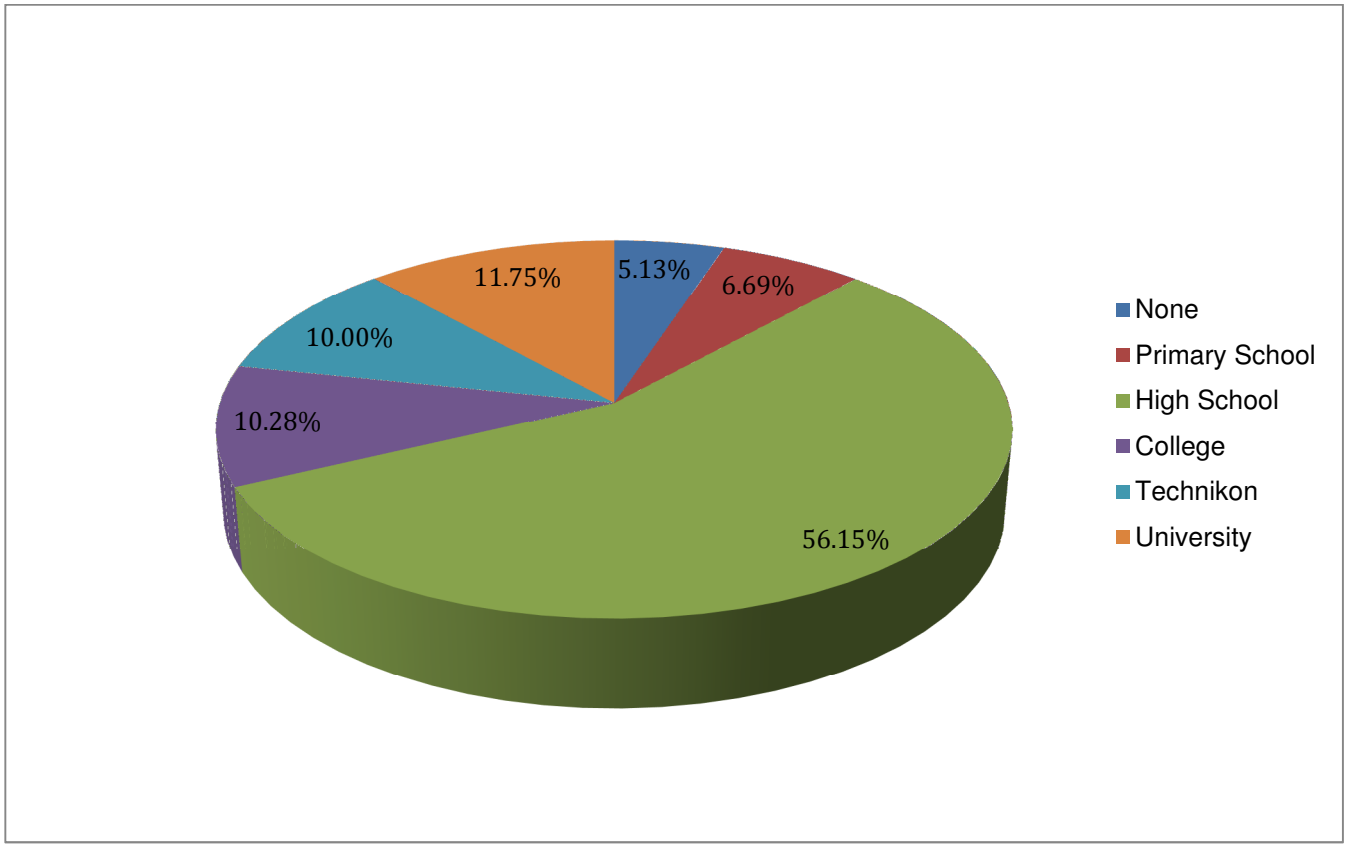

Figure 5:2: Education level.

When it came to occupational status, about 25% of respondents had permanent and formal employment with private companies and government departments. Twenty eight percent (28%) were self-employed and 17% earned a living through other means that were not disclosed. Lastly, 30% of respondents were not employed (Figure 5.3).

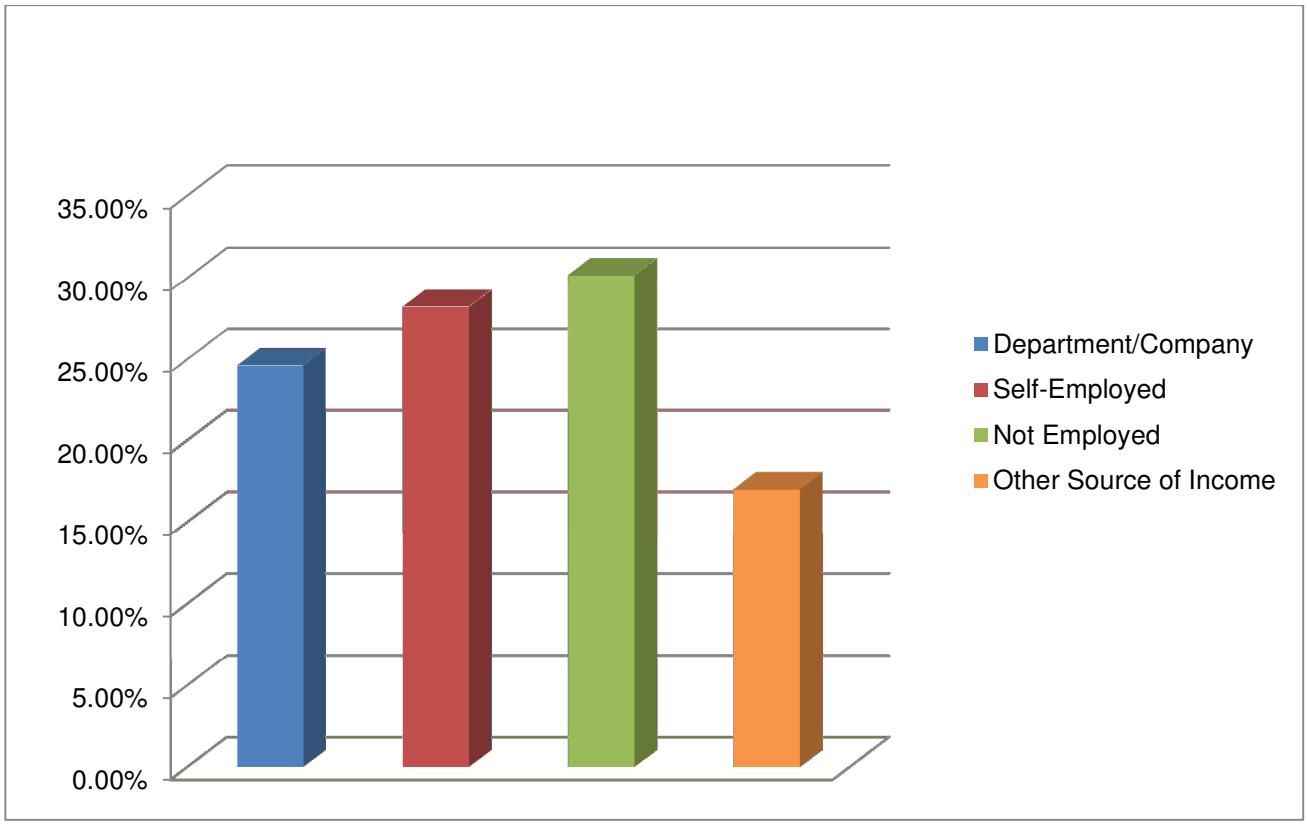

Figure 5:3: Respondent's occupation.

Figure 5.4 illustrate the monthly income earned either through permanent and formal employment or other means. Seven percent of respondents mentioned that they earn R1000 per month. Forty two percent (42%) of respondents indicated that they earned between R10000 per monthand more. Furthermore, whereas 16%earned between R5000-R6000,12%earned between R4000-R5000.

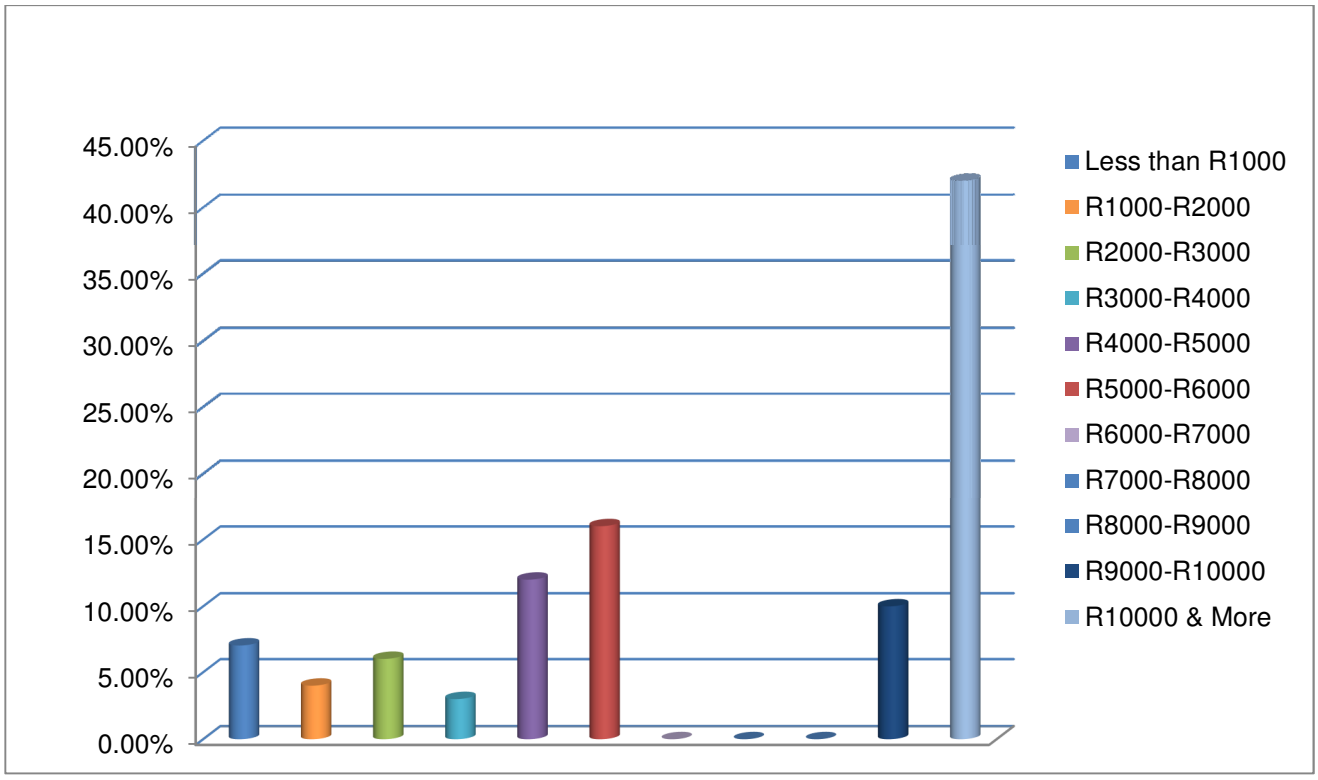

Figure 5:4: Respondent's income level.

5.2.2 Awareness on Waste Management and Minimisation

The results concerningwaste management awareness are presented from Figure 5.5 to 5.14. An overwhelming majority (70%) of respondents have demonstrated some awareness on municipal waste management issues. Nevertheless, 30%lacked such awareness. An aspect of waste management that appeared to be well known amongst the respondents was its collection (56%) and this was followed by the role of community initiatives (22%). Only 15% of respondents were aware of waste management infrastructure such as waste bins, waste skips and landfill sites (Figure 5.5).

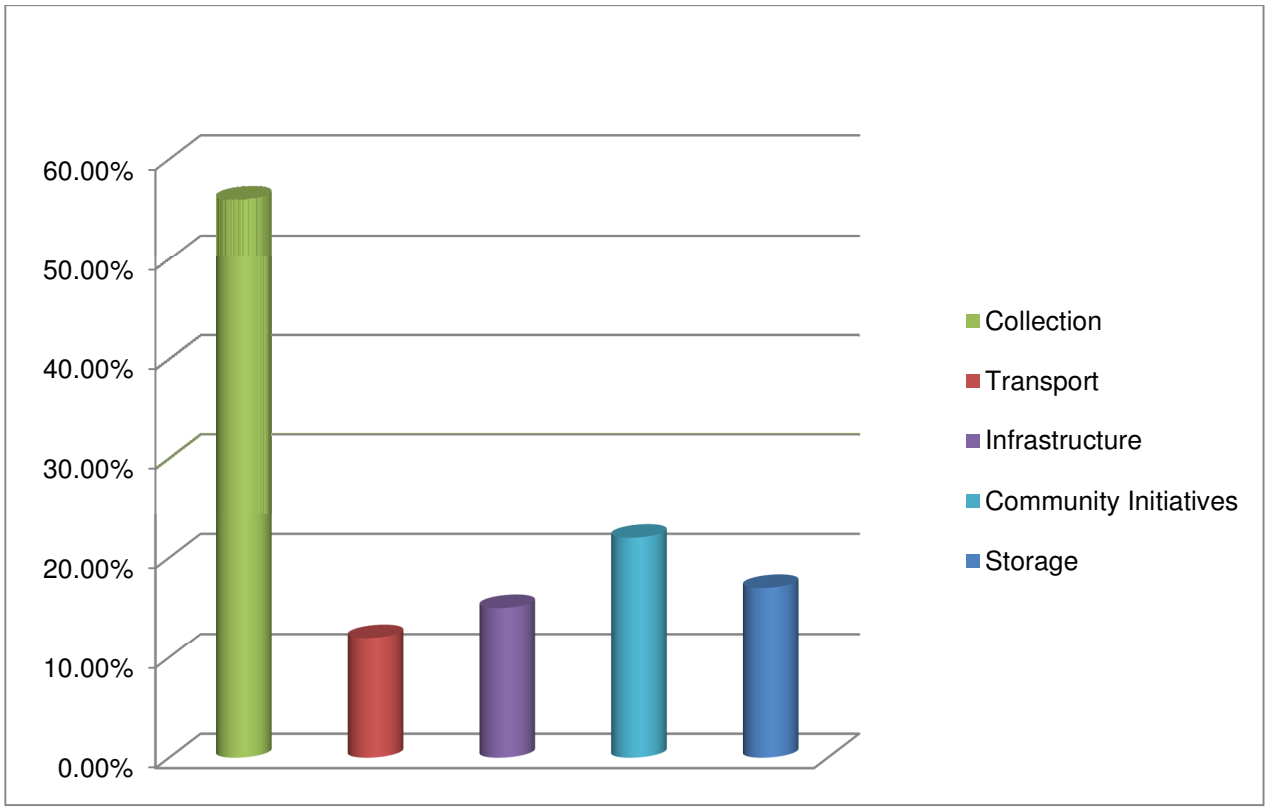

Figure 5:5: Waste management aspect known by households.

The waste disposal methods used by respondents ranged from waste bins (39%) to some form of recycling (25%). Illegal dumping was practiced by some (15%) of the respondents. This practice was mainly due to the failure of the municipality to collect waste regularly according to the collection schedule within residential areas, particularly in the townships. Waste disposal methods such as burning (8%), underground burying (6%) and separation at source (7%) were least used by the respondents (Figure 5.6).

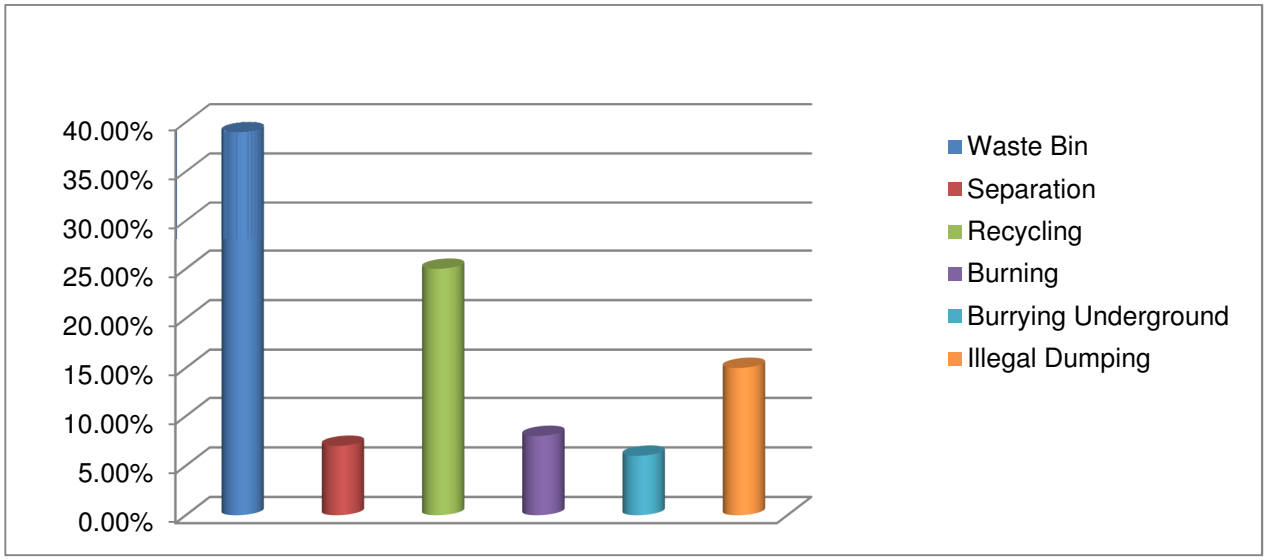

Figure 5:6: Methods of waste disposal.

Figure 5.7 illustrates the different types of waste generated and disposed of at household level. Such waste materials included cardboards (36%), food waste (18%), plastic (14%), glass (8%) and organic waste (7%). In contrast, tins (4%), scrap metal (4%), newspaper (3%), white paper (2%), cartons (2%) were the least waste types generated at household level. It appeared that most of the waste generated is related to product packaging (e.g. Plastic, glass, cartoons) from manufacturing companies and food leftovers, as well as spoiled food that was never consumed. All of these waste categories were disposed in various ways which included discarding them in waste bins and dumpsites meanwhile some were recovered for reuse and recycling.

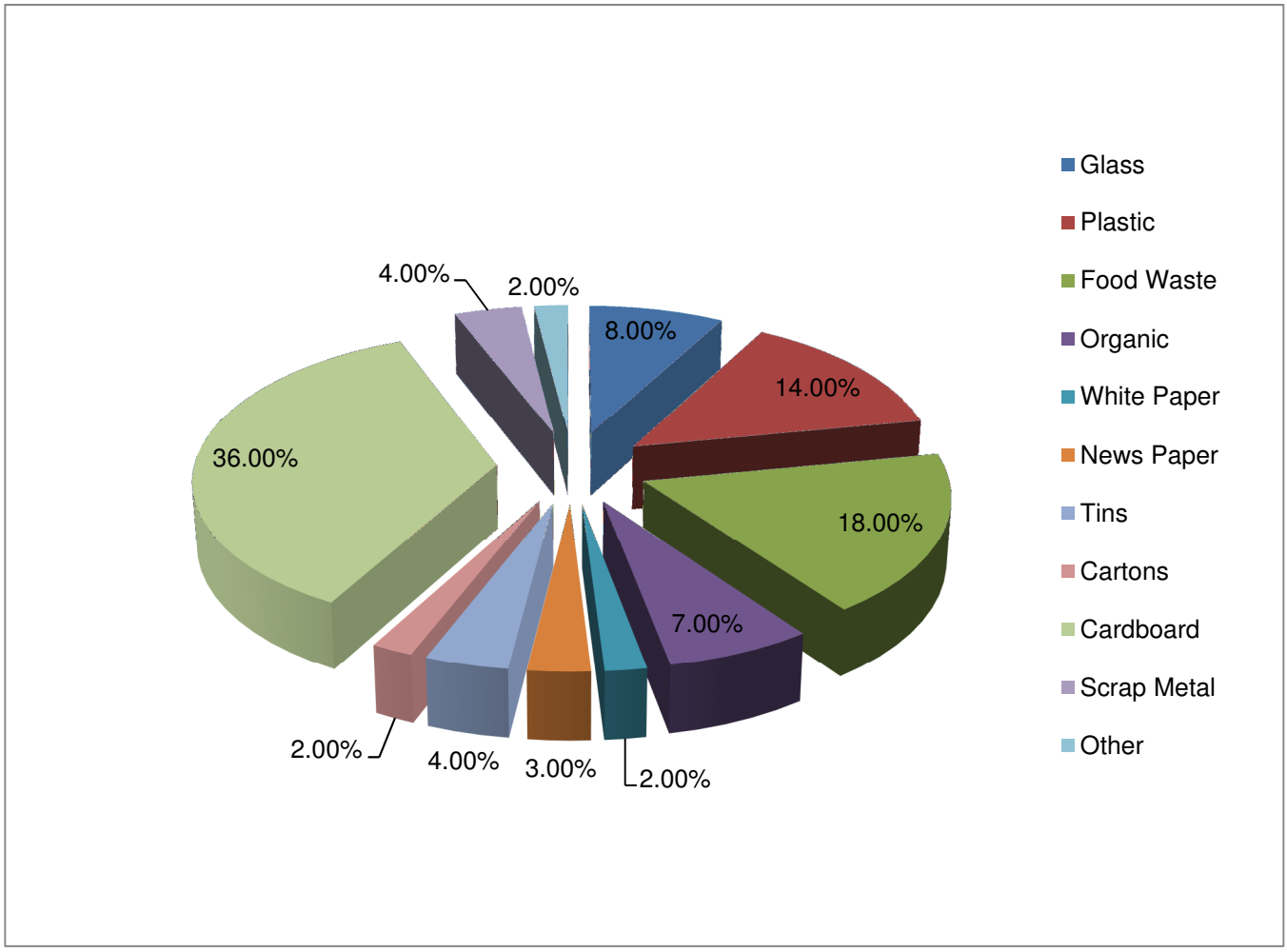

Figure 5:7: Types of waste generated.

Fifty eight percent(58%) of respondents mentioned that they receive monthly municipal statements;meanwhile 28% indicated that they do not receive suchstatements (Figure 5.8). On the other hand,14% were not aware whether or not they receive these statements.

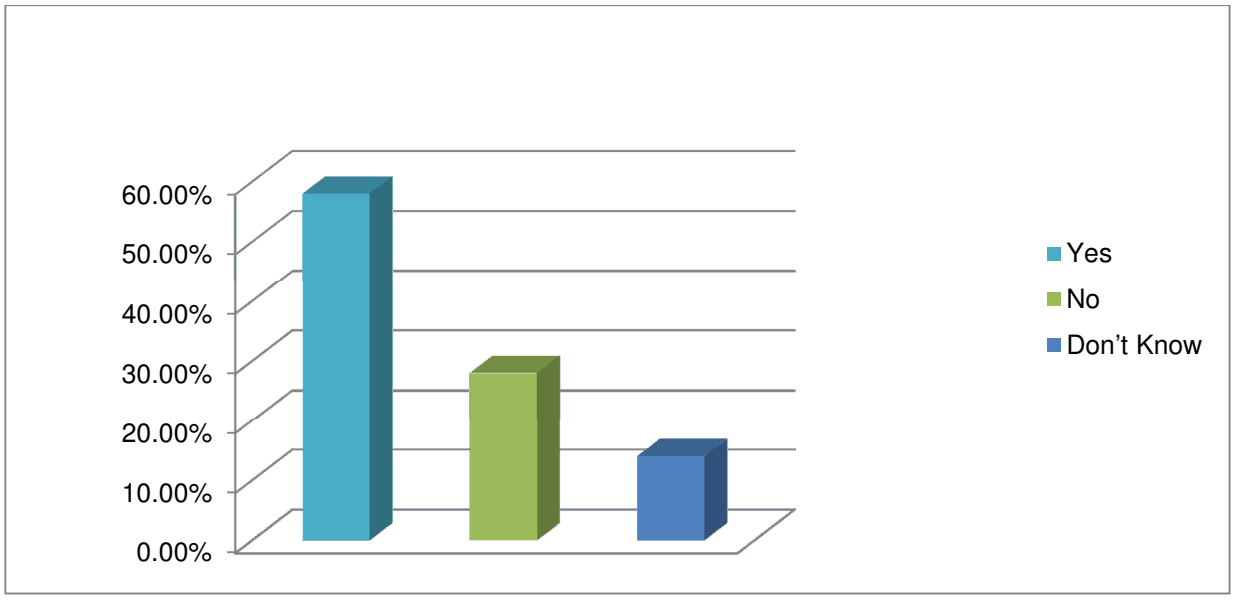

Figure 5:8: Municipal statement receipt.

Sixty percent (60%) of the respondentsindicated that they were aware about recycling centres within the EMMarea. Twenty twopercent (22%) were involved in such recycling centresand also knew about clean-up campaigns initiated by the municipality, private companies and theinformal recyclers. In addition, 18% claimed that they have seen waste skips in their communities (Figure 5.9).

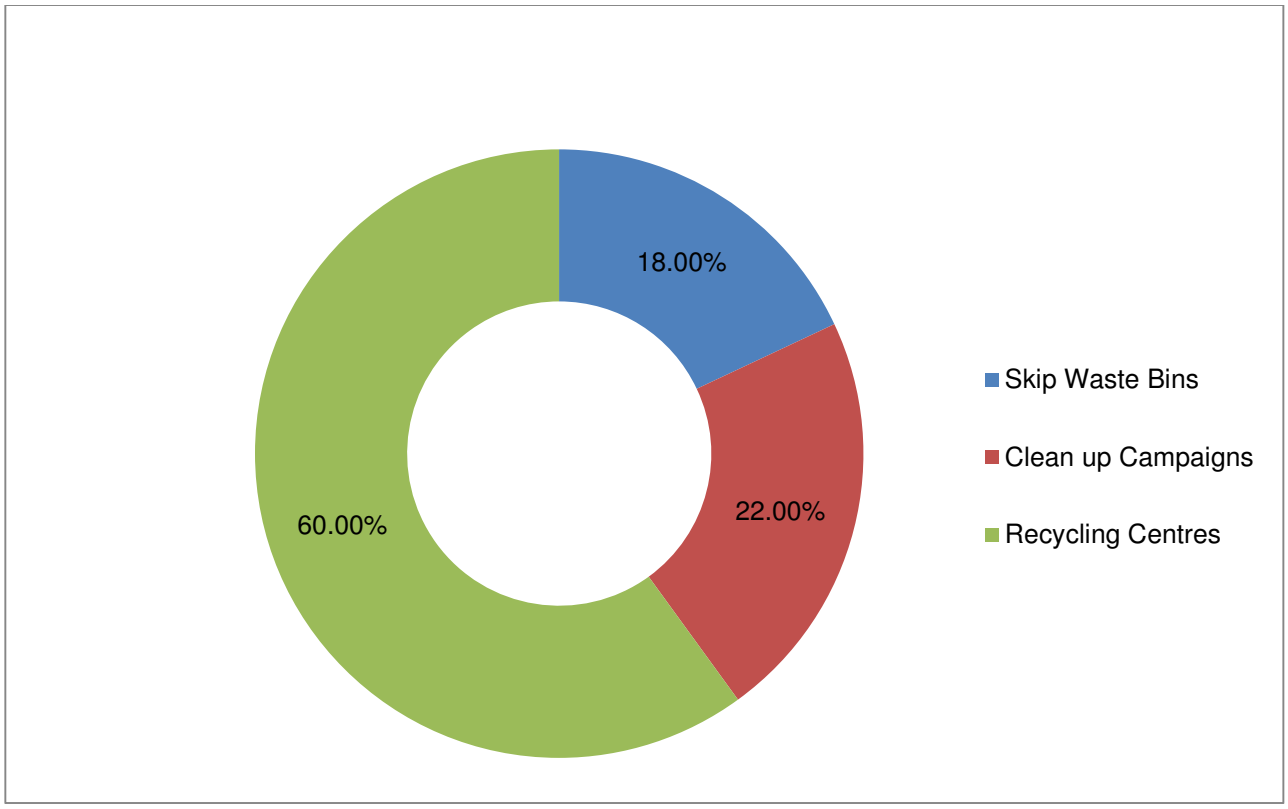

Figure 5:9: Community waste management awareness.

As for waste minimisation, 55% of the respondents indicated that they were involved meanwhile 45% did not participate in such initiatives. The involvement of respondents in waste minimisation was mostly through reclaiming (65%) and clean-up campaigns (35%) (Figure 5.10).

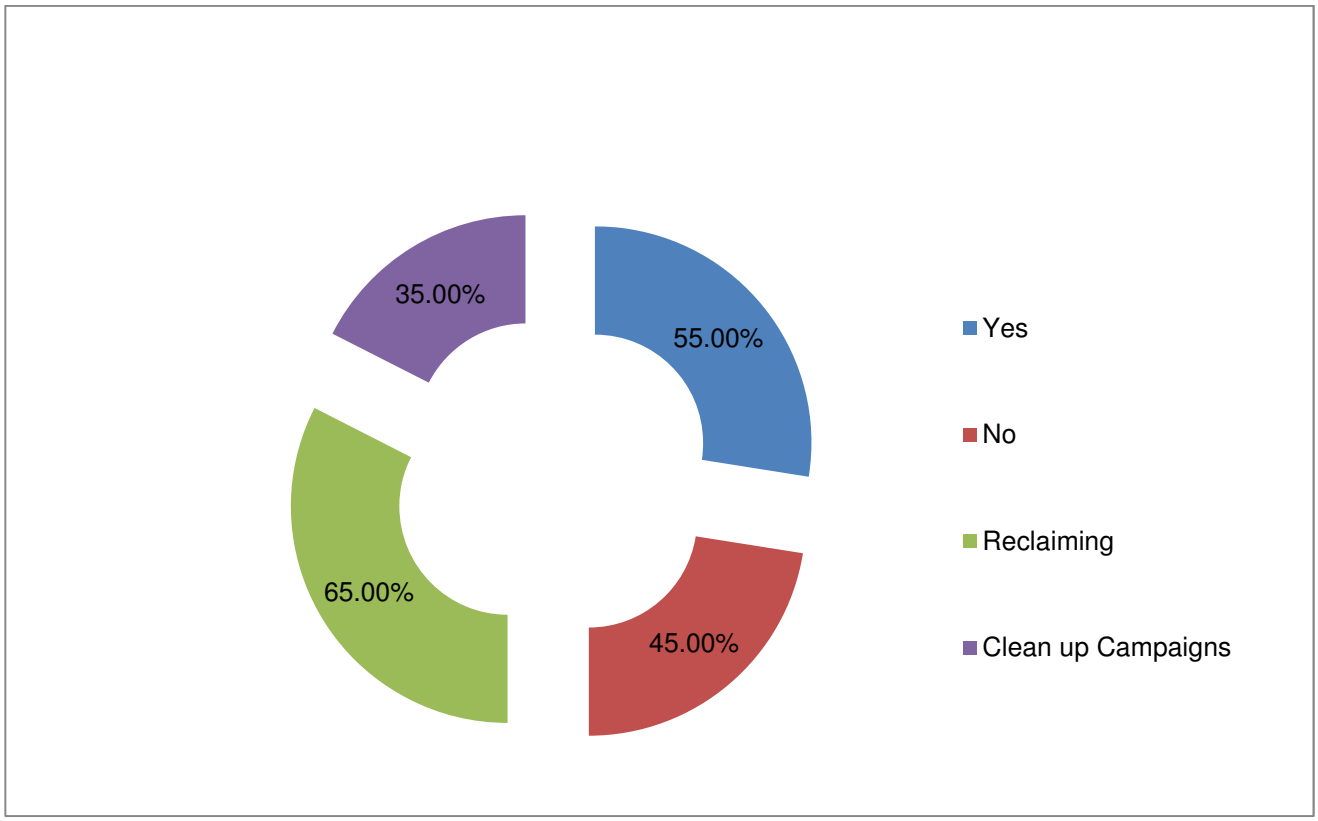

Figure 5:10: Community participation.

Sixty four percent(64%) of respondents knew about the importance of sorting waste at source from households although 36% of other respondents were unaware of sorting waste at source. The sorting of waste by respondents was conducted for the following reasons: (1) awareness that it can reduce environmental pollution (36%); (2) its usefulness for recycling and composting (30%); (3) influences from the media (20%); and (4) adoption of this practice by their neighbours (9%) as well as other community members (5%) (Figure 5.11).

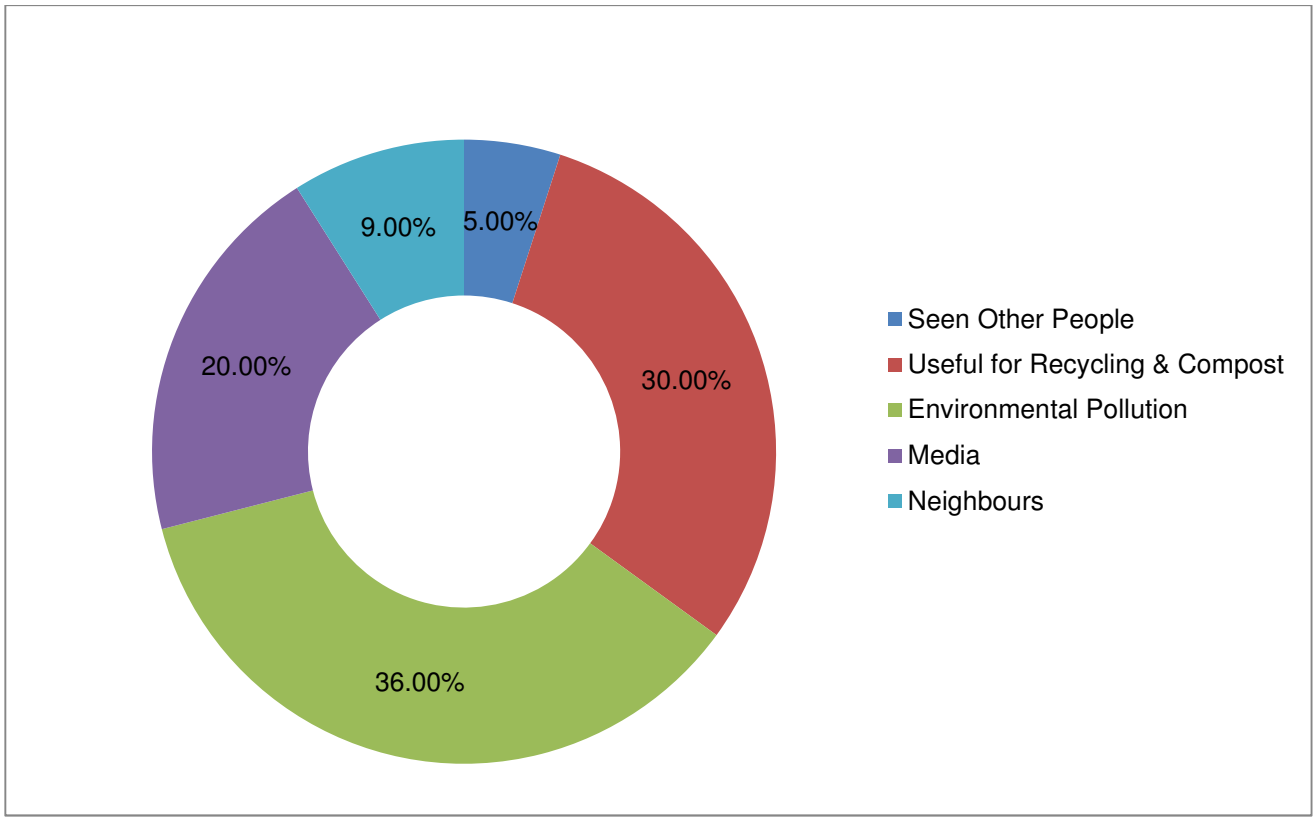

Figure 5:11: Community Participation.

The reluctance of respondents towards separation of waste at source was as a result of a number of constraints. These constraints entail amongst others, the lack of sufficient containers (44%); the lack of time for sorting (23%); and their degree of naiveté on the purpose and value of sorting. Furthermore, 6% indicated that they lacked adequate knowledge on waste management and minimisation (Figure 5.12). Despite these constraints, the various respondents indicated their willingness to participate in waste minimisation initiatives provided that there is (1) municipal supply of adequate containers for waste separation; (2) community wide adoption of recycling schemes; (3) environmental education by the municipal officials; and lastly (4) designated public areas for the temporary storage of sorted waste because residents do not have sufficient space to store such waste prior to collection. The respondents who are currently sorting waste also expressed similar concerns that the municipality must adopt a more sustainable and integrated approach towards waste separation and recycling. Also, the provision of municipal incentives for the communities that sort waste was recommended.

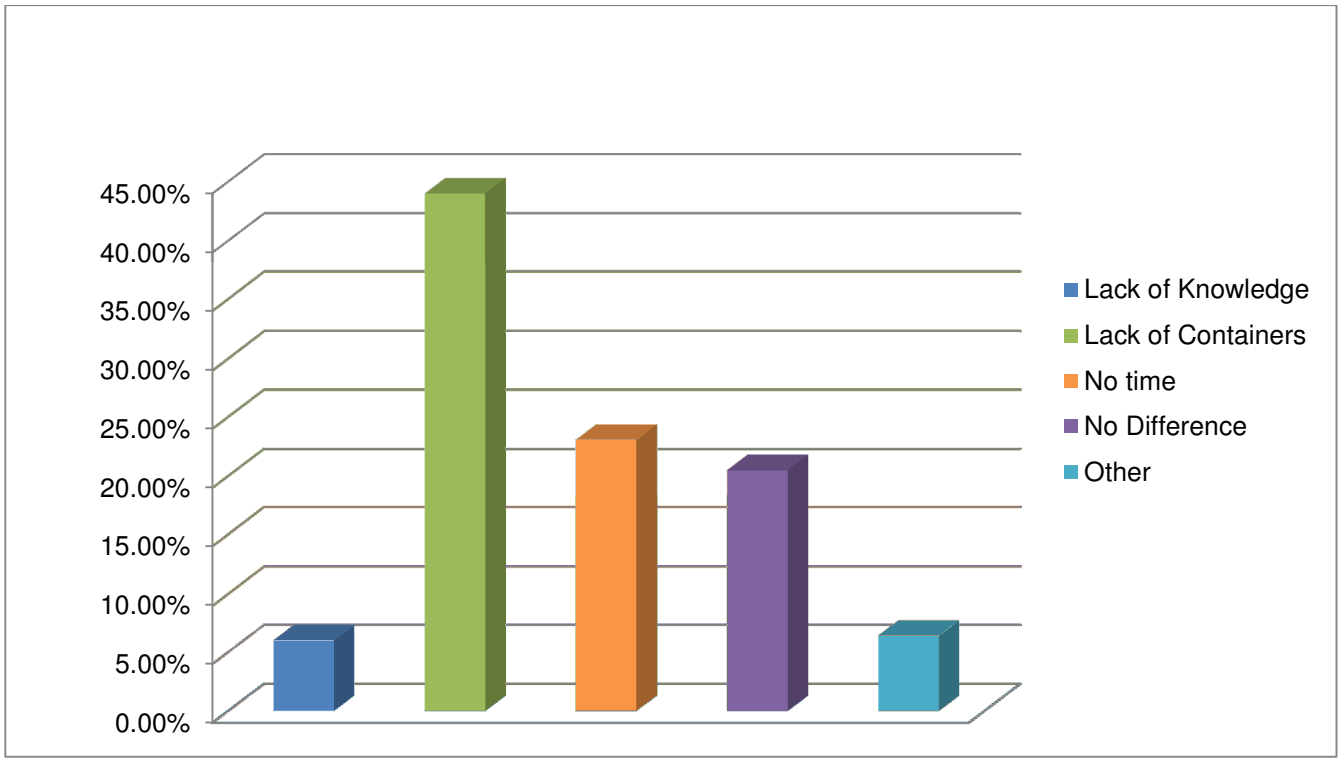

Figure 5:12: Constraints against waste minimisation by communities.

Table 5.1 illustrates the waste management trends and challenges indicated by respondents. Nineteen percent(19%) of respondents mentioned that they know about waste bins provided by the municipality and their collection schedule. Fourteen percent(14%) were aware about the campaigns (such as street and river clean up campaigns) which were undertaken on an *ad hoc* basis by the municipality and private companies. One of the main (36%) challenges constraining waste management in this municipality was inadequate waste collection schedules(Table 5.1).

Table 5:1: Waste management trends and challenges.

List of Minimisation Activities and Challenges	Percentage
Waste bin and collection	19.2%
Recycling	15.3%
Awareness Campaigns	14.3%
Waste collection schedule not maintained	35.9%
Nothing	8.6%
Waste collection vehicles not maintained	6.4%

To improve waste management and minimisation within communities in the EMM, the following aspects need to be addressed by the municipality and theseincludes:(1) the appointment of more Contractors; (2) provision of sufficient recycling bins and recycling bags;(3) increasing the number of waste collections days;(4) scheduling of adequate municipal awareness campaigns;(5) provision of

sufficient waste skips at taxi ranks, bus stops and along the main roads; and (6) effective enforcement of waste management by-laws by penalisingthose who are guilty of illegal dumping (Table 5.2). Environmental education (30%),extended waste collection days (14%) and the enforcement of waste by-laws(10%) were emphasised by respondents as critical interventions aspects, respectively (Table 5.2).

Table 5:2: Recommendations for improved waste management.

List of Recommendations	Percentage
Provision of recycling bin	12.0%
Provision of recycling bag	5.0%
Provision of waste skips at bus/taxi ranks and main roads	8.0%
Environmental education/Community awareness campaigns	30.0%
Increase in collection days	14.0%
Allow public offloading outside the landfill site	7.0%
Allow public to dump waste at mini disposal site	8.0%
Illegal dumping must be punishable	10.0%
Employ more private contractors	4.0%
Nothing	2.0%

5.3 THE ROLE AND BARRIERS CONSTRAINING INFORMAL WASTE RECLAIMERS

The respondents (informal waste reclaimers) who were interviewed were from Tembisa, Kempton Park, Brakpan and Daveyton. The majority (89%) of them were located in the Tembisa area, more specificallyat the Chloorkop landfill site. The Chloorkop landfill site is a privately owned facility. According to theinformation obtained from landfill site managers, this landfill site had approximately 120 reclaimers who reclaimdifferent kinds of waste. There was a contractual agreement between the private owner of the landfill site and informal reclaimers, whereby access to this facility by reclaimers is strictly regulated. The regulatory conditions include, for example, the requirement that informal recyclers should be organised intotwo working teams, whereby the first team commence their work shift at 7H00 AM until 12H00 midday and the second team start at 12H00 midday until 16H00. Otherregulatory requirements entail the point that reclaimers should first register themselves at thesecurity gate priorto entering the premises of the landfill site. This regulation is enforced by means of a signed daily register. Once reclaimers have entered the landfill site it is imperative for them to wear protective clothing such as long pants, long sleeve overall jackets, safety shoes and a reflector vest obtained from recycling companies or at the landfill site. Lastly, recyclers who are not abiding by these conditions are permanently dismissed out of the premises of the landfill site.

The agreement between reclaimers and landfill management came as a result of incidents of vandalism on landfill infrastructure.The private Contractor managing the landfill sitehad to replace the

infrastructure (palisade fencing) numerous times and the replacementswere not cost effective regarding the sustainability of operations undertaken at thelandfill facility.

The second group of respondentswhowere interviewed were from Weltervreden landfill site, which is owned by the EMM municipality and is located in Brakpan. The details of the respondents were not known by the Contractor appointed by municipality to oversee the daily operations of the landfill site. Weltervreden,like Chloorkop has experienced incidences of vandalism by informal recyclers such as the breaking of thepalisade fence in order to gain access to the landfill. In dealing with vandalism, the Contractor has built a separate gate for reclaimers to enter the landfill site. During fieldwork, it was observed that only few reclaimers had protective clothing on them, while others were wearing their private clothing, thus susceptible to on-site injuries by heavy-duty vehicles and other safety risks.

5.3.1 Demographic Profile of Informal Waste Reclaimers

The majority of respondentsare male58% and 42%arefemale. With respectto respondent's age,66% were between of 30-40 yearsof age and (30%) between 40-50 years. Four percent(4%) were younger than 30 years.A significant proportion of them lacked a good educational background because 70% of them only attended high school level meanwhile 26% completed primary school education. Twenty nine percent (29%) of respondent's had formal employment from different organisations prior to their commencement of informal waste picking activities. On the other hand, 71% have never had any formal employment and survived solely by salvaging waste.

5.3.2 Details of Reclaiming Aspects

There werevarious reasons which have led the respondentsto engage ininformal waste reclaiming activities in their communities within EMM. They mentioned that they recover waste because of socioeconomic challenges such as poverty (42%). However, others reclaimed municipal waste in order to obtain an extra incomefor supplementing their salaries (15%). Thirteen percent (13%)stated that they reclaim waste because it is an opportunity for self-employment(Figure 5.13).

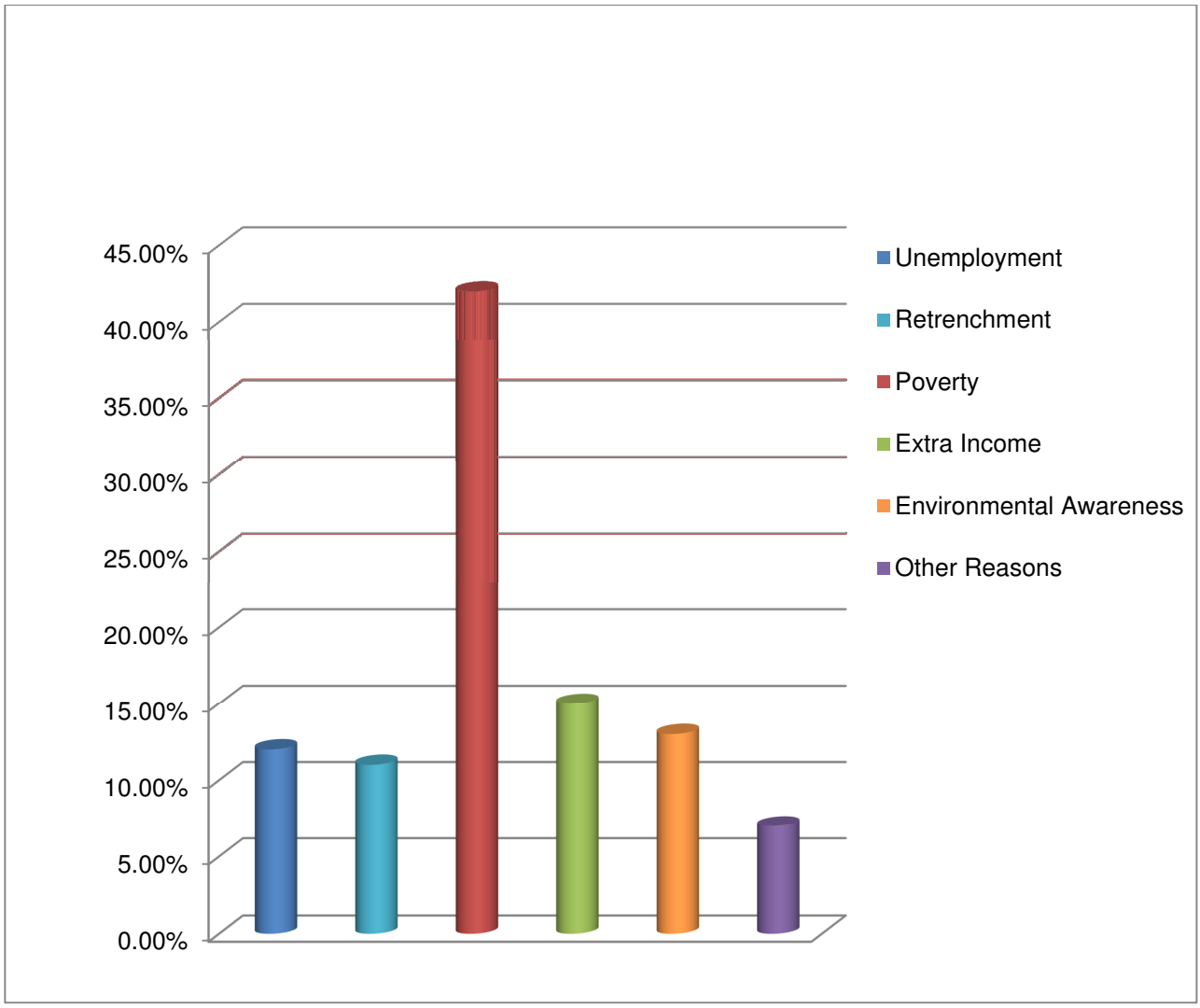

Figure 5:13: Summary of reasons for reclaiming.

Fifty two percent(52%) of the waste recovered was sourced from households meanwhile 23% was obtained from illegal dump sites and 19% was sourced from landfill sites. A small proportion (6%) of waste was sourced from other places which included shopping centres and industries (Figure 5.14).

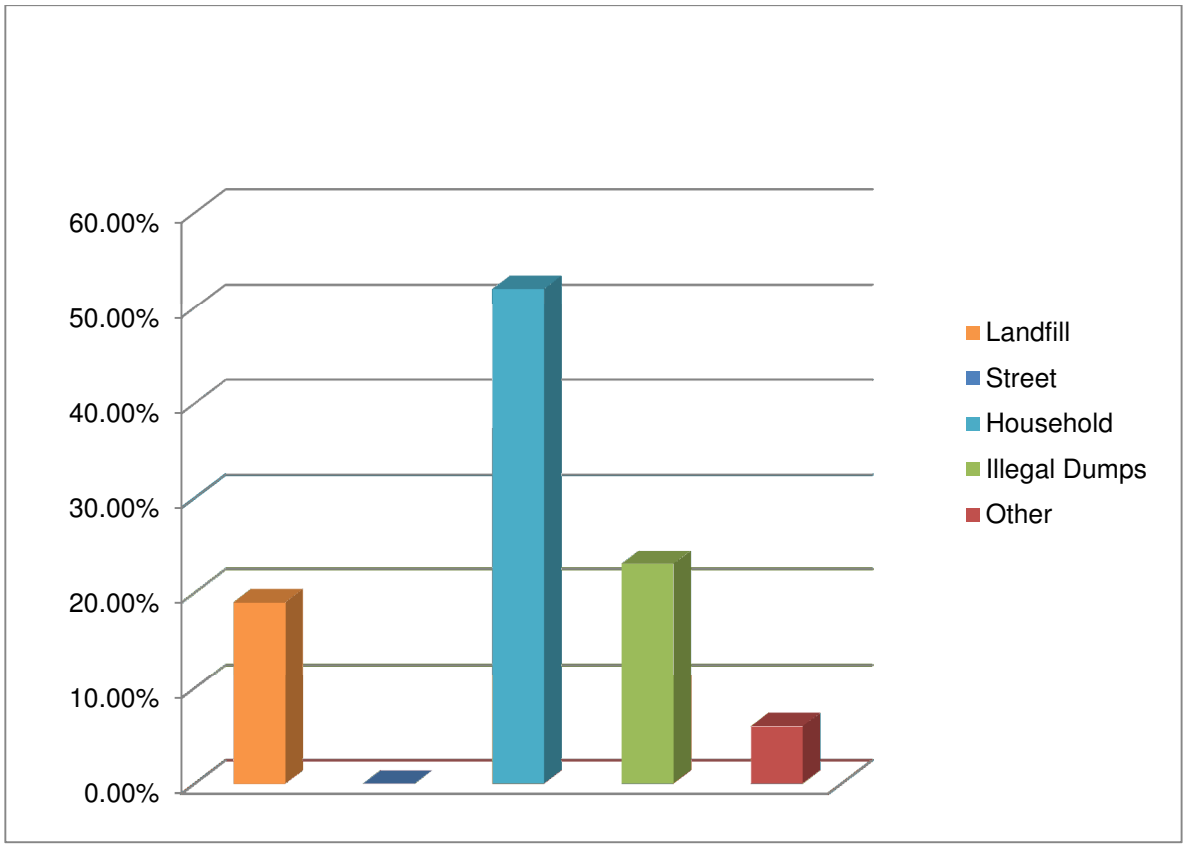

Figure 5:14: Source of waste reclaimed.

The types and volumes of waste reclaimed are illustrated in Table 5.3. Plastics were the most reclaimed type of waste (315 kg/month) and the least waste type reclaimed was glass bottles (25 kg/month). The greatest distance travelled by respondents to collect waste was more than 5 km (57%) and the shortest distance travelled was less than 2 km (2%).

Table 5:3: Waste types recycled and volume.

Waste type recycled	Volumes (kg)/month
Copper	86 kg
Aluminium	173 kg
Lead	201 kg
Iron	300 kg
Steel	471 kg
Cardboard	61 kg
White paper	196 kg
Colour paper	155 kg
Newspaper	200 kg
Plastic bottle	192 kg
Plastic bag	198 kg
Other plastic types	315 kg
Glass bottle	25 kg
Shattered glass	30 kg
Other glass	61 kg

The waste types recovered were further regrouped into metal, paper, plastic, glass and other types (clothes and food). The volumes recovered daily and on a monthly basis are depicted in Table 5.4. Compared to others, the least waste type recycled in a day and month was found to be waste in the form ofglass - 769 kg per day and 309kg per month, respectively. Whilst plastic was the major waste type recycled in a day (6042kg), paper was the highest most recycled waste material per month (14183 kg).

Table 5:4: Average weight of waste recycled.

Waste Type (Kg)	Day (Kg)	Month(Kg)
Metal	2685	9850
Paper	5198	14183
Plastics	6042	8683
Glass	769	309
Other (food and clothes)	5365	2548

With regard to the distance travelled by respondents to sell recovered waste, the greatest distance was more than 5km (51%) and the least distance was less than 1km (18%). The customers who bought recovered waste were other individual reclaimers (60%), private companies (29%) and buyback centres (11%) (Figure 5.15).

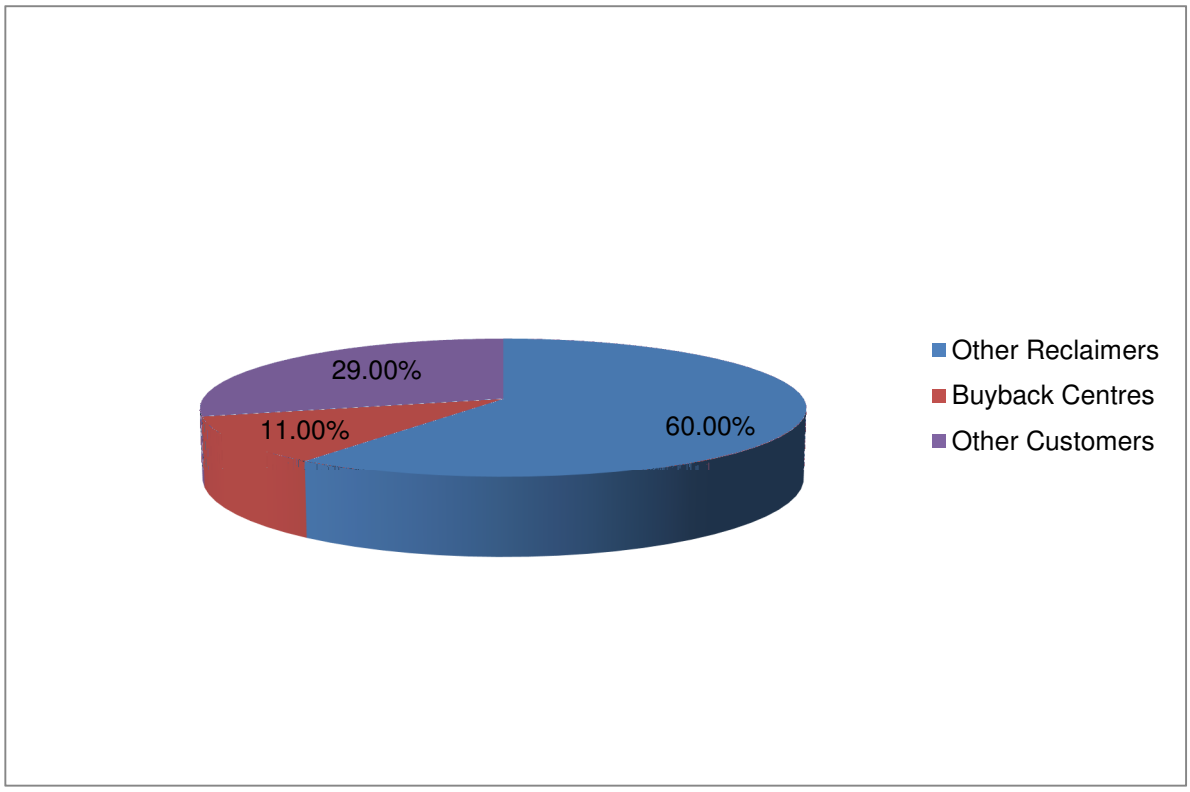

Figure 5:15: Reclaimer's customers.

According to Figure 5.16, the highest income earned by some respondents from selling theirrecovered wasteranged from R4000 to R5000 per month and this benefit was enjoyed by only 5% of the respondents. However,the majority (60%) of respondents earned between R1000 to R2000 per month.

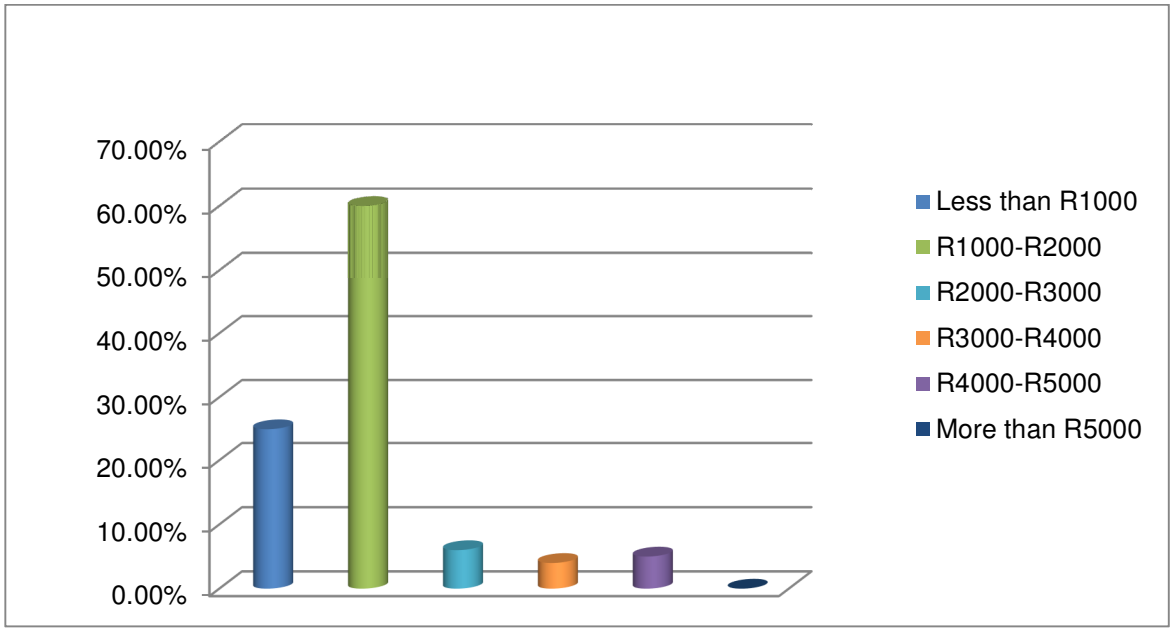

Figure 5:16: Recycling income.

There were certain challenges and barriers that hindered respondents from conducting their reclaiming and recycling activities effectively and these included exposure to an untenable and polluted work space and sheer presence of several environmental hazards (52%), especially as some don't alwayswear protective clothing. Furthermore,it was mentioned that some (25%) were being victimised and intimidated by the general public and other waste reclaimers. The distance which they travelled to source and sell their products was also found to be long, thus exposing them to different risks. It is imperative that the municipality be involved in order for the recycling activities to be undertaken in a controlled and safe environment in order to reduce health and safety risks (Figure 5.17).

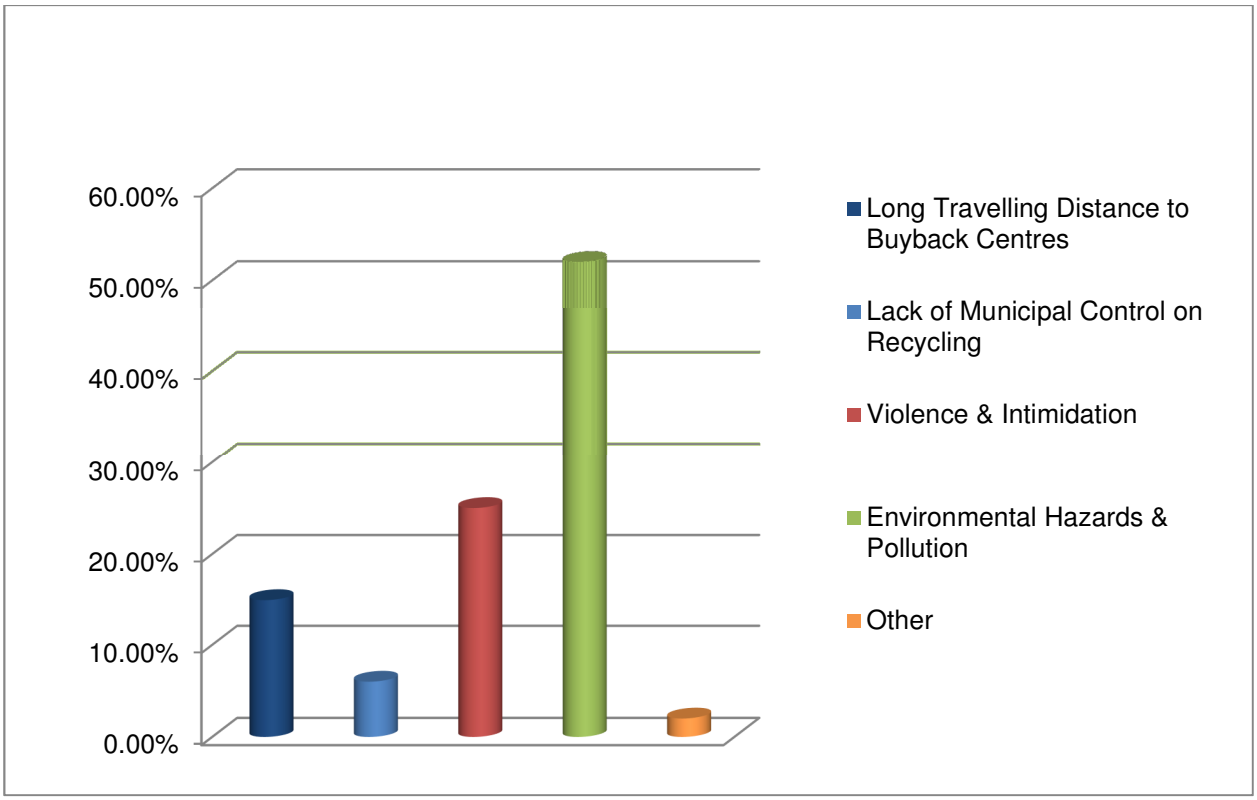

Figure 5:17: Challengesencountered.

5.3.3 Health and Safety of Informal Reclaimers

This section presents the negative aspects related to the health and safety of informal waste reclaimers. About 19%of respondents indicated thatthe recovery of municipal waste materials made them sick although 81% claimed that such activities do not make them ill.Amongst the majority of respondents who became sick (40%), common illnesses were found to be chest-related diseases such as influenza and cough. On the other hand, 20% of respondents (40%) complained about stomach aches (Figure 5.18).

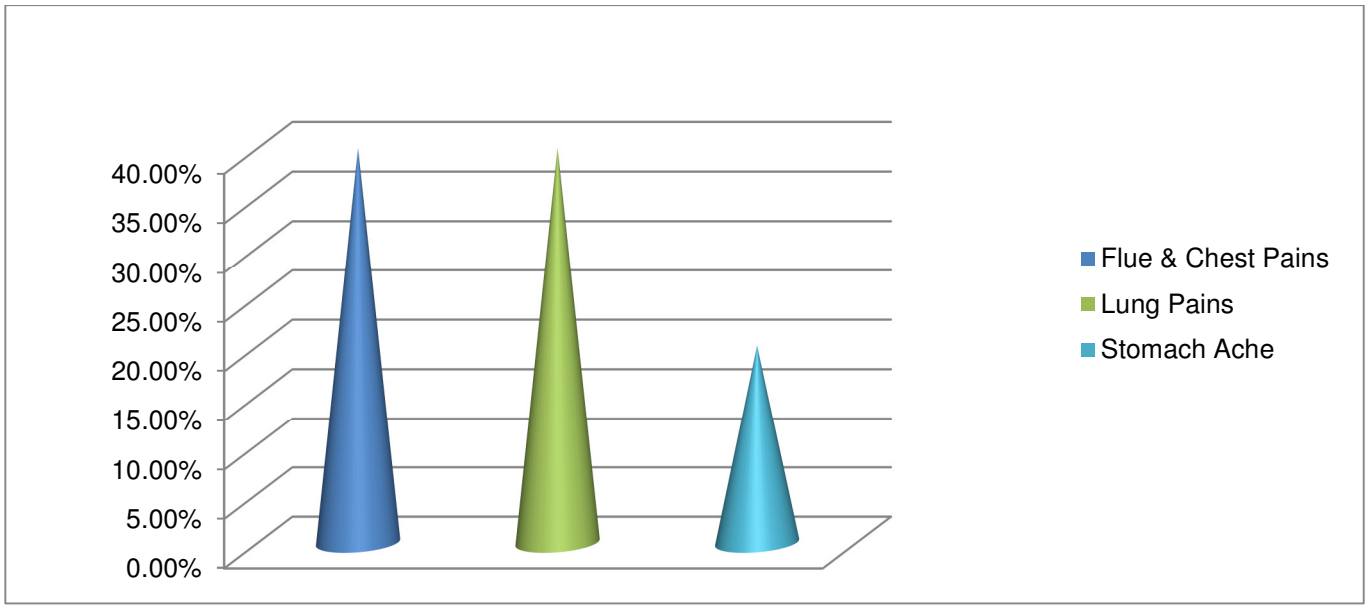

Figure 5:18: Types of sickness from the recycling workspace.

Seventy five percent (75%) of respondents indicated that they were not aware of health effects such as injuries and sicknesses that occurred at landfill sites and other places where reclaiming activities are conducted. Few respondents (25%) mentioned that they have experienced and seen other reclaimers being affected by the negative environmental conditions at landfill sites. The different types of health risks affecting informal reclaimersincluded dust inhalation (60%), the onset of sinus-related discomfort(15%), contracting tuberculosis (5%), odours and injuries (10%), respectively (Figure 5.19).

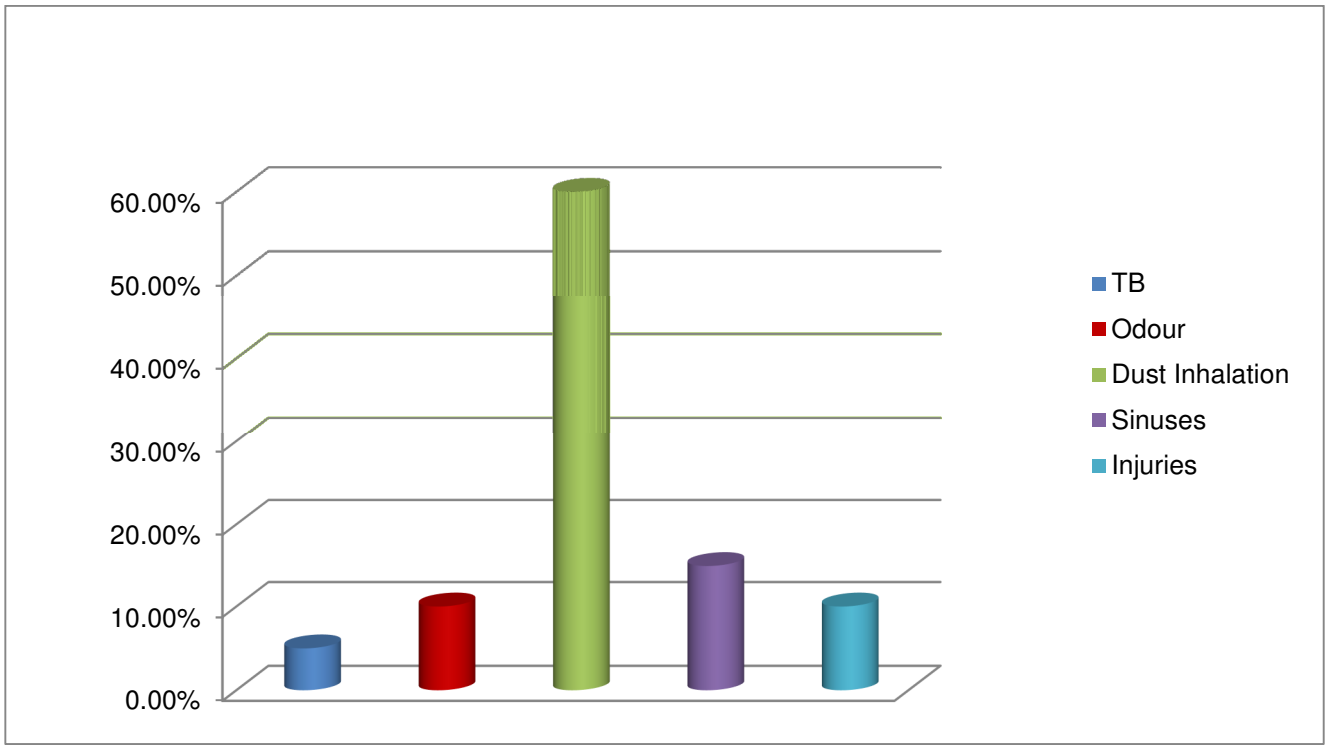

Figure 5:19: Healthrisks.

When it came to the frequency with which health impacts affect reclaimers at the landfill sites, the following patterns emerged. Twenty five percent(25%) of respondentsexperienced these hardships annually, bi-annually and four times a year, respectively, whereas (15%) indicated that health impacts affected them every two years. Only ten percent (10%) of respondents stated that the negative health impacts affected them as frequently as every two months (Figure 20).

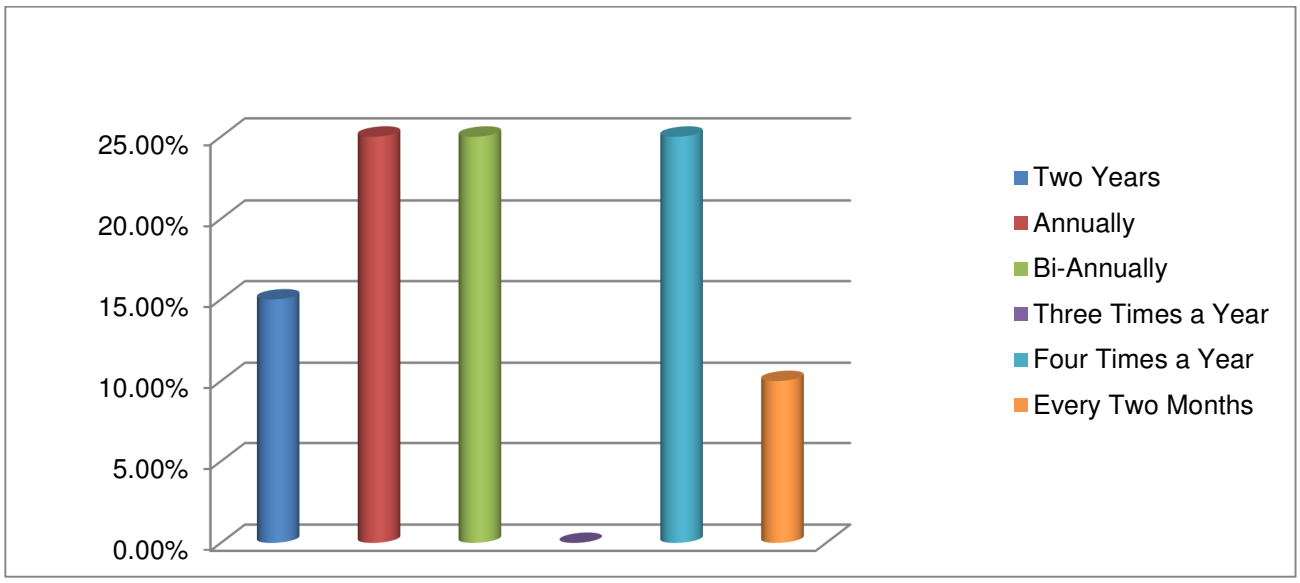

Figure 5:20: Frequency of health impacts occurrence.

Withrespect tosafety gear or personal protective equipments (ppes) owned by respondents, the majority (37%) owned protective gloves. Twenty one percent (21%) owned overall protective suitsmeanwhile 20% owned protective boots. To a lesser extent, other respondents indicated that they haveearplugs (10%), protective eye glasses (7%) and dustmasks (5%). In addition, respondents divulged out that they do not use ppesall the time when recycling because they cannot afford to buy such equipments or gear(Figures 5.21).

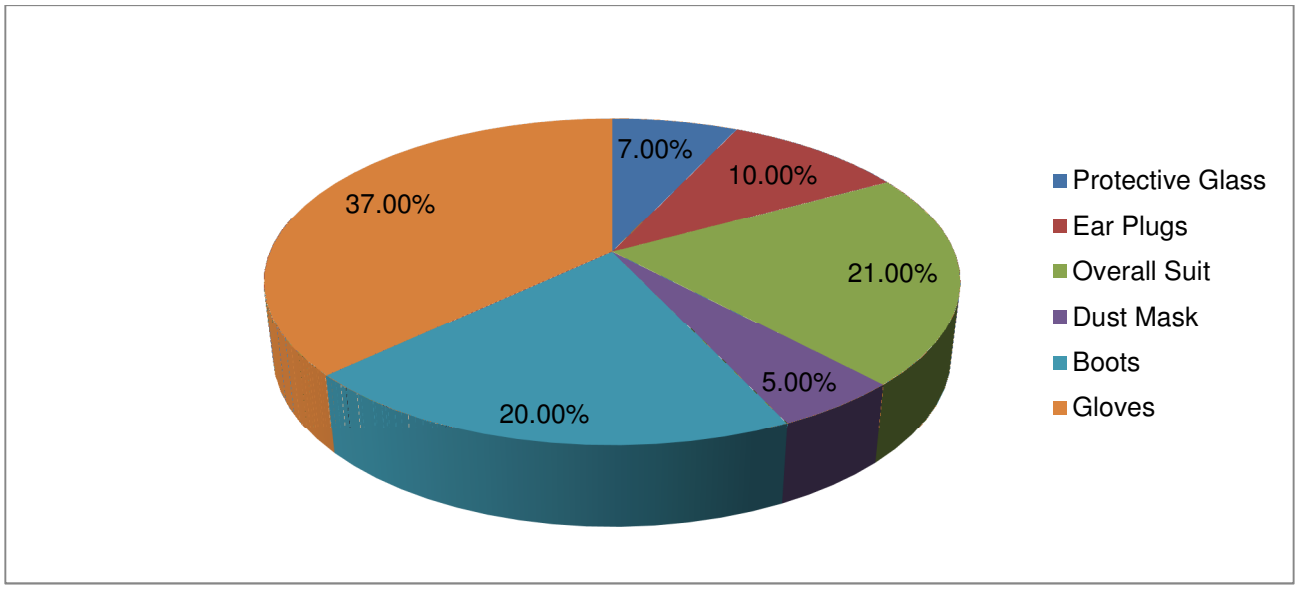

Figure 5:21: Personal protective equipment.

One of the aspects investigated in the current research related to the frequency with which informal reclaimers consulted medical health-care facilities or specialists for their own wellness. It was found out that 40% of them visit health care facilities twice a yearmeanwhile 23% consulted with themannually. Nineteen per cent (19%)do this every two months (Figure 5.22).

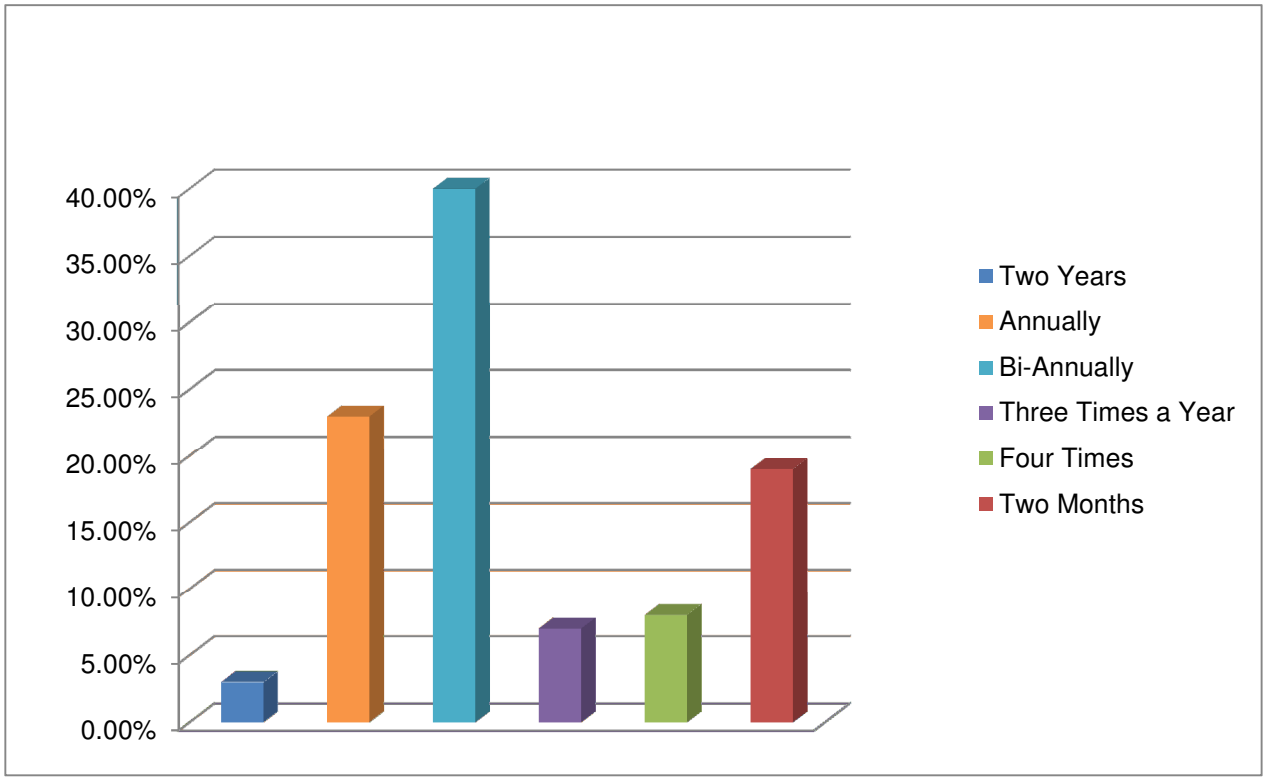

Figure 5:22: Frequency ofhealth care visits.

5.4 THE ROLE OF THE MUNICIPALITY IN WASTE MANAGEMENT AND MINIMISATION

This section presents the results emanating from the analyses of primary data collected by means of questionnaires directed at municipal officers.Asstated previously, such questionnaires had eight sections which entailed demographic details; capacity and skill; planning and development; problems encountered in the waste management service delivery; finances within the waste department; minimisation and recycling projects initiatives; and the role of buyback centres and the benefits of recycling and minimisation initiatives.

5.4.1 Demographic Profile of Respondents

The EMM provides waste management services to a total of about 3 million residentsand businesses within its jurisdiction. There is approximately 1.5 million householdswhich are provided with waste management services and out of that total, 1.3 million are formal households meanwhile 200 000 are informal households.Waste management services are mostly rendered to the urban areas rather than in the rural areas of this municipality. The urban areas have an average space of 2000 $km^2$and there was no relevant information on rural areas.

Whereas the EMM municipality collects about 80% of solid waste, 20% is collected by Contractors (Table 5.4). In terms of garden waste, collectionpatterns can be broken down as follows. About 69% of garden waste was removed by the municipality, 30% by the municipality's appointed Contractor, 0.5% by garden services and 0.5% by residents. Twenty two percent(22%) of recycled waste was collected by the municipality, 66% by Contractors and the restwas removed by private companies and residents(12%) Table 5.4).

Contractors were responsible for the maintenance of their own vehicles and the municipality maintained its own vehicles. The municipality owned a total of 290 waste transporting vehicles and the Contractors owned a total of 57. The environmental awareness campaigns on waste minimisation and recycling were undertaken by both the municipality and the private companies (Table 5.5).

Table 5:5: Waste services rendered by the municipality.

Function	Carried out by		
	Municipality	Contractor	Other
Collection of solid waste from domestic premises	80%	20%	-
Removal of garden waste from domestic	69%	30%	1%

Function	Carried out by		
	Municipality	Contractor	Other
premises			
Removal of recyclable waste from domestic premises	22%	66%	12%
Removal of recyclable waste from collection stations	11%	66%	23%
Removal of solid waste from informal dump sites	22%	66%	12%
Storage of solid waste collected	33%	22%	-
Disposal to landfill sites	77%	23%	-
Management of landfill operations	20%	80%	-
Waste transporting vehicle maintenance	66%	66%	-
No of waste collection vehicles	290	57	-
Environmental awareness campaigns on waste recycling& minimisation initiatives	22%	22%	-

5.4.2 Capacity and Skills

About 2336 people are employed permanently by the municipality for waste collection meanwhile 798 are employed on a contract basis. The depots were manned by 53 employees and Contractors were not employed at these sites. Eight permanent general employees and six waste management officers were responsible for the landfill facilities (Table 5.6). In terms of the academic status of the municipal employees, the collection department was staffed with a total of 7 employees on a permanent basis, where6 of them obtained a Grade 12 Senior Certificate and 1who possessed a national diploma with

20 years working experience. By contrast, the depots had1 permanent employee with a Grade 12 Certificate and 5 employees with national diplomas and university degrees with 14 years of working experience. Furthermore, thespecific information about the Contractors employed by the municipality was not available.

The types of containers used by residents to dispose waste that was collected by the municipality ranged from plastic bags to metal bins and plastic bins. The municipality formulated a waste collection schedule in order to provide an adequate service within its jurisdiction. According to the municipal schedule, waste is collected once a week. The recycled waste was collected by private companies who were involved in recycling. Containers provided to the residents for recycling wereplastic waste bins and there were no charges imposed by the municipality for the disposal of different types of waste in the same container as well as incentives provided to residents for the separation of waste at source.

Table 5:6: Employment status.

Permanent		Contractors
Collection	2336	798
Depots	53	0
Landfill sites	8	0
Municipal waste officers	6	0

5.4.3 Management Planning and Development

Table 5.7shows the different types of waste containers used to store waste in households and the frequency of usage. Plastic bins (66%) and bags (34%) emerged as widely used containers at households and communal area, whilst metal waste bins were the least used by households (26%).

Table 5:7: Residential waste storage containers.

Type of Residential Containers		Almost Exclusively Used	Frequently Used	Sometimes Used	Never Used
Waste collected at residents premises	Metal bin	-	-	26%	-
	Plastic bin	66%	44%	-	-
	Plastic bag	34%	22%	-	-
	Oil drum	-	-	-	-

Type of Residential Containers		Almost Exclusively Used	Frequently Used	Sometimes Used	Never Used
Waste collected from communal storage areas	Metal bin	22%	22%	-	-
	Plastic bin	11%	22%	-	-
	Oil drum	-	-	-	-
	Concrete bin	-	22%	-	-

Table 5.8 depicts the degree of waste separation at source for different waste types. Twenty two per cent(22%) of waste such as paper/cardboard, plastic, food waste, and glass metal were separated at source, respectively. On the other hand, 11% of waste classified as wood was separated at source.

Recycling bins and containers were mostly (66%) used to disposeaway plastic, food waste, glass and metal respectively, whereas these containers were least used to dispose of paper/cardboard (45%), wood, garden and inert (44%), respectively (Table 5.8). The recycled paper/cardboard waste was handled by private facilities and companies. There are two recycling centres within the municipality which are located in Actonville and Wattville.

Table 5:8: Estimated household waste separation at source.

Waste Types	Separated at Source	Recycling Container (Bin & Bags)	Disposal Facility (Private)
Paper/Cardboard	22%	45%	33%
Plastic	22%	66%	0.00%
Food Waste	22%	66%	0.00%
Glass	22%	66%	0.00%
Metal	22%	66%	0.00%
Wood	11%	44%	0.00%
Garden	0.00%	44%	0.00%
Inert	0.00%	44%	0.00%

5.4.4 Operational Problems Encountered associated withSolid Waste Management Service Delivery

The challenges experienced by the municipality in effectively providing waste management services ranged from insufficient number of staff, vehicles and equipment that are not maintained appropriately, budget limitations, and non-payment of services by those receiving municipal waste management services, the ignorance of the communities in terms of not using the facilities (waste bins along main roads and public areas) provided by the municipality; as well as not responding to waste minimisation and waste management campaigns conducted by the municipality and private companies. In addition, there was a lack of properly trained waste management officers to implement and enforce waste management plans and by-laws. The rapid pace of urbanisation was negatively affecting the waste management service delivery by the municipality where the constant provision of new resources and facilities was required. Lastly, the illegal dumping of waste and failure of business establishments to pay landfill site levies was mentioned as another operational problem.

- *Current Status of Solid Waste Management Service Delivery*

The monthly amount currently charged by the municipality for waste management services provided to residents in the suburbs wasR332.00 and R211.00 for township dwellers. Informal settlements are not charged for waste collection as the municipality provides waste skips that are centrally located for communal usage.

In 2012, the EMM announced its plans to supply 240 litre bins to all households within its jurisdiction by 2014 as part of its programme to improve waste management in the metro. As a result, an amount of R69 million has been budgeted to procure additional refuse removal vehicles to improve the quality of waste removal services (Kempton ExpressNewspaper, 28 February 2013). However, if these plans are not implemented accordingly, the current status quo would still prevail. According to the Kempton Express Newspaper (06 June 2013), the EMM will be increasing the waste removal services tariff from households by 15% during 2014. The increase will apply to high and middle income communities in order to subsidise poor households. As alluded to earlier, the municipality has emphasised its concerns with the non-payment of waste management services, especially with respect to poor households who may not afford to carry such increases.

5.4.5 Waste Minimisation and Recycling Projects in the Municipality

The main role players in the recycling of recovered or reclaimed waste were found to be private companies such as REMADE, CONSOL and MPACT as well as a few local communities. However, the EMM municipality does not have relevant and accurate information on the actual recycling patterns. Nevertheless, despite this dilemma, the municipality initiated small scale awareness programmes at local schools and communities and the scale of such projects could possibly increase in the future through further partnership with the private sector. The barriers encountered in the

minimisation of waste consisted of inadequate infrastructure and inadequate resources to enable the separation of waste at source. This limits the full realisation of effective waste minimisation within the municipal jurisdiction.

5.5 WASTE MANAGEMENT PRACTICES AT LANDFILL SITES

5.5.1 Operational Characteristics at Landfill Sites

The municipality has appointed private companies to manage daily operations at their landfill sites. Table 5.9 outlines the staff complement for each landfill site visited during fieldwork. No informal dumping sites were visited during fieldwork.

Table 5:9: Landfill sites employees.

Landfill name	No of employees
Chloorkop	6
Weltervreden	10
Rietfontein	19
Simmer and Jack	15

The characteristics of landfill sites are depicted in Table 5.10. Rietfontein has the most operational lifespan when compared with the rest of other landfill sites. Regarding the environmental permits of landfill operations within EMM, Weltervreden and Chloorkop permits were not available for analysis whilst Rietfontein and Simmer and Jack permits were available. The environmental permits for these landfill sites were obtained in 1997 from the Gauteng Department of Agriculture, Conservation and Environment (GDACE) which is currently known as Gauteng Department of Agriculture and Rural Development (GDARD), and these permits have been amended several times to include the current upgrades undertaken at the landfill sites, such as stormwater management systems and others. The conditions stipulated within the permits include the monitoring of ground and surface water as well as methane gas. The monitoring of these environmental aspects/parameters was conducted daily, and monthly and quarterly reports are produced based on results stemming from such monitoring exercises. Furthermore, environmental permits do not allow informal reclaimers on landfill sites due to the health and safety risks posed by activities undertaken at the landfill sites. It has, however, been noticed that the informal reclaimers do enter the landfills illegally to salvage what they can sell for survival due to the current poor socio-economic conditions and in particular the high unemployment rate (~25%) in South Africa. Not allowing them access into the landfill site will not be cost-effective, since the informal waste pickers (scavengers) will vandalise perimeter fences in an effort to gain access.

Table 5:10: Characteristics of waste disposal sites.

Name of the site and location	***Chloorkop Kempton Park***	***Weltevreden Brakpan***	***Rietfontein Springs***	***Simmer and Jack Germiston***
Is the landfill site owned by the municipality? If not ,please explain	Privately Owned	Owned by Municipality	Owned by Municipality	Owned by Municipality
Estimated lifespan remaining (years)	2 years	7 years	8 years	4 years
How many cells and please state the number of those in operation	6 cells and Cell 6 currently in operation	7 cells and 6 in operation	5 cells and 1 can be developed	7 cells
Summary of permit conditions & date obtained	-	-	Permit obtained in 1997 and has been amended several times Conditions: monitoring of water and gas	Permit obtained in 1997 and has been amended several times. Conditions: monitoring of water and gas
Amount of waste deposited daily (tonne/day)	600 tonnes	200 tonnes	800 tonnes	800 tonnes
Distance from collection area to the site (km)	60km	30km	30km	35 km
Disposal method (open dumping, controlled disposal with cover etc.)	Controlled disposal with cover.	Open dumping and controlled disposal with coverage	Controlled disposal with coverage	Controlled disposal with coverage.
Specify type of waste pickers on site	-	South Africans and emigrants from other	-	-

Name of the site and location	***Chloorkop Kempton Park***	***Weltevreden Brakpan***	***Rietfontein Springs***	***Simmer and Jack Germiston***
		countries.		
Existence of open burning on site and frequency	-	-	-	-
Specify proximity to residential areas	5km	10km	5km	-

5.5.2 Waste Management and Landfill Sites

The annual waste that was collected and disposed to various landfill sites located within EMM and also owned by EMM (Simmer and Jack, Platkop, Rietfontein, Weltevreden and Rooikraal) wasapproximately 1.2 million tons.Nearly 180 sectional areas within EMMwere serviced on a scheduled basis by making use of a collection schedule. The collection schedule is distributed to all households annually with colour coding indicating the day waste was collected in a particular area (EMM Media Unit, 2013). EMM operates35 mini disposal sites, 8 transfer stations and regular litter picking services in the CBD, industrial areas as well as along the main routes. The occurrence of illegal dumping and littering both remaina serious environmental management challenge for EMM (Ekurhuleni Growth and Development Strategy, 2011). Other challenges faced by the EMM waste department include: insufficient vehicles, equipment and personnel to provide an adequate waste collection service. Furthermore, there were approximately 37 000 informal households which the municipality was not able to service due to poor accessibility. To compensatefor this shortfall, waste concrete/metal bins and skips were placed at strategic positions for easy access by the communities residing in informal areas (Ekurhuleni State of the Environment Report, 2004). Conventional compactor vehicles are used to collect waste from formal sectors (commercial and businesses) and suburban residential areas as well as townships. Waste is collected by tractors and handheld carts in the informal residential areas (Ekurhuleni State of Environmental Report, 2004).

According to the Ekurhuleni State of the Environment Report (2004), a total of 1 235tons of domestic and industrial waste were disposed to landfill sites in 2003. Rietfontein, Simmer and Jack as well as Rooikraal landfill sites had experienced a remarkable decreasein the volume of waste handled from July 2002 to June 2003. Notably, the volumes of Platkop, Weltervreden and Chloorkop have increased slightly. Chloorkop is a privately owned landfill site which services Kempton Park and Edenvale (EMM Landfill Annual Report 2010/2011). Table 5.11 describes the landfill sites and types located within EMM and also identify the types of waste they receive and their waste classification. Holfontein is the only landfill site in Gauteng province that handles hazardous waste and it is situated outside of the EMM. All of the landfill sites are permitted as general waste sites. However, Platkop

and Weltervreden landfill sites are able to receive certain specified hazardous waste (Ekurhuleni State of the Environment Report, 2004).

Table 5:11: Landfill sites in Ekurhuleni.

Landfill Sites	Lifespan Available (year)	Types of Waste Handled									Gas & Groundwater Monitoring	Classification
		Domestics	Industrial	Garden	Unclassified	Tyres	Ash	Building	Paper Pulp	Sludge and		
Platkop (Heidelberg)	47	X	X	X	X	X	X	X			7 monitoring boreholes 12 gas probes 15 additional monitoring boreholes	GLB-
Simmer and Jack (Germiston)	5-10	X	X	X	X	X	X	X			No monitoring boreholes 14 probe, 4 wells, 2 vents shafts	GLB-
Weltevreden (Brakpan)	42	X	X	X	X	X	X	X			7 monitoring boreholes 5 gas probes in southern and western area	GLB-
Rietfontein (Springs)	20-38	X	X	X	X	X	X	X			2 additional monitoring boreholes 5 gas probes	GLB+
Rooikraal (Boksburg)	38	X	X	X	X	X	X	X	X		7 monitoring boreholes 7 gas probes	GLB (applied for)

GLB-: Waste Class: General Size: Large B-: no significant leachate

GLB+: Waste Class: General Size: Large B+: significant leachate

GMB-: Waste Class: General Size: Medium B-: no significant leachate

GMB+: Waste Class: General Size: Medium B+: no significant leachate

GSB: Waste Class: General Size: Small B-: no significant leachate

Source: Ekurhuleni State of the Environment Report(2004).

5.5.2.1 Landfill Sites of Ekurhuleni in Operation

There are a total of six operating landfill sites in the EMM and of these five are owned by the EMM meanwhile the Chloorkop landfill siteis privately owned. According to Figure 5.23, there has been a fluctuation in the quantities of waste generated and disposed at EMM landfill sites. During the year 2006/2007, the volume of waste was 163, 507.5 tons and it decreased during the following period

(2007/2008) to 156,598.5 tons. There was a similar pattern from the 2008/2009 time frame until 2009/2010 period. However, generally there is an increasing trend in the amount of waste generated annually as observed for the year 2010/2011 (EMM Landfill Annual Report 2010/2011). Table 5.12 illustrates the breakdown of waste quantities received per landfill. Simmerand Jack landfill site received and processed the largest quantities (429,771 tons/a) of waste when compared to other landfills and the lowest quantities processed were at Chloorkop landfill site (172,701 tons/a).

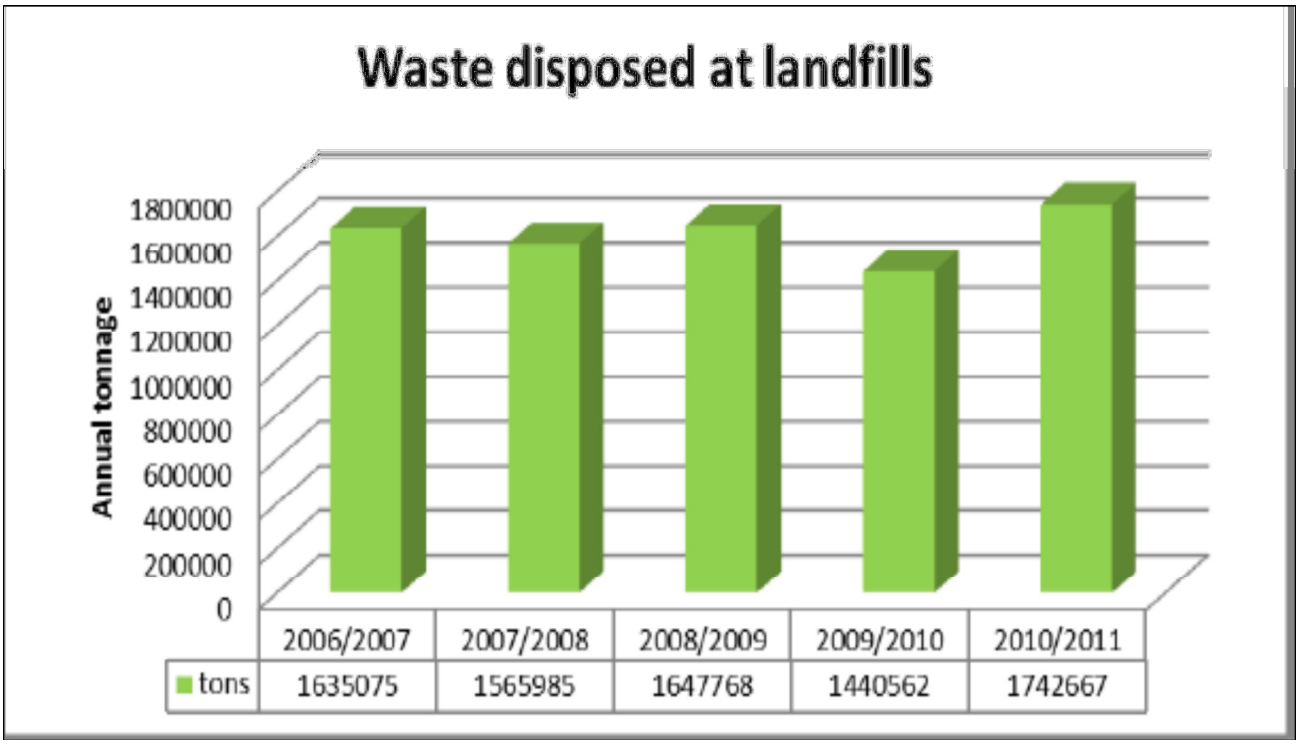

Figure 5:23: Annual quantities of waste disposed at EMM landfill sites.

Source: EMM Landfill Annual Report 2010/2011.

Table 5:12:Total annual quantities of waste processed at landfill sites 2010/2011.

Landfill Name	Total Quantities Processed (Tones)
Platkop	238 610
Rietfontein	355 336
Weltervreden	329 002
Simmer and Jack	429 771
Rooikraal	217 446
Chloorkop	172 701

Source: EMM Landfill Annual Report (2010/2011).

5.5.2.2 Operational Status of Landfill Sites in EMM

Table 5.13 presents the summary of the types of waste disposed or accepted at EMM landfill sites, lifespan and details of operational environmental permits. EMM has obtained permits for the operation of the landfill sites from the environmental authorities. The permits have been issued and amended several times to accommodate the changes that have occurred on the landfill sites (Platkop and Rietfontein) over the years. These changes include for example, acceptance of hazardous waste (asbestos, contaminated foot, hazardous hydrocarbons etc.) That can be processed by landfill sites. On the other hand, Weltervreden and Simmer and Jack landfill sites only had one issue of operational permit in 1994 and 1996. Weltervreden landfill site has the longest operational lifespan when compared to other landfill sites and the landfill site with the least number of operational years is Simmer and Jack.

Table 5:13: Summary of EMM landfill operational status.

Landfill Name and Classification	Operational Permit	Operational Life Span	Type Of Waste Handled
Platkop (G:L:B-)	First issue-1989 Second issue-1993 *	25 years	Domestic
			Garden refuse
			Tyres
			Building rubble
			Contaminated foodstuff *
			Ash
			Asbestos
			Industrial waste
Simmer and Jack (G:L:B-)	Issued-1996	16 years	Domestic
			Garden refuse
			Tyres
			Building rubble
			Ash
			Industrial
Weltervreden (G:L:B-)	Issued -1994	32 years	Domestic
			Garden refuse
			Tyres
			Building rubble
			Ash
			Light industrial
Rietfontein (G:L:B+)	First issue-1997	20 years	Domestic

Landfill Name and Classification	Operational Permit	Operational Life Span	Type Of Waste Handled
	Second issue-2001** Third issue-2003** Fourth issue-2005**		
			Garden refuse
			Tyres
			Building rubble
			Delisted solids and sludge
			Low carbon hazardous hydrocarbons
			Ash
			Light industrial
			Paper pulps < 40% liquids

* Inclusion of asbestos

**Inclusion of delisted solids & sludge, low carbon hazardous hydrocarbons and paper pulps

Source: EMM Landfill Annual Report, (2010/2011).

5.5.3 Waste Minimisation at Landfill Sites

There are recycling areas established within the landfill site premises to be used by the general public in disposing of their recycled waste. The recycled waste is collected by private companies for different use. In Weltevreden, for example the MPACT recycling company has employed two gentlemen who collate the different types of waste brought by the public and MPACT provides trucks to transport the collected waste for processing at a site which was not disclosed to the current research. The weight of waste recycled and recovered at the Weltevreden landfill site for the financial year 2010/2011 is outlined in Table 5.14 below. The information on volumes/weight of waste recycled at other landfill sites within EMM was not available.

Table 5:14: Recycling waste recovered at Weltevreden landfill.

Recycled items		Grand total (Kg)
G.50.01	News Print and Magazine	94449
G.50.03	White Grades HLI	41988
-	K4 Cardboard	515068
G.50.01	Plastic Pete	44292
G 51.02	Plastic HDPE	8103
G 51.04	Plastic HDPE Clear	31816

Recycled items		Grand total (Kg)
G.51.05	Plastic HDPE PP Bulk Bag	20093
G 51.06	General Plastic PC Mix	27754
G.52	General Glass	177630
G.53.01	General Metal (Ferous)	22690
G.53.02	General Metal (Non Ferous)	1204
G.51.03	General Plastic PVC	15805

Source: EMM Landfill Annual Report (2010/2011).

5.5.4 Greening of Waste Management at Landfill Sites

5.5.4.1 Kyoto Protocol and Mechanisms of Emission Reduction

Kyoto Protocol is an international treaty that sets binding obligations on industrialised countries to reduce the emissions of greenhouse gases (GHG) (carbon dioxide and methane). The main aim of the Kyoto Protocol is to contain emissions of the main anthropogenic greenhouse gases (GHGs) in ways that reflect underlying national differences in GHG emissions, wealth, and capacity to make the reductions (Grubb, 2004). The treaty recognises that developed countries are responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity and thus have binding targets in which they need to reduce their emissions. The Protocol was adopted by Parties to the UNFCCC in 1997, and entered into force in 2005 (UNFCCC, 2005).

The United Nations Framework Convention on Climate Change (UNFCCC) is an environmental organization with the goal of preventing harmful anthropogenic interference of the climate system. Developing countries such as South Africa do not have binding targets under the Kyoto Protocol, but are still committed under the treaty to reduce their emissions (UNFCC, 2005). Under the Protocol, emissions of developing countries are allowed to grow in accordance with their development needs (Liverman, 2008).

Actions that can be undertaken by developed and developing countries include support of renewable energy, improving energy efficiency and reducing deforestation. The flexibility mechanisms are International Emissions Trading (IET), the Clean Development Mechanism (CDM), and Joint Implementation (JI). IET allows countries to trade their emissions by using assigned amount of units (UNFCCC, 2005).

The CDM and JI are called project-based mechanisms, in that they generate emission reductions from projects. The difference between IET and the project-based mechanisms is that IET is based on the setting of a quantitative restriction of emissions, while the CDM and JI are based on the idea of production of emission reductions (Lecocq and Ambrosi, 2007). According to theWorld Bank (2010),

between 2001 which was the first year that CDM projects could be registered and 2012 the end of the first Kyoto commitment period, the CDM is envisaged to produce some 1.5 billion tons of carbon dioxide equivalent (CO_2e) in emission reductions. Most of these reductions are achieved through renewable energy commercialization, energy efficiency, andfuel switching (World Bank, 2010).

5.5.5 EMM Landfill Greening Initiatives

EMM has initiated a clean development mechanism (CDM) project using its large landfill sites at Simmer and Jack, Weltervreden, Rooikraal and Rietfontein and the project is underway. The aim of the project is to reducegreenhouse emissions commonly associated with the environmental problem of global warming as indicated in the Kyoto Protocol which the Republic of South Africa ratified in 2002 (UNFCCC, 2005 and EMM Landfill Annual Report 2010/2011). The CDM projects which are underway in the EMM have been undertaken through the recovery of landfill gas using vertical gas extraction wells and horizontal gas collection systems (Figures 5.24 and 5.25). The construction process of the flare gas stationscommenced in 2007and these stations are located at various landfill sites within the municipality refer to Figures 5.26 to 5.29. The process of extracting landfill gas is described as follows; the landfill gas recovery system consists of wellheads that connect individual gas wells to the gas collection pipe-work which is laid to grade in order to facilitate the condensate management. Wellheads control system includes gas monitoring points for quality, pressure and gas flow. The landfill gas is extracted from the landfill under the vacuum pressure at each well and pneumatic pumps that are installed in the vertical wells. The knockout pods then extract leachate and condensate from the system (EMM Landfill Annual Report, 2010/2011).

According to (UNFCCC, 2012 and EMM Landfill Annual Report (2010/2011)., EMM will initially flare (release) the collected gas for testing purposes thereafter the gas will bestored and used to generate power. Often the greenhouse gas emission reductions are achieved by the combustion of the recovered methane contained in landfill gas that is emitted in the atmosphere (UNFCCC, 2012).

Figure 5:24: Horizontal gas collection system at a landfill site.

Source: EMM Landfill Annual Report (2010/2011).

Figure 5:25: Vertical gas collection system installation.

Source: EMM Landfill Annual Report (2010/2011).

Figure 5:26: Rooikraal flare station.

Figure 5:27: Weltevreden flare station.

Figure 5:28: Simmer and Jack flare station.

Figure 5:29: Rietfontein flare station.

Source: EMM Landfill Annual Report (2010/2011).

5.6 DISCUSSION OF RESULTS

5.6.1 Municipal Solid Waste Management and Awareness in the EMM

The majority (60%) of the respondents were adults within an age of between 30-40 years and they lived in medium size householdswith an average of 5 persons per household. A study undertaken in Gaborone (Botswana)regarding waste management revealed similar results in the terms of the average household size (4 to 6) in urban areas (Gabairiti *et al.,* 2012). There were few respondents (22%) in the EMM who have advanced their knowledge base and competencies to tertiaryeducation level. This finding indicates that the majority (78%) of the residents within EMMhave not attained an advanced educational status.

Based on the results, the main contributor of EMM's economy is entrepreneurship and this is due to the largest concentration of industries which has resulted in this metropolitan area being named Africa's workshop (Ekurhuleni Metropolitan Municipality IDP, 2011/14). These industries provide employment opportunities to a significant number (50%) of EMM residents, thus allowingthem to improve their own livelihoods, thereby becoming able to meet their basic needs.

Waste management services are generally rendered to most households within EMM and collection was conducted once a week. The weekly collection of waste to households by the municipalityis a practice undertaken by most municipalities such as the City of Tshwane (Kamara, 2006), City of Cape Town (Davidson and Swilling, 2010) and eThekwiniMetropolitan Municipality (eThekwiniIntegrated Waste Management Plan, 2004). The majority of respondents were aware of this serviceas they mentioned collection trucks, landfill facilities and waste bins that are placed at strategic positions in public areas. There were various methods used by households to dispose offtheir waste and these included waste bins, illegal dumping and burning of waste. However, it must be noted that the waste bin was the most frequently used method of disposal, whilst the burning of waste and illegal dumping were the least used methods.

A significant proportion (68%) of respondents fromhouseholds was aware about the importance of waste minimisation and they obtained such vital information from radio, television and print media. Twenty two percent (22%) of the respondents were however, involved in the minimisation of waste. The majority of the respondents indicated their willingness to participate in waste minimisation, but the lack of adequate containers and a formal municipal recycling system was hindering them from sorting their waste. The lack of waste minimisation at households has also been reported in other municipalities includingthe Tshwane Metropolitan Municipality (Kamara, 2006) and the Buffalo City Municipality (Mazinyo, 2009).

The respondents were of the opinion that in order to improve waste management and minimisation within the communities surrounding the EMM, various aspects need to be addressed by the municipality which should include:(a) the appointment of more Contractors to handle recyclable and non-recyclable waste; (b) provision of sufficient recycling bins and recycling bags; (c) scheduling of adequate municipal awareness campaigns; (d) provision of sufficient waste skips at taxi ranks, bus

stops and along the main roads;and (e) effective enforcement of waste management by-laws by implementing stringent punitive measures against littering and illegal dumping activities. Similarly, some of these initiatives have also been raised by respondents in related studies conducted within the municipalities of Curitiba(Brazil)and Buenos Aires(Argentina) and include the deployment of more private contractors by the municipality to collect waste twice a week, provision of waste services where road access is limited, environmental awareness campaigns and the municipality providesfood as compensation for delivery of recyclables to 63 exchange stations (Mcbean*et al.*, 2007; World Bank, 2013). In addition, the communities of Tangail in Bangladesh stressed that environmental education was vital for the effective waste management (Sarker *et al.,* 2012). Jha *et al*. (2011) emphasises that capacity building to various spheres of governments, academics, community organisations and general community members are fundamental in effectively dealing with the waste mismanagement dilemma.

5.6.2 Informal Reclaimer's Role in Waste Minimisation and Associated Impediments

In the current study, some of the informal reclaimers ended their schooling career at high school level meanwhile a minority had attained no form of education. The main driver of recycling activities emanates fromattempting to receive an income in order to meet basic human needs. The current study has revealed that households were a major generator of municipal domestic waste.The informal reclaimers recovered waste from landfill sites and waste bins placed outside households on the day of collection by the municipality. Similarly, reclaimers inBrazil and India also sourced their waste from landfill sites and they also reside in close proximity to the landfill sites (Zurbrugg, 2002; Chaturvedi;2010; Helena *et al.,* 2011). The waste types which were in demand and recycled the most in the EMM were steel and paper when compared with other types of waste. In the Mogale City Local Municipality, used paper was also reported as the mostrecovered and recycled waste (Bhagwandin 2014; Ginindza and Muzenda, 2013). Buyers of recycled waste included recycling companies and other informal reclaimers. The waste recovery activities provided a very low monthly income which is between R100 and R1000. Suchlow monthly incomesare a norm in most developing countries where reclaiming and recycling activities are taking place (Simpson, 2005; Chaturvedi; 2010; Helena *et al*., 2011). The Brazilian informal waste reclaimers earned between US$120 and US$190 monthly which is equivalent to approximately R1200 to R190, respectively (Zurbrugg, 2002). Furthermore, the amount earned by conducting reclaiming activities has benefited numerous people including the municipal officials who undertake this activity in order to supplementing their income (Mcbean *et al*., 2007; Zurbrugg, 2002;Vidanaarachchia*et al*., 2006; Zia and Devdas, 2008).

The barriers experienced by informal reclaimers ranged from long distances travelled to collect and sell their reclaimed waste to negative health effects. The informal recyclers hardly visited the health care facilities. Similar challenges have also been reported in other municipalities such as Recife (Brazil). These challenges ranged from lung infections to injuries and miscarriages(Mcbean*et al.,*2007). In addition, informal recyclers tend to live near the landfill sites where they are exposed to high safety and health risks such as garbage and stench (Devi *et al*., 2014).

5.6.3 The Role of the Municipality in Waste Management and Minimisation

The formalisation of the recycling sector in South Africais pivotal as it has a potential which has not been fully realised as yet, to contribute positively to economic growth. The establishment of recycling centres across the country that are regulatedby government will enable the creation of formal employment thus limiting the impediments experienced by individual reclaimers. In addition, this will also allow informal reclaimers to earn income that will enable them to meet their basic human needs as well as increasing the employment rate of the country which is currently a challenge.

The municipality was fulfilling its Constitutional mandate of providing waste management services within its jurisdiction. Three millionhouseholds, retailers and corporate businesses were serviced weekly by the municipality and the appointed Contractor using a schedule created to indicate a collection day for respective areas located within the metropolitan. The municipality had a staff complement of 2336that were responsible for the management of waste within its jurisdiction. The majority of these employees have obtained Grade 12 Senior Certificate, whilst a few possess higher education diplomas and degrees.

The volumes of municipal waste disposed of at landfill facilities located within EMM are rapidly increasing annually due to the lack of waste minimisation at source (1 742 667 tons in 2011). The lack of waste minimisation at source has resulted in the closure of some of the facilities. For example the Chloorkop landfill site located in Kempton Park, whilst other landfills were in the process of increasing their operational cells and airspace (Weltervreden landfill) in order to accommodate the increasing waste volumes.

Community clean up and awareness campaigns were conducted on an *adhoc* basis by the municipality, leading to unsustainable waste disposal activities occurring just few months after the awareness campaigns have been conducted.Ginindza and Muzenda(2013) have expressed a similar point in the study conducted at Mogale City municipality, where sustainable community awareness campaigns that are focused in the waste hierarchy are vital in achieving effective waste management. Recycling activities were mostly undertaken by private companies and some individual community members.This trend of private sector involvement in recycling activities has also been evident in other countries such as India (Annepu, 2012) and Kenya,(Okomu, 2012). There are two recycling centres located within EMM. However, the detailed information about the centres was not available.

The waste department within the EMM was not immune to challenges which hindered the effective delivering of waste management services. These challenges ranged from staff shortages,inadequate operational budgets,and non-payment of services by residents toillegal dumpingdue to the lack of waste management bylaws enforcement. Furthermore, municipal officials indicated that the municipality was not ready to implement full scale recycling and minimisation programmes due to the above mentioned barriers. The formulation and implementation of the Integrated Waste Management Plan by the municipality as a requirement of the National Environmental Management Waste Act (No.

59 of 2008) was cumbersome. The above mentioned impediments hindering the provision of efficient waste management services by the municipalities have also been reported in Asian cities such as India (Zurbrugg, 2002).

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter deals with conclusions and recommendations stemming from the research undertaken The conclusionsare presented in section 6.2 and are divided into three sections dealing with household waste management and minimisation; the role of informal reclaimers in waste minimisation and associated barriers; and the role of the municipality in waste management and minimisation. The recommendations are covered in section 6.3.

6.2 CONCLUSIONS

6.2.1 Waste Management and Minimisation at Households

The respondents to the surveys were aware of waste management services provided by the EMM which included collection; transport vehicles;and provision of infrastructure (waste bins placed along main roads and landfill sites). The majority of the respondents were also aware of waste reclaiming and recycling activities undertaken within the EMM and some respondents were also involved in the waste recovery activities in order to earn an income due to unemployment. A significant number of the respondents indicated that they were willing to participate in the minimisation of waste.In fact, some of them are already undertaking waste minimisation activities such as informal waste reclaiming. However, the respondents also mentioned that there were barriers preventingthem from minimising their waste and managing it accordingly. These barriers included(1) lack of adequate resources such as waste bins that enables the separation of waste source thus compelling households not to sort their waste;(2) municipality defaulting in maintaining the set collection schedule which leads to illegal dumping by communities; (3) lack of adequate waste skips which can be easily accessed by households;(4) lack of waste management awareness campaigns to sensitise the communities about best practices of waste management;(5)the building of buyback centres easily accessed by informal waste reclaimers in order to encourage the continual recycling activities as well as having control of the recycling activities; and (6)lack of enforcement of waste bylaws which will discourage and minimise illegal dumping and litter. Similarly, such problems have also been reported in the study of Mogale City Local Municipalityby Ginindza andMuzenda(2013). In addition, the respondents also indicated that they were not receiving the municipal monthly bill statement in order to determine the charges allocated to waste collection services. This lack of awareness may be ascribed to the point that they were renting their place of accommodation, thus uncertain on this matter.

6.2.2 The Role of Informal Waste Reclaimers in Waste Minimisation

Informal waste reclaimers play a vital role in the minimisation of waste and in keeping the commercial and residential areas clear of waste. The waste recovery and recycling activities have ~~a~~ potential to be a formal industry that providesformal employment opportunities. This can be achieved through the provision of recycling bins to households by the municipality which will allow the separation of recyclable waste at source (NEMWA No. 59 of 2008); Bosman, 2009.This waste household can be collected and placed in areas where informal reclaimers can recover the recyclables in a safe environment.

The study revealed that there were health and safety risks associated with waste recovery activities. The majority of informal reclaimersreported that they did not get sick from undertaking the reclaiming activities. Those that became sick, their common reported sicknesses ranged from respiratory to gastrointestinal ailments. Injuries occurred less frequently. However, it must be noted that the visits to the healthcare facilities were conducted twice a year and most reclaimers did not have appropriate personal protective equipments or gear due to unaffordability.

The challenges experienced by informal reclaimers were identified as the lack of municipal control, where adequate formal buyback centres were not provided for their utilisation; health and safety risks; the lack of recognition of their work by government as formal employment andenvironmental law which prohibits them from entering landfill facilities in order to recover waste.

6.2.3 Role of the Municipality in Waste Minimisation

The municipality was fulfilling its constitutional mandate in terms of waste management service delivery, where approximately 3 million customers (corporate businesses, households and retail) were serviced by the municipality on a weekly basis throughout the year. Resources provided by the municipality for waste management included a 240L plastic waste bin, concrete and metal waste bins placed along main roads.

In terms of waste minimisation, this type of waste management was mostly undertaken by the private sector, households and informal reclaimers where waste was sourced from households, landfill facilities and public waste bins and sold to different customers at a cost rate which was unknown. There were different types of waste recycled and their weight differed per day and month, as did the demand from the customers. The municipality, to some limited extent did participate in recycling activities even though the exact amounts waste of recycled were unknown and the figures provided in this dissertation were based on estimates. Furthermore, the municipality has created a space at landfill facilities that allows the public community to dispose of their recyclables which are collected by private companies.

The municipality indicated the following barriers and constraints that prevented the provision of effective waste minimisation services: shortage of staff deployed; insufficient budget allocated to

waste management services; vehicles and equipment not maintained appropriately;non-payment of municipal services by the customers and illegal dumping by people to avoid paying the landfill site levies charged by the municipality. A study conducted by Majumder (2012), identified similar barriers affecting the Comilla City Corporation in Bangladesh with regards to effective waste management.

Furthermore, the information about four landfill sites (Chloorkop, Weltervreden, Rietfontein and Simmer and Jack) investigated for the research was also provided, where the staff complement of landfill sites was outlined as well as the appointment of private companies by the municipality for the daily operations of the landfill facilities. The managers of the landfill facilities indicated that there were no children involved in waste recovery activities. The information related to the informal waste reclaimer's biographical details was unknown.

The information on the waste types and quantities processed by landfill sites was discussed, where, within the period of five years (2007-2011), there was an increase in volumes processed by landfills sites. The waste types generated within the municipality and processed at landfill sites ranged from domestic to building rubble. Dedicated recycling areas have been established in the landfill facilities to be used by households and private companies that were involved recycling activities.

The landfill facilities have environmental permits that were issued by the Gauteng Department of Agriculture and Rural Development. The first issue was in 1997 and the permits have been amended several years after that to include the current upgrades at the landfill facilities such as stormwater management systems. The conditions stipulated within the permits included the monitoring of ground and surface water as well as methane gas. The monitoring of these environmental aspects/parameters is conducted daily and monthly and quarterly reports are produced.In response to climate change, the EMM has constructed gas flaring stations at their large landfill facilities namely Simmer and Jack, Weltervreden, Rooikraal and Rietfontein and the project is aimed at reducing the greenhouse gases released by landfills. The project entails the recovering of landfill gas using vertical gas extraction wells and horizontal gas collection systems.

6.3 RECOMMENDATIONS

In the light of the findings of the research and conclusions arrived at,the following recommendations can be made:

- It is recommended that the following aspectsbe explored by the EMM as they are of vital importance in the achievement of effective and efficient waste management. The undertaking of bi-annual waste management awareness campaigns by the municipality is importantfor the communityto fully comprehend the importance of effective waste management and the detrimental impacts that result from the mismanagement of waste. The awareness campaigns will be more relevant to informal settlements where municipal waste collection services are often not provided due toinaccessibility. However, the townships and suburban areas should not be

excluded from these campaigns. This recommendation has also been emphasised for the Mogale City Local Municipality which is experiencing similar problems with regards to waste management (Ginindza and Muzenda, 2013). Furthermore, a study conducted by Ali*et al.*(2012) in the town of Bangi, Selangor in Malaysia made similar recommendations.

- Provision of adequate waste disposal equipment colour coded for specific type of waste (plastic bags, bins and skip bins) by the municipality is vital to encourage waste sorting at source levelin order to minimise the volumes of waste disposed at landfill facilities and prolong the lifespan of landfill sites. This undertaking will also assist the municipality in reducing costs for the establishment of new landfill facilities and these funds could be channelled to other programmes that promote sustainable waste management. It must be emphasised though that the systems associated with the collection of the sorted waste need to be implemented for the sustainability of sorting activities at source. Countries such as Germany and Denmark successfully implemented these initiatives, eventually reaching a situation of less waste volumes disposed at landfill facilities. This also resulted in the reduction of landfill facilities operated in the country, thus creating more space for other land uses (Svendsen and Henrik 2000; Schwarz-Herion *et al*., 2008).
- Mechanisms to resolve constraints and issues associated with the allocation of adequate budgets for waste management services as well as collection of monetary for services rendered need to be explored and prioritised as this is vital in achieving effective and efficient waste management within the municipality. This will further accelerate the provision of municipal services to all residents within the municipality's jurisdiction.
- Forming partnerships with the private sectorthat is involved or interested in investing in recycling activities isvital as different benefits can be investigated and these include financial gains, and the transfer of skills to the municipal officials that will in turn assist the municipality to develop and operate their recycling centres. Such a partnership will also provide information with regards to the volumes of recycled materialsand customers which the municipality can use in the operational phase of buyback centres, thus strengthening the market. The companies who can be lobbied by the municipality include small enterprises, Collect A Can, MPACT, and Console.
- The viable operational mechanisms of buyback centre establishmentsthat can be sustainable need to be explored as this will allow the control of recycling activities within EMM. Furthermore, this will allow the documentation of recycled waste that can be used by the municipality in developing waste management planning instruments.
- The municipality needs to create a sustainable robust waste information system similar to the national information system in order to comprehend the dynamics of waste generated within its jurisdiction. This information will in turn assist the municipality in formulating the integrated waste management plan which is a requirement of the National Environmental Management Waste Act (No. 58 of 2008), as well as developing new or improving the existing planning tools.Such tools include waste management by-laws that can be easily enforced where contraventions occur. Engagement of the municipality with different stakeholders is vital for success in the implementation of this waste information system. The implementation of the integrated waste management by local authorities has proven to be successful in the Philippines (for example, the

execution awareness campaigns, establishments of composting projects, stringent enforcement of waste legislation by Malay municipality(World Bank, 2001; Agathou, 2011).

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APPENDIX A: HOUSEHOLD QUESTIONNAIRE

HOUSE HOLDS SURVEY QUESTIONNAIRES

The purpose of this questionnaire is to examine the experiences and perceptions of relevant general public as part of a larger review of the effectiveness and efficiency of waste management and minimisation in the Ekurhuleni Metropolitan Municipality. The Researcher would like to know your views to help identify weak points and areas that will be used by the Municipality to improve its waste management and minimisation services.

Your participation in answering this questionnaire is voluntary. The information that you provide will be treated confidentially. The answers that you give cannot be identified as yours. Your answers will be put together with that of hundreds of other people who will complete the questionnaire, so please feel free to indicate what you really think.

Notes:

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- The information obtained during the survey will purely be used for the purposes of this study.
- Where questions have grey boxes, mark the appropriate box with an "**X**".
- Where questions have white boxes, type your answer into the MS Word version, or write it in by hand.
- Please provide additional comment or explanation in the blocks provided, where indicated.

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Sibongile Gumbi
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Dr. Isaac Rampedi
Email: isaacr@uj.ac.za
Telephone: 011 559-2429

A: PERSONA DETAILS

A1: Personal Information (Confidential)

Name & Surname:						
Gender	Female		Male			
Marital Status	Single		Married			
Please fill in	**Household size**		**No of children**		**No of adults**	

A2: Age of Respondent	
Less than 20	
20-30	
30-40	
40-50	
50-60	
60-70	
70-80	

A3: Residential area*:(Where Applicable Please insert X)*	
Alberton	
Bedfordview	
Benoni	
Boksburg	
Brakpan	
Edenvale	
Germiston	
Kempton Park	
Nigel	
Springs	

A4: Education *:(Where Applicable Please insert X)*	
None	
Primary School	
Secondary/High School	
College	
Technikon	
University	
Other:	

A5: Occupation: *(Where Applicable Please fill in)*	
Company/Department Name	
Self employed	
Not working	

A6: Source of income (Please explain)

A6 (a): Monthly income (*Where Applicable Please insert X)*	
Less than R1000	
Between R1000 and R2000	
Between R 2000-R3000	
Between R3000-R4000	
Between R4000-R5000	
Between R5000-R6000	
Between R6000-R7000	
Between R7000-R8000	

Between R8000-R9000	
Between R9000-R10000	
Above R10 000	

A7: Do you own the following appliances?*(Where Applicable Please insert X)*	
Radio on waste management issues	
Television (TV) on waste management issues	

B: WASTE MANAGEMENT AWARENESS

B1: Are you aware of any municipal waste management services?			
Yes		No	

B2: If yes to B1 above, what aspect do you know? *(Where Applicable Please insert X)*	
Collection	
Transportation	
Infrastructure	
Community initiatives	
Storage	

B3: How do you dispose of your waste? *(Where Applicable Please insert X)*	
Municipal waste bins	
Separating it before disposal	
Recycling	
Burning it	
Burying it underground	
Illegal dumping	
Other	

B4: What kind of waste do you usually dispose?(*Where Applicable Please insert X)*	
Glass	
Plastic	
Food waste	
Organics	
White Paper	
Newspaper	
Tins	
Cartons	
Cardboards	
Scrap Metals	
Other	

B4 (1): Where do you dispose the types of waste listed below?	
Glass	
Plastic	
Food waste	
Organics	
White Paper	
Newspaper	
Tins	
Cartons	
Cardboards	
Scrap Metals	
Other	

B4 (2): Do you receive monthly statement on services rendered by the municipality? (*Where Applicable Please insert X)*	
Yes	
No	
Don't know	

B5: Are you aware of any waste management efforts at community level? (*Where Applicable Please insert X)*	
Skip bins	
Community clean up campaigns	
Recycling centers	

B6: Are you involved in any waste minimisation efforts? (*Where Applicable Please insert X)*	
Yes	
No	

B6(1): If yes specify

B7: Do you think sorting waste is important? (*Where Applicable Please insert X)*	
Yes	
No	

B7 (1): Do you sort waste? (*Where Applicable Please insert X)*			
Yes		No	

B7(2): If yes why do you sort ?(W*here Applicable Please insert X)*	
Because I see others doing it	
I know that sorting can be useful (for what: recycling? Compost? Other?)	
I know that sorting can reduce environmental problems (e.g. Volume of waste disposable)	
I have seen or heard it on the news (TV, radios, newspaper)	
I see neighbours doing, that is why I do it	
I don't see a need of sorting waste. It is waste anyway	
Other	

B7(3): If no why not ?(W*here Applicable Please insert X)*	
I do not know about it	
I know about it but there is no waste container nearby	
I know about it but I do not have time to sort	
I do not think it makes a difference to sort	
Other reason	

B7(4): If you do not sort your waste *I will start sorting* **(W*here Applicable Please insert X)***			
If I know about the health and environmental benefits of good waste management.			
Yes		No	
I will start sorting if garbage containers are available in the neighborhood or in my house.			
Yes		No	
I don't think I have time to sort even if containers are available.			
Yes		No	
I will start sorting if others will also do it.			
Yes		No	

Other:

B8: What do you think should be done to encourage you to start sorting waste or avoid dumping around?, Explain

B9: If you do sort your waste, *What problem have you encountered?* ***(Where Applicable Please insert X)***	
Unavailable containers or insufficient containers	
Waste collectors do not come on time	
I don't have enough time	
Other :	

B10: What do you think should be done to encourage you to continue sorting waste? Explain

B11: What do you know about the current waste management and minimisation, Trends and challenges? Explain

B11 (1): What do you think can be done to improve waste management and minimisation in your municipal area? Explain

THE END
THANK YOU

APPENDIX D: INFORMAL RECLAIMERS QUESTIONNAIRE

INFORMAL RECYCLERS

The purpose of this questionnaire is to examine and assess the current state of waste minimisation initiatives in different local municipalities in the east rand forming part of the greater Ekurhuleni Metropolitan Municipality. In order to achieve this goal, two research objectives are being pursued, namely (1) an integrated assessment of the effectiveness and efficiency of waste minimisation practices within Ekurhuleni Metropolitan Municipality and (2) the identification and analyses of management initiatives designed to reduce and minimise waste generation and promote recycling**.**

As a person involved in the informal recycling, I would like to request your help in completing this research questionnaire. Your assistance and cooperation is highly appreciated. All the information you provide will be treated in strict confidentiality and your participation will remain anonymous. Your participation in answering this questionnaire is voluntary.

Notes:

- The study is waste minimisation in Ekurhuleni and will thus require information on the awareness, existing policies and their implementation in waste management and minimisation.
- The information obtained during the survey will purely be used for the purposes of this study.
- Where questions have grey boxes, mark the appropriate box with an "**X**".
- Where questions have white boxes, type your answer into the MS Word version, or write it in by hand.
- Please provide additional comment or explanation in the blocks provided, where indicated.

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Sibongile Gumbi
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Telephone: 011 798 6449

Dr Isaac Rampedi
Email: isaacr@uj.ac.za
Telephone: 011 559-2429

A: BIOGRAPHICAL DETAILS OF INFORMAL WASTE RECYCLERS

A1: Personal Information (Confidential)

Name & Surname:						
Gender:	Female		Male			
Marital Status:	Single		Married			
Please fill in	Household size		No of children		No of adults	
Country of Origin if not a South African:						
How long have you been in South Africa:						
Race:						
Residential Area:						

A2: Age of Respondent *(Where Applicable Please insert X)*	
Less than 20	
20-30	
30-40	
40-50	
50-60	
60-70	
70-80	

A3: Education*(Where Applicable Please insert X)*	
None	
Primary School (Grade 1-7)	
Secondary/High School (Grade 8-12)	
Technical College	
Technikon	
University (Undergraduate and Post Graduate)	
Other:	

A4: Were you previously employed? *(Where Applicable Please insert X)*			
Yes		No	
If yes , Please provide the name of the company/organisation /department below			

B: RECYCLING ASPECTS

B1: Why are you recycling?	
Due to unemployment	
Retrenchment/laid off	
Poverty background	
Need for extra income	
Environmental consciousness	
Other reasons, please specify	

B2: Where do you obtain the raw waste material?	
Landfill site	
Street corners	
Households	
Illegal waste dumps	
Other , please specify	

B3: How far do you travel to collect the waste material?	
1km	
2km	
3km	
4km	
5km or more	

B4: What type of waste are you recycling? *(Where Applicable Please insert X)*	
METALS	Copper Aluminium Lead Iron Steel
PAPER	Cardboard White Paper Colour Paper Newspaper
PLASTICS	PVC Plastic Bottles Plastic Bags Plastic wares & other plastic
GLASS	Glass Bottles Shattered glass Other glass
OTHER	

B5: Please provide the quantities of the following waste recycled in kilogram (kg)		
	Day	Month
Metal	Kg	Kg
Paper	Kg	Kg

B5: Please provide the quantities of the following waste recycled in kilogram (kg)		
Plastic	Kg	Kg
Glass	Kg	Kg
Other	Kg	Kg

B6: How far do you travel to sell the waste material?	
1km	
2km	
3km	
4km	
5km or more	

B7: Who are your customers(who buys your waste)?	
Other recyclers	
Buy Back Centres	
Other, Please specify	

B8: Monthly income (*Where Applicable Please insert X)*	
Less than R1000	
Between R1000 and R2000	
Between R 2000-R3000	
Between R3000-R4000	
Between R4000-R5000	
Above R5000	

B9: What are your challenges and barriers in recycling?	
Long distances to travel to buy back centres	
No municipal control on waste picking activities	
Incidents of violence and intimidation	
Environmental hazards and pollution	
Other, Please specify	

C: ENVIRONMENTAL HEALTH CHALLENGES

C1: Does reclaiming make you sick (*Where Applicable Please insert X)*			
Yes		No	

C2: If Yes what kind of sickness. Please specify

C3: Please specify health dangers from the landfill site	
1	**2**
3	**4**
5	**6**

C4: Do you know or heard of any person who got injured on the landfill site			
Yes		No	

C5: How frequently does the injuries occur (*Where Applicable Please insert X)*	
Once every two years	
Once a year	
Twice a year	
Three times a year	
Four times a year	
Once every four months	

C6: Do you have any protective clothing in the landfill site (*Where Applicable Please insert X)*	
Eyewear	
Safety Boots	
Glasses	
Gas/dust Marks	
Earplugs	
Hand gloves	

C7 Why are you not using Personal Protective Clothing (*Where Applicable Please insert X)*	
I do not have such clothing	
It is expensive	
I don't want to wear it	
Other, Please specify	

C8: How often do you visit the health care facility for medical examination (*Where Applicable Please insert X)*	
Once every two years	
Once a year	
Twice a year	
Three times a year	
Four times a year	
Once every four months	

C9: What are the common illness do you suffer from (*Where Applicable Please insert X)*	
Colds or sore throats	
Skin illnesses and eruptions	
Lung disease	
Injuries while on duty	
Eye infections	
Ear infections	

C10: Do children under 18 become involved in waste reclaiming, Please elaborate (tell us more)

C11: Do you have a forum where you meet with the Municipality to discuss waste issues?			
Yes		No	

C12: If you have answered yes above, How often do you meet?	
Monthly	
Every two months	
Quarterly	
Every six months	
Once a year	
Other	

C13: What specific issues do you discuss? Please explain?

C14: Is there a progress in the implementation of the issues discussed?			
Yes		No	

END

THANK YOU

APPENDIX C: MUNICIPAL QUESTIONNAIRE

EKURHULENI METROPOLITAN MUNICIPALITY

The purpose of this questionnaire is to examine and assess the current state of waste minimisation initiatives in different local municipalities in the east rand forming part of the greater Ekurhuleni Metropolitan Municipality. In order to achieve this goal, two research objectives are being pursued,namely (1) an integrated assessment of the effectiveness and efficiency of waste minimisation practices within Ekurhuleni Metropolitan Municipality and (2) the identification and analyses of management initiatives designed to reduce and minimise waste generation and promote recycling**.**

As an official working for this municipality I would like to request your help in completing this research questionnaire. Your assistance and cooperation is highly appreciated. All the information you provide will be treated in strict confidentiality and your participation will remain anonymous. Your participation in answering this questionnaire is voluntary.

Notes:

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- Please provide additional comment or explanation in the blocks provided, where indicated.

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Telephone: 011 798 6449

Dr Isaac Rampedi
Email: isaacr@uj.ac.za
Telephone: 011 559-2429

A: MUNICIPAL DEMOGRAPHICS

A 1: Municipality Jurisdiction	
Name of municipality being examined (Service Delivery Area)	
Name of urban area	
Size of urban area/s	(sq. Km)
Name of rural area/s	
Size of rural area/s	(sq. Km)
Specify total population in this municipality	

A 1(a): Specify the total number of households from which waste is collected in this municipality:	
Number of households being serviced?	
Number of households not being serviced?	

A1 (b): Waste management service rendered by the municipality	
Number of households in formal residential areas	
Number of households in informal residential areas	

A1 (c): Waste disposal service not provided in these households	
Number of households in formal residential areas	
Number of households in informal residential areas	

A 2: Waste management functions carried out by the Municipality (please mark with an X as much as possible)				
Function	Carried Out By			Any comments please specify
	Municipality	Contractor (specify)	Other (specify)	
Collection of solid waste from domestic premises				
Removal of garden waste from domestic premises				
Removal of recyclable waste from domestic premises				
Removal of recyclable waste from collection stations				
Removal of solid waste from informal dump sites				
Storage of solid waste collected				
Disposal to landfill sites				
Management of landfill operations				
Waste transporting vehicle maintenance				
No of waste collection vehicles				
Environmental awareness campaigns on				

A 2: Waste management functions carried out by the Municipality (please mark with an X as much as possible)				
Function	Carried Out By			Any comments please specify
waste recycling& minimisation initiatives				
Other (specify)				

B: WASTE MANAGEMENT DEPARTMENT CAPACITY AND SKILLS

B1:How many people are employed by the Waste Department			
Permanent		Contractors	
Collection			
Depots			
Landfill sites			
Municipal waste officers			
Other			

B2: What is their highest qualification and years of experience	
Permanent	Contractors
Collection department	
Qualification:	
Experience:	
Depots	
Qualification:	
Experience :	
Landfill sites	
Qualification:	
Experience	
Municipal waste officers	
Qualification:	
Experience:	
Other	
Qualification:	
Experience:	

B3: What challenges /barriers are faced by the Waste Department

C: WASTE MANAGEMENT PLANNING AND DEVELOPMENT

C1: Physical characteristics of solid waste		
C1(a): if data on domestic waste characteristics are available, please complete the following table:		
Component	% By Weight	Any comment
Paper		
Plastic		
Organic or vegetables		
Glass		
Metal		
Wood		
Garden waste		
Bio-resistant (leather, rubber, and bones)		
Total proportion of biodegradable waste		

C1(b): Specify the year and date when this data was collected:

C1(c)): Is the data collected by actual survey or by rough estimation, please provide details

C2: Temporary storage of solid waste					
C2 (a): Specify the type of storage bin used by residents for solid waste (please mark appropriate space with an X)					
Type of Residential Containers		Almost exclusively used	Frequently used	Sometimes used	Never used
Waste collected at resident's premises	Metal bin				
	Plastic bin				
	Plastic bag				
	Oil drum				
	Others				
Waste collected from communal storage areas	Metal bin				
	Plastic bin				
	Oil drum				
	Concrete bin				
	Others				

C3: Waste Collection						
C3(a): Domestic waste collection						
	Number of households serviced by the municipality	Frequency of collection (daily, weekly etc.)	Estimated Recycling Rate (%)			
			0-25	**26-50**	**51-75**	**75-100**
Urban Areas						
Rural Areas						

C3(b): Household Recycling Initiatives	
Aspects of household recycling initiatives	Responses
i. Specify, how many households have their recyclable solid waste collected at their premises?	
ii. Have separate bins been provided by municipality for recyclable waste? **(Yes/No)**	
iii. If yes, how many households have received bins for recyclable waste?	
iv. For households that received recycle bins, what percentage (%) actually separate their waste?	
v. How often is recyclable waste collected? (**E.g. Weekly, bi-weekly)**	
vi. Is there a charge for removal of recyclable waste? **(Yes/No)**	
vii. If yes, what is the fee?	
viii. Is there an incentive for the public if they do contribute to recycling? E.g. Discount on waste collection charges **(Yes/No)**	
ix. Is there a penalty for mixing solid waste with recyclable waste? (**Yes/No)**	

C3 (c): Please indicate which waste types are separated at source by households for the purpose of recycling.			
Component	Is waste separated at source? (Yes/No)	Which recycling containers have been provided to households?	To which contractor/facility is the recyclable waste taken to for recycling
Paper/Cardboard			
Plastic			
Food waste			
Glass and Crokery			
Metal/cans			
Wood			
Bio-resistant (leather, rubber, bones)			
Garden waste			
Inert (stone, brick, ashes)			
Other, please specify			

C3(C1): Communal Recycling *What percentage of residents have communal recycling facilities available and close to their home*				
Distance from home to recycling station				
Percentage of residents (%)	0 - 2 km	2 - 5 km	5 - 10 km	More than 10 km

Urban area				
Rural area				
Other comments please provide below				

C3(C2): Municipal Level Recycling
C3 (C2.1): Does the municipality have recycling centres, how many and where they are located?
C3 (C2.2): Are the recycling companies available to manage the volumes of recyclable waste that are currently generated sufficient?
C3 (C2.3): If the volumes of recyclable waste increase by 20% are these companies suitably equipped to handle increased volumes?
C3 (C2.4): Are there waste types that are not recycled due to a lack of companies to process and recycle the waste? Please provide details

D: OPERATIONAL PROBLEMS ENCOUNTERED IN SOLID WASTE MANAGEMENT SERVICE DELIVERY

D1: Specify some of the problems encountered in solid waste management service in this municipality. (Mark with an X in appropriate box)

Problem	Very serious	Serious	Not so serious	Not a problem
Inadequate service coverage (some areas not serviced)				
Lack of quality service (not frequent enough, spill, etc.)				
Lack of financial resources				
Lack of trained personnel				
Lack of vehicles/equipment				
Old vehicle/equipment, frequent Breakdown				
Lack of enforcement measures				
Lack of authority to make financial and administrative decision				
Rapid urbanisation outstripping service capacity, rise of informal settlements				
Poor public cooperation				

Extreme public ignorance				
Poor response to waste minimisation				
Other (please specify)				

E: FINANCE

E1: Services charges for domestic waste collection	
E1 (a): What is the monthly fee for waste removal service?	
Urban Areas	R
Township Areas	R
Rural Areas/Informal Settlement	R

G. WASTE MINIMISATION AND RECYCLING PROJECTS IN THE MUNICIPALITY

F1: Provide details of projects and initiatives to promote waste separation at source and waste recycling
F1 (a): Who is funding the project?
F1 (b): How effective is the project and is it considered successful? Please provide more details
F1(C) What are the challenges or obstacles experienced with waste separation at source?

G: THE ROLE OF RECYCLED WASTE BUYBACK CENTRES

G1: Specify the number of buy-back centres acting as local markets for buying recycled waste in this municipality.

G2: Specify what type of recycled material are being sold or traded at these buyback centres

G3: Specify the name of companies involved in the buying back of recycled waste materials.

G4: Specify since when have these buy-back centres been operating.

G5: Specify how many formal and informal recyclers are involved in the selling of recyclable materials to the buy-back centres.

G.6: Specify where do recyclers source or collect their recycled material from? Landfill sites, streets in the residential areas, or from unregulated dumping sites. Please mark with an X in the appropriate space.	
Sources of recycled waste/Where is this waste collected	
Regulated landfill sites	
Dustbins in streets in residential areas	
Streets in town/city CBD	
Unofficial dumping sites at street corners or open spaces	
Other sources, please specify	

G7: Specify the type of recycled materials purchased at landfill sites and the one that are purchased at used material shops. If purchased please mark with an X next to type of recycled material.

Items purchased	Purchased at landfill site				Purchased at used material shops			
METALS	Copper	Yes	No	Hardly	Copper	Yes	No	Hardly
	Aluminium	Yes	No	Hardly	Aluminium	Yes	No	Hardly
	Lead	Yes	No	Hardly	Lead	Yes	No	Hardly
	Iron	Yes	No	Hardly	Iron	Yes	No	Hardly
	Steel	Yes	No	Hardly	Steel	Yes	No	Hardly
PAPER	Cardboard	Yes	No	Hardly	Cardboard	Yes	No	Hardly
	White Paper	Yes	No	Hardly	White Paper	Yes	No	Hardly
	Colour Paper	Yes	No	Hardly	Colour Paper	Yes	No	Hardly
	Newspaper	Yes	No	Hardly	Newspaper	Yes	No	Hardly
PLASTICS	PVC	Yes	No	Hardly	PVC	Yes	No	Hardly
	Plastic Bottles	Yes	No	Hardly	Plastic Bottles	Yes	No	Hardly
	Plastic Bags	Yes	No	Hardly	Plastic Bags	Yes	No	Hardly
	Plastic wares &	Yes	No	Hardly	Plastic wares &	Yes	No	Hardly

	other plastic				other plastic			
GLASS	Glass Bottles	Yes	No	Hardly	Glass Bottles	Yes	No	Hardly
	Shattered glass	Yes	No	Hardly	Shattered glass	Yes	No	Hardly
	Other glass	Yes	No	Hardly	Other glass	Yes	No	Hardly

H. BENEFITS FROM RECYCLING AND WASTE MINIMISATION INITIATIVES

H1: Has the municipality realised any environmental management improvements or benefits stemming from recycling and waste minimisation operations that are currently underway within its jurisdiction?			
Yes		No	

H2: If yes, please specify these benefits in detail and what lessons can be learned from them

H3: Are there any barriers to recycling and waste minimisation that you would like to indicate, if so please specify in detail.

THE END

THANK YOU

APPENDIX D: LANDFILL QUESTIONNAIRE

LANDFILL SITES SURVEY QUESTIONNAIRE

The purpose of this questionnaire is to examine and assess the current state of waste minimisation initiatives in different local municipalities in the east rand forming part of the greater Ekurhuleni Metropolitan Municipality. In order to achieve this goal, two research objectives are being pursued, namely (1) an integrated assessment of the effectiveness and efficiency of waste minimisation practices within Ekurhuleni Metropolitan Municipality and (2) the identification and analyses of management initiatives designed to reduce and minimise waste generation and promote recycling**.**

As an official working for this municipality I would like to request your help in completing this research questionnaire. Your assistance and cooperation is highly appreciated. All the information you provide will be treated in strict confidentiality and your participation will remain anonymous. Your participation in answering this questionnaire is voluntary.

Notes:

- The study is waste minimisation in Ekurhuleni and will thus require information on the awareness, existing policies and their implementation in waste management and minimisation.
- The information obtained during the survey will purely be used for the purposes of this study.
- Where questions have grey boxes, mark the appropriate box with an "**X**".
- Where questions have white boxes, type your answer into the MS Word version, or write it in by hand.
- Please provide additional comment or explanation in the blocks provided, where indicated.

For any matter uncertain with you or protocols followed please contact Sibongile Gumbi or Dr Isaac Rampedi for more information by using the below contact details.

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A: LANDFILL MANAGER AND BIOGRAPHICAL DETAILS

A1: How many managers are employed at this landfill site?

A2: Personal Information (Confidential)

Name & Surname:						
Gender	Female		Male			
Marital Status	Single		Married			
Please fill in	Household size		No of children		No of adults	

A3: Age of Manager	
Less than 20	
20-30	
30-40	
40-50	
50-60	
60-70	
70-80	

A4: Education*(Where Applicable Please insert X)*	
None	
Primary School	
Secondary/High School	
Technical College	
Technikon	
University	
Other:	

A5: Monthly income (*Where Applicable Please insert X)*	
Less than R1000	
Between R1000 and R2000	
Between R 2000-R3000	
Between R3000-R4000	
Between R4000-R5000	
Between R5000-R6000	
Between R6000-R7000	
Between R7000-R8000	
Between R8000-R9000	
Between R9000-R10000	
Above R10 000	

A6: What knowledge do you have on waste management?

A7: How often do you attend waste management training courses? (*Where Applicable Please insert X)*	
Monthly	
Quarterly	
Every six months	

Annually	

A8: Characteristics of waste disposal sites	
Name of the site and location	
Is it the landfill site owned by the municipality? If not ,please explain	
Estimated lifespan remaining (years)	
How many cells and please state the number of those in operation	
Specify permit conditions & date obtained	
Amount of waste deposited daily (tonne/day)	
Distance from collection area to the site (km)	
Disposal method (open dumping, controlled disposal with cover etc)	
Specify type of waste pickers on site	
Existence of open burning on site and frequency	
Specify proximity to residential areas	

A9: Please provide the treatment methods used in treating waste.

A10: What are the operational costs of the landfill site?

A11: What type of environmental monitoring is conducted on the landfill site?

A11 (a) How often is the environmental monitoring conducted? (*Where Applicable Please insert X)*	
Monthly	
Quarterly	
Every six months	
Annually	

B: CHARACTERISTIC OF INFORMAL WASTE RECYCLERS AT THE LANDFILL SITES

B1: Specify some of the characteristics of informal waste pickers at landfill sites that you know. Please fill in the information required in the spaces provided.	
WOMEN	
No of women involved in recycling materials	
What materials being reclaimed?	
Any immigrants involved	
MEN	
No of men involved in recycling materials	
What materials being reclaimed?	
Any immigrants involved	
CHILDREN	
No of children involved in recycling materials	
What materials being reclaimed?	
Any immigrants involved	

B2: Apart from informal waste pickers, please specify bigger waste recyclers that you are aware of.

B3: What do the informal waste pickers use to transport their waste collections and how much weight of waste is conveyed during these trips?

B4: Average weight picked up by various categories of recyclists				
Category and Mode of Transportation	Weight (kg) **MANUALLY**	Weight (kg) **TROLLEY**	Weight (kg) **BICYCLE**	Weight (kg) **TRICYCLE**
Children				
Men				
Women				

END

THANK YOU