

**A Review of Solid Waste Management Practices in Polokwane  
City**

by

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## DECLARATION

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I declare that \* A Review on Solid Waste Management Practices in Polokwane City 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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SIGNATURE

(Ms P.H Maluleke)

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DATE

## **DEDICATION**

I dedicate this work to my family. A special feeling of gratitude to my siblings, Fannie and Ntsako who mean so much to me. And also to my mother, although she is no longer of this world, her memory continues to inspire me. To my father whose love for me knew no bounds and, who taught me the value of hard work. Thank you so much I will never forget you.

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I would like to express my gratitude to my supervisor Professor S.J. Moja for the useful comments, remarks and engagement through the learning process of this master thesis. Furthermore I would like to thank my father for the financial support through this study. Also, I like to thank the participants in my survey, who have willingly shared their precious time during the process of interviewing. I would like to thank my loved ones, who have supported me throughout the entire process, both by keeping me harmonious and helping me putting pieces together. I will be grateful forever for your love.

## ABSTRACT

This study reviews solid waste management practices in Polokwane City. The study area covered some of the residential areas in Polokwane City; namely; Ivy Park, Fauna Park, Welgelegen, Westernburg and the City Centre. This article describes two main methods that were used to collect data; that is Qualitative and Quantitative method. Field survey was also made to validate data obtained from the participants that were interviewed during qualitative data process. After framing the problem, the objectives of Solid Waste Management Practices in Polokwane City were briefly outlined as follows:

- Assess solid waste management practices in Polokwane City.
- Make comparison on how households and the municipality take responsibility in storing, collecting, transporting, treating and disposing solid waste.
- Investigate what problems the City encounters in managing solid waste.
- Make relevant recommendations aimed at improving solid waste management practices within the City.

The service management was administered by the municipality and private sector. From the five study residential areas, the Municipality manages waste in the City Centre while the private sector manages waste in the other residential areas. However, the City continues to play an administrative role over the contracted service provider.

Statistical results were presented in figures and tables. The results showed the storage habits, frequency of collection, mode of transport and methods of disposal for solid waste in Polokwane City.

The only method of disposal in the city was found to be landfilling. Activities that took place at the landfill site, such as reclaiming were outlined together with the economic values that these activities add to the City. The study also revealed that as population increases, the amount of solid waste generated also increased.

**Key Terms:** Waste Management, Solid Waste, Polokwane, Qualitative Method, Quantitative Method, Waste Disposal, Waste Storage, Landfill, Household Waste and Recycling.

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## **GLOSSARY OF TERMS**

**Composting-** is a method of waste disposal whereby waste is discarded on the ground and can be covered by soil or grass.

**Domestic waste-** waste that is produced by households.

**Dumps-** spots that are either owned by government or private owners but communities have designated for illegal dumping .

**Globalisation-** is the process of international integration arising from the interchange of world views, products, ideas and other aspects of culture.

**Gross domestic product-** the market value of all official recognised final goods and services produced within a country in a given period of time.

**Health hazards-** the state of events that have the potential to cause harm in environmental or people's health.

**Incineration-** burning waste and disposing their ashes and may include reusing other resulting compositions.

**Industrialisation-** is the period of social and economic change that transforms a human group from an agrarian society into an industrial one.

**Landfill-** is a site for disposal of waste materials by burial.

**Leachates-** is any liquid that in passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed.

**Positive Correlation-** a relationship between two variables such that their values increase or decrease together.

**Qualitative method-** a method of inquiry in different academic disciplines seeking to gather in depth understanding of human behaviour and the reason that governs such behaviour.

**Quantitative Method-** a research method where systematic empirical investigation of social phenomena through statistics or mathematical techniques is applied.

**Random Sampling-** a subset of individuals chosen from a larger set

**Reclaimers-** the term refers to people who identify goods from waste that is disposed and sell these waste as goods for either recycling or reuse.

**Recyclables-** goods that can also be regarded as waste by some individuals but can be recycled.

**Refuse collectors-** people employed by the government or private sectors to collect and remove waste from homes and businesses to the disposal site.

**Resource recovery-** selective extraction of disposed materials for specific next use such as recycling.

**Sampling plan-** a detailed outline of events to be taken, time frames and responsible persons for a sample.

**Scavenging-** refers to searching through for salvageable material; such as looking through waste storage bins for food.

**Solid waste management** -controlling the generation, storage, collection, transfer and transport, processing and disposal of solid waste.

**Urbanisation-** the physical growth of urban areas which results in migration and even suburban concentration into cities.

**Waste classification-** grouping wastes according to their characteristics and compositions.

**Waste generation-** quantity of materials that enter waste stream before composition,

**Waste management-** is the collection, transport, processing or disposal, managing and monitoring of waste materials.



## **ACRONYMS AND ABBREVIATIONS**

**BGCM- Bursa Greater City Municipality**

**CERCLA- Comprehensive Environmental Response, Compensation and Liability Act**

**ECA- Environment Conservation Act**

**EUPWD -European Union Packaging Waste Directive**

**HWSA- Hazardous and Solid Waste Amendments**

**ICGM- Istanbul Greater City Municipality**

**ISWM -Integrated Solid Waste Management**

**IZMIR- Izmir Greater City Municipality**

**JICA- Japan International Cooperation Agency**

**LDPFA- Land Disposal Programme Flexibility Act**

**MRF- Material Recovery Facilities**

**MSW- Municipal Solid Waste**

**MSWM- Municipal Solid Waste Management**

**NWMS- National Waste Management Strategy**

**NCC-Nairobi City Council**

**NERF- National Environmental Regulatory Framework**

**RCRA- Resource Conservation and Recovery Act**

**SIS- State Institute of Statistics**

**SWDA- Solid Waste Disposal Act**

**SPSS- Statistical Packaged for Social Science**

**US- United States**

## **CHAPTER 1: INTRODUCTION**

### **1.1 Background**

South Africa faces urban growth problems, in an Op-Ed piece published. South African Parliament member Ian Ollis (2011) describes the problems that modern African cities face. He notes that while the state of urban cities are connected to the environment, we should not look at it like that. Poorly planned cities hurt that environment, but what is more important is the impact that a poorly planned city has on its finances and job opportunities.

The crisis in our cities is whether we can sustain our cities with current practices in the full sense of sustain, including, (but not limited to) financial planning, spatial and town planning, roads and storm water infrastructure, water, electricity and sewer installation and recycling as well as the human migration and sustainable employment practices. It is not just a green revolution that we need. The environmental crisis is but a subset problem. With current practices, our cities are not sustainable financially either. Nor can we control people movements and job opportunities, which makes spatial and urban planning very difficult.

Ollis (2011) goes on to describe the problems with poorly planned city infrastructure projects. The initial problem is suburban sprawl. People moving away from the city into the suburbs creates problems from trying to get city services to the citizens who live away from the central city; it includes building roads, waste management services, sewer systems and electric lines to people who live far away. The second problem with this is the cost of maintaining of those roads and utilities. Infrastructure naturally breaks down and needs to be fixed, maintained and replaced. This creates quite a financial hardship on local governments who are not willing to raise taxes to increase revenue (Ollis, 2011).

The Daily Trust (2013) indicates that during the course of the last century, industrialisation has affected the lives of everybody living in Southern Africa shaping the society we live in today. This feature examines the process of industrialisation in South Africa.

Industrialisation describes a complicated process of change. This process has unfolded in a variety of ways across different countries (Daily Trust, 2013) . In the late 19th Century, South Africa changed rapidly from an agricultural society, where most people lived off the land, to an industrial society. This took place largely as a result of the discovery of large diamond deposits in Kimberley in 1867 followed in 1886 by the discovery of gold on the Witwatersrand. These resulted in the migration of people from rural areas to urban areas with a hope to find jobs. However, the increase in the number of people to the cities resulted in the increase in waste generation in cities.

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity and the process is generally undertaken to reduce their effect on health and the environment. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. Generally, waste management tends to treat all waste materials as a single class, whether solid, liquid, gaseous or radioactive substances, and attempt to reduce the harmful environmental impacts of each through different methods.

Waste can take many different forms: solid, liquid, gas, or energy in the form of heat or noise. Liquid waste includes any waste that is liquid at 20 °C regardless of whether it is packaged or otherwise contained and irrespective of whether or not the packaging container is to be disposed of together with the liquid that it contains (EPA, 2009). Gas waste is produced by homes, mines, construction industries and it pollutes the air. Energy waste can be divided into two categories, waste heat refers to heat produced by machines, electrical equipment and industrial processes for

which no useful application is found, while noise waste is created when noise is made for no particular purpose (EPA, 2009).

Solid waste definition includes a number of materials that are not generally thought of as 'solid'. Household garbage, trash, refuse and rubbish are all solid waste. It include solids, various semisolids, liquids and gas that are produced from mining, agricultural, commercial and industrial activities. Often substances such as liquids and gases are confined in solid containers and disposed of with more conventional solid wastes. Sewage, effluent and wastewater from commercial enterprises, organisations and private homes are not solid waste, but once wastewater is treated and various residues are removed from the water to form sludge, the sludge is usually treated as a form of solid waste (APO, 2007).

Solid waste may be divided into two broad categories depending on its origination: municipal solid waste (produced by various institutions, businesses, and homes) and industrial solid waste. This study will focus on municipal solid waste that is generated by homes (households).

Asian Productive Organisation (APO), 2007 defined solid-waste management as the discipline associated with controlling the generation, storage, collection, transfer and transport, processing and disposal of solid waste. The discipline should be in accordance with the best principles of health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes. It can also cause serious pollution that may result in environmental degradation. It is therefore important that this solid waste be managed effectively and efficiently to promote a healthy community. This enshrined in the constitution of the Republic of South Africa, 1996.

## 1.2 Problem Statement

As urbanisation increases, the amount of municipal solid waste (MSW) increases too. People immigrate from various areas in Limpopo Province to Polokwane City. The City is the heart of the Province where everyone hopes for a better job opportunity to improve their livelihoods.

Professionals buy properties around the City and some become permanent residents. Some can afford to buy houses while others rent property within the city. An increase in the number of residents result in the increase product consumption and waste generation. This will in turn require more resources to manage waste generated that is; storage and disposal. This causes a strain to the municipal budget that must effectively manage waste. If the municipal budget is limited waste will not be properly managed and this will put the environment and people's health at risk. Residents store waste on storage bins and there are prescribed days given to each residential site by the municipality for collection.

As urbanisation and economic development increases in Polokwane, nowhere is the impact more obvious than in society's solid waste. In years to come, 10 years from now on, government should anticipate spending at least double the amount on solid waste management related activities.

To carry out integrated solid waste management, Polokwane City need partners. Local governments must reduce the externalities of waste by considering measures such as full cost accounting, package deposits, manufacturer responsibility, and extended product care. The general community, which is probably the most important stakeholder in waste management activities, must also actively participate in the solutions by modifying their behaviour patterns. For example, they need to exert discipline in separating waste, using containers in a beneficial way, and exercising environmentally friendly purchasing habits.

### 1.3 Rationale

The rationale of solid waste management practices is clearly based on the fact that everyone generates waste and can be affected directly and indirectly if waste is not well managed. Waste can be hazardous to human being and the environment if not appropriately managed. Poor management of waste can also affect ground water. Consequently everyone has to be involved in waste management programmes for its effective and efficient waste practices. On the other hand solid waste can be a resource that can be used and provide employment opportunities that may contribute to poverty alleviation if research articles, thesis and papers are published to inform and educate people in waste management practices and processes.

Mismanaging solid waste will lead to both health and environmental problems. Degraded households' solid waste would lead to contamination or pollution of natural resources (such as water, marine life, soil and air). This in turn would increase the health risk of those who are utilising or are exposed to these resources. Hence, the subject is taking central place in the national environmental policies of many countries. In developing countries, solid wastes have not received sufficient attention. This is because, very often, environmental issues compete with other sectors of the economy for very limited resources available. Thus, management of solid waste end up not getting the priority it deserves.

In many countries, hazardous and medical wastes are still handled and disposed together with domestic wastes, posing a great health risk to municipal workers, the public and the environment (Blight, 2000). Medical waste must be separated from municipal solid waste. Some of these wastes may be infectious and may also contain sharp objects such as needles that can cause injury to men. This tend not to apply in many parts of Africa as it tends to be collected along with the rest of the waste stream (Kgathi & Bolanee, 2001).

## **1.4 Aims of the Study**

The study achieved the following:

- Assessed solid waste management practices in Polokwane City
- Made comparison on how households and the municipality take responsibility in storing, collecting, transporting, treating and disposing solid waste.
- Investigated what problems the City encounters in managing solid wastes
- Made relevant recommendations aimed at improving solid waste management practices within the City.

## **1.5 The research questions**

Waste management practices questionnaire was carried out from the five residential study areas in Polokwane. The questionnaire focused on the type of methods used to dispose solid waste and also whether waste is recycled.

## **1.6 Study area**

The Polokwane Local Municipality is located within the Capricorn District Municipality of Limpopo Province (See Figure 1.1). The Municipality covers a surface area of 3775 km<sup>2</sup> and accounts for 3 % of the provincial land area of 12 400 km<sup>2</sup>. Polokwane Municipality is urbanised, 71 % rural and smallholdings, industrial recreational land. Polokwane's economy is essentially built on its function as a central service hub for the entire Limpopo Province and to a lesser degree for the neighbouring provinces and countries. The data and analysis of this study should help to inform on regional economic development and other work being undertaken by the Municipality. (S.A History, 2013).

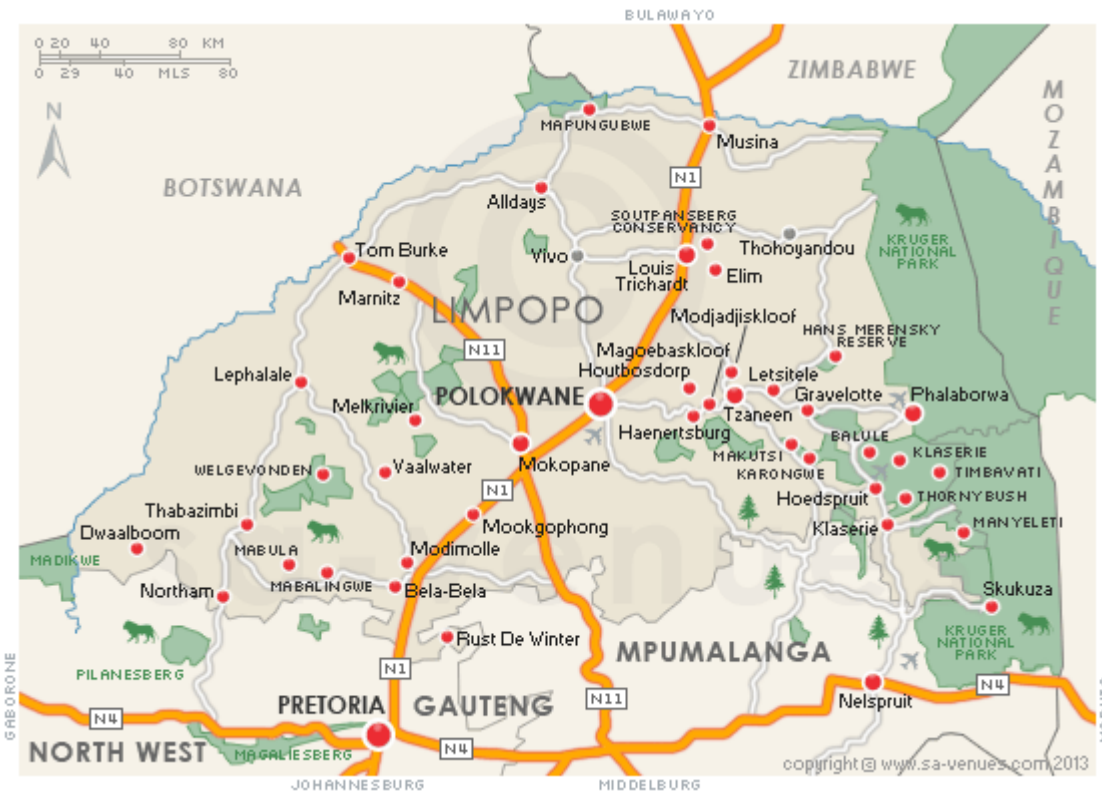


Figure 1.1: Polokwane City located on the map of South Africa (S.A Venues, 2013)

### 1.6.1 Population size

The municipal population size in 2010 was 625 000 with a current growth rate of 1,6 % per annum (S.A History, 2013). Over the past four years the population has increased by 9 %. The growth in population can be 23 % attributed in part to the fact that 6 %. Polokwane is the economic hub and much wider area than that of the municipal boundaries. A growing number of people, from both within and outside the province migrate to the City in search of work (S.A History, 2013).

### 1.6.2 Economic situation

The gross domestic product of Limpopo province is mainly from three sectors; that is Agriculture, Forestry and Mining (GCIS, 2013). These are the three sectors that



creates a large percentage of employment in the province. Apart from these industry, government creates jobs to semi-skilled personnel as well.

### 1.6.3 Waste management

Polokwane Declaration on Zero Waste by 2022 was agreed upon at a meeting held in Polokwane City in 2001 so as to address the problems of waste in the country. This declaration was based on the urgent need to reduce, re-use and recycle waste in order to protect the environment and introduce waste management system which promotes effective waste reduction. The goal of this declaration was to reduce waste generation and disposal by 50 % and 25 % respectively by 2012 and develop a zero waste plan by 2022 (Kumar, 2011). The South African Government developed a National Waste Management Strategy to address waste management aspects including the zero waste plan as envisaged (Ogola, 2012).

Other initiatives taken by the South African Government is the plastic bag agreement. South Africa amended the Environmental Conservation Act 73 of 1989 by developing plastic regulation in terms of section 24. This regulation came as a result of problems associated with the collection and disposal of plastic bags which resulted in pollution and degradation. The problem was mainly affecting low income areas where refuse removal services are inadequate. The regulation's main aim is to restrict the production of non-reusable plastic bags, and unnecessary use of excessive amounts of disposable thin plastic film for packaging (DEAT, 2001).

## 1.7 Methodology

Quantitative method was applied through enquiring on how waste is handled that is, whether waste is weighed before being transported from different waste generators' areas. It was applied through field surveys that were conducted for data collection from households and analysed to address the research objectives.

Qualitative method through interviews, observations and field notes were used as data collection methods. Interviews were used to collect information from the municipal officials for solid waste. Observations and field notes were made while visiting the study areas.

Information on whether waste is separated or measured before collection was acquired from participant households. The five residential areas were from different directions of the city i.e. Westernburg is located on the western side of the city, Ivy Park from south west, Fauna Park on the east, Welgelegen from the northern part of the City, the City Centre is the Central on the centre of the City. Data was analysed through the use of Statistical Packaged for Social Science (SPSS), where descriptive analyses through the use of numbers, tables and graphs was used to describe and present data.

## **1.8 Limitations**

In compiling these data, the author identified shortcomings with sampling plan and built-in problems with consistency. A sampling plan through questionnaire participation of **100** Voluntary respondents from five research areas was used during research. This required 20 respondents from each of the 5 residential areas, this was done randomly per street in order to draw a summary from each residential area. The fact that this was a voluntarily participation raised a concern of willingness to participate to the study by respondents as they will be selected in a random manner. Another issue of honesty when responding to the questionnaires arose. Randomised samples was also not possible in houses where owners were not available at the time of the study i.e. some leave caretakers while they relocates to other places. This can made answering the questionnaire a bit difficult.

These factors challenged the accuracy of the results that was used to explain the state of solid waste management practices in Polokwane City. The study made recommendations to help overcome these limitations and for improving solid waste

data collection and presentation. It is beyond the scope of this paper to venture into the debate on the negative environmental impacts that will occur from wastes generated by an increase in the number of people immigrating to Polokwane City.

### **1.9 Concluding thought**

Solid Waste Management is one of the critical functions that Polokwane Municipality has to perform. It involves the collection, transportation and disposal of solid waste generated by various users. Failure to perform this function can lead to an outbreak of various diseases and can cause serious pollution and hence cause degradation of the environment. The municipality has the mandate to remove and transport refuse to the landfill sites. The mandates also include the management of landfill sites and transfer stations. The Municipality also ensures that the streets are clean and monitors illegal dumping. Currently, only the City and Seshego and some parts of Mankweng and Sebayeng clusters have conventional waste management services in place. The municipality should explore alternative service delivery mechanisms to deal with waste management taking into account the growth in the City (Mihelcic & Zimmerman, 2010).

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## CHAPTER 2: LITERATURE REVIEW

### 2.1 Background

This chapter reviews various studies concerning waste management practices around the world. Similarities and comparison was made on how waste is handled focusing on waste classification, municipal solid waste, policies and solid waste management practices.

During the past fifty years, cities in the developing world have undergone rapid urbanization. Between 1987 and 2015, the number of urban dwellers is expected to double. Nearly 90 per cent of this increase will take place in the developing world, where growth rates exceed 3 per cent a year, three times that of the developed countries (UN-HABITAT, 2003).

A positive correlation tends to exist between a community's income and the amount of solid waste generated. Wealthier individuals, who consume more than people on lower income, generate a higher rate of waste. The processes of accelerated population growth and urbanization translate into greater volume of waste generated. Globalization can promote economic growth, a desirable outcome. However, this economic growth- in addition to population increase and urbanization- will seriously strain the municipal resources in order to deal with a booming amount of waste (Beall *et al.*, 2010).

Higher income and economic growth also tend to have an impact on the composition of waste. Wealthier individuals consume more packaged products, which results in a higher percentage of inorganic materials- metals, plastics, glass, textiles, and so on- in the waste stream (Medina, 2010). Higher volumes of waste and a changing composition have a profound impact on waste management practices. More waste being generated, and with a higher content of inorganic materials, could have a significant impact on human health and environment. If the additional waste resulting from population and economic growth is not collected, treated, and disposed of

properly, health and environment in urban areas of the developing world will further deteriorate (Beall *et al.*,2010).

Distinct differences have been identified in literature between Municipal Solid Waste Management (MSWM) in developed and developing countries. In most developed countries, public health is no more a major driver of waste management; the current focus is on optimization of waste management practices with a broader goal of resource conservation (McDougall *et al.*,2001). Municipal Solid Waste Management (MSWM) in most developing countries is often characterized by inadequate service coverage, operational inefficiencies of services, limited utilisation of recycling activities, inadequate management of non-industrial hazardous waste and inadequate landfill disposal (Zurbrügg & Schertenleib, 1998).

Although distinct differences exist between waste management in developed and the developing countries, as developing countries achieve economic growth coupled with population growth. The environmental and economic burdens of solid waste management will increase. According to UNEP (2005) the rate of waste generation generally increases in direct proportion to that of a nation's advance in development. Failure to provide a management system could result in greater environmental degradation with increase health risk to the urban population.

## **2.2 A Review of different experiences**

### **2.2.1 International experiences**

Most cities in the developing countries do not collect the entire waste generated by their residents, which has a negative impact on human health and the environment. In areas that are not served by the municipalities, local entrepreneurs provide waste collection for a fee. In many Latin American cities, informal refuse collectors use pushcarts, tricycles, donkey carts, horsecarts, and pick-up trucks to serve the poor. They retrieve the recyclables contained in the garbage, before disposing of the remainder of the waste (Beall *et al.*, 2010).

In Santa Cruz, Bolivia, for example, informal refuse collectors serve about 37 per cent of the population. In the low-income areas around Mexico city, hundreds of informal collectors with pick-up trucks, pushcarts, and horse carts provide service in areas that are not served by municipal authorities. The municipalities employ sweepers to sweep the city streets and public areas by using simple tools and facilities (Weiner & Matthews, 2003).

Since dumping waste on the roadside or in other public places is a common practice in Asian developing countries, street sweeping is one of the important activities in the waste-management system. Household's waste, is commonly placed in plastic bags or other containers and stored at the collection centres. Community containers are placed at the roadsides to be collected by vehicles or hand-operated carts. Generally, Asian cities collect their household waste once a day. Major streets are generally swept on a daily basis, while other streets are swept less frequently (Weiner & Matthews, 2003).

The legislation for water and air pollution control are comprehensive and well established, in Asia but not for solid-waste management. Solid-waste management is still very much a municipal government responsibility. The lack of awareness, technical knowledge, legislation, policies, and long-term strategy are major issues for solid-waste management in Asian developing countries (EPA, 2007).

The Environment Conservation Act 1995 (ECA, 1995), the Environmental Conservation Rule (ECR, 1997), and other national-level basic laws and regulations are stipulated for environmental issues in Asia. However, even prior to these rules, provisions existed that addressed environmental issues. Subsequently, the Asian government has given its highest priority to the environment and passed the Environmental Court of Law (2000) for completing environmentally related legal proceedings effectively (APO, 2007).



Municipal solid waste (MSW) management is a growing problem in Sri Lanka. It has a direct relationship with urbanization and industrialization. Therefore, MSW-related matters are more serious in cities and in urbanized areas than in rural areas. However, MSW management is statutorily treated as a local-government subject in Sri Lanka (EPA, 2009). Policy analysis and evaluation focus on the process of policy formulation, implementation, and evaluation (Van Dijk, 2006). There are three mechanisms of regulating public services in cities: price regulation, service quality regulation and access to information regulation. One may also wonder whether it is a question of a good regulatory framework or of working in a context in which people have confidence. In countries like China and Tanzania operators seem to have confidence in the new policies, which makes it much easier to implement them (EPA, 2009).

Like all other developing countries, concern for the environment is growing in Bangladesh at all levels, including the government, for an effective and economic management of environmental issues. In Bangladesh, the Ministry of Environment and Forestry is the authority for making environmental policy, regulations, standards, and enforcement. Its implementing agency is the Department of Environment. In the fourth Five-Year Plan (1990) the government's environmental objectives have been described as follows:

- To control pollution and degradation related to soil, water, and air.
- To promote environment-friendly activities in the development process.
- To preserve, protect, and develop the natural resource base.
- To strengthen the capabilities of the public and private sectors to manage environmental concerns as a basic requisite for sustainable development.
- To create public awareness to encourage participation in environmental promotion activities (Kamaliski, 2010).

Asian Productivity Organisation, (APO), 2007 indicates that Bangladesh has established the following regulations in order to minimise the risk of harming the environment; National Environmental Regulatory Framework (NERF) in Bangladesh:

1. Environmental Conservation Rule, 1997 (ECR 1997)
2. Environmental Court of Law, 2000

The initiative on the legal front of environmental issues, however, has been far from adequate. This has been compounded by the lack of awareness and technical knowledge that is the major factor causing the deterioration of the environment.

Metin *et al.*, (2003) review the existing data on Solid Waste Management (SWM) in Turkey. Since, solid waste management constitutes one of the major Municipal expenditures; an additional attempt was made to review the cost data of solid waste management practices. The characteristics and costs for managing solid waste alters from one Municipal application to another and in addition to demographic facts, it is also a factor of how cost and solid waste terms are defined. The authors have made an attempt to consolidate some of the solid waste data representing demographic and social facts of Turkey. This study can be assumed as a summary of long-standing efforts in establishing reliable figures on solid waste characteristics of Turkey (Metin *et al.*, 2003).

### **2.3.2.1 Solid waste statistics**

The State Institute of Statistics (SIS) has published a major source of information in solid waste in Turkey. This extensive research published in 1993, provides valuable data on compositional variations in the household solid waste in Turkey (SIS, 1993). The household solid waste data collected from 57% of municipalities, corresponds to a sufficiently long sampling time frame and statistically acceptable waste collection frequencies. Therefore, almost all scientific publications emanating from Turkey,

reference this important study. This particular data covers only solid waste generated by individual households. The SIS also published “Municipal Solid Waste” statistics in 1994 (SIS, 1994). The results of these two major studies are summarized in table 2.1 and 2.2 (Metin *et al.*, 2003):

Table 2.1: Household solid waste (HSW) composition in Turkey

Season	HSW (kg/day)	Organic and wet (%)	Ash and slag (%)	Recyclable (%)
Summer	0.6	80.21	2.61	17.18
Winter	0.5	46.2	45.89	7.9
Average	0.57	68.87	17.04	14.09

Table 2.2: Municipal solid waste in Turkey

Municipal solid waste (kg-person-day)		Treatment of solid waste		
		1994	2001	
Summer	<b>0.9</b>			
Winter	1.0	% Landfill	4.7	15
Average	0.97	% Compositing	1.1	2.0

The data in table 2.1 indicates that the majority of the household waste in Turkey is organic in nature, and that slag and ash constitute an important fraction. Because this study was conducted about eight years ago, when coal heating used to be the dominant heating method employed in most of the households in Turkey, recent

studies should reflect significant variation in the characteristics of solid waste. Natural gas has now become the major source of energy used for household heating, at least in major towns. Therefore, significant alterations in the household solid waste characteristics in the recent years should be expected.

The lack of periodicity in SIS studies remains to be the main problem in obtaining reliable solid waste data in Turkey. This called for a survey with municipalities representing some major large cities and with municipalities representing a group of small -medium towns constituting a region has been conducted.

Metin *et al.* 2003 cite Bursa, Istanbul, Izmir, Adana and Mersin as the sources of information representing major cities utilized in this paper. The Municipality of Bursa (an industrial town with a population of two million people) has supplied the most comprehensive and extensive data on solid waste. It covers more than five years of continuous and detailed data collection process which constitutes an important reference for Turkey (BGCM, 2000). Also, some efforts conducted by international agencies in southern parts and major cities of Turkey must be referred to as well (IGCM, 2000).

A summary of the data gathered from these various resources are presented in Table 2.3. The table shows that major constituents of the municipal solid waste (MSW) are organic, whereas recyclable materials constitute almost 1/3 of total MSW in big cities. Another extensive municipal solid waste survey conducted with Municipal Authorities in the Aegean coast of Turkey indicates the difference between big cities vs. small towns as well as peculiarities of touristic towns (Kirkitsos *et al.* , 2000).

The data summarised in [Table 2.3](#) show the variation in MSW as well as the compositional characteristics of waste. In summary, two different groups of MSW data are provided in [Tables 2.2](#) and [2.3](#). The data corresponds with the nationwide research of SIS and long-term statistical data gathered from major cities of Turkey. The comparative analysis of these three sets of data reflects the typical variation of MSW based on the demographic, social and economic differences. Such differences are typical of many developing countries

(Sundaravadivel & Vigneswaran, 2002). However, most of the time, for general purposes, overall figures reflecting the national average characteristics of MSW are useful.

Table 2.3: Municipal solid waste composition in major cities of Turkey, (% in weight)

	<b>BURSA (Bursa Greater city Municipality , 2000)</b>	<b>ISTANBUL (Istanbul Greater city Municipality , 2000)</b>	<b>IZMIR (Izmir Greater city Municipality , 2000)</b>	<b>ADANA (JICA, 2000)</b>	<b>MERSIN (JICA, 2000)</b>
<b>Population</b>	1 958 529	9 198 809	3 114 859	1 682 483	1 508 232
Organic	53.1	43	46	64.4	63
Recyclable	36.4	33.9	31.0	25.2	29.4
Paper/board	18.4	7.8	12	14.8	18.42
Plastics	11.6	14	12	5.92	6.69
Metal	3	2	3	1.4	1.25
Glass	3.4	5.8	4	3.08	3.08
Other	10.5	6.2	23	11.4	7.6

Based on these evaluations and interpretation of the MSW in Turkey, it is concluded that the average per capita MSW generation in Turkey can be assumed to be 0.95 kg/person-day. When it comes to compositional characteristics of MSW, one should take into account the social and demographic factors of the individual town or village.

### **2.3.2.2 Solid waste recovery and recycling in Turkey**

Solid waste recovery and recycling has been a longstanding commercial activity in Turkey. Glass and paper recycling have been conducted at industrial scales since the 1950s ( Banar *et al.*, 2001). With the recent investments in the recycling industry, almost all types plastic materials, glass, paper and metals can be recycled at industrial levels in Turkey. Recycling of scrap metal should be considered at a scale beyond the municipal solid waste management system; however, due to similarities of the collection process of recyclable waste, it will only be mentioned briefly here.

As one of the biggest steel scrap importers of the world, Turkey recycles more than 2 million tons of steel scrap annually (Metin *et al.*, 2003). Recycling of nonferrous metals is also widespread and conducted at industrial scale, including aluminium, copper, lead and silver. The scrap metal recycling industry essentially is built on small and medium scale scrap dealers spread around the country. Recovery of plastics, paper, glass and metal from municipal solid waste is mostly conducted, as indicated above, by the scrap dealers and individual collectors (scavengers).

Paper and cardboard are collected through the scrap/ waste dealers and delivered to recycling facilities nationwide. There exists approximately 30 medium to large-scale paper recyclers operating with capacities exceeding 50 tons/day. The output of these facilities is mostly the packaging cardboard made out of recycled paper. Glass recycling also works on the free market principles, which is mostly operated by the Glassworks Co. of Turkey, consuming more than 90% of the collected used glass bottles. The collection and recovery scheme is essentially the same as paper and cardboard recovery. In addition to glass bottle banks well spread in large cities, private entrepreneurs and scrap dealers collect, sort and prepare used glass bottles for recycling (Metin *et al.*, 2003).

There exist five major buy back centres and glass cullet preparation units nationwide. Significant efforts have been made, in recent years, to increase the

number of glass bottle banks and separate collection systems. The plastics and metal packaging collection system is essentially the same. PET recycling has been an industrial activity since the establishment of a major PET recycling plant in 1992. Currently, three industrial scale PET recycling plants exist in Turkey with a total operating capacity exceeding 25,000 tons per year. In summary a strong market demand exist for almost all types of packaging waste, regardless of its nature. Current scrap material prices are indicative of the influences of world markets. However, glass, paper and PET recycling are being conducted at fairly high industrial capacities, which is another important recyclable item in household solid waste.

Used beverage and tin cans are being recycled together with steel scrap by the steel smelters. Several small-scale aluminium recyclers are spread around the country; and a major aluminium can recycler recently started operation in the western part of Turkey with a capacity of 12,000 tons/year.

### **2.3.2.3 Separate collection of household packaging waste/ review of municipal programmes**

Separate/curbside collection of the recyclable materials has started within the last ten years in Turkey. Currently more than 60 municipal recovery programmes are operational nationwide. These pilot programmes have been a useful tool to develop relevant statistical basis for solid waste recovery activities in Turkey; the data have been summarized elsewhere (Banar *et al.*, 2001).

Metin *et al.*, (2003) show a list of municipal recovery programmes implemented in Turkey in Table 2.4. This list also supplies the data on the amount of used packaging material recovered and recycled through these programmes. Data on collection frequency are also given, which refers to a fairly long period of time, and therefore represents a relatively high statistical significance. The collection scheme is similar in all of the municipal separate collection programmes and is based on the weekly,

commingled collection by plastic bags. Commingled recyclable waste materials include plastic, glass, metal, and paper. The collected packaging waste is either transported to Material Recovery Facilities (MRF) or is being handled by the individual private waste contractors.

Table 2.4: Scope and source of separate collection data used in this study

Number of municipalities	31
Number of households	186 311
Number of hotels	320
Number of schools	237
Number of commercials	179
Total waste collection (kg/month)	1 090 000

(Metin *et al.*,2003)

#### **2.3.2.4 Influence of participation and awareness in separate collection programmes**

Public participation and awareness in municipal recovery programmes has been an important issue in all curbside/separate collection programmes. Several types of tests and opinion polls have been conducted in order to gain an insight to the role of public awareness in these types of environmental programmes (Banar *et al.*, 2001).

Metin *et al.*, (2003) further shows an example of such comprehensive programmes has been implemented by a joint effort of UNDP-CEVKO local municipalities as a part of a programme in the earthquake-affected regions of Turkey (CEVKO, 2000). This programme covered 39,000 prefabricated temporary settlements and approximately 130,000 people directly influenced from the earthquake, after which solid waste management has become a serious problem for municipalities. The



results, show that even under difficult living conditions, such as in temporary settlements in the disaster region, regular citizens support and participate in environmental actions especially when properly informed.

### **2.3.2.5 Costs and financing of solid waste collection and recovery operations in Turkey**

According to Metin *et al.*, (2003); a cost data on solid waste management in Turkey is usually highly controversial and complicated due to the nature of the subject. The cost data is further complicated by the specifics of the Municipal Region and the cost accounting methodology employed. However, here we attempt to simplify some of the factors involved (by separating out some cost build up operations) in order to gain an overall assessment of Municipal Solid Waste (MSW) management cost factors. In this section, two separate Municipal cost analyses have been conducted. The first one covered Municipal collection and transport costs whereas the other one is essentially an economic performance analysis of two small-medium scale material recovery facilities.

The data on cost of collection and sorting has been summarized in Tables 2.5 and 2.6 for a medium-to-large city.

Table 2.5: Cost estimation for a medium sized city wide recycling programme for Turkey, with difficult collection methodology

Cost method	item/collection	Bring centres	Plastic bins	Door-door, plastic bags
			Invest	Invest
			980 000	0
			750 000	750 000
			650 000	650 000
			2 380 000	1 400 000
			Monthly	Monthly
			34 000	28 000
			25 500	78 000
			60 000	60 000
			119 500	166 000

(Metin *et al.*,2003)

Table 2.6: Sales values of sorted material with different collection source

<b>Material source</b>	<b>Paper and board</b>	<b>Plastics</b>	<b>Metal</b>	<b>Glass</b>	<b>Average revenue \$/ton</b>	<b>Total revenues \$/month</b>
Sales value \$/ton	80	150	120	35	96.25	
Residential	38 %	21%	9%	32%	99	170 000
Commercial	72 %	26%	2%			200 00
composite	70 %	18%	3%	9%	89.75	182 000

(Metin *et al.*,2003)

An average population is estimated to be 1.0 million in Turkey. Based on the detailed waste analysis, a cost/revenue analysis for a city wide recycling programme is made. The analysis indicates that revenues are sufficient to cover the general operational costs of material recovery facilities if operated at full capacities. Depending on the source composition or depending on the collection method employed, a relatively acceptable commercial profit can be retained.

Collections through bring-centres yields relatively high investment costs and low operational costs, whereas door-to-door collection of recyclable materials by plastic bags has the lowest investment cost. However the continuing consumption of plastic bags yields relatively higher operational costs. These analyses are found to be consistent with the data published by Coopers and Lybrand (2000) and seem to be

in line with similar studies (White et al., 1995). Obviously, the cost of separate collection, purely on financial terms will be misleading since environmental costs and benefits are not accounted for in simple financial evaluations. The results indicate that at large scales of collection and sorting, market gains of the sold material are usually sufficient to support the operational costs of material recovery facilities.

Additional costs due to separate collection and public training processes are usually considered to be compensated as an environmental benefit. These costs and benefits must be studied through a life cycle approach, which has been a topic of various publications. Intensive efforts are being made by the European Commission and European Countries in order to assess the “value” of material recycling versus other methods of waste management, such as land filling, incineration, composting (Coopers & Lybrand, 2000). The results indicate that material recycling has the highest environmental benefit. Therefore, the recent legislative proposals in the European Union Packaging Waste Directive (EUPWD) targets higher recycling rates.

Environmental Protection Agency (EPA) 2009 explains the legislation of solid waste in the United States (U.S). The Solid Waste Disposal Act (SWDA) of 1965 was the first U.S. federal solid waste management law enacted. It focused on research, demonstrations, and training. In a second phase, the Resource Recovery Act of 1970 emphasized reclaiming energy and materials from solid waste instead of dumping. In a third phase, the federal government started playing more active regulatory role, with the Resource Conservation and Recovery Act (RCRA) of 1976. RCRA instituted the first federal permitting program for hazardous waste and it also made open dumping illegal. RCRA focuses only on active and future facilities and does not address abandoned or historical sites which are managed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 - commonly known as Superfund.

Implementation of RCRA was relatively slow and Congress reauthorized and strengthened RCRA through the Hazardous and Solid Waste Amendments (HSWA)

of 1984. This was the beginning of the fourth phase. The 1984 RCRA Amendments suggested a policy shift away from land disposal and toward more preventive solutions. RCRA has been amended on two occasions since HSWA: the Federal Facility Compliance Act of 1992 which strengthened enforcement of RCRA at federal facilities and the Land Disposal Program Flexibility Act (LDPFA) of 1996 which provided regulatory flexibility for land disposal of certain wastes (EPA, 2009).

In the past twenty years, there has been an increased emphasis on reduction, reuse and recycling (the three Rs) as part of the pollution prevention hierarchy in the U.S . Numerous local, state, and national regulations have been enacted to increase the use of the three Rs (SWIRP, 2013). These initiatives have been motivated by a desire to further reduce adverse social and environmental impacts and to conserve natural resources (including water and energy). At the same time, there has been an increased recognition of the importance of lifecycle assessment in evaluating solid waste- management options in the U.S. Recent trends place greater importance on an integrated or systems-based approach to solid- waste management (Mihelcic & Zimmerman, 2010).

### **2.2.2 Regional Experiences**

UNEP, 2005 states that administration is one of the major weaknesses of Municipal Solid Waste Management (MSWM) systems in Africa. Limited funding and restrictions on raising or directly accessing user fee revenues is another. Cost recovery by municipalities through retained user fees and taxes has shown promise in several cities. Private enterprise may play a role in vastly improving MSWM services in Africa. In many cases improvements may be obtained with high-labour, low-capital alternatives and enabling administrative changes. Cooperatives and community organizations may also play a role in providing MSWM services, from pre-collection to recycling and composting (UNEP, 2005).

In areas that lack refuse collection- usually low-income communities- residents tend either to dump their garbage at the nearest vacant lot, public space, creek, or river,

or simply burn it in their backyards. Uncollected waste can accumulate on the streets and clog drainage systems when it rains, which might cause flooding. Waste can also be carried away by run-off water to rivers, lakes, and seas, affecting those ecosystems. Alternatively, waste can end up in open dumps, legal and illegal: the most common disposal method in the developing world. Open dumping of solid waste generates various environmental and health hazards. The decomposition of organic materials produces methane, which can cause fire and explosions, and is a potent greenhouse gas. The biological and chemical processes that occur in open dumps produce strong leachates, which pollute surface and groundwater (Medina, 2010).

Fires periodically break out in open dumps, generating smoke and contributing to air pollution. In the Mexican city of Tampico, on the Gulf of Mexico coast, for instance, a fire burned for over six months at the local open dump. Fires at open dumps often start spontaneously, caused by the methane and heat generated by biological decomposition. Dump managers in some cities deliberately and periodically set fires at the dumps in order to reduce the volume of the waste, which allows more waste to be disposed there and thus extends the life of the dumps. Human scavengers might also cause intentional fires, since metals are easier to spot and recover among the ashes after the fires than among piles of mixed wastes. Food leftovers and kitchen waste attract birds, rats, flies, and other animals to the dumps. Animals feeding at the dumps can transmit diseases to humans living in the vicinity. Biodegradation of organic materials could take decades, which might limit the future use of the land on which open dumps are located (UNU,WIDER, 2013).

Collecting, transporting, and disposal of MSW represents a large expenditure for developing country cities: waste management usually accounts for 30-50 per cent of municipal operational budgets. Despite these high expenses, cities collect only 50-80 per cent of the refuse generated. In Cairo, for instance, about 50 per cent of the refuse generated is collected. Disposal receives less attention: as much as 90 per cent of the MSW collected in Asian cities ends up in open dumps (Cointreau, 2008). For example, according to the Public Health Act in Kenya chapter 242, the Department of Environment of Nairobi City Council (NCC) is responsible for

implementation of policy, collection and disposal of waste. The department continues to carry regulation and monitoring of activities of waste companies and generators of solid waste. The NCC also enforces all laws and by-laws relating to solid waste, and coordinates actors involved in solid waste management (UNEP, 2005). The private companies in Nairobi operate without any regulation, monitoring or supervision by the NCC (Karanja, 2005). The private sector participation in solid waste collection is spontaneous, unplanned and open to competition without the NCC regulation. The companies violate many of the solid waste laws and by-laws, especially those on disposal (Van Dijk & Oduro-Kwarteng, 2007).

Looking at Ghana on the other hand, the implementation of the national environmental sanitation policy is not receiving the necessary attention and therefore influences the quality of solid waste service (Awortwi, 2003). The Kumasi Metropolitan Assembly (KMA) has powers conferred on it by the Local Government Act 1993 (Act 462) to promulgate and enforce by-laws to regulate solid waste management, sanitation, cleansing and abatement of nuisance in the Kumasi Metropolis. Companies cannot operate without the approval of or license from the KMA (Van Dijk & Oduro-Kwarteng, 2007).

Thompson (1995) reviews waste management in Ghana. The Republic of Ghana is home to 22 million residents. Accra, the nation's capital serves as the economic, administrative, and cultural centre of the country. Its geographical position has allowed it to function as a natural port to the Atlantic Ocean, which has in turn made it an important destination point for number of Ghanaian trading industries. It covers an area of approximately 65 square miles. It houses a full 18 % of the total Ghanaian population and 30 % of the country's urban population. Unlike the towns and villages spread throughout the majority of the countryside, Accra is a veritable urban Mecca for labour-seeking residents from all over Ghana. Half of Accra lives below the World Bank's absolute poverty threshold of little less than a dollar a day. Still, for the past two decades this city of roughly 4 million inhabitants has had an annual growth rate of 4 % making it one of the fastest growing metropolis in Africa. This phenomenal

growth has contributed to municipal waste production that far outstrips the city's capacity for containment and processing. (Thompson, 1995)

Thompson (1995) further indicates that Ghana has waste management difficulties that extend from the state to the local municipalities, and refuse of all shapes and sizes is a common site in both urban and rural areas. These difficulties are concentrated and complicated by population pressures in the few heavily populated cities of which Accra is the most prominent. Inequality features heavily in the capital. 80 % of the city population lives in low income, high density population areas. The middle class is occupied by 17 % of the population. Only 3 % of Accra lives in high income, low density residential areas. The sanitary infrastructure of Accra is reflective of the income divisions. Only 30 % of all houses have toilets that actually flush. Only 1 in every 5 houses has functioning indoor plumbing. The public latrines that have been built to accommodate these disparities are overused and often shared by 10 or more people.

According to Thompson (1995), visitors to Accra are confronted by two narratives. In one, Accra is the posh clean "gateway to Africa". Streets are manicured, palm trees are coiffed, and all the amenities of the western world including regular waste removal can be heard. In the other version, city residents are contending with congestion, illegal settlements, substandard housing, and poor sanitation. This environment is the predominant experience of most city residents and is reflective of growing inequality that that has come to represent Accra. The confluence of poor governance and human factors (such as indiscriminate dumping) has resulted in a city environment characterized by choked drains, clogged gutters, and garbage piles heaped in the open. (Thompson, 1995).

The story of how two such divergent experiences came to exist in the same city speaks to the challenges of urbanization with regard to waste management. Accra's modern day waste management deficiencies has it beginnings in the 1980s when Ghana was in a period of economic decline. In Ghana privatisation is usually an



exercise meshing political capital with governmental responsibility. Many staff positions, jobs, and contracts are linked to the party in power. The management of public services can be disrupted cyclically with every election. New parties in power may remove those in charge of sanitation duties because of their support or instalment by another party. Private firms are usually receiving the patronage of the current administration. The administrative priorities and the management approach of the Accra Metropolitan Authority (AMA) however have managed to remain rather consistent over the past decade, and by most accounts privatisation has allowed AMA to increase the average yearly waste collected.

Accra is currently divided into 16 waste collection zones each contracted to different waste management firm responsible for collecting and disposing solid waste. Collection of solid waste from these zones has been delegated to the private sector. The AMA concentrates on supervision of waste collection, monitoring of the public-private partnership, and management of final disposal points. The private local firms are the ones in charge of actual collection and provide their services for a fee according to specific contractual agreements that each company makes with the city authority, the AMA. The AMA pays those companies with national budgetary allocations from the state government and internally generated funds.

Benneh *et al.*, 1993 point out that “half of Accra households perceive local accumulations of solid waste to be a problem, and more than one third mention open dumpsites in their neighbourhood where waste goes uncollected for a week or more”. The current situation is not tenable. The advent of e-waste imports—old TV sets, radios, and computers from developed nations-- threaten to further destabilize an environmental approach that is not keeping pace with emerging health risks. In the near future Accra will have to improve its waste management.

This study will centre on the present approaches and strategies being used to address Accra’s growing waste management problem. Thompson focused the analysis on solid domestic waste. Characteristics of Ghanaian society that both aid

and detract from effective waste management will be considered. The environmental and health consequences of the waste dilemma will be explored. Solutions being proposed to help resolve the current predicament will be discussed.

Domestic waste in Accra is primarily made of organic material (65 %). The remainder of the disposed waste consists of paper, plastics, glass, metals and textiles. The organic material is typically a mixture of kitchen waste (vegetables, rotten fruits, crop residues, and leaves) and animal excreta. None of the organic material is in and of itself toxic to humans or the environment. Frequently it is the manner in which the waste is kept that dictates the exposure to health risks. The largest risk to humans comes in the form of diseases associated with unsanitary conditions. Infectious diseases of poor sanitation and poverty are the most common diseases affecting the residents of Accra (Thompson,1995).

In the Accra households it is not uncommon to find open waste containers. Many households store their waste in baskets and plastic bags. The hot and humid weather conditions favour accelerated fermentation of organic matter. The lack of substantive toilet infrastructure means that citizens at times resort to defecating outside. Past studies have found more than two-fold increase in childhood diarrhoea prevalence due to neighbourhood outdoor defecation.

About 18 % of households in greater Accra region (mostly low-income households) burn their waste. This burning can contribute to outdoor air pollution. As a result, leachants from burned refuse can enter the groundwater. Even though the burning of domestic waste has been associated with respiratory illness, households that are inconsistently serviced by waste collection companies sometimes burn their waste. Hence, in these households, respiratory diseases are more common in mothers and children.

Water pollution is another important potential outcome of inappropriately managed waste. For example, the unregulated leachants from refuse near waterways increase

the technical difficulty of providing clean water and subject city residents to urban flooding risk. Urban floods occur when drainage systems and other storm control devices overflow because of waterway blockages.

The poorer population of Accra bears a disproportionate amount of the environmental health risk burden. The most vulnerable populations are sanitation workers and the migrant workers from the North. Migrant workers frequently resort to scavenging to provide income. Scavengers can be seen in broad daylight searching through refuse at open dumps for materials—plastic slivers and metals—that can be sold back to processing factories.

Sanitation workers are hired by private companies. However, they receive little or no protective clothing from the waste management companies which employ them. These workers earn low wages, and thus are not able to purchase appropriate clothing for their protection. Thus, they suffer more exposure, and as a consequence have a higher turnover rate, higher incidences of sick days and work-related accidents, and higher mortality than the rest of the city population.

### **Present approaches:**

Many approaches to waste management exist in Ghana. Generally, solid waste in Accra is managed through economic instruments, landfills, incineration, recycling or reuse. A thorough discussion of Accra's governance would necessitate a detailed retelling of Ghana's political history. For the purposes of this study; the reader should consider good governance as a potential moderator for each of the approaches discussed. Bad governance will weaken the approaches. Good governance will bolster the approaches. Improvements to any of the elements discussed will in turn enable better governance.

Like most developing countries, Ghana and consequently Accra has an established set of comprehensive environmental laws. However it lacks the means to enforce

those laws. This study did not discuss advanced waste disposal systems, such as gasification and pyrolysis, which Ghana does not have the financial and technical resources to support. It will only address the technologies and approaches already in use in Accra and other comparable heavily populated urban cities in sub-Saharan Africa.

### **Economic Instruments: Privatisation**

Economic instruments can be grouped into two categories: revenue-raising instruments (licenses, user charges), and non-revenue instruments (performance-based management contracting, clean neighbourhood competitions, privatisation). The problem of waste collection is structurally dissimilar from the problem of waste disposal.

The AMA's main economic tool is privatisation. Advocates of privatisation believe that for-profit competitive systems increase efficiency and better calibrate supply and demand. Opening the waste management market to competition can stimulate development of better pollution control technology and expertise. Before 1995 solid waste management was run purely as a government monopoly. However the government was failing to adequately address the sanitary needs of its citizens.

Privatisation has permitted waste collection services to be allocated to the parties who value them the most. Opponents to Accra's privatisation program acknowledge that the living standard in higher social economic classes has increased, but they argue that the benefits of privatisation are not experienced equally by residents of Accra. Poorer socioeconomic classes have only received marginal benefits.

Low-income residential areas (which make up the majority of Accra) are still under serviced. Critiques of privatisation point out that waste collection relies on the government management of infrastructure (ensuring streets are paved and accessible, enforcement of zoning laws against squatters) independent of public or private servicing. Private firms will only be as good as the infrastructure that supports

them. Private firms have little incentive (and virtually zero technical capacity) to repair and maintain roads.

Privatisation depends on fees. In high-income neighbourhoods each household pays a fee for the privilege of waste collection. Houses are sufficiently spread that if a household determines not to pay the fee and waste accumulates, that action does not immediately offend the aesthetic environment of neighbouring households. In low-income neighbourhoods, the opposite is true. Waste is accumulated at central collection points. When payment schemes have been instituted (such as requiring residents to pay a specific fee before the central container units are collected), residents simply free-ride.

The population is too dense and municipal workforce too sparse for effective policing of environmental by-laws. Thus paying households in poor neighbourhoods receive little tangible aesthetic benefit as their immediate surroundings are still polluted by other residents. Cities are permitted to appoint designated landfill sites, but these sites are more accurately designated as open dumps. Sanitary or engineered terminal end sites for Accra's waste deposition are non-existent.

Accra's landfills mostly consist of abandoned stone quarry sites, gouged natural depressions in the earth, old mining areas, or man-made holes in the ground. Many of these sites are at the outskirts of the city where the poorly maintained roads present significant risks to waste transport.

The Ghanaian Environmental Protection Agency has recognised the need to have the municipal dumps of Accra replaced or upgraded to engineered landfills and has set a 2020 target for the conversion of all these sites. Waste management disposal is underdeveloped. Most of these landfills operate near or beyond maximum capacity. Waste is not subject to compaction. Volume remains expanded, and as a result these dumps are frequently infested by roaches, rodents, and flies.

## **Composting:**

Composting is a minimally used form of waste disposal in Accra and does not contribute to the danger of food pollution. Of the 1250 tons of garbage collected per day – about 10 – 15 % is composted. In theory composting could reduce environmental pollution and provide job opportunities. Compost fertilizer also could help improve agricultural production and improve soil structure – which means it offers a longer term advantage over other non-compost mineral-based fertilizers. The high percentage of organic material that is disposed as trash suggests that composting could be a viable municipal solid waste technology.

In practice, composting is not a widely employed technology. Greater use of composting requires analysis of the different levels of technical sophistication and the potential transport capacity of Accra's waste collection system. Profitability and investment analysis for constructing and operating compost facilities in Accra would have to be undertaken. Such forms of analysis have actually been done as recently as 2004. Results show that the overall cost of building and operating composting facilities in the Accra-Tema Metropolitan area is much lower than for incineration and land filling. There are two active compost plants active near Accra. These plants are capital intensive and require very few men for efficient production. It is not fully clear why composting plants are not used and encouraged more.

The price of compost is also sensitive to transport costs. As Accra has grown and expanded, agricultural end destinations for compost have become further and further removed from the site of compost production adding to the expense of compost purchasing. The current preference of non-composting waste management technology may be difficult to adjust considering these circumstances, which is a shame as many urban farmers (inexperienced and experienced) have positive perceptions and are willing to use compost. One potential solution to this impasse is using farmer associations (already in existence) to purchase compost in bulk to reduce transport costs. Until transport costs are reduced, composting will likely

remain low on the priority list of technological processes expected to ameliorate the waste management burden in the future.

### **Recycling:**

Only 2 % of the solid waste is recycled at a recycling facility. Recycling is practiced informally, but the recycling base of Ghana is in general weak. Households in low income areas do not dispose of plastics, bottles, paper, cardboards and cans readily. Recyclable materials are used and reused for domestic purposes and only thrown away when they are no longer of any use to the owners. In high income areas, domestic servants will sell these materials to middlemen to supplement income instead of disposing them along with the other refuse. There are two main recycling plants in operation in Accra.

Unlike other poor cities around the world, Accra lacks a substantial sector of waste pickers to collect and sort household waste on behalf of merchants, recycling firms, and composting units. Encouragement of the waste picker labour market and other participants in the informal recycling sector could help extend the lifespan of the cities landfills through waste diversion.

### **Incineration:**

It is used primarily as disposal for biological waste associated with medical care. Policies governing the appropriate use of incineration exist in Ghana, but Accra incinerators mostly consist of ovens or open pits used to burn bandages and blood products. After burning, the ash is usually moved straight to an adjacent landfill, where it takes up only a tenth of the volume of the original waste. Ghana's national policy recommends small scale incineration plants, but primarily as a disposal option for health care wastes.

Public apathy to environmental issues prevents residents from making meaningful contributions to the difficult decisions that are required to prioritize environmental

health. Historically, community participation in Accra municipal decisions has been low. Accra lacks the resources to organise dialogue sessions, and rarely employs facilitators to involve people in decision making.

Labour is one of the most available inputs in Ghana's waste management sector. It is certainly more readily available than capital stock and imported technologies. But no institute has responsibility for research into Accra's major resource—its people. A major research effort on the economics of the waste management labour market is needed to determine if substantial gains in output, employment, and services can be had from the introduction of labour-intensive methods of waste collection and disposal. It is possible that short-term efficiency gains could be had if waste companies used a higher ratio of labour to capital.

Community participation is vital for all these proposed plans of action. The literature is replete with examples of projects that have yielded sustainable results from community organising efforts. One of the most successful examples is the Orangi Pilot Project in which residents of Karachi Pakistan slums were given the capacity to participate effectively in the creation (purely community financed and constructed) of their own sewage system. It is crucial to create and access a self-referential body of research (through focus groups, small scale pilot projects, and published studies) to help determine if similar initiatives are applicable to the environmental conditions in Accra. These research demonstrations can help guide citywide policy and highlight how best to engage with the city's poor communities.

### **Landfill Gas Recovery Research:**

A technological intervention with the potential for long term impact on Accra's waste management woes is landfill gas recovery. At sites with large inputs of commercial and industrial organic waste, large amounts of methane gas are produced. Methane gas can be captured and fed to gas wells used to generate electricity. This technology is already in use in the developed world. The first Landfill gas capture



project was recently started in South Africa and is currently entering phase 2 of its completion. Already electricity is being produced and sold to the local population to generate revenue. Additional revenue is being received from carbon credits that can be sold on the carbon market through the Kyoto Protocol.

While landfill methane capture will not reduce the amount of waste generated, it can serve as a potential source of energy for local residential and commercial buildings. Additionally, it can lower environmental risk by lowering overall emission of methane. Methane, the second most important greenhouse gas after carbon dioxide, has a global warming potential that is 23 times that of carbon dioxide.

The utilisation of such a technology in Ghana would allow citizens to make more use of the landfills by harnessing the effort put into collecting and storing garbage and transforming it into needed power supply. Currently, landfill electricity-from-gas generation projects in Africa are not competitive with local electricity costs. In South Africa for example, the gas-recovery landfill in Durban is 66% more expensive than the current electricity supply. However, the landfill construction is funded from the Worldbank's Prototype Carbon fund – a recently available form of finance provided from carbon credit market. Ghana stands to benefit from research into innovative projects like the gas-recovery landfill in South Africa if only investors can be attracted to the waste management sector.

## **Solid waste management in Egypt**

### **Municipal solid waste composition**

Municipal waste composition varies from one region to another according to income levels, population density and predominant activities. Seasonal changes in food composition result in seasonal changes in waste composition. Changes in the lifestyle and the increasing dependence on processed food and its associated

plastic, carton, and metallic packaging continuously alter the composition of solid waste in Egypt (Zayani, 2010).

## **Collection and treatment**

Zayani (2010) states that collection of municipal solid waste is the responsibility of local municipalities in Egypt. However, in Cairo and in the big cities, waste collection is subcontracted to local “zabaleen” (garbage collectors), and in recent years to private local and multinational companies. The average collection rate in urban areas is 30-77 %, in Cairo it ranges between 0 % in the slums and the poor neighbourhoods and 90 % in the private residential compounds. The collected waste is disposed in open dumpsites, where scavengers separate recyclable materials, and the rest is left to rot, or is burned to reduce the volume. Spontaneous fires are very frequent and so is landfill gas and leachate formation, two substances that are very harmful to the atmosphere and the ground water table.

In rural areas, waste collection and disposal systems are virtually non-existent. The organic fraction is generally used to feed the household's feedstock. The non-usable fraction is dumped in empty land lots, along roads, irrigation and drainage canals. A few municipalities in some villages use trucks and tractors to collect municipal solid waste, which is dumped in open dumpsites, where it is burned to reduce its volume, or left to rot naturally.

## **Future plans**

Landfilling and incineration have recently been introduced in Egypt as more environmentally sound solid waste treatment techniques. The Egyptian Government also adopted a national plan for establishing composting plants throughout the country, whereby produced compost would be used as an organic fertilizer. However, government plans were not successful in the last ten years, as in the year 2000 it announced its objectives of collecting 99 % of waste in urban areas and 70 %

in rural areas, but despite the announced spending of 1.9 billion Economic Gross Product (EGP) over ten years<sup>17</sup>, and the Spanish and Italian contractors, the situation of municipal solid waste in Cairo has worsened greatly in the past 10 years (Zayani, 2010).

### **Current state agricultural solid waste**

Agricultural activities generate around 17 million tons of crop residuals, an average of 147 million m<sup>3</sup> of cattle manure and 1.1 million m<sup>3</sup> of poultry manure annually. Agricultural solid waste did not represent a problem in Egypt's rural areas, until the introduction and rise of artificially synthesized materials that are not biodegradable. Farm waste has been generally re-used on the farm in various ways (as cattle fodder, as fertilizer or as combustible). Crops residuals used to be stored by farmers on top of their roofs to be used as a source of fuel when burned.

However, the increasing spread of propane/butane gas fired ovens and stoves resulted in decreasing the use of waste as a fuel. Moreover, new regulations were introduced by the Ministry of Agriculture to ban the storage of agricultural waste as a measure to fight pests and diseases, and to prevent hazardous fires. Due to the lack of resources, farmers prefer to dispose off the undesired, non-storable waste by illegal means such as burning or random dumping. This reduced the utilisation rate of agricultural waste from 100 % to 40 %.

### **Composting current status and potential**

The national production capacity of compost in 2001 was about 20.7 million tons/year, creating a severe shortage. The current production capacity is estimated to be higher with no precise figure. In a report made for the USAID and the Ministry of water resources and irrigation in July 2005, the demand for compost has been estimated to around 53 million tons/year for the old Nile Valley land, and 1.5 million

tons/year for reclaimed land. The demand for compost for the reclaimed desert land is expected to reach at least 30.7 million tons/year by 2017 (Zayani, 2010).

### 2.2.3. Local Experience on Solid Waste Management

Table 2.7: Local Experience on Solid Waste Management

<p>Local Experience on Solid Waste Management</p> <p>Waste in South Africa is currently governed by means of a number of pieces of legislation, including:</p> <ul style="list-style-type: none"><li>• Environment Conservation Act (Act 73 of 1989)</li><li>• National Water Act (Act 36 of 1998)</li><li>• The National Environmental Management Act (Act 107 of 1998)</li><li>• National Environmental Management: Waste Act, 2008 (Act 59 of 2008)</li></ul> <p>The President of the Republic of South Africa signed The National Environmental Management: Waste Bill into an Act of Parliament in March 2009, The Act took effect from 01 July 2009. It is the intention of this Act to address the current fragmentation in waste legislation in South Africa.</p>
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The process of waste management may be divided into six functional components. The waste management process takes place within a complex milieu of ever-changing economic, social, political and biotic factors, all of which have to be taken into account in the development of any waste management strategy. The term waste management strategy implies a holistic approach to waste management should not be based on crisis management, although allowance must be made for this. It should be the implementation of a logical and systematic discipline which has considered all appropriate alternatives and in which all sectors co-operate in an informed and responsible way to arrive at the best practicable environmentally acceptable option for the disposal of any given waste (Lombard & McPherson, 2003).

In rural areas of South Africa, households are responsible for their own waste. The common practices used to dispose waste are; burning and burying waste in the yard. A Case Study in Limpopo Province, South Africa conducted by Ogola *et al.*, (2012) describes six general sources of waste generation in Polokwane. These include; domestic, commercial, industrial, agricultural, institutional and natural.

- Households are the highest producers of domestic waste. Domestic waste includes, among others, paper and cartons, plastics, glass, leftover food and cans.
- main agents of commercial waste producers are stores, business premises, markets and restaurants.
- Industrial waste refers to wastes from construction and demolition debris and food processing outlets.
- Agricultural wastes refer to the waste outcomes from dairy and poultry farms, livestock and other agricultural activities like vegetation cultivation. Most of the agricultural wastes contain biodegradable components.
- In case of institutional wastes, major producers are schools, offices and banks. This type of waste contains paper and cartons.
- Natural waste consists of leaves, tree branches, seeds and carcasses of animals.

Ogola *et al.*, (2012) further used the following methodology to collect data on waste management in Polokwane.

### **2.3.1.1 Data analysis**

The data obtained were subjected to statistical analysis in order to establish whether there was any significant relationship between the quantity of waste obtained and the income groups. The significant relationship was based on 95% level of confidence.

The study focused on the household solid waste generated within the three selected residential areas of Polokwane city, namely: Low income-Ivypark, Middle income-Florapark and High income-Sterpark. Food waste was the highest across all the

income groups with a percentage waste generation of 34 % . The trend of wastes was as follows: Paper-20 % > plastics-18 % >glass-11 % > cans- 11 % >garden waste –6 %.

Ogola *et al.* (2012) indicates that wastes from the households were not sorted. Instead, all the wastes collected from individual households were mixed in refuse bags. This makes recycling of wastes from homes not practical, and thereby reducing the quality of recyclable wastes like paper and cardboard through mixing of waste. The waste refuse bags from households are collected weekly on a specific day for each suburb. For example, for Ivypark, collection is on Thursday, Florapark collection on Wednesday and Sterpark on Tuesday. The amount of waste collected on a weekly basis from the residential areas and city center amounts to 456 m<sup>3</sup>. The collection system is quite effective, thus no refuse bag is left by the road side to litter the city.

Ogola (2012) indicates that currently, there is no recycling programme implemented by the Municipality of Polokwane City. It has been found that 60 % of waste disposed in the landfill consists of recyclable waste. Although the Municipality does not have a formal waste recycling system, it was found that the disposal site has informal waste reclaimers that are collecting recyclable wastes on a daily basis.

Ogola *et al.*, 2012's discussions and recommendations:

This study indicates that waste generation in the three income groups to be computed as 0.3-0.7 kg per person per day, which was distributed as follows:

Low income group at 0.3 kg per person;

Middle income group at 0.4 kg per person and;

High income group at 0.7 kg per person.

This amount of waste generated was low as compared to the findings of the Baseline Studies (DWAF,1998). Where the average amount of waste generated per person was found to be 0,7 kg per person in South Africa. Generally, it was observed that the amount of waste generated by the three income groups depended on the socio-economic level of the group. The High income group was found to generate more waste than the low and middle income groups. This was attributed to the affordability of goods by this income group.

It is worth noting that the waste generated per person in Polokwane city is lower than that generated per person in Johannesburg. For example, in Johannesburg, the average waste generated per income group ranged from 0.4-0.7 kg per person, 0.7-1.1 kg per person and 1.2-2.5 kg per person for low, middle and high income groups respectively (City of Johannesburg, SOER, 2003). This is rather not surprising since most of the people residing in Johannesburg earn more than their counterparts in Polokwane and, therefore are expected to afford more goods which are disposed of after utilisation.

### **2.3.1.2 Waste composition**

Food waste constitutes the highest percentage of waste generated in all the income groups, although the percentage varied with the high income group having 37 %, middle group-36 % and low income group-25 %. The waste composition found in the three income groups varied markedly. While the waste from the low income group had the highest percentage of grass waste, and that from the middle and high income groups were composed mainly of recyclable waste: plastics, glass, paper and cans. Studies conducted in Nairobi agree with the data in Polokwane city that household waste comprised high percentage of food waste in all the three income groups sampled. Almost 50 % of waste generated in Nairobi was food waste, whereas in Polokwane food waste comprised 34 % of the total waste generated from the income groups (Henry *et al.*, 2006)

The results of this study shows that in Polokwane amount of organic waste generated amounts to 40 % which is low as compared to other studies conducted in Nepal, where organic wastes was 70 % of the total waste generated, and 60 % recyclables for Polokwane versus the 20.5 %. According to the studies carried out in Macao in China, food waste accounted for 15 % of the total waste generated, and 52 % was of recyclable waste(Jin *et al.*, 2006).

### **2.3.1.3 Waste recycling**

Ogola (2012) indicated, that about 60 % of wastes generated can be recycled. This included glass – 11 %, plastics -18 %, paper- 20 % and cans-11 %. The amount of potentially recyclable waste in Polokwane city is much high as compared to other cities for example, Nairobi 35 %, Macao-China 52 %, Singapore 30 % and Kathmandu 20.5 %, (Bai & Suntato, 2001). Although the Municipality does not have a formal waste recycling system, it was found that the disposal site had informal waste reclaimers that are collecting recyclable waste on a daily basis. This has also led to development of an informal settlement close to the landfill. Waste reclaimers collect all the waste that is re-usable, ranging from bricks, plastics, steel, card boxes, cans.

No formal recycling programme exists in Polokwane Municipality whereas other Municipalities such as the City of Johannesburg and the City of Cape Town have initiated recycling programmes. This is one area that the Municipality must explore in order to achieve the Polokwane Declaration target on Zero Waste (Trois *et al.*, 2008).

Ogola *et al.*, 2012 recommendations were as follows:

- There is a need to develop an integrated waste management plan for Polokwane City with a priority on waste recycling to reduce the final amount of waste for disposal.



- The Polokwane Municipality should develop an environmental awareness programme on recycling supported by placement of the recycling containers at strategic points to collect recyclable waste.
- The Municipality should come up with a strategy of supporting household separation at source.
- The programme of cooperatives for litter picking should be extended to include recycling.
- Waste generation is a vital component of waste statistics. The accuracy of these statistics is important in planning, development and monitoring waste management strategies. The Municipality should develop a monitoring system for waste classification, quality and quantity.

## **2.4 Summary**

Profound differences exist between developed and developing countries in terms of income, standard of living, consumption patterns, institutional capacity, and capital available for urban investment. Conventional solutions usually do not take into account these differences resulting in less than optimum outcomes. Residents of low income countries tend to generate less garbage than people in wealthier areas. But they are catching up fast. China, with its billion-plus population, growing economy and improving standard of living, surpassed the US as the world's largest generator of solid wastes in 2005. If current trends continue, India will also generate more total wastes than the US in the year 2025 (Medina, 2008a).

There are also profound differences between waste management in urban and rural areas. If per capita incomes are higher in the cities than in rural areas as is often the case in developing countries- urban residents tend to generate more waste per person. The composition of urban wastes tends to be highly diverse due to the wide variety of production activities and all the various material inputs used in them. Productive activities also generate wastes in their processes and consumers discard products and packaging materials after consumption. Thus, urban wastes are highly

diverse and urban residents tends to generate more wastes than their rural counterparts.

Rural areas, however, can generate large amounts of wastes, depending on the type of existing economic activity, but these tend to be less diverse than urban wastes. (Cointreau, 2008). Due to their dispersion, the cost of collecting wastes from rural residents can be much higher than in urban areas. Not surprisingly, many rural area in developing countries lack waste collection services. Rural residents who lack refuse collection often dump their wastes on vacant land, bodies of water, or simply burn them.

Table 2.8: A summary of comparative analysis of solid waste management.

	<b>International Experiences</b>	<b>Regional experiences</b>	<b>Local experiences</b>
Sources of waste	domestic, commercial, industrial, agricultural, institutional and natural.	domestic, commercial, industrial, agricultural, institutional and natural.	domestic, commercial, industrial, agricultural, institutional and natural.
Waste Management Practices	Open dumping, incineration, composting and landfilling in Sri Lanka	Landfilling, composting and incineration in Egypt.	Landfilling, incineration, composting in Polokwane.

Waste Transportation	Latin American cities use pushcarts, horsecarts and pick-up trucks	Carbside used in Ghana	Trucks
Methods of storage	Containers and plastic bags	Ghana uses basket and plastic bags,	Refuse bags and storage bins
Strategies to improve solid waste management	The U.S has introduced the 3 R's ( Recycling, reuse and recovery)	Recycling and reclaiming	Waste minimisation and recycling, Source reduction in South Africa.
Waste Management Policy/Legislation	Resource Conservation and Recovery Act (RCRA) of 1976  The Environmental Conservation Act 1995 (ECA, 1995), the Environmental Conservation Rule (ECR,	Public Health Act chapter 242 in Kenya, the Department of Environment of Nairobi City Council (NCC) is responsible for implementation of policy, collection and disposal of waste.  The Kumasi	<ul style="list-style-type: none"> <li>• Environment Conservation Act (Act 73 of 1989)</li> <li>• National Water Act (Act 36 of 1998)</li> <li>• The National Environmental Management Act (Act 107 of 1998)</li> <li>• National Environmental</li> </ul>

	<p>1997), Environmental Conservation Rule, 1997 (ECR 1997), Environmental Court of Law, 2000.</p>	<p>Metropolitan Assembly has powers conferred on it by the Local Government Act 1993 (Act 462) to be promulgated in order to enforce by-laws and regulate solid waste management, sanitation, cleansing and abatement of nuisance in the Kumasi Metropolis.</p>	<p>Management: Waste Act, 2008 (Act 59 of 2008) Polokwane city is currently reviewing the refuse (solid waste) and sanitary by-law, the Administrative Notice No 845 of 1983, in line with the Integrated Waste Management Plan for the city.</p>
Challenges	<p>Asia shows lack of awareness and technical knowledge is a major factor causing the deterioration of the environment.</p>	<p>Lack of regulation, monitoring and supervision by City councils in Kenya. Ghana lacks means to</p>	<p>Limited formal recyclable programmes.</p>

		enforce laws established to manage waste.	
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Table 2.8 shows challenges that are faced by Asian waste management system. There is a lack of awareness and technical knowledge in waste management. A review of municipal and household solid waste statistics in an Asian country (Turkey) focused on solid waste management costs. The results indicated that average household waste generation per capita is 0.6 kg/day and average municipal solid waste is 0.95 kg/day. The composition of municipal solid waste varies by the source of waste; however in all cases organic constituents accounts for more than 50 % of municipal solid waste.

Material recovery data have been obtained from 31 municipal separate collection programmes, with data period extending up to 5 years of collection and sorting operations. These data clearly indicate that the composition of recovered material shows some variation depending on the source (commercial, residential and mixed) and the season of the year. However, regardless of the source of collection, whether it is commercial, residential or a tourist site, the majority of the material collected is composed of paper and cardboard. Glass packaging ranks second with an average of 20–25 % (by weight) and plastics constitute 15–20 % of the outputs of the material recovery facilities.

The US showed a strength on waste management due to the phases that were followed when developing waste management legislation. The first phase emphasised research and training, followed by the second phase that focused on resources recovery and reclaiming. The third face encouraged active future use of facilities to manage waste. The final phase enforced RCRA at federal facility.

The regional review on solid waste reveals that the challenge lies with the percentage of waste generated and waste collection. An example is seen where only 50% of the waste generated in Cairo is collected for disposal. This is mainly due to lack of enough attention given to policy formulation to manage waste and the implementation of such policies. An example is a situation in Nairobi, Kenya where private companies operate without any regulation, monitoring and supervision by Nairobi City Council.

Solid waste generated by households, industry and agriculture is clearly badly-managed in Egypt, creating countless environmental and health problems. The collection and separation of municipal solid waste is technologically feasible and economically sound. Recycling and recovery of metals, plastics, paper, glass and several other materials is already done in an effective way, without being efficient. Garbage collectors and scavengers are exposed to unhealthy and risky conditions. The remaining fraction of municipal waste that is not collected also creates several health and aesthetic problems. The existing landfills generate a lot of greenhouse gases and pollute the soil and the ground water.

Agricultural solid waste is being under-managed and under-exploited as well. The existing and mature composting technology already offers economically and environmentally interesting solutions as domestic as well as international demand exist and are growing with the ever increasing global interest for organic farming.

Environmental consciousness and green investments are on the rise in Egypt and there is no doubt that the waste management field will grow considerably in the future, especially with the rising prices of raw materials and with the expected cuts in natural gas subsidies.

A Solid Waste Management Strategy for Egypt had been developed in 1992. Its full implementation was not realized at the time for several reasons. In 2000, a National Strategy for Integrated Solid Waste Management (NSISWM) was prepared.

This national strategy focused on Municipal Solid Waste (MSW), identifying core problem areas, root cause(s), and conceptualizing a vision for possible and foreseeable solutions. The goal and the major outcome from the implementation of the national strategy are to establish and achieve an effective, sustainable national system for IMSWM. The strategy anticipates a partnership of the Central Government, the Governorates, Local Governments, Industry and the Public. It depends heavily on the regional approach; with the Governorates being the principal participant for the implementation of that strategy.

The strategy also adopts a philosophy of management that addresses solid wastes as a natural resource that is founded on the development of its various prerequisites; embodying proper policies, legislation, institutions, human resources, technological infrastructure and supportive public awareness. In addition, it aims to provide Solid Waste Management services to all segments of the community in an environmentally sound manner and with least possible cost. The broad objectives of the NSISWM are to eliminate uncontrolled accumulations of solid waste, and provide an efficient storage, collection, transfer and final disposal.

Accra city in Ghana indicates that recent policy directives and legislation suggest the Accra Metropolitan Authority (AMA) is at the very least interested in taking small steps that will place Accra's waste sector on the road to sustainable development. The range of options available is at present constrained by technical know-how and financial support of the state administration. But even within these constraints, the extent to which AMA can implement preferred technologies will depend on the greater participation of the residents it serves. For better or worse the future of Accra's waste management services is irrevocably tied to the involvement of the public. Neglect of these potential actors will result in severe consequences for the capital's environment health.

South Africa lacks formal recyclable programmes to recycle waste. Ogola *et al*, (2012) study indicates that South Africa's 60 % of waste can be recyclable and this is more as compared to other African countries. The implications of recycling would lead to the achievement of the Polokwane Zero waste declaration target of 50 % waste reduction by 2010 and zero waste generation by 2020. Ogola (2012) focused on the income groups versus waste generation. It was concluded that level of income of each household group determines the volume of waste generated by such a group, thus the higher the level of income for the group, the more waste it generates.

Ogola *et al.*, 2012 observed that volumes of waste and composition were not the same in each household group but this depended on the lifestyle. For example, the high income group had the lowest garden waste since they can afford private garden services that dispose garden waste after its generated, as compared to the low income group. The high income group also had the highest percentage of paper waste in a print form, which is linked to affordability.



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## CHAPTER 3: RESEARCH METHODOLOGY

In this chapter, a detailed description of the study area is discussed. Various methods used to collect data are also discussed. This study focuses on quantitative and qualitative characterisation of the wastes generated in Polokwane. In addition, it investigates solid waste management practices that are in place in the city, especially with respect to their environmental and institutional resilience. Assessment on recycling and recovering of waste will also be made.

### 3.1 Study area



Figure 3.1: The physical location of different suburbs in Polokwane (Net- Focus Interactive, 2012).

In 1904 Pietersburg had a population of 3,276, of whom 1,620 (49.5 %) were whites. The remaining 50 % were probably black. Pietersburg was a white-designated area during the apartheid period and so had an overwhelming white majority before 1990. After the dismantling of apartheid, the city retained a large white population. Neighbouring townships have an overwhelming (if not exclusive) black majority (S.A. History, 2010)

Polokwane features a semi-arid climate under the Köppen climate classification. Despite its position on the Tropic of Capricorn, the climate is tempered by its position on a plateau 1230 meters above sea level. Average temperatures reach around 21–22 °C in summer and fall to 11 °C in winter. As with much of inland South Africa, Polokwane has experienced notably warmer seasons over the last decade than its long term average. It has a dry climate with a summer rainy season and a pronounced dry spell during winter. The average annual rainfall is 495 millimetres in December or (less often) January the wettest month and July the driest. A comparative study of the solid waste management practices of experiences from four suburbs and city centre was undertaken.

The South African Census showed the population of Polokwane as 271,911 in 2001 and 503,000 in 2011. The population almost doubled in nine years. An increase in population means an increase in waste generation in the city. This requires a rapid increase in the municipal budget in order to effectively manage waste.

Under the apartheid government certain areas were allocated to certain racial groups; these areas still have a majority of these racial groups present.

- Westernburg - Former Coloured township
- Seshego and Mankweng - black townships outside Polokwane
- Nirvana - Former Indian township and;

Former White suburbs in the city include:

Bendor, Flora Park, Fauna Park, Penina Park, Hospital Park and Ster Park

These suburbs no longer host exclusive racial groups as the local government has launched a project to encourage integration.

The study was conducted in five residential areas located in the four different directions from the city centre within the Polokwane Municipality (see Figure 3.1)

The five residential areas were from different directions of the city. For instance, Westernburg is located at -23.9045587 Lat and 29.4309914 Long, 2.2 km on the western side of the city centre. Ivy Park is located at the South Westerly direction at -23.9188394 Lat & 29.4433238 Long at 1.873 km from the city centre. Fauna Park is on the East of the city centre at -23.9065.96 & 29.4861164 at 3.971 km., Welgelegen is located on the Northern part of the city centre at -23.893147 Lat & 29.4694361 Long at 5.681 km., and as one would expect, the City centre is on the centre of the city at -23.90881 Lat & 29.45279 Long.

### **3.2 Methods and Materials**

The approach and methodology used to achieve the study objectives were the following:

#### **3.2.1 Quantitative method**

Quantitative method is defined as a research method that is used to quantify the problem by way of generating numerical data or data that can be transformed into useable statistics (Wyse, 2011). This method was applied through enquiring on how waste is handled. That is, whether waste was weighed before being transported from different waste generators sites. It was applied through field surveys that were conducted during data collection from households. Questionnaire distribution took place over a period of 5 working days (8<sup>th</sup>-10<sup>th</sup>) in April 2013. Twenty voluntary participants were recruited from each residential area. These totaled 100 for the whole study area. Questions such as how the

participants dispose solid waste were asked and the responses were recorded on the questionnaire forms.

### **3.2.2 Qualitative method**

Wyse (2011) defines qualitative research as an exploratory research that is used to gain an understanding of underlying reasons, opinions, and motivations. Wyse (2011) further indicates that it provides insights into the problem or helps to develop hypotheses for potential quantitative research. Interviews, observations and field notes were used as data collection procedures. Interviews were used to collect information from the municipal officials for solid waste. Polokwane Municipal Office and the Waste Management Strategic Business Unit were visited where a number of questions on how waste is managed were asked. A visit to the landfill site was undertaken by researcher in the company of Municipal official for observations.

Question asked during the interview were as follows:

General information. For example, age, gender, educational level, employment information, income, assistance provided by the government.

- Methods used for disposal
- The number of bags or trash disposed weekly
- Types of containers used to store waste
- Whether waste is recycled.

### **3.2.3 Field survey**

Enquiry whether on-site waste separation and measurements is done at individual households from five residential areas. Ten *litre* plastic bins and 50 kg weighing scale were used to collect and weigh the wastes selected during sampling from households (Ogola *et al.*, 2006). Gloves and refuse bags were



used for sorting the wastes; while facemasks and safety attires were used for protection during the sampling and measurement period.

### **3.3 Sampling Plan**

About 100 voluntary respondents were recruited from the five study areas. Respondents were representative of all local ethnic groups, genders and were all 18 years or older. All respondents were briefed in advance about the study and what it entails. The respondents were also briefed about their rights and were also assured that their identities will be kept secret. Respondents were also assured that they could withdraw anytime from participating in the study when they want and nothing will be held against them. Basic demographic information was required from the participants such as age and education. Random sampling method was used during the study, where participants were recruited randomly in each study area. The interview schedule was 15 minutes and the participants were asked questions related to solid waste management practices.

The Qualitative interview was divided into two sections.

Section 1 comprised questions which were aimed at eliciting respondents' biographical profile, age, gender, educational level, employment information, income, kind of assistance received and the type of assistance received from the governments collected from the work which is relevant to the objectives of the study. These questions provide information which might have a bearing on the findings of the study.

Section 2 covered a range of questions pertaining to the key investigative questions in an attempt to ascertain the impact of solid waste and wastes management practices in the Polokwane City.

This could, amongst others, shed more light on:

1. Current disposal of garbage by using one or more of these methods:

- 1.1 Burn it somewhere near your house or business?
- 1.2 Bury it somewhere near your house or business?
- 1.3 Haul it to the community dump or landfill yourself?
- 1.4 Dump it in a secluded spot away from the community?
- 1.5 Collected and taken to the landfill
- 1.6 Recycle cans or order waste.
- 1.7 Type of container to store garbage in before disposing it off
- 1.8 Large dumpster near your home or business
- 1.9 Metal or plastic garbage cans at your home or business
- 1.10 55-gallon drums / barrel
- 1.11 Plastic bags

2. About how many bags of trash do you dispose of each week?

- 2.1 1-2 bags per week
- 2.2 3-4 bags per week
- 2.3 3 -7 bags per week
- 2.4 More than 7 bags per week

3. Types of waste

- 3.1 Old batteries
- 3.2 Old appliances, snow machines....
- 3.3 Household hazardous waste
- 3.4 Used oil

In other sections, questions were referred to a range of questions pertaining to the key investigative in an attempt to ascertain how the municipality manages solid waste.

- Take them to the landfill / dump.
- Throw them out in the yard.

- Take them to a battery collection area or tote.
- Dump them in the landfill / dump
- Dump them in your hard
- Pour them in the sewage lagoon
- Take them to a special collection area in the community.

In the qualitative questionnaire, respondents had to:

1. Described any ways that they dispose garbage
2. Indicate the method used most often
3. Specify what they recycle

### 3.4 Polokwane Disposal Site

Figure 3.2 shows a sign board at the only landfill site, Weltevreden, in Polokwane which was visited during the study. Interview with the site management revealed that the site has been operating for almost 15 years. The Polokwane Municipality has contracted a company to operate the landfill.



Figure 3.2: Weltevreden land fill site

A mountain of waste (see Figure 3.3) is formed due to compaction that is done using a compactor from time to time. This rubbish heap looks like any other normal mountain from a distance, but a closer look shows the waste material protruding in different parts. Tons of waste are disposed off daily and they are weighed at a weighing bridge (see Figure 3.4) at the entrance to the landfill. A report compiled by a contracted company indicated that waste disposed by April 2013 was 4 242 tons.



Figure 3.3: A mountain of waste in Weltevreden landfill site



Figure 3.4: Waste weighing bridge

The municipality of Polokwane collects solid domestic and business waste and dispose to the landfill. Individuals are responsible for the collection of rubble and garden waste to the disposal site. The records from the landfill site indicate that the municipality disposes the highest amount of waste by their trucks (see Figure 3.5).





Figure 3.5: Municipal truck after waste disposal at Weltevreden landfill site

The landfill site only allows the disposal of domestic, garden, rubble and business waste. However the municipality agreed with some companies such as Polokwane Brewery, to manage their special wastes. Since the Weltevreden landfill is not lined, it cannot be used to dispose off hazardous waste. This landfill is accessible for 24 hours every day by the municipality and from 7:00 to 18:00 by individual residents.

There are waste reclaimers on site who reclaim waste for reuse, recycling and recovery. Most of the reclaimers come from Zimbabwe and a few are South Africans. They reclaim different material. For instance, some reclaim papers, card boards, bottles and plastic bottles. Most reclaimers focus on plastic bottles (see Figure 3.6). Every reclaimers reclaims according to their needs and they have contracted with buyers who come to the site to collect the reclaimed items. Reclaimers have weighing scales where they way items per kg and buyers pay them before they leave the site.



Figure 3.6: Reclaimed plastic bottles

The private sector has over the last decade predominantly been involved with waste minimisation and recycling issues in South Africa. The new focus of government enhanced the importance of waste characterisation studies in terms of identifying the recycling and composting potential of general waste streams generated from various socio-economic residential areas and central business districts of South Africa. Even though a number of pilot studies and small scale separation at source projects have been undertaken, at municipal level very little is currently in place. Legislation has not compelled the public or industry to reduce waste generated or to separate out their recyclables at source. The Waste Bill mandates municipalities to undertake separation at source for general (household and commercial) waste, which they are responsible to manage (Fiehn, 2007).

The modern practices of waste management such as open dumping, incineration (burning), composting and landfill (burial), can be traced back to early civilisation.

However, the practices were conducted haphazardly and specific to particular cultures and traditions. The quest for a cleaner environment has introduced the modern systematic management approach of storage, collection and disposal of waste. Countries all over the world have acts that provide for the removal by the local authorities, on specified days, accumulated wastes from premises. The waste is normally placed into removal receptacles, bags and bins, for easier removal. This rapid revolution of waste management that started in the developed countries has spread to the developing countries, particularly the more affluent areas.

Department of Environmental Affairs and Tourism (DEAT), 2000 indicates that the advances in technology have also contributed immensely to the common practices today of waste management. Fifteen years back, waste management was not regarded as a national priority issue in South Africa. The waste management practice that took place before 1994 focused mainly on waste disposal. The low emphasis that was accorded to waste management has resulted in waste impacting negatively on South African environment and on human health. In 1999, South Africa adopted the National Waste Management Strategy (NWMS). This strategy outlines the goals to address waste management in the country. The entire strategy is based on a 3R (Re-use, Reduce, and Re-cycle) to improve the quality of the environmental resources affected by uncontrolled and uncoordinated waste management.

Solid waste management in developing countries/emerging economies is generally characterised by highly inefficient waste collection practices, variable and inadequate levels of service due to limited resources. There is also a lack of environmental control systems and appropriate legislation, limited know-how, indiscriminate dumping, littering and scavenging and, most of all, poor environmental and waste awareness of the general public (Matete and Trois, 2008).



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## **CHAPTER 4: DATA ANALYSIS AND INTERPRETATION OF RESULTS**

### **4.1 Introduction**

In this chapter, an analysis of data collected from residents is presented. A discussion of the findings will be based on the responses of the 100 residents who completed the questionnaires for this study.

The goal of this research was to assess solid wastes management practices in Polokwane City. Historically, solid waste generated from homes (households) includes a number of items that are not generally thought of as `solid`. This type of waste includes household, refuse, rubbish, liquids and gases that are confined in solid containers and disposed of with conventional solid wastes. It is noted that solid waste could be harmful to the environment, the health and well-being of the public and other living and non-living organisms within and beyond the area as some pollutants possess poisonous chemicals. This calls for knowledge of solid waste management and compliance with the regulation.

It is well known that the environment still continues to be massively destroyed through degrading human activity as the different metros and municipalities in this country are highly littered. To this end, the solid waste management and procedures have to be adequately enforced to comply with the remedy of the environment from destruction. Failure to pay attention to solid waste management often leads to various diseases and serious pollution as it is important that such waste be disposed of effectively and efficiently to promote a healthy community. This benefit will be directed to the community and the public sector on a mutual understanding of protection of the environment and the people.

This study first made a comparison on how households, suburbs and the municipality took responsibility in storing, collecting, transporting, treating and disposing of solid waste. Secondly, it investigated problems encountered by the City

in managing solid wastes. Lastly, it made relevant recommendations aimed at improving solid waste management practices within the Polokwane City.

Data were collected by means of a questionnaire which was specifically designed for this study by the researcher, based on literature review and the investigative questions to be answered. The questionnaire was divided into three sections.

The first part covers qualitative data and is divided into two sections.

The first section reports on the following the demographics variables: Gender, age, educational level, employment information and income. The second section covers the role of local government and the last section will focus on the specific waste management variables.

Each of the variables were analysed independently and then paired up to assess their impact on solid waste management within the community.

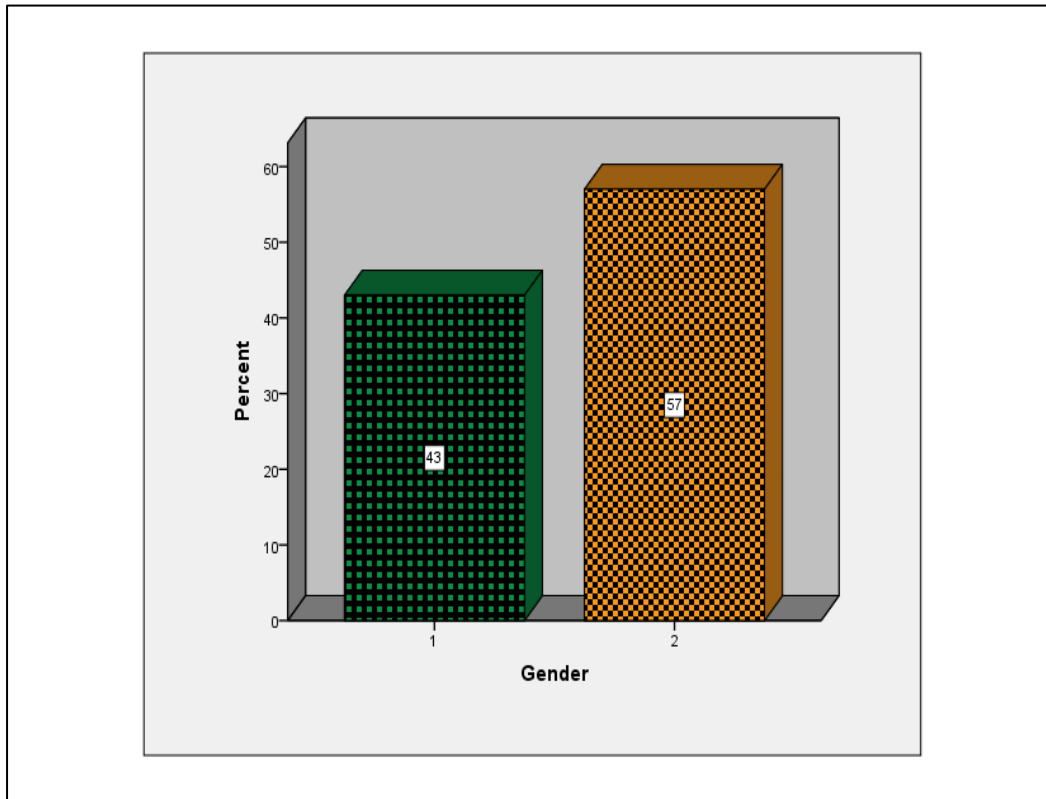
## **4.2 Demographics**

Demographics is the study of the behaviors and other characteristics of groups of human beings in terms of statistics (Rouse, 2005). These are socioeconomic groups characterized by age, income, sex, education, occupation, etc.

### **4.2.1 Gender of respondents**

As indicated in the bar chart below, of the 100 employed respondents 43 were males and 57 were females (Figure 4.1). This is to be expected because of the historical exclusion of women from formal employment especially in professional positions. This composition is reflective of the report on labour survey (Stats S.A, 2013). With the changing social changes, transformation within organisations, employment opportunities and other career options which were previously reserved for men have now opened for women.

Figure 4.1 presents gender distribution of the 100 employed respondents who participated in the questionnaire of solid waste management practices in Polokwane city.



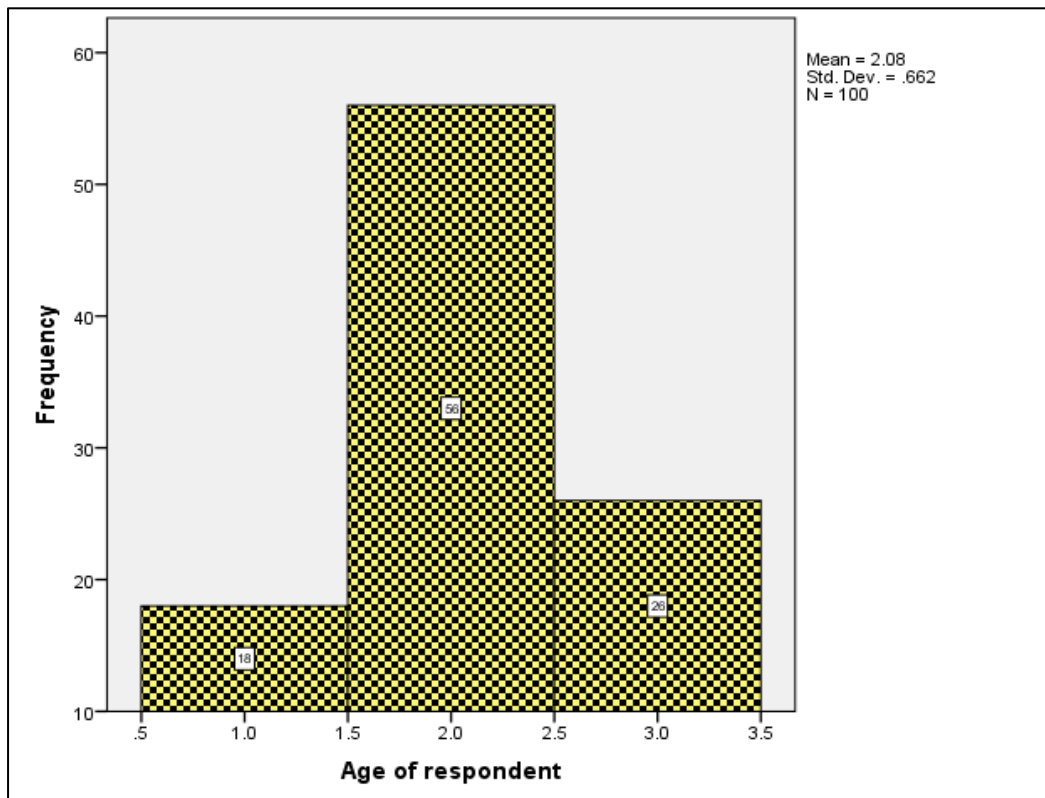
**Figure 4.1 Gender distribution**

As indicated in the bar chart (Figure 4.1), 100 respondents 43 were males and 57 were females. This is to be expected because of the historical exclusion of women from formal employment especially in professional positions. This composition is reflective of the report on labour survey. With the changing social changes, transformation within organisations, employment opportunities and other career options which were previously reserved for men have now opened for women.

Historically, employees were predominantly males. As in other careers and professions such as information technology, financial, institutions and science. Some sectors started to accept and recruit women very late; the new regulation like employment equity compels the public works to employ more women.

#### 4.2.2 Age of respondents

Figure 4.2 presents data on the age of household respondents who participated in the study.

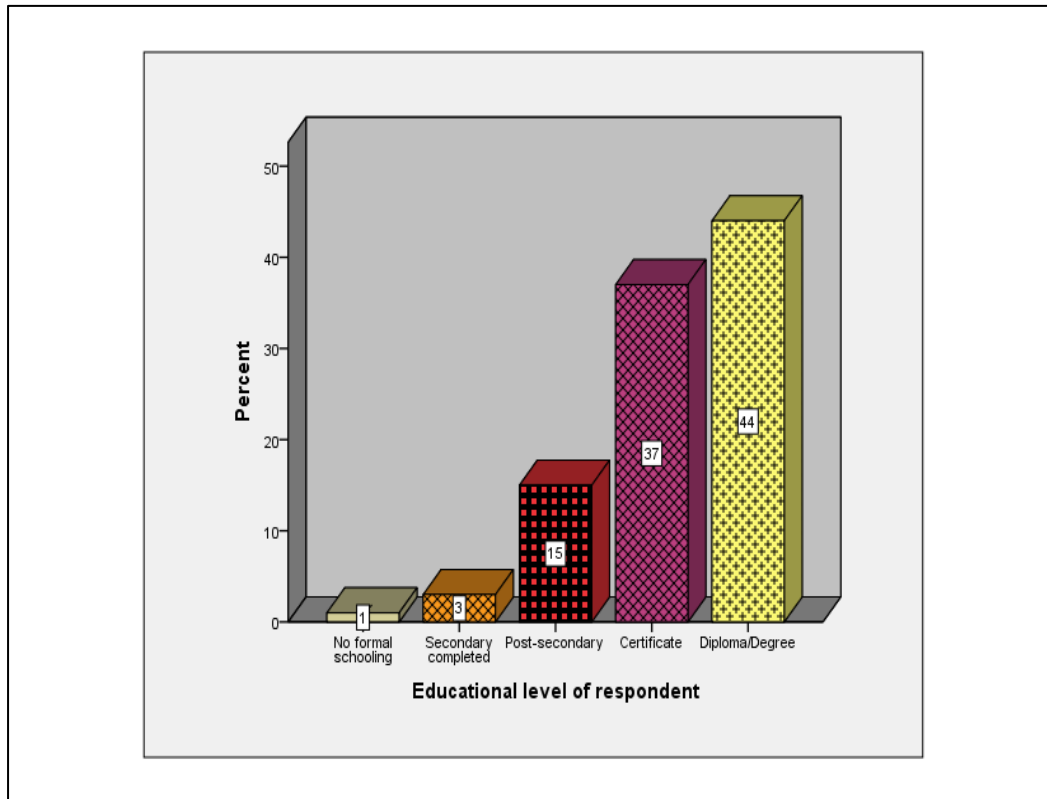


**Figure 4.2 Age of respondents**

The age distribution of the respondents in figure 4.2 shows an interesting aspect, in that the most common age group slots are that of 35 to 44 years, followed by the group age of 45 to 64 years, which represents 56 % and 26 % respectively. This is pointing towards the national trend. This is in relation with the Labour report that indicated people within these age groups are the ones employed.

### 4.2.3 Educational level of respondents

Figure 4.3 provides a summary of the data on educational level of the respondents.

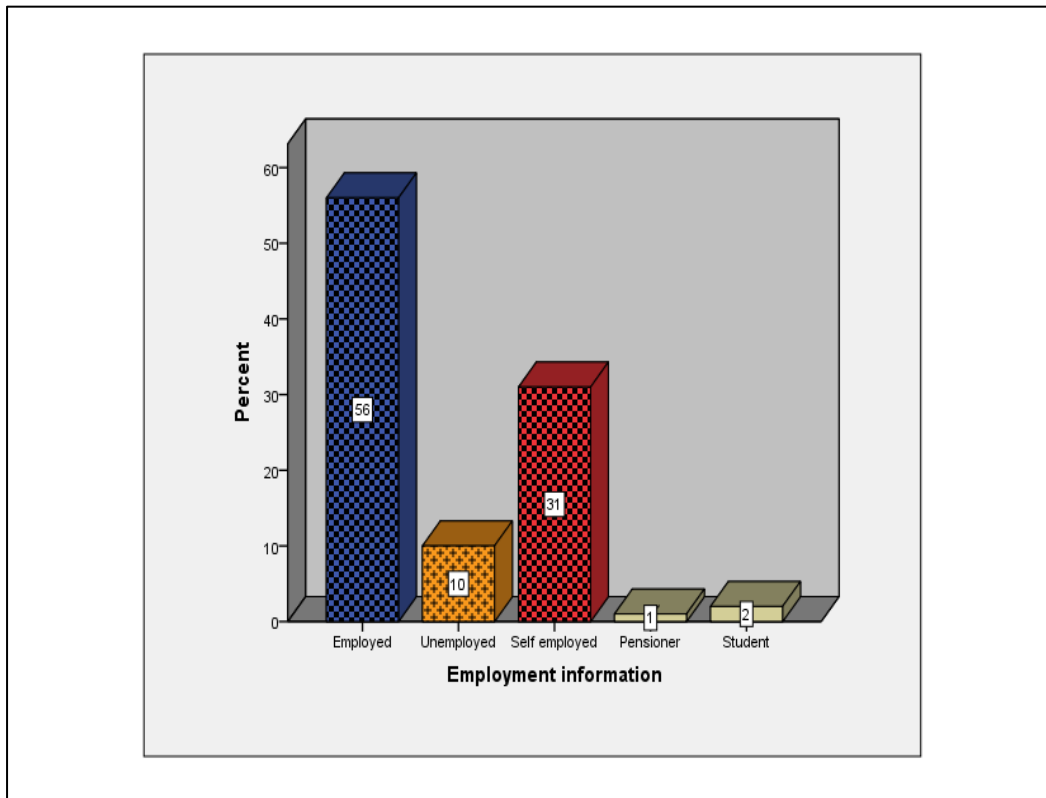


**Figure 4.3: Educational Levels**

A large number of respondents (81 %) had post high school education (certificate, diploma and degree). Fifteen percent had high school education, 3 % had Intermediate school education and 1 % had no formal schooling. The high number of individuals who completed post high school education augurs well for the city's waste management endeavours and economy.

### 4.3 Employment information of respondents

Figure 4.4 presents data of the employment information of the 100 respondents who participated in solid waste management practices questionnaire in Polokwane city.

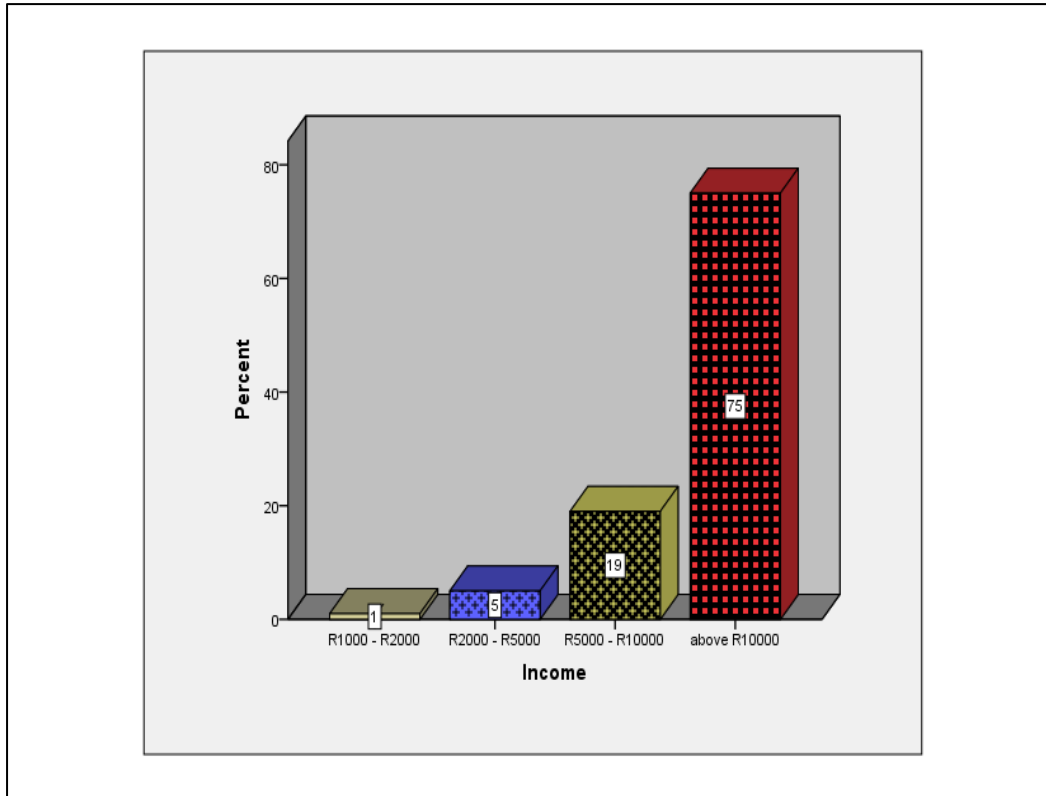


**Figure 4.4: Employment information**

The majority of the respondents in Polokwane, 56% were found to be professional employees, 31 % indicated that they are self-employed and 13 % are unemployed. These statistics correspond with the level of education of the respondents. For example, the high number of respondents that have acquired post high school education (81 %) could have influenced the employability of the participants to a total of 87 %. From the results of the analysis, it may be assumed that there is a very good support from the government which promotes policies that promoted job creation and made the market favourable.

#### 4.2.5 Income of respondents

A high percentage of the respondents, 75 %, indicated that they earn above R10,000 followed by 19 % who earn between R5,000 to R10,000 and 6 % of the respondents earn between R2,000 to R5,000 (see Figure 4.5).



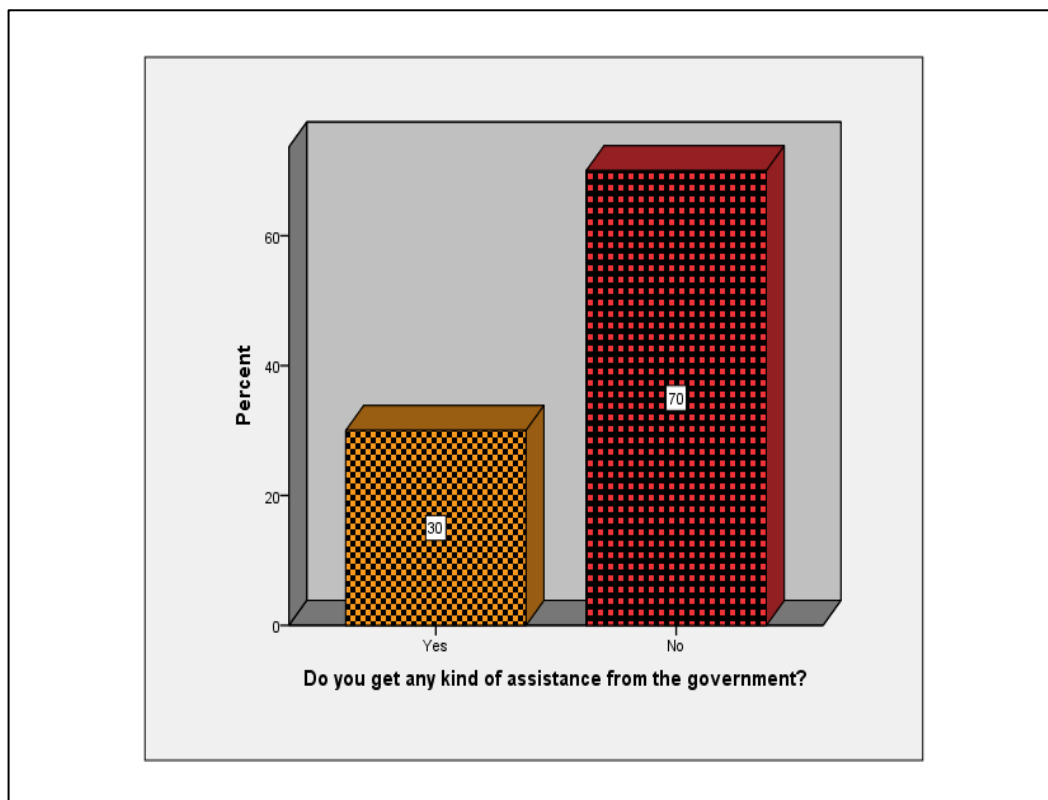
**Figure 4.5: Income Distribution**

The positive response by a high number of respondents indicates the benefit of the educational and the desire to obtain a degree / diploma as a reward of further studying after completing high school education. Better post school qualification improves employment opportunities, as it was discussed earlier.



### 4.3 Assistance from the government

Figure (4.6) shows percentages of people from the 100 respondents who receive assistance from the government. This sort to find out any assistance that the respondents receive from the national government; example; social grants. And also assistance that the government as an employer can provide to the people, example, medical aid subsidy and housing allowance.

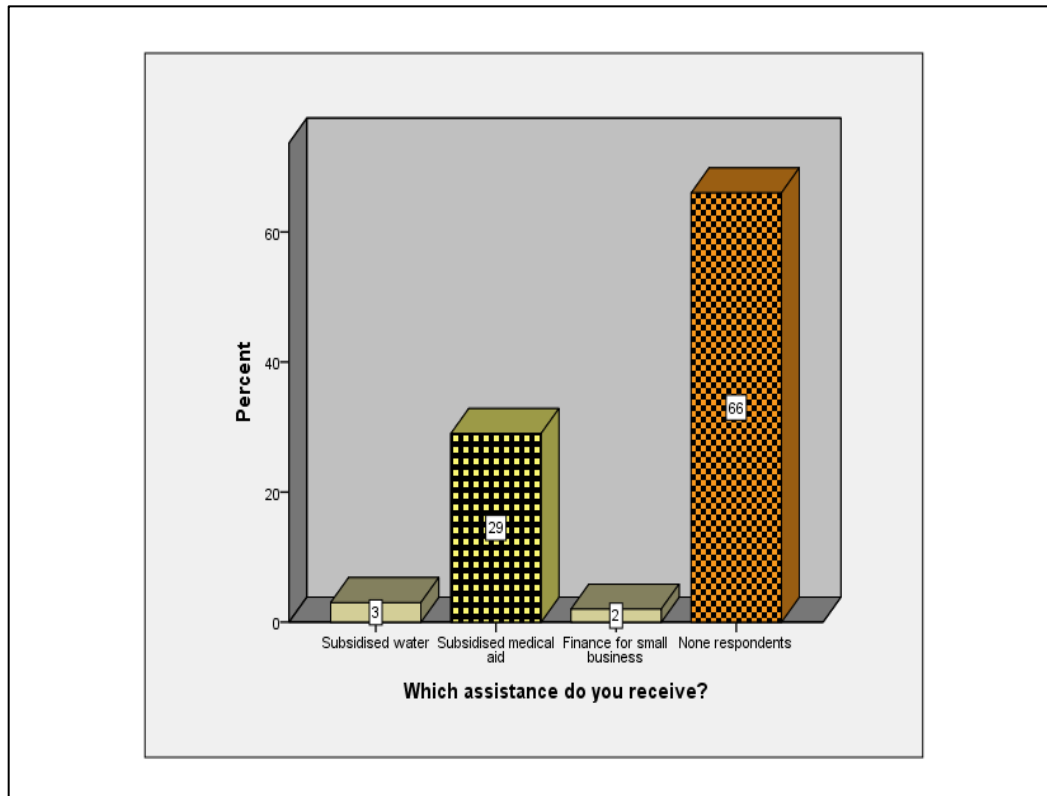


**Figure 4.6: Assistance from the government**

A large number of respondents, 70 %, disagreed that there is adequate support from the government. One can infer that this problem might depend on the relevant skills or educational qualifications or work experience of the candidate.

### 4.3.1 Kind of assistance received

Figure 4.3 below indicates types of assistances that participants from the 100 respondents received. These participants took part in the questionnaire for solid waste management practices in Polokwane city.



**Figure 4.7: Kinds of assistance**

About 66 % of respondents reported that they do not receive any form of assistance, but these results could also mean that the question was not understood (Figure 4.7). About 29 % of the respondents indicated that they received subsidised allowance towards their medical aid costs; 3 % indicated that they receive subsidized water, 2 % indicated that they are subsidised in form of finance for small business. This disparity could be directly ascribed to the skills levels, position occupied and the productivity of employees.

## 4.4 Waste management practices

### 4.4.1 Burning of solid waste material near houses or businesses

Figure 4.8 indicates the percentage of respondents who burn waste near their houses or businesses. About 99% of the respondents indicated that they do not burn waste near their houses. The remaining 1% agreed to have been burning waste near their houses. This could mean that a larger percentage in Polokwane city are not putting the environment at risk with regard to waste burning. However, it could not be concluded that people are aware of the damage waste burning can cause to the environment.

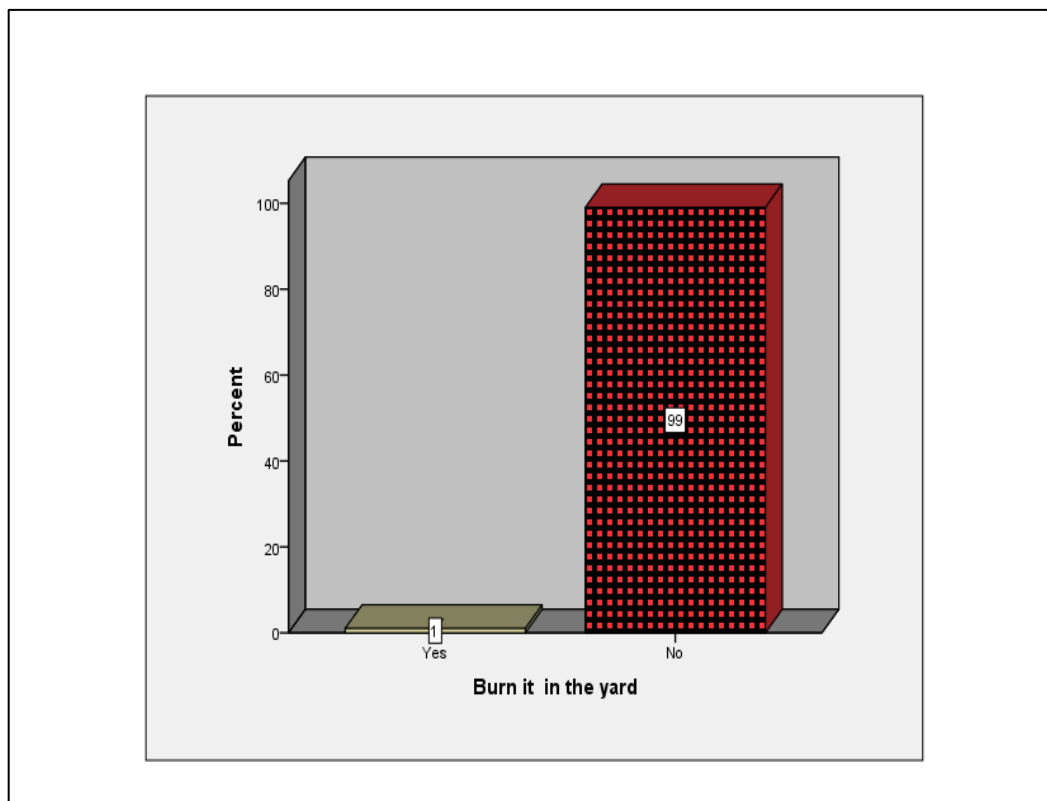


Figure 4.8 Distribution of waste burnt in the yard

#### 4.4.2 Burying solid waste near the house or business

Table 4.1 indicates the frequency and percentage of people who bury wastes near houses.

**Table 4.1: Burying of solid waste near your houses**

	Frequency	Percent
Yes	1	1.0
No	99	99.0
Total	100	100.0

The large number of respondents (99 %) do not bury solid waste near their house and it is collected from their homes by the municipal waste management company. This practice will limit possible diseases that could emanate from the decomposed solid waste buried near the house.

#### 4.4.3 Hauling of solid waste to the community dump or landfill

Table 4.2 below indicates the frequency and percentage of people from the 100 respondents who haul waste in the community dump or landfill it themselves.

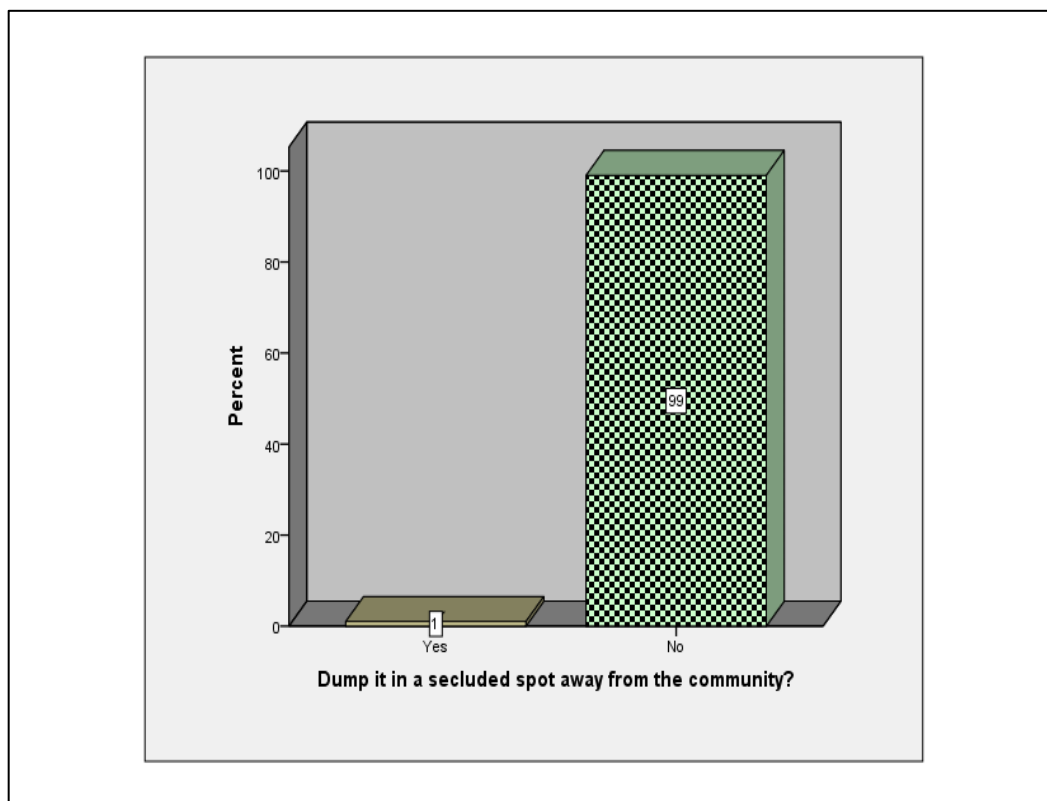
**Table 4.2: Haul waste to the community dump**

	Frequency	Percent
Yes	1	1.0
No	99	99.0
Total	100	100.0

Of the 100 respondents 99 % indicated that they do not frequently haul waste to the community dump. This could be because the respondents have prescribed days where the municipality collects waste to the landfill and do not see a point for hauling it. The remaining 1 % responded positively to hauling waste in the community dump. This could mean that the prescribed single day in a week for the municipality to collect waste is not enough. The waste storage bins may be full and people do not have alternative storage containers and may cause bad odour in the households.

#### 4.4.4 Dumping solid waste in a secluded spot

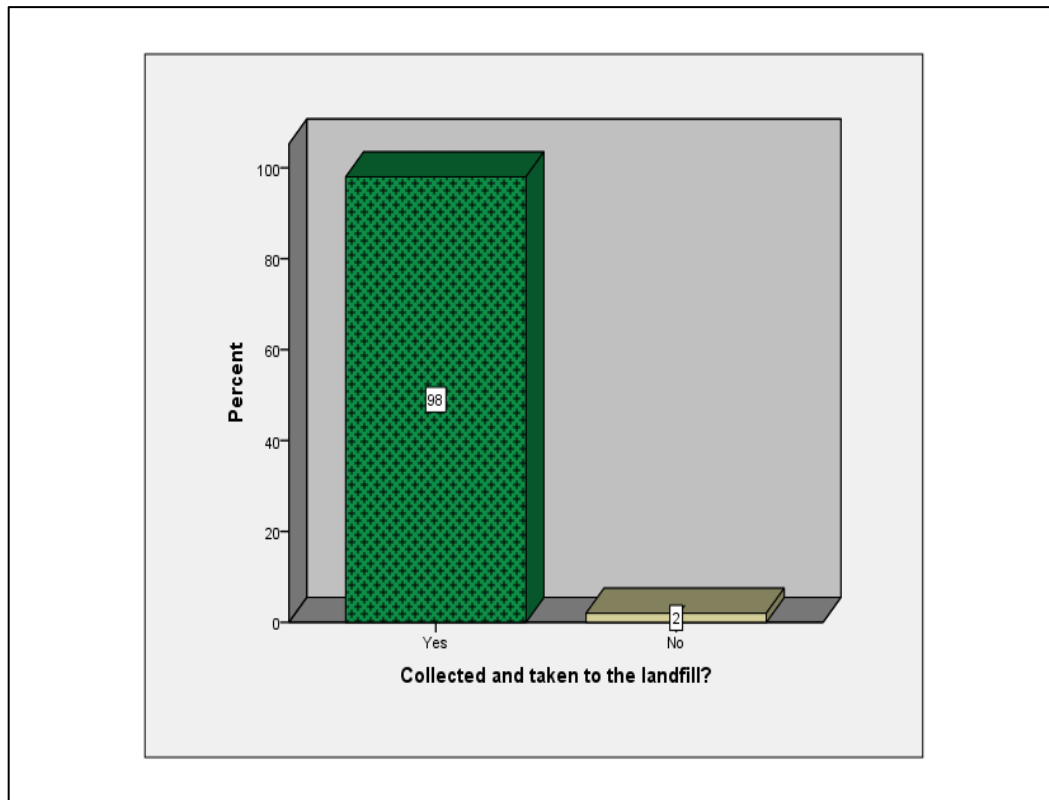
Figure 4.9 indicates that 99 % of the respondents do not dump their solid waste randomly in secluded spots. This response indicates a high level of awareness about good waste management practice. Only 1 % of the respondents randomly dump waste in the scheduled spot. This could be waste that the municipality does not collect for landfilling; that is grass, leaves, etc.



4.9: Dumping in a secluded spot

#### 4.4.5 Collection and taking solid waste to the landfill

Figure 4.10 shows the percentage of respondents whom their waste is collected and take to the landfill.

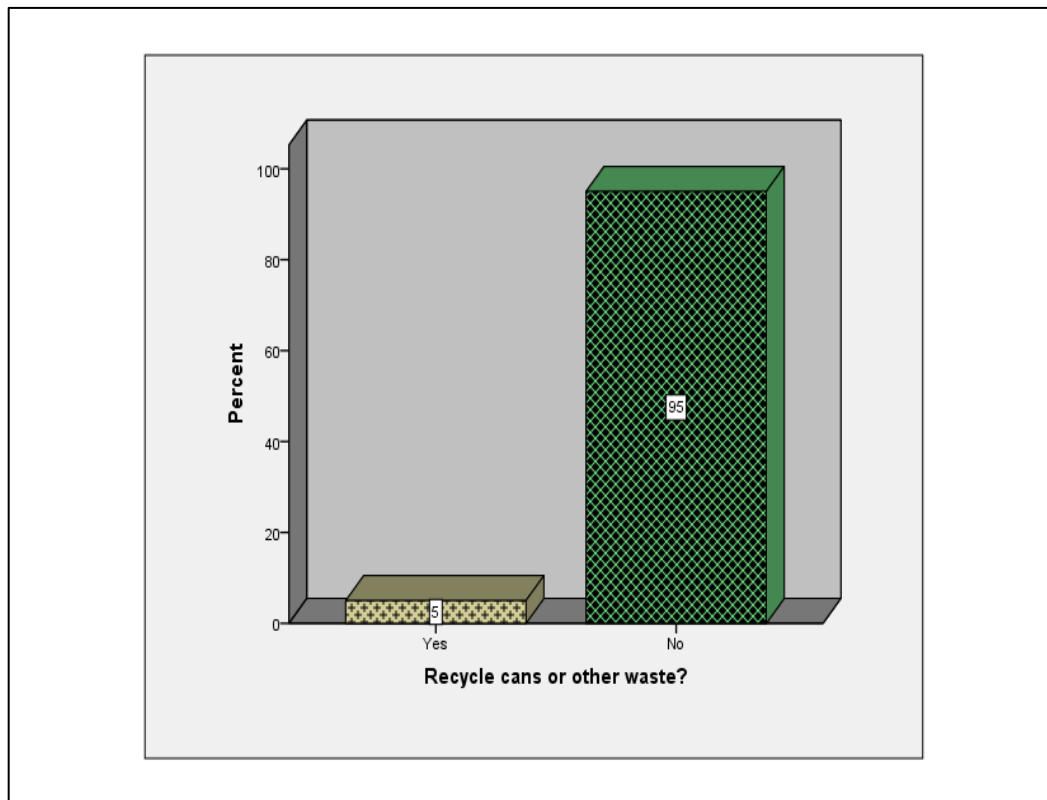


**Figure 4.10: Waste collected and taken to the landfill**

Regarding this section, a large number of respondents (98%) agreed that there is regular collection of waste in the area. This points out that waste management works as a cohesive unit in the implementation of their plan and achieve their project objectives successfully. Failure to take attention to solid waste management will lead to various diseases and serious pollution as it is therefore important that solid waste be rendered effectively and efficiently to promote a healthy community. This benefit will be directed to the community and the public sector on a mutual understanding of protection of the environment and the people.

#### 4.4.6 Recyclable waste

Figure 4.11 below indicates the percentage of recycling waste from the 100 respondents in a questionnaire conducted in Polokwane City.



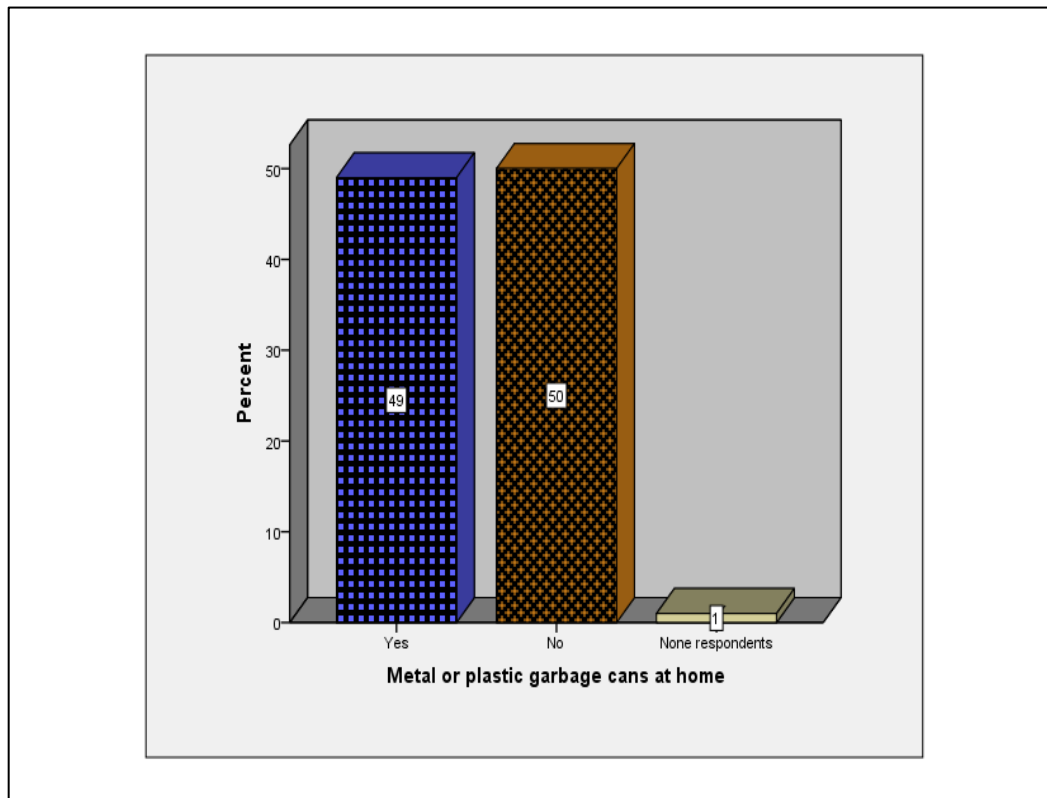
**Figure 4.11: Recycling waste**

As indicated in the above bar chart, 95 % of the respondents strongly disagreed that they recycle waste. It is the responsibility of the management to recycle waste products.

#### 4.4.7 Type of storage container for garbage before disposal

##### 4.4.7.1 Metal or plastic garbage cans at home

Figure 4.12 indicates the percentages of metal or plastic garbage cans at their homes or businesses.



**Figure 4.12: Metal or plastic garbage cans at your home or business**

As indicated in the preceding bar chart, 50 % disagreed and 49 % agreed to the statement. This is positive because collection and disposal of waste are viewed generally as tools for keeping the environment clean and safe from objects that could cause damage to the environment.



#### 4.4.7.2 Cardboard boxes at your home or business

The following Table (4.3) indicates the frequency and percentage of people who store waste in cardboard boxes at their homes or businesses.

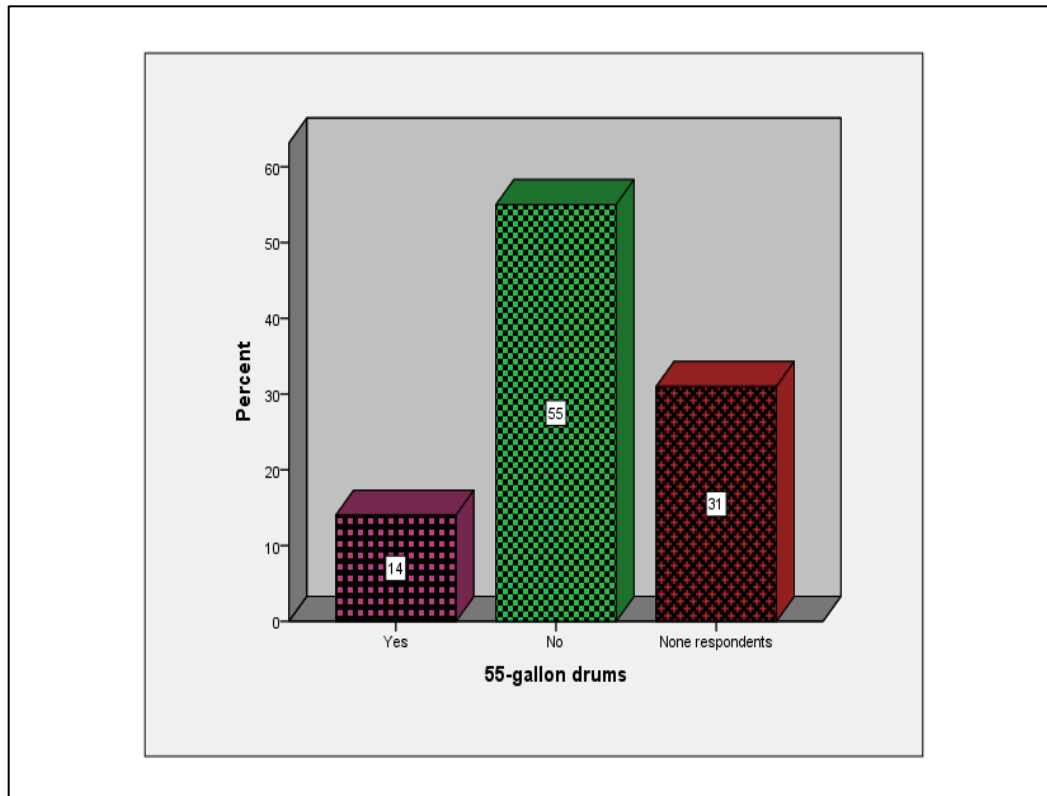
**Table 4.3: Cardboard boxes**

	Frequency	Percent
Yes	1	1.0
No	98	98.0
None respondents	1	1.0
Total	100	100.0

Of the 100 respondents, 98 % indicated that they do not use cardboard boxes as containers to store garbage prior to disposing of it. This indicates that the majority of the respondents utilise other types of container.

#### 4.4.7.3 55- gallon/ 200 litre drums

Figure 4.13 shows the percentage of people who store waste on 200 litre drums from the 100 respondents who participated in a questionnaire of solid waste management practices.

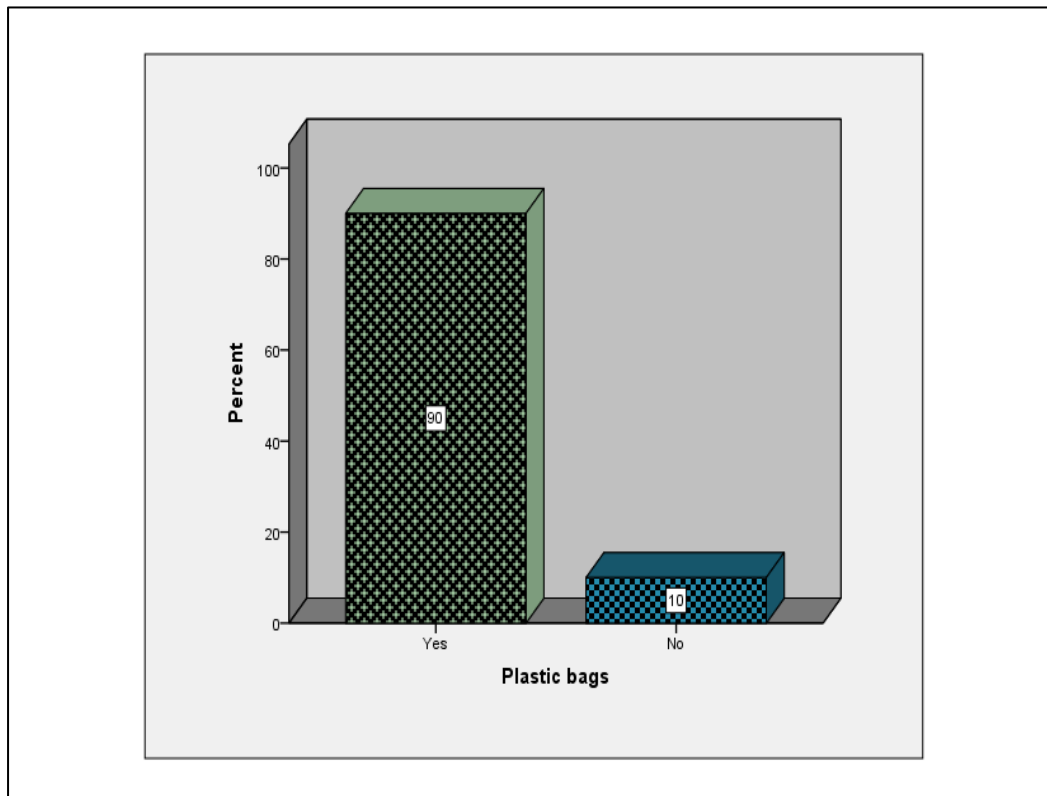


**Figure 4.13: 200 litre drums**

The analysis shows that 55 % of the respondents strongly disagreed and 14 % agreed to dispose the 200 litre drums.

#### 4. 4.7.4 Plastics bags

The following Figure (4.14) shows the percentage of people who store waste on plastic bags from the 100 respondents; who participated in the solid waste management practices questionnaire.

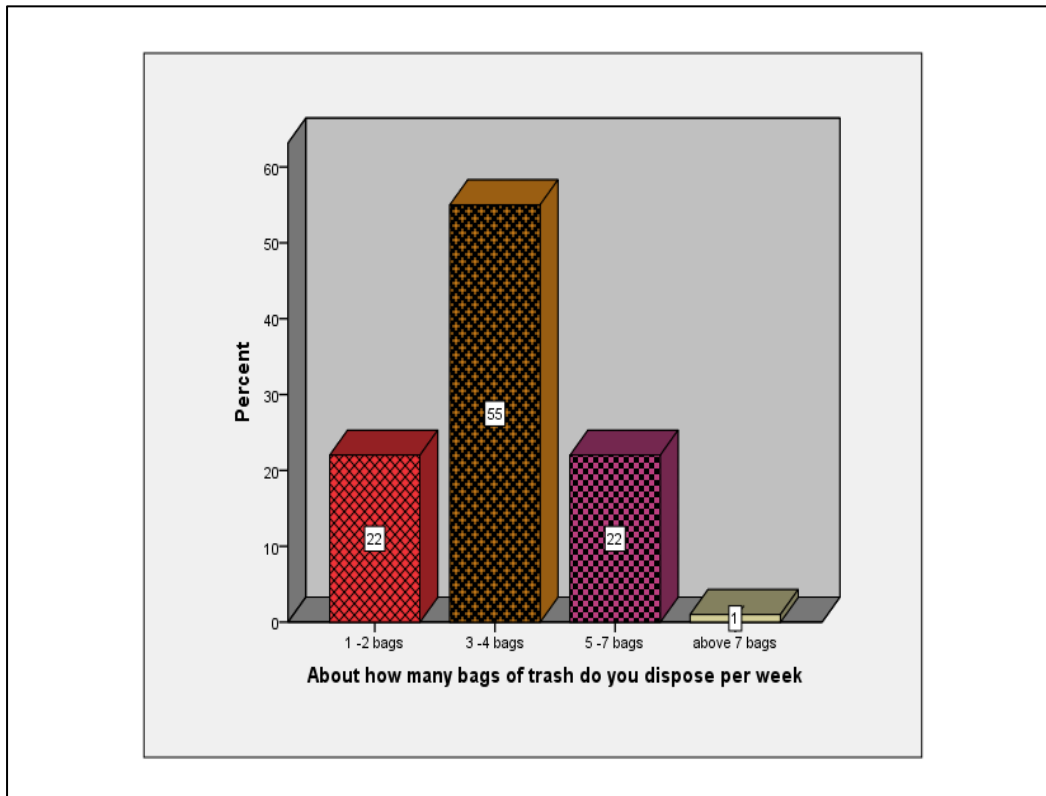


**Figure 4.14: Plastic bags**

The large number of respondents agreed that they store garbage in the plastic bags. This view is aligned with the government strategy which seeks to ensure that communities protect their environment. This indicates that, for the Polokwane municipality, to educate the community on how to keep solid waste management is not a problem.

#### 4.4.8 20 L bags of trash disposed of each week

The Figure (4.15) below indicates the number of bags disposed of weekly by respondents who participated in a solid waste management practices questionnaire in Polokwane city.

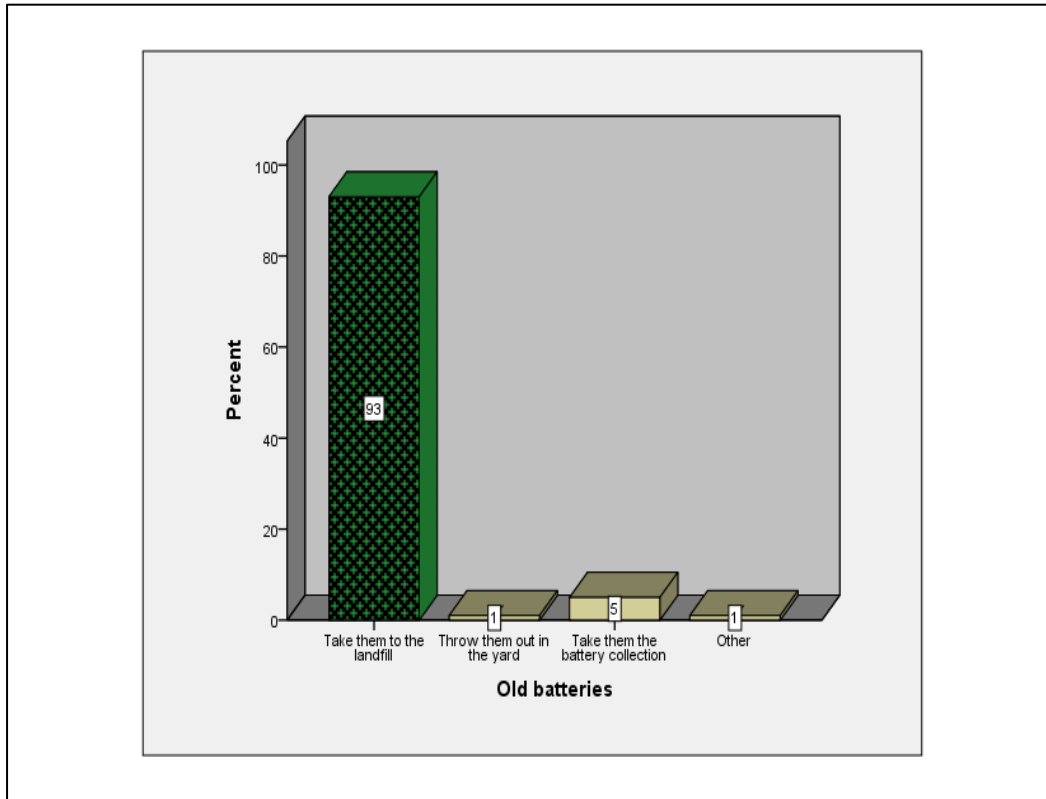


**Figure 4.15: Bags of trash disposed per week**

From the results of this study, 55 % indicated that they use 3 to 4 bags (20 L) per week. 22 % indicated that they use 1 to 2 disposable bags. Similarly, 22 % indicated that they use 5 to 7 bags per week and only 1 % was using more than 7 bags. This was not surprising since the community knows about the solid management. All this adds to the success rate of solid waste management practices in Polokwane city. This confirms that solid waste management is rendered effectively and efficiently to promote a healthy community in this municipality.

#### 4.4.9 What do you do with the following types of waste? Old batteries

The following Figure (4.16) shows what the participants do with old batteries.

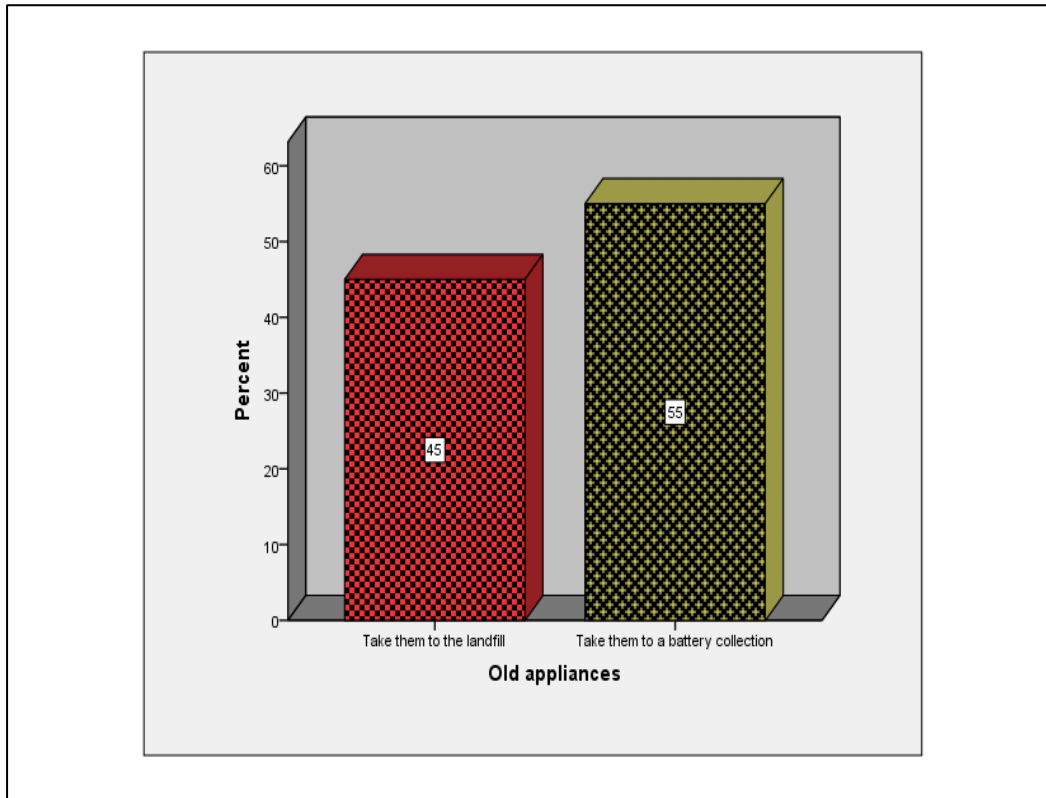


**Figure 4.16: Old batteries**

A large number of the respondents, that is 93 % believed that they have to take solid waste to the landfill as they know the impact of solid waste health, economics, engineering and environmental considerations. Failure to take action may lead to various diseases and pollution that might also cause degradation of the environment.

#### 4.10 What do you do with the following types of waste? Old appliances, snow machine, four wheelers, boat motors, trucks

The following Figure (4.17) shows what the people do with old appliances in percentage.



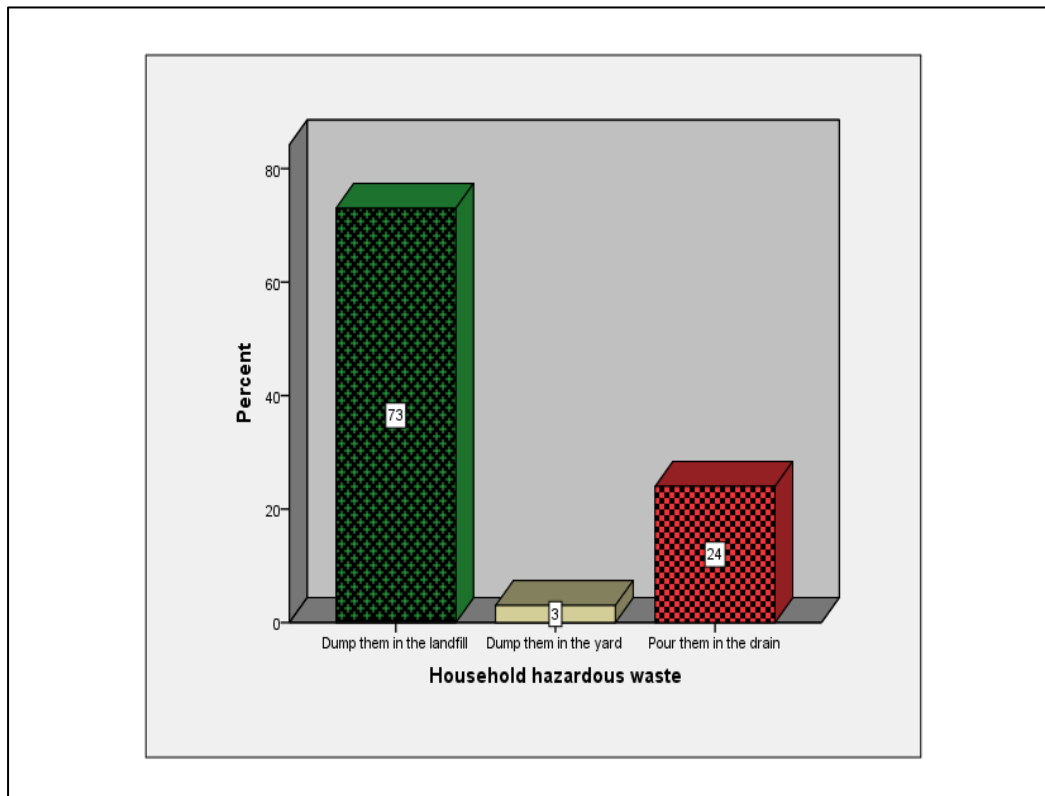
**Figure 4.17: Old appliances**

Of the 100 respondents, 55 % believed that old appliances and other staff have to be taken to a battery collection centre and 45 % believed that it is important to take them to the landfill. What is positive about this response is that the community is aware that solid waste needs to be moved out of their homes. This approach inevitably leads the success of the Polokwane municipality to solid waste programme.

#### 4.4.11 What do you do with the following types of waste?

##### 4.4.11.1 Household hazardous waste

Figure 4.18 shows how households handle hazardous waste in Polokwane city. this was part of the questionnaire for solid waste management practices.



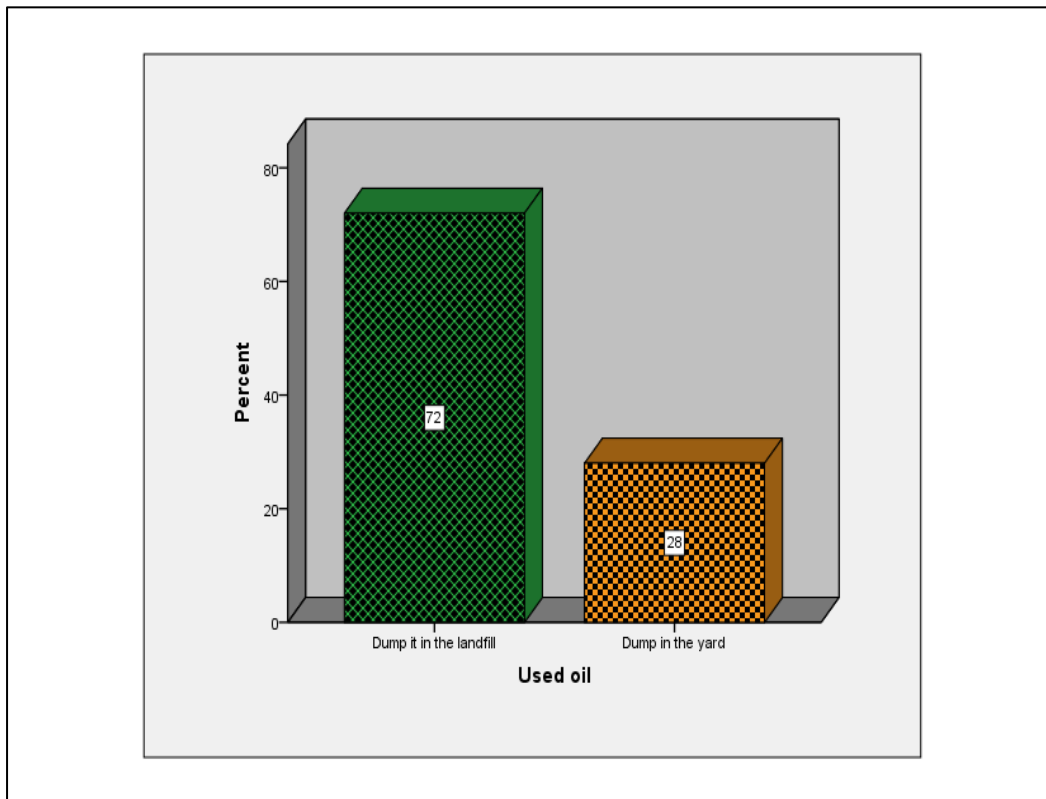
**Figure 4.18: Household hazardous waste**

The majority of the respondents 73 % agreed that household hazardous waste have to be dumped in the landfill. 24 % indicated that they have to be poured in the drain, whilst 3 % indicated that they should be dumped in the yard. This result suggests that little challenges exist as far as household hazardous waste with the community is concerned. The lack information thereof of the community to handle hazardous waste, calls the waste management to continue educate the community as this will create serious problems in the City. New sets of knowledge, skills and behaviour are necessary to be undertaken within the Polokwane city in hazardous waste management. Organisations are required to become learning entities that

continuously enhance the knowledge, skills and experience of their human resources, including Polokwane Municipality.

#### 4.4.11.2 Used oil

Figure 4.19 indicates the percentage of people and how they dispose of used oil.



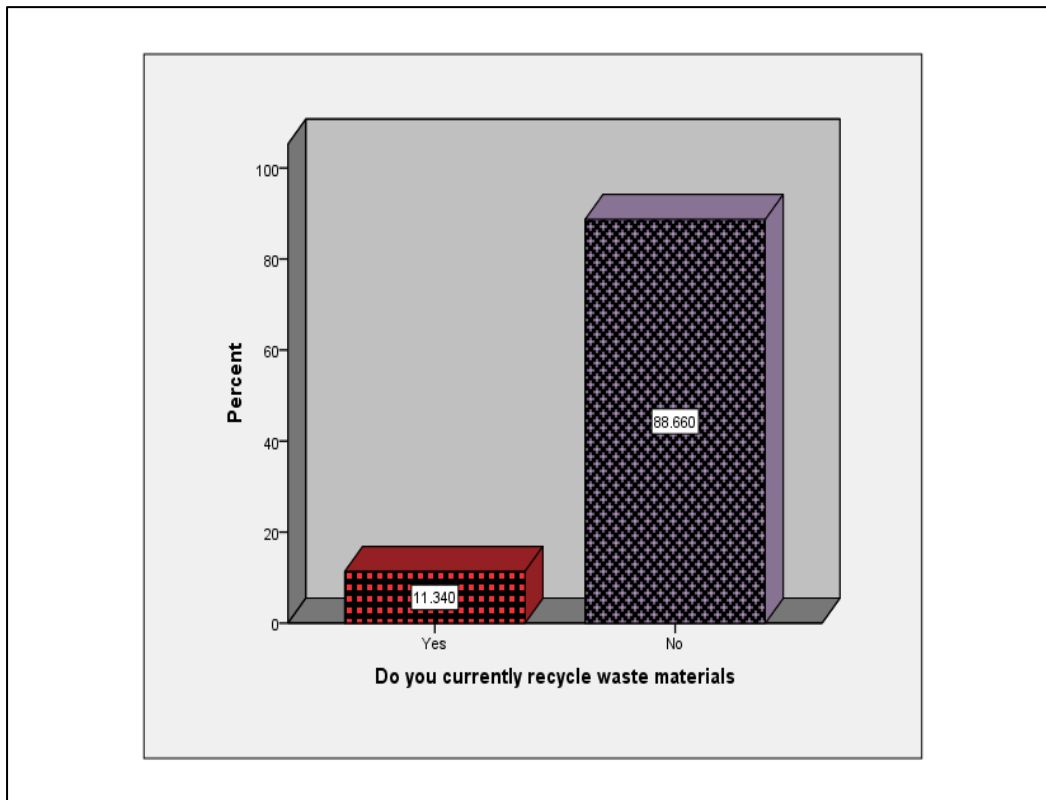
**Figure 4.19: Used oil**

The majority of respondents 72 % believe that used oil can be dump in the landfill while 28 % think to dump in the yard. Lack of knowledge about solid waste could be harmful to the environment, the health and well-being of the public and other living and non-living organisms within and beyond the area. This is due to some pollutants that possess poisonous chemicals existing in the community of Polokwane. This confirms that this community have the knowledge of solid waste management and comply with the regulation. This could further explain the increase in the likelihood of the Municipality success within the city.



#### 4.18 Current state of recycled waste materials

The following figure (4.20) indicates the current state of recycling of waste materials in Polokwane city.



**Figure 4.20: Current state of recycled waste materials.**

The above results shown in Figure 4.20 indicates that, 88.66 % do not recycle waste materials as they are not sufficiently informed and trained on recycling solid waste. A new waste management education philosophy, coupled with new sets of knowledge, skills and behaviour are necessary to be proposed so that the Municipality could take an initiative to include on the plan. This benefit will be directed to the community and the public sector on a mutual understanding of recycles waste materials.

The following table provides data on the educational level in relation to the income of the respondents who participated in a solid waste management questionnaire in Polokwane city.

**Table 4.4: Educational level of respondent \* Income Crosstabulation**

		Income				Total
		R1000 - R2000	R2000 - R5000	R5000 - R10000	above R10000	
Educational level of respondent	No formal schooling	1	0	0	1	2
	Secondary completed	1	0	0	2	3
	Post-secondary	0	1	4	10	15
	Certificate	0	1	14	22	37
	Diploma/Degree	0	3	1	40	44
Total		1	5	19	75	100

Table 4.4 indicates the relationship between the educational level and income in the study area. The Table indicates that 44 % of the residents who hold diplomas/degrees (classed as the highest qualification in this study) earn more than R10 000. No residents in this class were found to be in the lowest income range; that

is; R1 000- R2000. 50 % of people with no formal schooling and those 40 % of people with secondary schooling were found in the lowest income range.

**Table 4.5: Educational level of respondent \* Do you get any kind of assistance from the government? Cross tabulation**

The Table shows the educational level of respondents in relation to the kind of assistance they receive from the government.

		Do you get any kind of assistance from the government?		Total
		Yes	No	
Educational level of respondent	No formal schooling	0	1	1
	Secondary completed	0	3	3
	Post-secondary	1	14	15
	Certificate	8	29	37
	Diploma/Degree	21	23	44
Total		30	70	100

Table 4.5 indicates the kind of assistance that residents in the study area receive from the government. Those who are in the highest qualification class 21 % received

assistance from the government. People with no formal schooling and with secondary schooling showed that they do not receive any assistance. Therefore, the higher the qualifications one possesses, the higher the chances of getting government assistance. This may be due to the fact that people in this class know their rights and access information on services that they can be assisted with.

**Table 4.6: Age of respondent \* Employment information Crosstabulation**

The following table shows the age of respondent in relation to the employment information.

		Employment information					Total
		Employed	Unemployed	Self employed	Pensioner	Student	
Age of respondent	18 to 34	11	0	5	0	2	18
	35 to 44	35	6	14	1	0	56
	45 to 64	10	4	12	0	0	26
Total		56	10	31	1	2	100

The table indicates the age of respondent in relation with the employment information. Only 10 % of the respondents are unemployed while the remaining 90 % is comprised of 56 % of which is employed, 31 % self-employed, 1 % pensioners and 2 % students. According to the results, the rate of employment is shown as high in Polokwane.

The following table indicates gender in relation to employment information of the respondent in a solid waste management practices questionnaire.

**Table 4.7: Gender \* Employment information Crosstabulation**

		Employment information					Total
		Employed	Unemployed	Self employed	Pensioner	Student	
Gender	1	20	2	21	0	0	43
	2	36	8	10	1	2	57
Total		56	10	31	1	2	100

Table 4.7 indicates that 57 % the employed respondents were female, while the remaining 43 % were male. It can be concluded that gender equality in the employment category is balanced in Polokwane city.

### Factor analysis

As statistical technique, factor analysis discovers simple patterns of the relationship among the variables. In particular it seeks to discover if the observed variables can be explained largely or in terms of much smaller number of variables called factors (Nacson, 2007).

The researcher wanted to understand about solid waste management practices in Polokwane.

- To separate factors for the variables involved, factor analysis would be used to identify the underlying evaluative dimensions. Specific items that correlated highly are assumed to be a “member” of that broader dimension. The following

correlation matrix was found: A typical factor analysis suggests to answer to the two major questions:

- How many different factors are needed to explain the pattern of the relationships among these variables?
- What is the nature of those factors?

**Table 4.8:Rotated Component Matrix**

	Component							
	1	2	3	4	5	6	7	8
Educational level of respondent	.086	-.196	.805	.192	.086	.110	.076	-.019
Employment information	.111	.507	-.569	-.119	-.142	-.119	.119	-.038
Do you get any kind of assistance from the government?	-.118	.871	-.242	.088	.085	.072	.039	.014
Which assistance do you receive?	.027	.889	.176	-.186	-.096	.085	-.002	.023
Burn it in yard	-.110	.104	.014	-.639	.122	.067	-.124	-.002
Bury it near house	.912	.055	.043	.054	.061	.018	.012	-.052

Haul it to the community dump	.005	.225	.833	-.094	-.100	-.060	-.033	-.002
Dump it in a secluded spot away from the community?	-.024	-.006	-.023	.087	.004	-.904	-.087	-.042
Collected and taken to the landfill?	.013	.076	.061	.095	-.005	.913	-.142	-.066
Recycle cans or other waste?	.018	-.060	.024	-.159	.001	-.170	.824	-.006
Large dumpster near home	.069	.012	.008	-.019	.923	-.034	-.003	.062
Metal or plastic garbage cans at home	-.249	-.246	.035	.187	.450	.168	.307	-.515
Cardboard boxes	.690	.047	.036	.025	.693	-.011	.007	.006
55-gallon drums	.305	.174	.025	-.684	-.332	-.060	-.087	.172
20 L Plastic bags	-.011	.069	.151	.840	-.004	.060	-.213	.091

About how many bags of trash do you dispose per week	.070	.097	-.319	.091	-.328	.005	-.105	.389
Old batteries	-.839	.093	.032	.083	.031	-.019	.080	.074
Old appliances	-.074	.066	-.052	-.142	.161	.051	-.078	.840
Household hazardous waste	-.198	-.270	.177	.232	-.050	-.065	.182	.678
Used oil	-.199	-.397	-.136	.235	-.099	.246	.411	.293
Do you currently recycle waste materials	-.052	.137	.005	.119	.069	.083	.813	-.070

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.



From the findings eight factors retained to define broad areas for influential actions. The Factor 1 reveals that one variable is generally high: Bury it somewhere near your house or somewhere (0.912). This variable stand alone as it could be seen not having any negative impact with solid waste.

Factor 2 indicates three variables high variables: Do you get any kind of assistance from the government (0.871), which assistance do you receive? (0.889), and the question regarding the employment information (0.507). The results of the factors indicate that there is support from the government level when respondents obtained a diploma/degree.

The factor 3 includes two variables: Educational level (0.805), haul it to the community dump or landfill it yourself? (0.833). This indicates that with a high educational level the knowledge of solid waste is not a problem.

The factor 4 has three high variables: Burn it somewhere near your house or business (-0.639), 55-gallon drums / barrel (-0.684) and plastic bags (0.840). The practice of burning solid waste is inversely to the used of the plastic bags. This is positive practices that the community is exposed to solid waste to be out of the yard.

The factor 5 includes two variables: Large dumpster near your home or business (0.923) and Cardboard boxes (0.693). This reinforces the argument that the community does not encounter problems in managing solid waste.

The factor 6 reveals two variables: Dump it in a secluded spot away from the community (- 0.904) and collected and taken to the landfill? (0.913). These two practices are opposite but they are aligned with the knowledge of the community to solid waste.

Factor 7 has one variable that is high: Recycle cans or other waste (0.824)

Factor 8 includes one variable: Metal or plastic garbage cans at your home or business (- 0.515).

The qualitative data obtained from the respondents is presented below:

1. Described ways that they dispose garbage.
2. Indicated the method used most often
3. Specified what was recycled

Two questions of the questionnaire were open ended. For thorough analysis, underlying themes were identified from the various responses. The results are reported below:

**In section 2 “waste management practices” two questions under 2.1 of the questionnaire:** Do you currently dispose of garbage by using one or more of these methods?

Major themes identified were as follows:

Describe any other ways that you dispose of your garbage and which method do you use most often?

Ninety nine per cent (99 %) of the respondents reported that they store solid waste in refuse bags and bins. Waste is then collected weekly by service providers contracted by the Municipality and transported to the landfill. One percent (1 %) suggested that burying solid waste near their houses, hauling waste in a dump and burning waste satisfied them. The favour of the responses was that respondents share responsibility in storing, collecting, transporting, treating well and disposing solid waste. Respondents had good knowledge of solid waste and the regulations governing this type of waste.

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## **CHAPTER 5: CONCLUSION AND RECOMMENDATIONS**

The study was about finding out how solid waste is managed in Polokwane city. This was achieved through conducting field surveys, interviews, observations and taking field notes to collect data from households. Of the five (5) study areas; four are in the suburbs of Westernburg, Ivy Park, Fauna Park and Welgelegen. The fifth study area is located within the residences in City Centre. This chapter summarises and assesses the findings of the research. It concludes with gaps and weaknesses; and policy recommendations. Recommendations are also made at the end of this Chapter.

Waste management is not a new phenomenon. As human society become more complex, as our numbers increased, so is the range and scale of environmental issues experienced such as waste have multiplied. Polokwane city has experienced an increase in waste generation as people move to the city in search of work.

### **5.1 Research Findings**

The study results showed that 43 % of people who participated in the questionnaire were males while 57 % were females. The most prevalent age group of the interviewed individuals was between 50-60 years old. This may be due to the fact that houses in town are expensive and people within this age range have saved and invested and are likely to afford houses. Others afford because they have established businesses that increase their monthly incomes. The results showed that most people have studied beyond matric. Their higher educational level should have contributed to their better lifestyle because the results indicated a high employment rate followed by people who are self-employed. Acquiring post matric education by those who are self-employed may have helped them to secure loans from banks to start their businesses.

Most people have indicated to be at a scale of the highest income group (>R10 000 / month) in the study. This may mean that this group of people are professional employees and run successful businesses. About 70 % of the residents from the study area indicated that they receive no assistance from the government. This could be an indicator of people doing well economically and it is not necessary for the government to assist them with anything. However, from the percentage that has indicated to receive assistance from the government, 85 % of them are subsidised on medical aid.

On waste management practices; only 1 % burn, haul, bury and dump waste in a scheduled spot. About 1 % of the participants positively responded on waste recycling. This is an opportunity for the city to raise awareness and highlight the benefits on recycling cans and bottles and the income it can generate. However, people could be aware of recycling and its advantages but see it as a job for the poor. Most people indicated that they store waste in refuse bags and storage bins. These are good storage practices. Every participant was able to give the exact number of refuse bags they dispose every week. This indicated that almost everyone is keeping a good track of their garbage and is aware that it has to be taken to a landfill site.

About 55 % of the participants indicated that they take old appliances for recycling. There is a need for the remaining 45 % to be made aware of recycling goods. Most people do not separate waste, they place oil and hazardous waste with any other waste. This requires awareness because hazardous waste can cause fires in the landfill sites. The study has confirmed that the City of Polokwane is managing their waste satisfactorily, however, there is room for improvement with regard to promoting recycling activities.

The research revealed financial benefits that were found in waste reclaiming from the landfill site. There is little or no doubt that the cash earned from waste reclaiming is a welcome relief to the households involved, and provided traders with another source of income. Indeed, commercialization of waste has had the effect of

expanding the limited choices that people have to earn income. This product is most important in overcoming shortfalls in income. Also, in providing cash at crucial times in the household schedule for instance; for school fees, grocery and payments of furniture bills. This assists households to cope with unusual expenses, in diversifying livelihood options, and in offering a safety net or survival strategy for the poorest members of society. Waste reclaiming plays a significant role in poverty reduction and is demonstrated by the growing numbers of people joining the trade, particularly by the unemployed.

#### 5.1.1 Solid Waste Management Options for Polokwane City

The main waste management practice currently favoured by the suburbs of Ivy Park, Fauna Park, Welgelegen and Westernburg is privatization. However, the municipality is responsible for managing waste in the City centre.

#### **5.2 Gaps and weaknesses of waste management in Polokwane city include:**

- Appropriate final treatment and disposal glass facility does not exist in Polokwane city.
- Lack of full recognition by authorities of the important role of local reclaimers in the landfill.
- Long-term and focused awareness campaign in solid waste management has not been implemented in Polokwane city.
- Technology transfer programme to support co-manufacturing of solid waste technologies has not yet been introduced.

### 5.3 Policy recommendations

Reform of the roles and responsibilities of Polokwane municipality and the Provincial Department of Environmental Affairs would serve as a factor that could improve the management of solid waste in Polokwane city.

- Polokwane municipality and the Provincial Department of Environmental Affairs should try to provide awareness and also highlight the importance of solid waste management. The fact that it provides job creation and alleviates poverty through reclaiming that leads to recycling, reuse and recovery should be emphasised.
- In order to be successful and sustainable, any future investments in equipment and in technology must be preceded by background studies and surveys of the solid waste management situation. This will ensure that the use of means is best suited to the capabilities of the city and their people.
- Education and communication channels between sectors, especially government and civil society, should be made efficient and broadened. A right to know, transparency and openness to information will have a major contributory factor to good waste management practices in Polokwane City.

Good environmental practices and application of the Integrated Solid Waste Management (ISWM) approach as per Polokwane declaration on waste management must be emphasised to the community. The declaration says that government, business and civil society need to join in common efforts toward the accomplishment of the goal of the declaration. The goal aimed for reduction of waste generation and disposal by 50 % and 25 % respectively by 2012; and develop a plan for zero waste by 2022 by engaging in the following actions (DEAT, 2001).

(1) Prioritization of Waste Management by the City.

(2) Implementation of the National Waste Management Strategy in the City.

(3) Development and implementation of a Legislative and Regulatory Framework to promote waste avoidance, prevention, reduction, re-use and recycle.

- (4) Provision of efficient and effective collection and disposal facilities within Polokwane Municipality as a whole.
- (5) Establishment and enforcement of targets for waste reduction and recycling.
- (6) Setting benchmarks towards achieving the 2012 target.
- (7) Disseminate information on the status and trends on waste reduction in the country.
- (8) Introduce mandatory waste audit processes.
- (9) Explore the use of economic instruments to support waste management initiatives.
- (10) Develop and provide the public with educative resources necessary to allow participation in the waste elimination process on an informed basis.
- (11) Develop Intergovernmental Capacity.
- (12) Develop Waste Information and Monitoring Systems.
- (13) Establish systems that ensure that physical and financial responsibility for waste is borne by the product producers.
- (14) Effectively manage waste disposal/reprocessing facilities, thereby avoiding the need to establish new, or expand existing facilities.
- (15) Promote employment and economic empowerment opportunities, in particular in Small, Medium and Micro Enterprises, through increased product reuse and material recycling.
- (16) Promote clean technology and clean production.

Polokwane Municipality is responsible for waste management in Polokwane City, however, a contractor has been allocated part of the City to manage waste. The Municipality is providing storage bins for the residents. The Municipality has taken responsibility for street sweeping in town and grass cutting in town. The municipality is monitoring and evaluating the contractor on a regular basis.



The declaration for reducing waste generation and disposal by 50 % and 25 % respectively by 2012 has not yet been met. The Municipality indicates that waste generation has not been reduced by the targeted 50% instead it has rapidly increase. The landfill site also confirmed an increase in the waste disposed daily as it is weighed before disposal. A plan for zero waste by 2022 is not yet in place and by the observation made during the study it is unlikely that the city will be able to reach the target by 2022

## **5.4 Recommendations**

The following section presents the recommendations that were proposed for this study under the following sub-headings adopted from the IWMP (2005):

### **5.4.1 Waste Generation**

- The use of plastic bags especially by shops and supermarkets should be discouraged; for example: A loaf of bread being provided in two plastic bags at the same time.
- Recyclable paper bags as value added plastic bags should be introduced.
- Introduction of natural products such as sorghum plastic could reduce waste generation.

### **5.4.2 Recycling and Re-use**

- Value-adding should be encouraged for waste products with a view to encourage recycling and re-use of products.
- Lower taxation for recycled products to encourage the value of these products should be made.
- Manufacturers should be given incentives to encourage consumers to recycle

their products and reduce their waste production.

#### 5.4.3 Punitive Measures- Polluter Pays Principle

- Monitoring mechanisms should be placed on dumping sites to avoid illegal dumping.

#### 5.4.4 Community Awareness and Education

- The community needs to be educated on the impacts of dumping waste on the natural environment, and the degradation that this can cause to the land.

#### 5.4.5 Waste Separation

- Separation of waste at source should be started by households.
- Different colour bags could be provided for waste separation at household level.
- People should be made aware that broken bottles in plastic bags are dangerous to waste collectors and should be encouraged to separate from other waste.

#### 5.4.6 Community Involvement

- Community based contracts should be issued for the management of waste separation facilities.
- Community based waste collection projects should be initiated by the City.

#### 5.4.7 Effective Storage and Collection

- All households in Polokwane City should be provided with bins to ensure effective waste storage.
- An incentive scheme facilitated by the City should be developed to reward households or companies making use of effective waste storage and reward recycling initiatives.

#### 5.4.8 Illegal Dumping of Waste

- Trees should be planted on open spaces within the City and these areas can be converted to parks, whereby it would not be easy for people to dump waste.
- There should be rewards of monetary value for individuals who report the illegally dumping of waste.
- The reasons why people dump waste illegally need to be understood and addressed to ensure that this practice does not continue endlessly.

## APPENDICES

### Appendix i Permission letter to conduct research by Polokwane Municipality



Ref: 4/6/2  
Enquiries: Ngobeni TS  
Tel: (015) 290 2102  
E-mail: SamN@polokwane.gov.za

28 November 2012

Ms. Prudence Maluleke  
Attention: Phokele Maponya  
College of Agriculture and Environmental Science  
Department of Environmental Science  
University of South Africa

**RE: REQUEST FOR INFORMATION RELATED TO MY RESEARCH STUDIES AS WELL AS ACCESS TO OFFICIALS FOR INTERVIEWS – Yourself**

We acknowledge receipt of your letter dated 28 November 2012 on the abovementioned subject. The Municipality is hereby granting you permission to conduct your research work in Solid Waste Management Practices. You are advised to use the Office of the Municipal Manager as your point of entry.

The Municipality wishes you good luck in your studies and hopes that you'll be able to share your findings with us.

Kind regards

T.C. MAMETJA  
MUNICIPAL MANAGER

MUNICIPAL MANAGER'S OFFICE



**Appendix ii SURVEY QUESTIONNAIRE FOR SOLID WASTE MANAGEMENT PRACTICES IN POLOKWANE CITY:**

**SURVEY QUESTIONNAIRE FOR SOLID WASTE MANAGEMENT PRACTICES IN POLOKWANE CITY**

My name is Prudence Maluleke. I am carrying out a research titled as A REVIEW ON SOLID WASTE MANAGEMENT PRACTICES IN POLOKWANE CITY for Master of Science Degree in Environmental Management with University of South Africa (UNISA).

The information given will be treated with confidentiality and you do not have to write your name on the questionnaire to remain anonymous. Please read ALL questions and answer them carefully.

**1.GENERAL INFORMATION**

**SURVEY RESPONDENT: PLEASE CHECK EACH BOX THAT APPLIES.**

**PLEASE INDICATE THE NAME OF SURBUB:.....**

**2. Gender**

Male

Female

**3. Age of Respondent**

<b>18-35</b>	
<b>35-45</b>	
<b>45-60</b>	

#### 4. Educational level of respondent

No formal schooling	
Primary completed	
Secondary completed	
Post- Secondary	
Certificate	
Diploma/Degree	

#### 5. Employment information

Employed	
Unemployed	
Self employed	
Pensioner	
Student	

#### 6. Income

R 1000- R2000	
R2000-R5000	
R5000-R1000	
> R10000	

#### 7. Do you get any kind of assistance from government

Yes  No

If yes which assistance do you receive?

<b>Subsidised electricity</b>	
<b>Subsidised water</b>	
<b>Free water</b>	
<b>Free housing</b>	
<b>Free refuse removal</b>	
<b>Subsidised medical aid</b>	
<b>Training</b>	
<b>Finance to establish small businesses</b>	
<b>Other (please specify)</b>	

## 2. WASTE MANAGEMENT PRACTICES

### 2.1 Do you currently dispose of garbage by using one or more of these methods?

Burn it somewhere near your house or business (i.e., in the yard)? Yes  No

Bury it somewhere it near your house or business? Yes  No

Haul it to the community dump or landfill yourself? Yes  No

Dump it in a secluded spot away from the community? Yes  No

Collected and taken to the landfill Yes  No

Recycle cans or other waste Yes  No

Describe any other ways you dispose of your garbage \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Which method(s) do you use most often? \_\_\_\_\_

---

**2.2. What type of container do you store your garbage in before disposing of it?**

(check all boxes that apply)

Large dumpster near your home or business

Yes  No

Metal or plastic garbage cans at your home or business

Yes  No

Cardboard boxes

Yes  No

55-gallon drums/ barrels

Yes  No

Plastic bags

Yes  No

Other types of containers \_\_\_\_\_

---

**2.3. About how many bags of trash do you dispose of each week?**

1-2 bags per week

3-4 bags per week

3-7 bags per week

More than 7 bags per week. How many more? \_\_\_\_\_

**2.4. What do you do with the following types of waste?**

a. Old batteries

Take them to the landfill/dump

Throw them out in your yard or a secluded area

Take them to a battery collection area or tote

Other \_\_\_\_\_



b. Old appliances, snow machines, four-wheelers, boat motors, trucks, etc.

- Take them to the landfill/dump
- Throw them out in your yard
- Take them to a collection area
- Other \_\_\_\_\_

c. Household hazardous waste (e.g. old paint, cleaning products, etc.)

- Dump them in the landfill/dump
- Dump them in your yard
- Pour them in the sewage lagoon or down the drain
- Take them to a special collection area in the community
- Other \_\_\_\_\_

d. Used Oil

- Dump it in the landfill/dump
- Dump it in your yard
- Take it to a collection place or waste oil burner
- Other \_\_\_\_\_

**2.5 Do you currently recycle waste materials (i.e., glass, soda cans, paper, plastic)?**

- Yes, What do you recycle? \_\_\_\_\_
- No

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**1.General Information**

1.1.Name and address of authority responsible for solid waste management

.....  
 .....  
 .....

1.2 Area jurisdiction

Total area..... (sq.km)

1.3 Population

<b>2002</b>	<b>2007</b>	<b>2012</b>

1.4 Department responsible for solid waste management

(1) Name, address and telephone of the Department

.....  
 .....  
 .....

(2) Name and telephone of the Head of Department

..... Telephone:.....

(3) Name and telephone of officer responsible for solid waste management

.....Telephone.....

**2. Function carried out by the Department**

Function	Carried		Out	By	Remarks
	Own staff	Contractor	Others, please specify		
Solid waste management service to domestic premises					
Solid waste management service to commercial/ trade premises					
Solid waste management service to industrial premises					
Street sweeping					
Grass cutting					
Drain/river cleansing					
Public toilet cleansing					
Removal of dead animals					
Removal of					

garden waste				
Removal of bulky waste e.g. TV				
Development/building approval				
Training of solid waste management staff				
Special solid waste management campaign/project				
Others				

### 3. Planning and Development

#### 3.1 Physical characteristics of solid waste

3.1.1 If data on waste characteristics are available, please complete the following table:

Component	% By Weight
Paper	
Plastic and rubber	
Organic or vegetables	
Glass and ceramic	
Ferrous metal	
Aluminium	
Wood	
Textile	
Garden waste	
Others	
Total	

3.2 Year when the data was collected:

3.3 Data collected by actual survey or by estimation:

### 4. Storage

(1) Does the Department have a storage bin standardisation policy? If so, please briefly outline the policy.

.....  
.....  
.....  
.....

.....

(2) Type of storage bin used (please tick appropriate space)

Type of containers		Residential Premise				Commercial Premise			
		A	F	S	N	A	F	S	N
Individual Containers	Metal bin								
	Plastic bin								
	Plastic bag								
	Oil drum								
	others								
Communal Containers	Metal bin								
	Plastic bin								
	Oil drum								
	Concrete bin								
	Roll-on roll-off								
	others								

A=Almost exclusively used

F= Frequently used

S= Sometimes use

N= Never used

### 5. Collection

(1) Collection service coverage for domestic premises for the year 2011

% of Total Population	Frequency of Collection

(2) Amount of waste collected (by both the Department and contractors) for the year 2011:

Waste Type	Estimated Recycling Rate (%)	Amount Collected			
		Measured	Estimated	Measured	Estimated
Domestic, institutional, commercial and trade waste					
Industrial waste					
Street/park cleansing waste					
Drain cleansing waste					
Bulky waste					
Others					
Total					

Note: Attempt should be made to provide the breakdown data. If impossible, at least data for the total should be provided.

## 6. Disposal

Items	Disposal Site		
	Site 1	Site 2	Site 3
Name of site			
Total area (ha)			
Year when disposal started			
Estimated lifespan remaining			

(year)			
Amount of waste deposited daily (tonne/day)			
Distance from collection area to the site (km)			
Disposal method			
Existence of animals on site	Yes/No	Yes/No	Yes/No
Existence of scavengers on site	Yes/No	Yes/No	Yes/No
Existence of open burning on site	Yes/No	Yes/No	Yes/No

**7. Problems encountered in solid waste management service.** Please tick appropriate spaces

<b>Problem</b>	<b>Very serious</b>	<b>Serious</b>	<b>Not so serious</b>	<b>No problem</b>
Inadequate service coverage (some people not given service)				
Lack service quality (not frequent enough, spill, etc)				
Lack of authority to make financial and administrative decision				
Lack of financial resources				
Lack of trained personnel				
Lack of vehicles				
Lack of equipment				
Old vehicle/equipment frequent breakdown				
Difficult to obtain spare parts				



Lack of capability to maintain/repair vehicle/equipment				
No standardisation of vehicle/equipment				
No proper institutional set-up for solid waste management service				
Lack of legislation				
Lack of enforcement measure and capability				
Lack of planning (short, medium and long term plan)				
Rapid urbanisation outstripping service capacity				
Uncontrolled proliferation of squatter settlements				
Difficult to locate and acquire landfill site				
Difficult to obtain cover material				
Poor cooperation by Government agencies				
Poor public cooperation				
Uncontrolled use of packaging material				
Poor response to waste minimisation (reuse/recycle)				

## 8. Human Resource

Personnel responsible for solid waste management service

Type of personnel	Area of Work						
	A	CT	S	G	FD	O	Total
Administrator							

Health officer							
Public health inspector (PHI)or equivalent							
Assistant to PHI							
Engineer							
Technical assistance							
Technician							
Mechanic							
Mechanic's assistant							
Supervisor							
Driver							
Labourer							
Others							
Total							

A= Administration/supervision

CT=Collection and transportation

S= Street sweeping

G=Grass cutting

FD= Final disposal

O= Others

## **Appendix iii**

Title: A Review of Solid Waste Management Practices in Polokwane City

Authors: P.H Maluleke and S.J Moja

Targeted Journal: Journal of Waste Management and Research

Year: 2014