

# Management of Municipal Solid Wastes: A Case Study in Limpopo Province, South Africa

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## 1. Introduction

Wastes are inevitable part of human activity. The problems associated with waste can be traced back to the very beginning of civilization, when humans gathered in communities (Priestly, 1968). Wastes generated then were contained and disposed of by natural processes. However, as population increased and villages grew into towns and then into cities, the amount of waste generated increased. Consequently, wastes were dumped indiscriminately into waterways, empty lands and access roads. The appalling conditions gave rise to epidemics like the “Black Plague” that destroyed large population of Europe in the 14<sup>th</sup> century (Priestly, 1968). Similar conditions were also experienced in the other continents.

The industrial revolution that took place in Europe in the 19<sup>th</sup> century marked a turning point in waste management. It brought with it, among other things, migration of people from rural areas to towns and cities in search of jobs. The resulting concentration of people in towns and cities gave rise to alarming proportion of wastes being dumped in the streets and waterways. Legislations were passed by the governments of the day in order to curb the indiscriminate dumping of waste. Progress was slow until a positive link was established between vermin invested wastes and the spread of disease. The discovery of pathogens as the agents of diseases that for centuries had been the scourge of mankind, paved the way to the modern sanitary practice.

The modern practices of waste management such as open dumping, incineration (burning), composting and landfill (burial), can be traced back to early civilization. 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. 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. This strategy outlines the goals to address waste management in the country. The entire strategy is based on a 3R (Re-use, Reduce, Re-cycle) to improve the quality of the environmental resources affected by uncontrolled and uncoordinated waste management.

South Africa realized the impact of waste on the environment and a policy referred to as "Integrated Pollution and Waste Management Policy (IPWM) of 2000 was established (DEAT, 2000). The policy outlined goals to be achieved through the National Waste Management Strategy (NWMS) of 2001 (DEAT, 2001) and focuses on different key elements of integrated waste management planning, waste information system, general waste collection, waste minimization, recycling, waste treatment and disposal, capacity building, education and awareness. The key objective of the NWMS is to reduce waste generation and environmental impact of all forms of waste and to ensure that the health of the people and the quality of the environment are no longer affected by uncontrolled and uncoordinated waste management. This chapter looks at the historical perspective, best practices and waste management in Polokwane City.

The Limpopo Province has six district municipalities of which Polokwane city is found within the Capricorn District municipality. Polokwane city previously known as Pietersburg is about 270 km to the northeast of Tswane (Pretoria) City. Polokwane City lies between 23° 54' 59" S latitude and 29° 27' 00" E longitudes (Fig. 1).

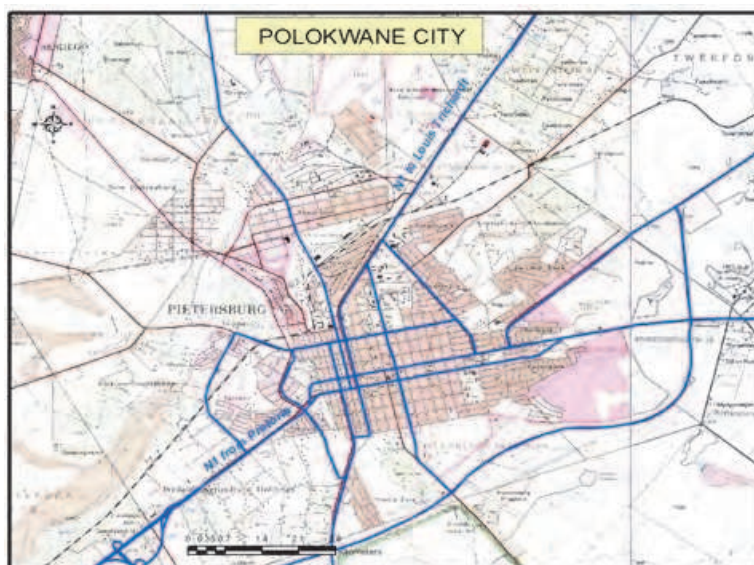


Fig. 1. Location map of Polokwane city (Source: Spot 5, Satellite image CSIR, 2007).

Polokwane area generally has rain in Summer and dry in Winter. Land use in Polokwane city falls under the following categories: business and retail, industrial, community services, recreation and tourism, residential, agricultural and nature conservation areas.

## 2. Sources of waste

There are six general sources of waste generation, namely; 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, left over food, cans.
- The main agents of commercial waste producers are stores, business premises, markets and restaurants.
- Industrial waste refers to wastes such as 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.

## 3. Solid waste hierarchy

The waste management hierarchy has been adopted by most industrialized countries as the menu for developing waste management strategies. According to Seadon (2006), many programmes have adopted waste management hierarchy to address solid waste, for example, New Zealand's Local Government Act Amendment No. 4 (1996) defines hierarchy as "reduction, reuse, recycling, recovery, treatment and disposal" with desirability of decreasing down the hierarchy.

In Singapore, the hierarchy is based on waste minimization (reduce, reuse, and recycle-3R) followed by incineration and landfill. Land is very scarce in this country and this has resulted in incineration as the most preferred method of treatment (Bai and Suntanto, 2001). The United States Environmental Protection Agency (USEPA, 2006) has ranked the most environmentally sound strategies for Municipal Solid Waste (MSW) as source reduction (including reuse) the most preferred method, followed by recycling and composting, and, lastly, disposal in combustion facilities and landfills.

South Africa has adopted solid hierarchy that puts waste prevention as a priority followed by waste minimization through cleaner production (Table 1). The second preferred method is recycling which entails re-use, recovery and composting of waste generated. The third method is treatment process, for example, incineration of waste prior to disposal. Landfill disposal is regarded as the last resort for all waste that remains from the other three methods.

Integrated waste management (IWM) in its simplest forms incorporates the waste management hierarchy by considering direct impacts (transportation, collection, treatment and disposal of waste) and indirect impacts (use of waste material and energy outside the waste management system). IWM is also a process of change that gradually brings in the management of wastes from all media (solid, liquid, and gas) (Seadon, 2006).


WASTE HIERARCHY		
Focus	Activity	Order of aplicación
Cleaner Production	Prevention	
	Minimisation	
Recycling	Re-Use	
	Recovery	
	Composting	
Treatment	Physical	
	Chemical	
	Destruction	
Disposal	Landfill	

Table 1. Solid waste hierarchy adopted by South Africa (DEAT, 2001)

## 4. Components of solid waste management system

### 4.1 Waste generation

According to the 1999 State of Environmental Report for South Africa (DEAT, 1999), the country generates over 42 million m<sup>3</sup> of solid waste every year. This is about 0.7 kg per person per day, compared to 0.73 kg, 0.87 kg and 0.3 kg for the UK, Singapore and Nepal respectively. In 2001, the amount of general waste produced throughout South Africa was reported to increase annually due to population growth, economic growth and unsustainable lifestyles. In South Africa, disparities in the volumes of waste generation between higher income groups and lower income groups exist. In general, the higher income groups generate more waste per capital (2.7 m<sup>3</sup>/per capital/annum) than the lower groups (0.2 m<sup>3</sup>/capital per annum) (DWAF, 1998).

The State of Environmental Report (2003) compiled for the City of Johannesburg indicated that the City with its all regions and population of 2,982, 033, generates a total of 1,560,400 tonnes of waste per annum. There has also been prediction of 1,700,000 tonnes of waste by 2010. The waste generated in this City is as follows: 23% commercial activities, 10 % industrial and 67 % household wastes. Households generate a total of 889,665 tons a year and this is also expected to increase to 1,079 055 tons a year, based on the economic development growth of the City.

High income earners currently generate on average 1.3-1.6 kg of waste per day. Middle income earners generate 0.7-1 kg per day and lower income group generates 0.35-0.6 kg of waste per day (City of Johannesburg Report, 2003). The City of Johannesburg recycles 6-8% of waste, and with the prediction in waste generation increase, it will therefore be necessary for the City of Johannesburg to increase the levels of recycling.

### Waste Collection and Transportation

Solid waste collection and transportation are often the most costly components of a local waste management system. A study conducted in Ghana outlined the collection system and design aimed at significant cost savings focusing on the utilization of waste containers fitted with level sensors and wireless communication equipment, which alerts the waste

collector's access to information on the status of each container (Amponsah and Salhi, 2004). Transporting of waste can be done either using the collector trucks, canal or rail. Transportation through the canal has been regarded as an option that can save fuel, although it has not yet been practiced anywhere since there are no facilities for canal (Kulcar, 1996).

The collection system is uniform in most countries, wherein individual households place their daily refuse into a container nearby, then the refuse is collected and delivered to the waste collection point or disposal site (Fig. 2). The challenging aspect has been source-separation of household waste which is one of the key elements of the integrated waste management system, and which has not been successfully implemented in municipalities of many countries such as China (Hui et al., 2005).



Fig. 2. Waste collection at residential areas of Polokwane City.

Population size and density, the area size, the quantity of household generated solid waste, the collection distance, the geometric design of streets and roadways, and the level of area traffic congestion all have a pronounced impact on the cost of collection and transport of solid waste to the landfills. Difficulties in populated areas are pushing disposal facilities away from waste sources and increasing the costs of transporting wastes. Transfer stations can potentially reduce the costs of transporting wastes (Koushki et al., 2004).

According to the survey conducted in Sri Lanka, it has been revealed that 50% of local authorities collect less than 2 tons of waste per day and only 24% of households in the Southern Province of Sri Lanka have access to waste collection, hence rural areas have a waste collection of less than 2% (Vidanaarachchi et al., 2005).

#### 4.2 Waste disposal

The nature and procedures for waste disposal vary from country to country. In South Africa, there are about 540 landfill sites of which 61% have permits, however, there could be 15,000 landfill sites including communal sites in the country (DEAT, 1999). The 5 million tons of waste produced every year, only 5% is disposed of in designated sites, thus most waste in South Africa is disposed in environmentally unsafe sites.

The State of Environmental Report for the City of Cape Town (2003) outlines the expanding economy, increasing population and visitors as contributing factors to the increased waste generation rates in the city. This has contributed to 7% increase in waste landfilled between

2001 and 2002, which is far in excess of 2% population growth. This report reflects that 90% of waste generated in the City of Cape Town is landfilled. In 2002 a total of 1,722,807 tonnes of waste was disposed at the six landfills and this showed an increase of 7.3% as compared to 1,596,000 tonnes disposed in 2001, which was an increase of 6.5% from 1,493,000 tonnes generated in 2000.

Waste landfilled consists of 30% household waste, 15% sewage sludge and 55% industrial and commercial waste. The amount of waste recycled in 2002 was 2% as a result of informal salvaging activities. This percentage of recycling will increase as the city is currently busy with the material recovery facility plans. The City of Johannesburg's State of Environment Report (2003) shows that there are six landfills with a total of 1,560,400 tonnes of waste disposed annually, which shows that there is more waste disposed to waste disposal sites in the City of Cape Town as compared to the City of Johannesburg.

## 5. Strategies to improve solid waste management system

### 5.1 Waste minimisation and recycling

It has been observed that many countries such as the USA have been engaged in waste minimization strategies through waste recycling. This has been confirmed by the statistical records from 1960 to 2005, wherein recycling increased from 6,4% to 32,6%. According to the information on Table 2, recycling has diverted almost 82 million tons of recyclable material away from disposal. Typical materials recycled include batteries recycled at a rate of 99%, paper and paperboard at 52% and yard trimmings at 62%. These materials have been recycled through the curbside programs, drop off centers, buy-back programs and deposit systems.

No	Year	Total waste in tons	Total waste recyclable(tons)	Recycling (%)rate
1	1960	88,1 million	5,6 million	6,4
2	1970	121.1 million	8 million	6,6
3	1980	151,6 million	14,5 million	9,6
4	1990	205 million	33,2 million	16,2
5	2005	251 million	82 million	32,6

Source : [www.epa.gov/msw/facts](http://www.epa.gov/msw/facts) (2006)

Table 2. Municipal solid waste recycling rates in the USA (1960-2005)

Other countries like England and Wales, have a strategy for waste management referred to as Waste Strategy 2000, which also introduced statutory targets of waste reduction through recycling as follows: 20% of household waste 2003/4; 30% of household waste 2005/6; 30% of household waste by 2010 and 33% of household waste by 2015. These reduction targets were also applicable to biodegradable waste to 35% reduction. Oxfordshire's residents produce 300,000 tonnes of household waste per year. In 2001/2, 17% of this waste was recycled or composted and 83% was landfilled. The targets set out puts the municipalities under pressure of having to double the quantities of waste currently recycled.

The Taiwan government introduced a restriction programme for plastic bags and disposable dishes use as a way of altering the throw away consumer habits of the public. This

programme was aimed at encouraging the businesses to introduce re-usable shopping bags and dishes. The target was to reduce the amount of plastic bags by 20,000 tonnes annually, which had an effect since 31% reduction rate, was achieved. The same applies to disposable dishes where consumption was 12,000 tons and reduction rate of 28% was achieved.

South Africa developed a national waste management strategy in 1997 which outlines the different action plans that include waste minimisation and recycling. This action plan resulted in the formulation of guideline on recycling of solid waste for the municipalities to use when implementing recycling programmes in their areas

Recycling in South Africa has so far focused mainly on paper, glass, plastics and metals. Well established companies have been involved in recycling in order to reduce the utilization of natural raw materials as resources in the production systems. Recycling plays an important role in the reduction of landfill space. For example, 1 tonne of paper waste occupies 3 m<sup>3</sup> of landfill space. The following facts represent a brief state of recycling in South Africa (PACSA, 2002):

- In 1999 it was reported that the paper industry recycled 720,000 tonnes per annum which represents 38% of paper produced and an increase from 29% in 1984. Out of the 3% recycled waste in that year, only 2% was from domestic waste. Almost each and every type of paper in South Africa has a recycling content. For example, newspaper contains 25% recycled paper, cardboard 50%.
- Total plastics collected in South Africa were 113,000 tonnes which was 13%. This quantity had resulted in placing South Africa in the fore front in plastic recycling industry world-wide.
- Glass collection has grown from 54,370 tonnes in 1986 to 104,550 tonnes in 1999. The total tonnage produced in 1999 was 520,000 tonnes, thus 20% was recycled.
- There were 32,130 tonnes of returnable bottles that were collected in 1999 from South African Brewery (SAB) and Coca Cola Company as bottles that reached the end of life. The quantities of bottles increased as a result of change-over from 1 litre bottles to 1.25 litre bottles, which resulted in 8,000 tonnes of bottles collected.
- Steel beverage cans have a high recovery rate in South Africa as it has grown from 18% in 1992 to 63% in 1998. These increases have also been affected by the subsidies offered by "Collect a can" for collection system. Based on assessment made on the rate of collection for different recyclables, materials without subsidies like glass always had the lowest recovery rate.

Currently, in South Africa, the statistics presented by Packaging Council of South Africa (PACSA, 2002) shows that recycling is increasing enormously from time to time with an increase of above 168 % over a period of 18 years (Table 3).

Material	1984 (tons)	2000 (tons)	2002 (tons)	Increase (tons)
Paper and Board	365 000	770 000	922 000	557 000
Plastics	37 000	133 000	150 000	113 000
Metal	34 000	121 000	119 000	85 000
Glass	50 000	102 500	114 000	64 000
Total	486 000	1 126 000	1 305 000	819 000

Table 3. Total recyclable materials collected in South Africa (1984-2002)

## 5.2 Source reduction

Source reduction involves altering the design, manufacture, or use of products and materials to reduce the amount and toxicity of what gets thrown away. Source reduction can be a successful method of reducing waste generation. Practices such as glass recycling, backyard composting, two-sided copying of paper, and transport packaging reduction by industry have yielded substantial benefits through source reduction. Source reduction has many environmental benefits. It prevents emissions of many greenhouse gases, reduces pollutants, saves energy, conserves resources, and reduces the need for new landfills and incinerators.

More than 55 million tons of municipal solid waste were source reduced in the United States in 2000, and this comprised 28% containers and packaging materials, 17% non-durable goods (newspapers, clothing), 10% durable goods (appliances, furniture, tires), 45% other MSW (yard trimmings, food scraps) ([www.epa.gov.msw/facts](http://www.epa.gov.msw/facts), 2006). Most countries have developed strategies aimed at reducing waste generation by addressing waste from the source.

Polokwane Declaration on Zero Waste by 2022 was agreed upon at a meeting held in Polokwane city in 2000 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 the 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. The South African Government developed a National Waste Management Strategy to address waste management aspects including the zero waste plan as envisaged.

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.

## 6. Materials and methods

### 6.1 Quantitative and qualitative method

The quantitative and qualitative methods were applied during the study. This incorporated questionnaires and interviews, field surveys and data presentation.

### 6.2 Quantitative method

This method was applied through weighing waste generated in all the different waste generators. It was applied through field surveys that were conducted for data collection from households and analysed to address the research objectives.

### 6.3 Qualitative method

Structured questionnaire was used as one of the data collection methods.. This questionnaire was used to collect information from the municipality officials through an interview



regarding waste management services and practices for Polokwane city. The questionnaire was structured for open-ended questions, where the municipality officials provided answers from questions that were asked, and close-ended questions, where some response and answers were provided.

#### 6.4 Field survey

On-site waste separation and measurements were done at individual households from the three income groups at Ivypark, Florapark and Sterpark residential areas, representing low, middle and high incomes respectively. The three categories were based on the municipality categories of income which is done according to the size of the residential stand (Table 4). A 10 l plastic bin and 100 kg weighing scale were used to collect and weigh the wastes selected for sampling from households. Gloves and refuse bags were used for sorting the wastes; while facemasks and worksuits were used for protection during the sampling and measurement period.

Income level	Size of the residential site
Low	0 - 300 m <sup>2</sup>
Medium	300 - 500 m <sup>2</sup>
High	500 m <sup>2</sup> +

Source: Polokwane Spatial Development Framework

Table 4. Classification of low, medium and high level incomes based on the size of the residential space occupied

The formula below was used to determine the number of samples in all the three income groups:

$$W_g = (W_i - W_b) \quad (1)$$

Where:

$W_g$  = Waste generated per income group per week,

$W_i$  = gross weight of bin and waste

$W_b$  = weight of empty bin

First the weight ( $W_b$ ) of empty bin, using the weighing balance, was determined. Thereafter, the bin was filled with the sorted waste, while shaking the bin constantly to fill the voids. The difference corresponded to the weight of the waste.

#### 6.5 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 proportional allocation of samples in the three income groups was based on the formula used for stratified sampling which was as follows:

Low income group

$$n_i = \frac{N_i \times n}{N} \quad (2)$$

Where:  $n_i$  = sample size per income group,

$N_i$  = Total population per income group,

$N$  = Total population of the three income groups

$n$  = General sample size of all the three income group

A total of 325 households were sampled out of 2111 households within the three income groups. The distribution of the sampled household was as follows:

Low income group (Ivypark): 77 households were sampled out of a total of 500 households

Middle income group (Florapark): 194 households were sampled out of a total of 126 Households.

High income group (Sterpark): 54 households were sampled out of a total of 350 households.

To calculate the total waste generated by each income group, the following formula was used:

$$W_a = \frac{W_b}{W_d} \quad (3)$$

where:

$W_a$  = Total waste generated day/income group,

$W_b$  = Total no of households sampled

$W_d$  = No of days in a week

Similarly, to calculate the amount of waste that was generated per day per household involves the following formula:

$$W_k = \frac{W_a}{W_h} \quad (4)$$

Where:

$W_k$  = Total waste generated /day/household,

$W_a$  = Total waste generated/day/income group and

$W_h$  = No of households sampled/income group

## 7. Results and interpretation

### 7.1 Waste generation

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 (Table 5). Food waste was the highest across all the income groups with a percentage waste generation of 34% (Table 5a). The trend of wastes was as follows: Paper-20% > plastics-18% > glass-11% > cans- 11% > garden waste -6% (Table 5b). represent waste composition generated per household per day per person from the income groups. The mean composition of waste generation in the three groups is presented in Figure 3.

Waste component	Low -income group (kg/week)	Middle income group(kg/week)	High-income group (kg/week)	Total waste generated (kg)/week	Average waste generated (kg)/week
Paper	183	658	422	1263	421
Cans	153	437	88	678	226
Glass	261	347	112	719	240
Plastics	181	571	406	1158	386
Food wastes	341	1227	640	2208	736
Garden waste	194	154	33	381	127
<b>Total waste generated per week</b>	<b>1313</b>	<b>3392</b>	<b>1702</b>	<b>6406</b>	<b>2135</b>

Table 5. (a) Total waste composition from the three income groups

Waste component	Low -income group (%)	Middle-income group (%)	High-income group (%)	Average waste generated/week (%)
Paper	14	19	25	20
Cans	12	13	5	11
Glass	20	10	7	11
Plastics	14	17	24	18
Food wastes	25	36	37	34
Garden waste	15	5	2	6

Table 5. (b) Percentage of total waste composition generated per week from the three income groups

Waste component	Low -income group		Middle-income group (kg/week)		High-income group (kg/week)		Mean	
	Kg/household/day	Kg/household/day/person	Kg/household/day	Kg/household/day/person	Kg/household/day	Kg/household/day/person	Kg/household/day	Kg/household/day/person
Paper	0.39	0.05	0.48	0.08	1.11	0.18	0.66	0.11
Cans	0.28	0.04	0.32	0.05	0.23	0.03	0.27	0.04
Glass	0.14	0.02	0.26	0.04	0.29	0.04	0.23	0.03
Plastics	0.33	0.05	0.42	0.07	1.07	0.17	0.60	0.10
Food wastes	0.63	0.10	0.90	0.15	1.69	0.28	1.07	0.17
Garden waste	0.36	0.06	0.11	0.01	0.08	0.01	0.18	0.03
<b>Total waste generated</b>	<b>2.1</b>	<b>0.32</b>	<b>2.5</b>	<b>0.4</b>	<b>4.47</b>	<b>0.7</b>	<b>3.01</b>	<b>0.48</b>

Table 5. (c) Total waste composition generated per household per day per person from the three income groups

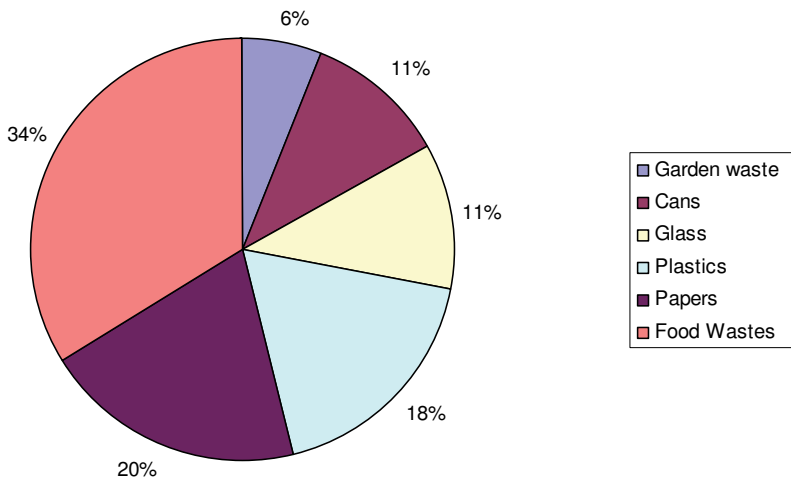


Fig. 3. Mean composition of waste generation for the three income groups

**7.1.1 Waste generation in the low income group**

The waste generated income in the low group was as follows: food waste 25% (341 kg/week) > glass -20% (261 kg/week) > garden waste - 15% (194 kg/week) > paper and plastic - 14% (181 kg/week plastic and 183 kg/week) > cans 12 % (153 kg/week) (Fig. 4).

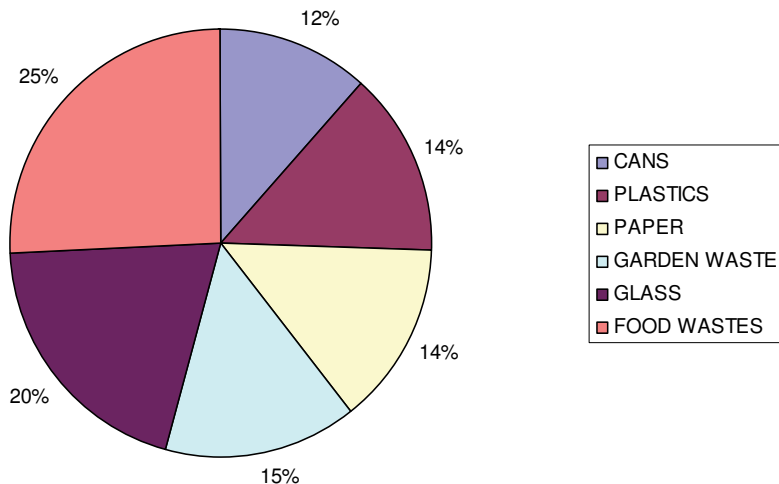


Fig. 4. Composition and percentage of waste generation from low income group.

**7.1.2 Waste generation in the middle income group**

Similarly in the Middle Income Group, waste was generated as follows (Fig. 5): food waste - 36% (1,226.50 kg/per week) > paper -19% (658 kg/week) > plastics - 17% (570.50 kg/week) > cans - 13% (436.50 kg/week) > glass - 10% (346.50 kg/week) > garden waste - 5% (153 kg/week).

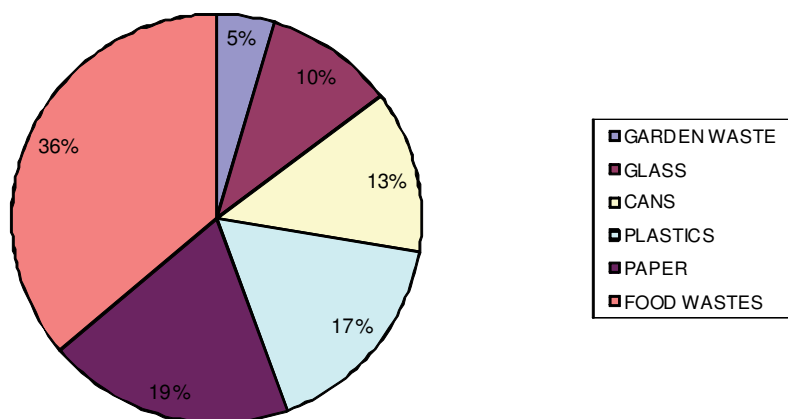


Fig. 5. Composition and percentage of waste generation from middle income group.

### 7.1.3 Waste generation in high income group

The composition and amount of waste generated was as follows (Fig. 6): food waste - 37% (640 kg/per week) > paper - 25% (422 kg/week) > plastic - 24% (406 kg/week) > glass - 7% (112.40 kg/week) > cans - 5% (88.50 kg/week) > garden waste - 5% (33 kg/week).

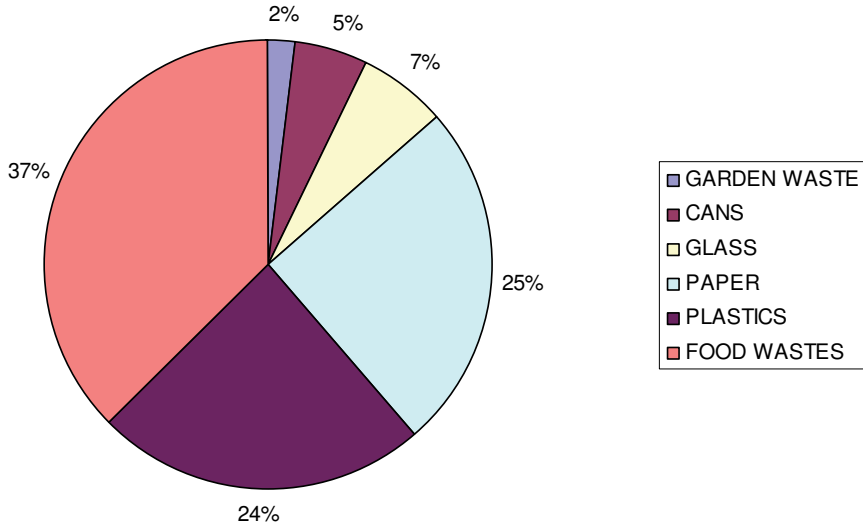


Fig. 6. Composition and percentage of waste generation from high income group.

## 7.2 Waste management system

Observations of the waste management system was made during sampling and follow up interviews were conducted with the personnel of the Department of Waste Management in Polokwane city, focusing on the waste management system, policies, municipality by-laws and regulations in place for controlling household waste. The response focused on Waste Management Policy, waste collection and transportation, and allocation of resources for refuse collection.

### 7.2.1 Waste management policy

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. This notice addresses illegal dumping and sanitation related problems and penalties thereof in open places within the residential areas.

The policy has to be in line with the Constitution of South Africa 108 of 1996 and the Environmental Management Legislation, namely, National Environmental Management Act (1998), the Local Government Structures Act 117 of 1998 and the Local Government Municipal System Act 32 of 2000 which outlined the roles, responsibilities and the operations of all the municipalities. The development of Waste Management Plan is also in progress in order to align its function with the National Waste Management Strategy (1998) and Polokwane Declaration of Zero waste (2000).

### 7.2.2 Solid waste collection and disposal

It was noted 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.

There are four cooperatives involved in litter picking in the city with a total number of 47 workers and four ton truck for collection of waste from litter picking group. The municipality has allocated a total of 13 contractors that collect waste from residential areas in refuse bags and bins in the business area, 3 loadlagers that collect solid waste from the skips in the factories, 7 grab that collect waste in transfer station and illegal dumping areas, and 3 multilifts for waste bins in the factories.

Waste was being disposed in one permitted waste disposal site, named the Weltevreden Landfill. The permit was issued in 1998 by the Department of Water Affairs and Forestry in terms of the Environment Conservations Act of 1973. In this case, Polokwane landfill had a license for operations which most municipalities in the Limpopo province do not have. Johansen and Boyer (1999) indicated in their study that South Africa is the only country in Africa with specific regulations and guidelines in place governing solid waste landfills. The minimum guidelines requirements for landfill classify land fills in terms of type of waste, size of waste stream and climatic conditions with focus on leachate generation. Polokwane landfill has been licensed as a G: M: B site which allows disposal of dry industrial waste, dry domestic waste, builder's rubble and garden waste. This classification allows for disposal of General waste, size is Medium, B- climatic water balance with no leachate management system required based on site specific factors of rainfall and evaporation rate (DWAF, 1998).

### 7.2.3 Waste recycling

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. This has also led to the development of an informal settlement close to the landfill. Waste reclaimers collect all the waste that is re-usable/recyclable ranging from bricks, plastics, steel, card boxes and cans (Fig. 7). Interview was conducted with the waste reclaimers to get data on the amount of recyclable waste collected per day. Unfortunately they never kept records of the amount collected apart from the price per Kilogram. For example, plastic- 60 cents/kg, aluminum cans-R 2/kg, cardboxes-R30/kg, plastic 2l cold drink containers -80 cents/kg, plastic milk containers -50 cents/kg, copper-R 15/kg brass R 4/kg. They were able to quantify the amount of money received at the end of the month which was approximately R300 per person, depending on the rate of collection for every individual.

Consultation with the recycling agent that collects waste from the reclaimers indicated that a total of 2,7120 kg recyclable waste was being collected from the landfill site daily, then sent to large recycling industries in Gauteng for further processing.



Fig. 7. Waste recycling by local waste reclaimers at the landfill site in Polokwane city.

A total of 28,000 m<sup>3</sup> was disposed per month which comes to a total of 336,000 m<sup>3</sup> of waste disposed per year. The entrance of the landfill had a weigh-bridge (Fig 8), to weigh all the trucks disposing waste after collection.



Fig. 8. Weighing bridge at the entrance of the Polokwane landfill site.



### 7.3 Allocation of resources

Resources allocated for refuse collection are as follows: 12 workers and three drivers with three trucks that are used to collect waste within the residential areas. Each Labourer is given a set of protective clothing comprising 4 overalls, 2 pairs of boots, 1 pair of rain coat per year and 1 pair of gloves monthly.

Currently, the Polokwane Municipality makes provisions of about R38,000,000.00 for refuse removal for the whole municipality. This budget is also supplemented by the monthly refuse removal services fee paid by residents. The fee is calculated based on the Local Government Municipal Property Rates Act No 6 of 2004 of South Africa (Table 6). These fees are revised annually based on the inflation rate and on the size of the size of the standirrespective of the income levels of different residential areas. The municipality issues out a utility bill on a monthly basis which incorporates the assessment rates for the property, sanitation, refuse removal, electricity and water.

Size of residential site	Rates payable by residents refuse removal & sanitation effective from 01/07/2008
0 - 500 m <sup>2</sup>	R20.05
500 - 1000m <sup>2</sup>	R52.25
1000m <sup>2</sup> +	R93.85

Source: Polokwane Municipality rates policy (2008)

Table 6. Rates for sanitation and refuse removal for Polokwane City

## 8. Discussion and recommendations

### 8.1 Waste generation

Globally, the rate of waste generation has increased over the years in different societies with increase in population and change in lifestyle and technological advancement. Recent research results reflect a population increase of 8.2 % from 2001 to 2007 in South Africa, and 9.5 % in Polokwane (Statistics S.A-Census 2007). This means that more waste is being disposed of into the landfill. As the number of land space for the establishment of landfill sites is becoming limited, other methods of waste management should be sought. This is where recycling programmes are expected to play a vital role in prolonging the life-span of landfill sites.

Waste generation in the three income groups was computed to be 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 utilization.

## 8.2 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 (Henry et al., 2006), whereas in Polokwane food waste comprised 34 % of the total waste generated from the income groups. The studies in Nairobi also stated that 50 % of waste disposed of in landfills in that country is mostly organic waste which can be reduced by composting before disposing into landfills.

The results of this study shows that in Polokwane the 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% (comprised recyclable waste such as cans, plastics and papers generated) (Viraraghan and Pokkhrel, 2005). 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., 2005).

## 8.3 Waste recycling

This study 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 and Suntato, 2002). 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 informal 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) investigated the idea of zero waste in emerging countries using South African experience. In this study, two communities, adjacent to the Mariannhill Landfill site in Durban were selected as a case study for comparative analysis of formal and informal settlements. On the basis of the results of the analysis of the recyclable yields and information provided by the questionnaire, a waste minimization scheme was proposed for zero waste schemes. This scheme lays responsibility on households to recycle their waste at source. It makes use of existing recycling strategies currently applied in other urban areas in South Africa such as drop off, kerb-side and central sorting. In another study by the same authors (Trois and Simelane, 2010), studied the possible implementation of separate waste collection and mechanical biological waste treatment. This model advocates pretreatment of the waste in passively aerated open windows for 8 weeks before finally taking it to the landfill. The pretreatment leads to volume reduction due to reduced biodegradable compounds in the municipal solid waste.

#### **8.4 Waste collection and transportation**

Domestic waste is collected from households weekly by the Municipality trucks. The Municipality has sub-contracted litter picking co-operatives to pick up litter along the streets in the residential areas and finally dispose at the landfill. Litter collected is not sorted into recyclables or non-recyclables; is all disposed to the landfill with no sorting, which could be another area where the Municipality can initiate a recycling programme through the litter picking cooperatives.

It has been outlined in the baseline studies on waste generation conducted in 1998 and State of Environmental Report (2003) for City of Johannesburg that over 50% of waste going to the landfills has the potential to be recovered for recycling or re-use. Based on the information from the Municipality, a total of 28,000 m<sup>3</sup> of domestic waste is disposed of in Polokwane landfill. Out of this 60% of waste generated in the households can be recycled, if proper waste recycling system is put into place.

### **9. Conclusion**

The current study established the following:

- The 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.
- It was 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.
- The amount of waste from households in Polokwane Municipality that can be recycled constituted about 60%. This could significantly reduce the amount of waste being disposed into landfills. The implications of this strategy would lead to the achievement of the Polokwane Zero waste declaration target of 50% waste reduction by 2010 and zero waste generation by 2020.

## 10. Recommendations

- 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.

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