SOLID WASTE GENERATION AND COLLECTION FOR RECYCLING IN SMALL AND MICRO ENTERPRISES: A CASE STUDY OF BRAAMFONTEIN DISTRICT, JOHANNESBURG

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A research report submitted to the Faculty of Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Master of Science in Environmental Sciences.

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Declaration

I declare that the research report is my own unaided work. It is being submitted for the Master of Science by coursework and research report to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

30-05-2011

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(Signature of Candidate) (Date)

Abstract

A survey was carried out on small and micro enterprises in the Braamfontein region of Johannesburg, to determine the aggregate compositions of solid waste materials generated and collected for recycling purposes, and to determine the attitude(s) and perception(s) of manager(s) and owner(s) of such enterprises, to the collection of solid their waste(s) for recycling purposes.

A stratification method based on staff numbers was used to select 60 random samples of small and micro enterprises. Results reveal that 62% of these businesses were not collecting their solid wastes for recycling purposes, despite a high daily occurrence of recyclable (paper: 95%, plastic: 72% and organic: 68%) wastes in their daily waste streams. Low levels of collection by businesses were attributed to 'time-factor' issue in the collection of their recyclable wastes, while the provision of more recycling facilities in the area could improve their participation.

Waste to landfill transportation trends in Johannesburg's landfills were analyzed, as a measure of the waste problem in Johannesburg. Results suggest about 18% reductions in recycling waste materials transported to the various landfill sites in the city, from 2004 to 2008, and a 14% increase in other categories of general solid wastes for the same period. Despite the reductions in recycling waste materials recorded, the city recorded low levels of waste recovery practices for recycling purposes, particularly in small and micro scale commercial sectors.

In achieving the City of Johannesburg's wastes reduction goals, particularly the waste reduction targets set in the Polokwane Declaration, of reducing the amount of wastes disposed of by 50%, achieving a 25% reduction in disposable wastes by 2012 and to developing a zero waste plan by 2022 (City of Johannesburg, 2008), the municipality needs to play a pivotal role by providing needed recycling infrastructures, educating the society on the need for sustainable waste management and providing waste collection and management incentives.

Dedication

I dedicate this work to my wonderful family for their endless support of my goals and aspirations. I would also like to dedicate this work to the various environmental professionals and activists who strive endlessly towards promoting sustainable developmental practices throughout the world.

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Table of Contents

List of Figures

List of Tables

List of Acronyms

BRT:	BUS RAPID TRANSPORT
CBD:	CENTRAL BUSINESS DISTRICT
DEAT:	DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM
DSF:	DIGITAL SOLIDARITY FUND
EIA:	ENVIRONMENTAL IMPACT ASSESSMENT
EPR:	EXTENDED PRODUCER RESPONSIBILITY
GHG:	GREEN HOUSE GAS EMISSIONS
GDP:	GROSS DOMESTIC PRODUCT
IPCC:	INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
IPWM:	INTEGRATED POLLUTION AND WASTE MANAGEMENT FOR SOUTH AFRICA
ISO:	INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ISO14001:	STANDARD FOR ENVIRONMENTAL MANAGEMENT SYSTEM
MDG:	MILLENNIUM DEVELOPMENTAL GOAL
MSW:	MUNICIPAL SOLID WASTE
MT:	METRIC TONNES
M^3:	CUBIC METRE
N:	SAMPLE SIZE
NGO:	NON-GOVERNMENTAL ORGANISATIONS
R:	RAND (SOUTH AFRICAN CURRENCY)
RSA:	REPUBLIC OF SOUTH AFRICA
SHE:	SAFETY HEALTH AND ENVIRONMENT
SME:	SMALL AND MEDIUM ENTERPRISES
UK:	UNITED KINGDOM
UN:	UNITED NATIONS

USA:	UNITED STATES OF AMERICA
USD:	UNITED STATES DOLLARS
VAT:	VALUE ADDED TAX

Chapter 1

Introduction

The South African government, through operational linkages with the City of Johannesburg municipality regarding waste management, identified waste recycling as one of the solid waste minimization strategies that needs to be incorporated across sectors of the South African society, in order to achieve the waste reduction targets set in the Polokwane Declaration in 2001. The Declaration was made to stabilize waste generation, reduce the amount of wastes disposed of by 50%, to achieve a 25% reduction in disposable wastes by 2012 and to develop a zero waste plan by 2022 (City of Johannesburg, 2008).

Towards achieving some of these rather ambitious targets, the government of South Africa introduced the National Waste Minimization Strategy (NWMS), which is to be followed up at municipal and local levels (City of Johannesburg, 2008). It is aimed at ensuring that all municipal wastes are avoided where necessary, recovered, re-used, recycled, treated, disposed and remediated in an environmentally friendly manner, taking into account, the bottom-up implementation of the Waste Hierarchy (fig 1.1) (NWMS, 2010).

Figure 1.1: Waste Hierarchy, NWMS 2010

In relation to the waste minimization objectives of the South African government, specifically in terms of the sector-wide adoption of the 'waste hierarchy' (fig 1.1), its 'bottom–up' implementation process has continued to be hampered by lack of reliable solid waste data in South Africa and as a result, monitoring progress and developing synergies for improved implementation has been problematic (Nahman and Godfrey, 2010; DEAT, 2010).

Implementation of the waste hierarchy across major operational, manufacturing, developmental, household and service oriented sectors in South Africa would certainly require prior knowledge or baseline information on the status of solid waste generation and management in these sectors (DEAT, 2009). This would inform the relevant municipality, waste management authority, government and waste stakeholders, on relevant waste issues that may need attention, provide information on the characteristics of the waste streams generated, provide measurable and defensible data on aspects of waste management that needs further improvement in each of the sectors of the South Africa economy. Similarly, it provides a knowledge based platform for improved implementation and monitoring of waste reduction objectives set by the South African government.

Environmental knowledge, in terms of waste information and management is essential for civil society and waste stakeholders in South Africa, towards providing relevant waste data required to address the significant solid waste information and data gap in the country (DEAT, 2009; DEAT, 2010). Particular concern is given to the limited information available on solid waste generation quantities available for recycling among small-scale enterprises in South Africa (City of Johannesburg, 2008; Nahman and Godfrey, 2010). This inspired the need for this study, to provide information to stakeholders and the South African municipalities on the status of solid waste recycling programme in small-scale enterprises* across Braamfontein district of Johannesburg, as an adoption of the second stage (see fig 1.1) of the waste hierarchy strategy.

* Also referred in this report as 'small and micro enterprises'.

The South African National Small Business Amendment Act 26 of 2003, defined small-scale enterprises as follows: small (*less than 50*), very small (*less than 10*) and micro (*less than 5*) (RSA, 2003). In this study, these small-scale enterprises were further categorized into 'small' (>5 and <50) and 'micro enterprises' (<5), to have a more structured and representative sample within each strata. The need to study small and micro enterprises was further inspired by the following factors:

- Small-scale enterprises can contribute significantly to the amount of solid wastes assigned to landfills, due to their mobility in terms of 'ease of spread' and their 'operational diversity'. Hillary (2004) argued that they are widely distributed in most commercial centres of global cities, yet their solid waste footprints are often not known. For instance, in Europe and United Kingdom, they make up to a great extent, the majority of the businesses and yet their waste foot prints are not known (Hillary, 2004). Likewise, due to their heterogeneous nature, it is difficult to determine their impacts on the environment, thus resulting in poor waste management (Hillary, 2004).

- Small enterprises often do not consider their own environmental impacts as significant. However, when assessed collectively, they could be significant contributors of solid wastes (Hillary, 2000; Redmond *et al.*, 2008).

- In South Africa, little is known about these enterprises in relation to their solid waste generation and recycling footprints, and as such; waste management has been problematic (Geoff, 2009).

- Effort has been made towards regulating and monitoring large commercial establishments in South Africa, with little or no effort made to regulate and monitor small enterprises (Coleman, 1997). This may have allowed these enterprises to generate significant amounts of solid wastes.

To sustain and improve waste management in South Africa, there is need to incorporate strategic research information into the South African waste reduction strategies, which will not only reduce waste generation, but provide reliable waste data for future research.

1.1 Overview of solid wastes

Most of the solid waste materials generated from human activities are transported to landfill sites. Landfills sterilize land which could have been used for other purposes. The Gauteng Provincial Government (2004) categorized wastes according to the health and environmental risks they pose. These include general, hazardous, health-care and mineral wastes. Table 1.1, presents a brief summary of the various safety health and environmental (SHE) risks associated with different wastes.

The Gauteng Provincial Government (2004) also classified wastes according to their various risk profiles. For instance, general wastes are wastes which do not pose an immediate threat to the environment. They include dry business, industrial, household and garden wastes. Hazardous wastes are wastes contaminated by chemicals and may impact negatively on human health and the environment, especially with the infiltration of water, which can act as a solvent and a carrier. Health-care wastes are generated from health-care facilities such as hospitals, labs, clinics, dental suites and others. Health-care wastes may contain micro organisms (e.g. bacteria and viruses) which may pose some health and environmental risks (spread of diseases, pollution etc). Mineral wastes are generated from power stations, mining industries, metallurgical and bulk chemical industries.

Table 1.1: Below is a brief Safety Health and Environment (SHE) assessment for the various categories of wastes and their potential impacts on the environment and human health

RECYCLABLE WASTE VARIABLES	Paper	Plastic	Metal	Organic food wastes	E-wastes	Lead Battery
RISKS/ ENVIRONMENTAL IMPACTS	Aesthetic impacts**,** which may affect tourism, fire risks, clog drains, emits green house gases (GHG) from incinerators, fumes from incinerators may cause acid rain.	Aesthetic impacts, which may affect tourism, fire risks, animal ingestion of plastic bags, GHG emissions, dispersion of chemicals, burning can also cause the production of acid rain	Aesthetic impacts which may affect tourism, workplace health hazard, obstruction, fire risks as metal/ aluminum can/container could explode on high temperature	Health risks- micro organisms/ bacterial etc, odour and poor air quality, contributes to leachate production which can contaminate ground and surface water	Aesthetic impacts, workplace hazard, obstruction, chemical pollution, GHG emissions from incinerators	Workplace hazard, obstruction, health risks chemical pollution
NON RECYCLABLES	**Light bulb/ fluorescent**	**Mirrors/ window/ glass**	**Rubble from building/ construction**	**Paint ,tins /pesticides**	**Dry cell battery**	
RISKS/ ENVIRNMENTAL IMPACTS	Environmental hazards- mercury leaks	Health risks, aesthetic impacts	Air quality, health, aesthetic impacts	Chemical pollution /explosions at landfills/ incinerators	Chemical pollution/ explosions risks at incinerators	

The volume of these classes of waste increase as urbanization and population increases (Zia and Devadas, 2007). This is as a result of the increasing socio-economic activities associated with urbanization and population growth (examples are the development of new residential areas, administrative and business services among others).

Urbanization can be defined as a process whereby the number of people living in cities increases faster than the number of people living in rural areas (City of Johannesburg, 2004/5). Agamuthu *et al.* (2007) noted that most cities of the world have the greatest portion of their solid wastes coming from their urban centres. In South Africa, the Gauteng province has the largest share of the entire population of South Africa, with about 10.5 million people living in the province (Statistics South Africa, 2008).

The Gauteng province accounted for 20.9% of the entire human population of South Africa in 2005, and in mid 2008, the human population was 21.5% (Statistics South Africa, 2008). Percentage growth from 2005 to 2008, suggest a human population increase of 2.8%. This increase may have huge implications for the landfill sites in the province, particularly through increased waste generation. This explains the need to reduce the quantities of solid wastes generated across Gauteng, and indeed South Africa. This can be achieved by adopting sustainable waste management strategies and policies like waste reduction, re-use and recycling (DEAT, 2005a; DEAT, 2010). Government institutions, businesses and other industries, should aim to increase efficiency in the use of resources through re-use, recycling and the reduction of waste discharged per unit output (UN, 1992).

With the global need to comply with various environmental standards, priority should be given to resource preservation in order to combat climate change (UN, 2009). This can be achieved by preventing waste generation from different processes and services before it is generated, and in doing so, environmental burdens and resource consumption is minimized (Laner and Rechberger, 2009).

1.2 Waste management legislation in South Africa

In line with the current environmental issues associated with solid waste generation and management, the government of South Africa has made attempts in various legislations to mitigate the impact of solid waste generation on the environment. Environmental policies have been set up in South Africa to protect citizens, civil society and the environment. These legislative efforts are aimed at contributing to the attainment of sustainable development and mitigation of pollution caused by waste generation in the region. Some of the legislative efforts applicable to waste management in South Africa are mentioned below, with specific legislations and policies targeting waste management defined.

- National Environmental Management: Waste Act 2008 (Act 59 of 2008)
- Extended Producer Responsibility (EPR) (2008),
- Mineral and Petroleum Resources Development Act (Act 28 of 2002)
- Polokwane Declaration (2001)
- Municipal Systems Act (Act 32 of 2000)
- National Environmental Management Act (107 of 1998)
- Municipal Structures Act (Act 117 of 1998)
- South African Constitution (108 of 1996)
- Occupational Health and Safety Act (Act 85 of 1993)
- National Waste Management Strategy (NWMS 1989)
- Environmental Conservation Act (73 of 1989)
- Health Act (Act 63 of 1977)
- Hazardous Substances Act (Act 5 of 1973)

Currently, there is no legislation in South Africa that mandates small and micro enterprises to collect their solid wastes for recycling purposes, but there is a need for businesses to improve their corporate and social responsibilities towards achieving the South African government's waste minimization targets. Towards achieving these targets, the South African government provides the following strategic waste policies and guidelines:

- South African Constitution (108 of 1996): *"Everyone has the right (a) to an environment that is not harmful to their health or wellbeing, and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that (i) prevent pollution and ecological degradation, (ii) promote conservation, and (iii) secure ecologically and sustainable development and use of natural resources while promoting justifiable economic and social development"* (p.1251-1253) (RSA, 1996).

- National Environmental Management: Waste Act 2008 (Act 59 of 2008): This act suggests the following: *"(1) A holder of waste must, within the holder's power, take all reasonable measures to — (a) avoid the generation of waste and where such generation cannot be avoided, to minimize the toxicity and amounts of waste that are generated,(b) reduce, re-use, recycle and recover waste,(c) where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner,(d) manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odor or visual impacts,(e) prevent any employee or any person under his or her supervision from contravening this Act, and 25(f) prevent the waste from being used for an unauthorized purpose"* (p. 32) (RSA, 2009).

- Extended Producer Responsibility Policy (2008): Heskell (2004) defined extended producer responsibility as a pollution prevention system with a broadened product responsibility beyond emissions generated through product manufacturing, but includes the management of the product after it has been discarded. This policy is widely adopted in various parts of the world and the South African government is developing a bill that will integrate 'duty care' and producer product responsibility (DEAT, 2005a).

- Polokwane Declaration: This declaration is aimed at 50% reduction of solid waste generation and 25% cut in total wastes disposed at landfills by 2012 (City of Johannesburg, 2008).

- The National Environmental Management Act (107 of 1998), requires in section 4(a), subsection (iv) "*That waste is avoided or where it cannot be altogether avoided, minimized and re-used or recycled where possible and otherwise disposed of in a responsible manner*"(p.12) (RSA, 1998).

- National Waste Management Strategy (NWMS 2010): "*Section 6 (1) of the Waste Act requires the development of a National Waste management*

Strategy that gives effect to the objects of the Act, which is: to protect health, well being and the environment by providing reasonable measures for - minimizing the generation of waste; reducing, re-using, recycling and recovering wastes, treating and safely disposing of waste as a last resort, preventing pollution and ecological degradation, securing ecologically sustainable development while promoting justifiable economic development, promoting and ensuring the effective delivery of waste services, remediating land where contamination presents or may present, a significant risk or harm to the health or the environment, achieving integrated waste management reporting and planning to ensure that people are aware of the impact of waste on their health , wellbeing and the environment, to provide for compliance with the measures set out in paragraph (a) and generally, to give effect to section 24 of the constitution to secure an environment that is not harmful to health and well-being" (DEAT, 2010).

1.3 Overview of chapters

This section of the study presents a short summary of the remaining chapters of this report and highlights the various topics covered. Below are the summaries presented in point format.

- Chapter 2 of this work reviews solid waste generation, collection and recycling status in the South African and regional context. Current solid waste issues in Johannesburg were highlighted as a measure of the waste problem. This is followed by the aims and objectives of the study, in order to build on the need for the research as identified in the reviewed literature. The chapter also deals with the scope of the research as well as the characteristics of the population surveyed in the research.

- In chapter 3, the study area is described together with the various research methods used. These include the survey methodology and the qualitative and quantitative analysis carried out.

- Chapter 4 presents and discusses the results together with the summary of the main findings obtained from the survey. Results presented were compared with results obtained by other researchers in developing and transitional countries to determine their similarities and variations in waste generation and collection. The outcome of the analysis of the landfill waste data was also discussed. The limitations and errors encountered were also outlined in this chapter.

- Chapter 5 draws conclusions from the findings presented and discussed in chapter 4. This was done in relation to the research objectives. The conclusions were drawn by critically analyzing the findings and subsequently making recommendations for implementation.

Chapter 2

Review of Literature on Solid Waste Generation, Collection and Recycling in South Africa

2.1 Review of solid waste generation and management in South Africa

Some of the major environmental problems facing South Africa are as a result of pollution caused by solid, liquid, gaseous wastes and the ever-increasing human population (Umkhanyakude Integrated Solid Waste Management Plan, 2004). Increasing socio-economic activities have subsequently increased waste generation in South Africa beyond effective management levels. These socio-economic activities continue to spread around major urban centres in South Africa (DSD, 2000), thereby generating a wide range of environmental issues (typical examples include air pollution, waste generation, contamination of land and water regimes, etc).

As the socio-economic standards improve, the human population also increases due to the migration of people into urban centres in search for better opportunities (DSD, 2000). Godfrey and Arendse (n.d.) established that there is a direct relationship between human population and solid waste generation (in other words, increases in human population leads to increased waste generation). Similarly, increases in human population also leads to increased demand for natural resources in relation to people's needs which include food, fuel/energy, water etc. This subjects the receiving environment (which acts as a sink for waste products) into enormous pressures in the form of increased levels of waste generation, deforestation, pollution and the negative effects associated with the depleting natural resources (DSD, 2000). DEAT (2010) explains that South Africa will continue to experience increasing solid waste generation within the next 50 years, with the highest concentrations at city centres (City of Johannesburg, 2007a) where there are increasing numbers of human population

and businesses. Figures for daily and yearly solid waste generation for South Africa is currently at 0.3kg/capita/day for rural areas, 0.8kg/capita/day for urban centres (Karani and Jewasikiewitz, 2007), and 42 million m^3 of solid waste per year (Umkhanyakude Integrated Solid Waste Management Plan, 2004).

Concerted efforts by the South African government in lowering these figures have been affected by number factors, and some of these factors are listed in the City of Johannesburg's 2008-9 Spatial Developmental Framework report, which outlines issues affecting solid waste management in Johannesburg. They include:

- Poor waste management facilities which contribute to poor collection and processing of generated solid wastes.

- Increasing waste generation (10% increase in waste generation per capita since 2001 (City of Johannesburg Status Quo Report, 2003), and an estimated 12 million tons per year by the year 2010, translating to increases in excess of 2 million tons in less than ten years (Karani and Jewasikiewitz, 2007).

- Illegal dumping and littering which affects waste management and the environment in terms of unrecorded waste generation data, health risks and visual impacts/odour among other factors.

- Limited waste disposal facilities for hazardous waste, which contribute to spread of diseases and improper disposals and transportation to landfills

- Low levels of recycling: Less than 10% in Gauteng province in 2004, 13% of wastes recycled in Johannesburg in 2007 and just 4% of recyclables currently recovered for recycling from landfill sites in Johannesburg (Gauteng Provincial Government, 2004; Pikitup, 2007; City of Johannesburg, 2010).

- A high number of commercial waste recycling initiatives were developed on an *ad hoc* basis and have been funded by the private sector, with minor financial inputs from the relevant authorities (City of Johannesburg, 2005b).

- Lack of accurate waste data in South Africa: Magatte and Purcell (2009) suggest that planning and designing of integrated municipal solid waste management system requires accurate predictions of waste generation which is lacking in South Africa.

Three striking points noted above are the increasing waste generation figures since 2001, the low recycling levels in Gauteng province and lack of accurate waste data. The Gauteng Provincial Government (2008) suggest that significant amounts (29%) of generated wastes in the province still contain recyclable materials, which end up in many of the landfill sites in the province, hampering waste management efforts and contributing to pollution.

Despite the ambitious targets set in the Polokwane Declaration, of stabilizing waste generation, reducing waste disposal by 50% by 2012 and developing a plan for zero waste by 2022, there is a more urgent need for municipalities to be more proactive by engaging all identifiable waste generators in sustainable waste reduction strategies towards achieving a gradual or significant waste reduction trend in South Africa.

2.2 The state of solid waste collection in Johannesburg South Africa

The Gauteng Provincial Government (2004) indicated that businesses may generate the following classes of waste:

- General (paper, glass, plastic, metal and organic wastes from restaurants/food outlets, business centres and tuck shops),

- Hazardous (some electronic wastes from electronic shops, offices, cafes, garages, chemical labs) and,

- Health-care wastes (mainly from clinics and pharmaceutical outlets).

These wastes are frequently collected and disposed at various landfill sites in Johannesburg by the City of Johannesburg municipality in partnership with private contractors (DEAT, 2010; Pikitup, 2007). Regarding the current decision by the South African government to transfer the costs of landfill management to businesses and consumers (DEAT, 2010), small-scale commercial businesses need to play a participatory role, to effectively reduce their waste management costs, considering their low profit margins when compared to big establishments. This should involve the adoption of sustainable waste management strategies like waste recycling, reduction etc. Similarly, enforcing and adopting waste minimization strategies by business owners and managers will depend on how effective the current municipal/private collection systems are (DEAT, 2010). For instance, implementing solid waste collection for recycling in a typical small-scale business would require very strong incentives and platforms to upgrade their capacities in terms of job creation, and a viable market (Luetkenhorst, 2004) among other factors. Hence, to achieve increased participation in recycling and other waste management strategies, the government of South Africa and the City of Johannesburg municipality should endeavour to provide these incentives and enabling platforms for increased participation.

Figures from reviewed literature, suggest that the City of Johannesburg collects 1.4 million tons of wastes per annum, compared to 1.6 million tons generated per annum (Pikitup, 2007). Extra effort is needs to be made in collecting and disposing all the wastes generated in the city in an environmentally sustainable manner.

In terms of the waste categories collected in the city, Pikitup (2007) indicates that about 26% of the classes of waste collected by the municipality are paper wastes.

10% are plastic, 5.7% are glass, 2.7% are metal, 20% are garden wastes and 21.8% are residue and the rest (approximately 13%) are recycled. This indicates a poor collection rate for recyclables (particularly paper and plastic wastes) by the city's waste management authority. Section 2.2.1 to 2.2.3 reviews the state of waste collection for the 3 classes of solid waste generated in Johannesburg area.

2.2.1 General wastes

The City of Johannesburg (2003b) reported that commercial/business activities accounts for about 23% of the total general waste produced in Johannesburg, with 10% coming from the industrial sector, while the rest are from households. Further increases are estimated - 10% for the city in 2010 (City of Johannesburg, 2003b; Karani and Jewasikiewitz, 2007). This needs to be flagged at relevant decision making processes, as the projected increase will subsequently lead to increased waste generation. Also, it is pertinent that further mapping and assessment of the current general waste trends and categories in Johannesburg be made in order to have an idea of the compositions and classes of wastes in the city's waste stream, and to make informed assumptions in terms of the future of waste management strategies for the city of Johannesburg. Figures from the Gauteng Provincial Government (2008) are presented below and listed according to the percentage of total waste generation in the city of Johannesburg:

- 39% are non-recyclables, *
- 29% are main line recyclables and,
- 20% are building rubbles
- 10% are organics,

*Gauteng Provincial Government (2008): All values are 2008 waste figures

Based on these figures, 59% of the wastes generated in Johannesburg are made up of general wastes (non-recyclables and building rubbles), and most of it will end up in landfill sites. It also reveals that main - line recyclables make up a fairly high composition after non - recyclables and devising planning guidelines towards collecting more of these wastes in the city for recycling is necessary towards achieving the city's waste minimization targets. Considering a yearly population growth of 2% since 2001 (Gauteng Provincial Government, 2004), 10% estimated increase in industrial and commercial waste volumes by 2010 (City of Johannesburg, 2003b) and landfill sites already reaching their capacities (See table 2.1), there is a need to enhance waste collection strategies in Johannesburg, with more targeted efforts in small commercial sectors.

Table 2.1: Table below shows the lifespan of the four operational landfill sites in the City of Johannesburg

OPERATIONAL LANDFILL SITES	LIFESPAN IN YEARS
ROBINSON DEEP	14
GOUDKOPPIES	29,5
MARIE LOUISE	7
ENNERDALE	10

Source: City of Johannesburg, 2008

Current efforts made by the commercial sector in collecting and disposing their business wastes in sustainable manner cannot be sustained, due to poor financial incentives, inadequate waste collection services, insufficient waste minimization and recycling strategies, lack of waste information and poor legislative measures (both in implementation and enforcement) (Fiehn and Ball, 2005; Nahman, 2009). As a result, DEAT introduced the National Waste Management Strategy (NWMS), which draws upon the experiences of previous waste policies like the 1999 NWMS and the White Paper on Integrated Pollution and Waste Management, to target the management of commercial and industrial waste

streams, and to improve waste collection within the South African commercial centres (DEAT, 2010).

The Johannesburg management council has given guidelines to businesses in the City of Johannesburg's Waste Management By-Laws of 2003, towards improved collection, transportation and disposal of wastes in the city (City of Johannesburg, 2003c). In these strategies and guidelines, DEAT suggested in the NWMS, that efforts should be made to avoid, reduce, re-use, recycle and recover waste products as often as possible, to improve storage and transportation of generated waste, with more emphasis on the prevention of pollution of the environment and harm to health, prevent wastes from blowing away, prevent accidental spillage and nuisances such as odour and visual impacts, to focus on how to avoid waste generation and how to manage its use and disposal (NWMS, 2010). The City of Johannesburg By-Laws also requires the City of Johannesburg council to request 'any' waste generator to furnish waste information in terms of the following: sources of wastes generation and identification of these wastes, quantities and classes of these generated wastes, management and handling of these wastes, progress reports on the handling of these wastes among others (City of Johannesburg, 2003).

Regardless of the high general waste figures noted for other sectors in Johannesburg, it is pertinent that the municipality takes into account, business and commercial wastes generation volumes and categories, which is also expected to grow significantly. Likewise there is an urgent need to manage this growth in relation to depleting landfill space and projected increases in the human population of city.

2.2.2 Hazardous Wastes

Solid waste collection systems in South Africa are affected by inadequate hazardous waste disposal systems (DEAT, 2010; City of Johannesburg, 2003d).

This contributes to the spread of diseases and the negative impacts on the air quality among other factors (see table 1.1). The Gauteng Provincial Government (2004) indicates that only one hazardous disposal site (Holfontein Waste Site) is operational in the entire Gauteng province. This is poor, considering that current disposal volumes rose from 175 000 tonnes per annum in 2003 to 420 000 tonnes per annum in 2006 (City of Johannesburg, 2008), thus stretching the operational capacity of the site. On the contrary, the rising volume suggests that more hazardous wastes were collected and disposed effectively by the municipality within that period, which is commendable. However, efforts to enhance further collection of hazardous wastes remain vital, through the construction of new sites, education and various awareness programmes. The City of Johannesburg (2003d) noted that lack of awareness or low education levels contributes to illegal dumping of hazardous wastes in Johannesburg. Hence the municipality should devise better ways to reduce this scourge and should include the distribution of pamphlets around strategic areas to educate people on the effects of certain classes of waste on the environment.

2.2.3 Healthcare wastes

Health-care wastes are continuously being generated in Johannesburg from clinics, hospitals, pharmacy stores, etc. About 71 000kg of these wastes are collected and disposed of at the Robinson Deep Incinerator, with potentials for increased collection and disposal of these wastes (City of Johannesburg, 2003d).

In terms effective health-care waste management, through applied standards in the collection, transportation and storage of these wastes, Gauteng province has performed below average, and this has resulted to cases of health care wastes being transported to landfill sites in the province (Gauteng Provincial Government, 2004). Generators of these wastes (including hospitals, clinics, pharmacy stores etc) need to be educated properly on health-care issues relating to

the sorting, storage and transportation of these wastes by relevant licensed waste collector(s). This will enable business managers, owners and staff to play an effective role in protecting lives and the environment. It also necessary for the municipality to be more involved by distributing fliers and information packs to businesses and civil society about the 'do's and don'ts' in managing health-care wastes. This could be supported by a fining system or command and control strategy, which involves the systematic control of waste attitude through the application of regulations, standards and land-use controls (Godfrey and Nahman, 2007).

2.2.4 General review of studies on the collection of recyclable solid wastes

Solid waste collection in Johannesburg has been plagued by the lack of a recycling culture in South Africa (Nahman, 2009). It has impacted negatively on people's participation in waste collection for recycling purposes. Bernstein (2004) suggests that the extent which the public is involved in strategic waste collection programmes is quite critical to the functioning as well as the sustainability of those programmes. For instance, strategic decisions by businesses or households to collect their waste for recycling are subject to decisions of business owners, managers (Redmond *et al*., 2008) and household heads, with direct consultations with business staff, household members and all the interested parties, in order to engage all the involved parties in the project. Likewise, business owners and household heads should educate their staff and household members on the need to collect and dispose their waste in an environmentally friendly manner to protect the environment.

Household waste separation and disposal studies in Ethiopia, revealed that the education level of the household heads were among the factors identified for increased involvement of households in the sorting and collection of wastes in separate lots for recycling purposes (Tadesse, 2009). His finding supports the opinion that if household heads, business managers or owners were more

educated, particularly in the area of waste management, the chances of increased participation in source separation and collection of recyclable waste products for recycling purposes will increase. Likewise, with well structured site specific waste systems, businesses would be better equipped to manage their waste in a more sustainable way.

Waste collection systems and practices are one of the problematic areas in municipal waste management (Kassim and Ali, 2006). In South Africa, these waste collection problems contribute to the low levels of recycling, when compared to developed countries (Karani and Jewasikiewitz, 2007). Indications are that poor solid waste collection and disposal systems contribute to the spread of diseases and environmental degradation, which include green house gas (GHG) emissions from landfill sites. In terms of disease spread, the most vulnerable are the informal waste pickers or recyclers, who often visit landfill sites, scavenging for marketable waste products. They are often exposed to a number of health issues ranging from the daily exposure to disease carrying micro-organisms, contaminated health-care wastes, and hazardous materials which may be radioactive. With the increasing human population in the City of Johannesburg and the need for more jobs, more people will venture into informal collection of wastes to earn money for their sustenance. Without formalized and well structured waste collection systems in Johannesburg, more people may continue be exposed to these dangerous elements.

An important determinant to an effective waste collection strategy is public participation. It is pre-requisite to any sustainable solid waste management programme (Garces *et al.,* 2002). Participation is a process that allows stakeholders to influence and share control over development initiatives, and the decisions and resources which affect them (Davis, 2004). Without an all inclusive strategy, waste management programmes may not effectively achieve its required targets. This suggests why a number of scholars continue to study people's perception and attitudes to various solid waste management strategies, to explore motivating and limiting factors affecting their participation in these waste

programmes. Common in the list of waste management programmes is solid waste collection for recycling purposes, which has been extensively studied at household levels globally. This section however reviews some findings from the commercial perspective.

Small-scale businesses usually prefer short - term profits in order to stay afloat. This is as a result of a number of factors, ranging from the highly competitive environment within their areas of operation to their vulnerability to evictions from their business premises due to alternative demands for space, etc. Starting up a collection system for recyclable wastes in these establishments would require a number of motivating factors and incentives that will encourage business owners to extend their responsibilities to waste collection. Hernandez *et al*. (2010) found that to ensure compliance to waste recycling programmes, participants need to be satisfied with the current or proposed waste collection system itself. Likewise, they need to have a thorough knowledge of the system as a whole. This requires the active role of the municipality and the local council in reaching out to various commercial establishments, to educate them on the need to collect their waste for recycling purposes. In consideration to their operational constraints, most of these small commercial businesses need to survive, due to their low profits margin and rather superficial customer relations. To increase participation from the commercial sector, the municipality and local council should provide incentives like buy-back centres and tax cuts, which will encourage businesses to collect their solid waste for recycling.

Knowledge of the environment is also an important determinant of a recycling programme. Garces *et al.* (2002) suggest that environmental awareness and knowledge of the environmental impacts of urban wastes can encourage participation amongst businesses, government and the civil society. In other words, if environmental knowledge is transferred to commercial sectors, owners and managers will understand why it is necessary collect their wastes, not just for financial reasons, but for altruistic reasons and the need to protect the natural environment. Matete *et al*. (2008) established the need for educational campaigns

in communities, in order to sensitize the public on the importance of collecting their waste for recycling purposes.

Other studies also reveal the importance of information technology in waste collection and generation studies. Vincentini *et al.* (2009) analyzed a model tested in Shanghai China, using *intelligent* solid waste collection containers to estimate waste collection and optimization in a project called the '*clean wings project'*. The project was aimed at gathering required waste data electronically from waste bins, which is fed into a database for analysis. Data is generated when every waste-bin tested is opened or closed. Similarly, a central processing unit is provided to constantly supply related waste recycling information about strategic regions, to provide the needed waste data for decision making and to monitor progress efficiently. This system is currently being perfected to improve solid waste data collection.

Such waste management models can be designed in South Africa, towards an effective waste management system. This will improve the quality of waste data collected. South Africa is still faced with a problem of poor quality waste data (Geoff, 2009), and applying such technologies in research can improve data quality through the effective collection and collation of solid waste data obtained from different regions. This will also enable municipalities to estimate how much waste materials (both recyclables and non recyclables) generated from businesses and commercial centres, to determine their contributions to landfill waste volumes.

Amidst the increasing human population and volumes of wastes generated in South Africa, current solid waste collection levels for recyclable wastes are generally low in Johannesburg. This is despite efforts made by the South African government in the introduction of various wastes policies. Towards achieving the waste reduction targets, relevant waste data has to be provided and made accessible in order to build on areas that are lacking. The next section reviews the viability of solid waste recycling as a sustainable waste minimization strategy that

can be introduced across South African households, businesses, educational institutions among other sectors.

2.3 Background on the importance of solid waste recycling

Ruiz (1993) defined recycling as "*a solid waste management strategy*" (p.1.1). It is a process where waste materials are converted into usable products (Wen *et al.*, 2009). There are various waste management strategies which include waste incineration, composting and recycling. However, solid waste recycling is one of the environmentally friendly ways of managing wastes to protect human health and the environment. Kaseva *et al.* (2005) explains that recycling has been recently recognized as a sustainable solid waste management strategy, and this should be encouraged to minimize waste generation and ensure sustainable development. Pimenteira *et al.* (2004) suggests that up to 3.5 mt (Metric Tonnes) of carbon-dioxide (CO_2) emissions can be avoided per year as a result of solid waste recycling in Brazil.

Waste recycling helps to save energy, conserve available natural resources, create jobs and also protects the environment (Read, 1999). It can help reduce land use issues (particularly by poor siting of landfills), by reducing the rate at which operating landfill sites reach their capacities. It encourages energy and resource conservation through the recycling of various waste materials. For instance, Wilson (1981) established that substantial energy can be saved simply by recycling paper products. This has good implications for paper production in South Africa, as the energy required to produce new paper products would be reduced due to available raw materials in the form of used waste paper products.

In terms of the financial gains, Batool *et al.* (2008) explained the importance of recycling for national income generation in Pakistan, which include estimated annual earnings of about $8.8 million (United States Dollars), from energy and natural resources, which could help protect the environment and create better

developmental opportunities. This highlights the benefits of solid waste recycling, which include the saving of resources and the reduction of the environmental impacts of waste materials achieved through the reduction of the volume of waste materials disposed at landfill sites (DEAT, 2005b). This is particularly important in the South African / African context where economic development draws heavily on natural resources.

Study reveals that solid waste recycling reduces greenhouse gas (GHG) emissions, by reducing the demand for energy needed in production and by the use of recycled materials (Bogner *et al.*, 2007). DEAT (2000a) also suggest that economic growth can be improved by the efficient use of natural resources within the framework of pollution and waste management. This may come from the recycling of solid wastes, provision of waste buy-back facilities, subsidies, tax incentives and the enhancement in the supply of recycled materials (In this context, supply to businesses, academic and administrative institutions situated in Braamfontein, Johannesburg).

Factors that also need to be considered, towards the effective implementation of recycling programmes by governments or municipalities include the consideration of recycling activities in relation to financial constraints, the current situation, regulation, institution, the environment, socio-cultural and technical issues (Suttibak and Nitivattananon, 2008). Other factors include waste composition, waste collection and segregation, education, municipal solid waste (MSW) management plan and administration, local recycling-material market, human resources, and land availability (Troschinetz and Mihelcic, 2009). Similarly, introducing regulations in resource use, extended to renewable resources will improve resource recovery and recycling programmes (Oelofse and Godfrey, 2008).

Wilson *et al.* (2006) discovered that informal recycling activities were carried out by the poor and marginalized in the society, who resorted to scavenging and informal waste collection as a source of livelihood. They suggest that there is need

to integrate informal recycling into waste management planning, while developing their practices and experiences to improve efficiency in the waste management system. This integration will create sustainable jobs and improve the welfare of the community if handled formally. Nzeadibe (2009) also identified the potentials of informal recycling in Enugu State, Nigeria, which include job creation and attainment of the millennium development goals, particularly goals related to poverty alleviation and environmental sustainability.

The role of managers and business owners in promoting solid waste recycling is very crucial. Redmond *et al.* (2008) surveyed small business owners / managers to determine the reasons for the disparity between their interest in waste management and inaction. Four factors were studied and they include: environmental interest, business impact on the environment, current environmental practices and awareness of local environmental matters. In terms of environmental interests, they observed that the interests of business owner(s) and manager(s) in environmental issues would not necessarily translate to an improved waste management practice(s). Their study also revealed that a considerable number of business owners did not know if their activities impacted on the environment, and they were likely to be involved in the waste management for personal reasons other than the environment. In terms of their current practices and awareness, the study revealed that business owner(s)-manager(s) attitudes and awareness, influenced their overall attitude towards waste recycling. This suggests that the effective decisions to collect business wastes for recycling are only made by small business owner(s) and manager(s), depending on their awareness on the relevance of sustainable waste management or recycling.

2.4 State of solid waste recycling and issues for commercial businesses in Johannesburg

Previous information available on businesses and commercial services in Johannesburg, reveal that they only collect a small proportion of their solid wastes for recycling purposes, judging by the low recycling figures: 6% to 8% in 2003

(City of Johannesburg, 2003), 13% in 2007- including collections from other sectors apart from commercial sectors (Pikitup, 2007). There has been 10 to 14% rise in waste generation in the city due to increases in human population, and a general low recycling attitude (City of Johannesburg, 2009/2010). As a result, the City of Johannesburg's Integrated Development Plan was introduced (along with other policies and strategies discussed earlier) by the municipality to salvage the waste situation in Johannesburg (City of Johannesburg, 2010). These strategies were also initiated as a result of the following global and regional factors:

- A continued world-wide need to improve industrial-environmental standards (Coleman, 1997).

- A need to reduce the amount of solid wastes transported to landfills through business participation (DEAT, 2005) and,

- The Polokwane declaration of a 50% reduction in solid waste generation and 25% cut in solid wastes disposed at landfills by 2012 (City of Johannesburg, 2008a), among others.

Among the waste minimization strategies, waste recycling remains the most efficient and environmentally sustainable solution towards reducing the amount of solid wastes sent to the country's landfills (Collect-A-Can South Africa, 2008). However, effective implementation of recycling strategies has not been smooth in South Africa as a result of the following issues:

- **Poor waste data**: Karani and Jewasikiewitz (2006) suggest that for effective implementation of waste policies, there has to be some information in terms of the types of wastes generated, the quantity of the wastes generated and how much of the streams will end up in our environment. In Johannesburg, there is little information on the types of wastes generated by all sectors on the economy (DEAT, 2005), which

makes decision making very difficult. Information on the compositions of generated waste can help mitigate the environmental impacts, through the design of waste-specific collection systems (Bandara *et al.*, 2007). The design and establishment of a good solid waste management system depends on the ability to generate good solid waste data, which can be used for developmental and management policies (Rhyner, 1992). Similarly, Wilson *et al.* (2001) established that data on solid waste composition would determine the demand for waste collection, transfer and treatment. They maintained that solid waste data will help determine the current status of recycling in the managing of municipal wastes, to determine the feasibility of future recycling programmes.

- **Lack of government assistance**: The municipality's role in enforcing environmental/waste management policies in South African businesses has been very weak (Coleman, 1997; DEAT, 2005), thereby indirectly encouraging businesses to generate wastes without a sustainable management system.

- **Lack of economic incentives or a viable market to support environmental initiatives**: As a result of the associated costs of adhering to environmental standards (Coleman, 1997), businesses have ignored environmental sustainable strategies like recycling, due to the low economic incentives for recycling of certain classes of waste in South Africa (DEAT, 2005b).

- **Low levels of education**: Collect-A-Can (2008) identified low levels of recycling awareness and its importance to the environment as huge obstacles towards reducing waste generation. Due to this lack of knowledge, people in the business sector are reluctant to participate in recycling.

This review highlights the status of waste generation, collection and recycling in South Africa, and the need for small and micro enterprises to minimize their daily wastes in South Africa. Important points noted, suggest that waste generation has continued to increase in Johannesburg as a result of both socio-economic development and population increases. Likewise, waste minimization efforts, through enhanced collection of wastes have not been commendable as a result of poor data, poor waste management practices, low levels of involvement in waste management by the municipality, lack of needed capacity and resources amongst others.

Similarly, waste recycling was considered as a sustainable waste minimization strategy that can not only reduce carbon dioxide (CO_2) emissions, but save energy, reduce land use, save money and provide jobs. Its implementation across sectors would include an evaluation and assessment of the current situation in particular sectors, consideration of the environment, financial constraints and capacities, socio-cultural and other technical issues. It also needs to include informal recyclers in order to provide jobs, reduce healthcare impacts and increase access across sectors. Finally, implementing recycling programme needs all generators of waste to be fully involved and acquainted with the process.

2.5 Aims of study

The aims of the study are as follows:

- To determine the compositions of solid waste materials generated and collected for recycling purposes, and to determine the involvement and perceptions of small and micro enterprises towards the collection of their solid wastes for recycling purposes
- To determine landfill waste disposal trends for the City of Johannesburg between 2004 and 2008 as a means of determining the waste generation and recovery trends in Johannesburg.

Specific objectives of this research were:

- To compare relationships between small and micro enterprises in terms of the following:

  a) Involvement of small-scale businesses in the collection of their daily solid wastes for recycling purposes,

  b) To determine the daily categories and compositions of solid wastes generated and collected for recycling,

  c) To estimate of their daily waste generation

  d) To analyze the City of Johannesburg's municipal waste disposal data from 2004 to 2008.

2.6 Specific research questions

a) Do small and micro enterprises differ in terms of their involvement in the collection of their daily wastes?

b) How much recyclable waste compositions are generated and collected for specifically for recycling purposes?

c) How much solid waste is generated daily by small and micro enterprises in the Braamfontein region?

d) What are the problems, faced by small and micro enterprises in effectively sorting their solid wastes in separate lots for recycling?

e) What factor(s) will encourage small and micro enterprises to collect their solid wastes for subsequent recycling?

f) What compositions of the solid wastes generated from small and micro enterprises are handled by the municipality (Pikitup), private recyclers, waste pickers, medical and specialized disposal systems?

g) What are the solid waste trends for the City of Johannesburg's landfill sites?

2.7 Hypothesis: Testing business involvement in daily recyclable waste collection

The study also assessed small-scale enterprises in terms of their involvement in waste collection, to determine if their staff numbers and organizational structures were related to their waste collection attitudes. Redmond *et al.* (2008) explained that the involvement of small-scale enterprises in waste management may be hampered by flatter organizational structures and resources. Also, having noted that this area of study is still under-researched globally (Worthington *et al*., 2005), it is only necessary to generate the study hypothesis based on the hypothesis that:

- *Small enterprises with higher staff numbers (as opposed to micro enterprises) and better organizational structures, will collect more of their solid wastes for recycling due to a large and specialized labour force, larger office space and increased efficiency.*

2.8 Background on the business population studied

The population of small and micro enterprises grew in Braamfontein region due to the various regeneration projects carried out in the region as well as available office spaces, occupying about *430,000*± square metres* (City of Johannesburg, 2003). Other factors are the presence of educational institutions, student's accommodation, hotels, recreation centres and the proximity to important centres like the Johannesburg central business district (CBD).

*2003 estimate

Small businesses are characterized by their small employee numbers, ranging from 1 to 50 staff members (RSA, 2003). They represent a viable economic sector in South Africa, and they contribute to the socio-economic development of the country.

2.8.1 Small enterprises and micro enterprises

The South African national small business amendment Act 26 of 2003 classified small businesses into three groups namely: small (*less than 50*), very small (*less than 10*) and micro (*less than 5*) (RSA, 2003). Due to unequal distribution of these businesses in the Braamfontein study area, two of the groups were merged, to ensure that the businesses were fairly represented in each group. Very small businesses (*with a staff size of less than <10 employees*) were grouped with small businesses (*with a staff size of less than <50*) and studied collectively as '*Small enterprises',* while businesses with a staff size of *<5 employees* were studied as *'Micro enterprises'*. This grouping or classification enabled the study of two distinct groups fairly distributed in the study area. This was done to capture waste data effectively from larger samples, to avoid having unrepresentative samples and to minimize the generalization of solid waste data.

Micro enterprises are usually characterized by a number of peculiar qualities. These qualities suggest that they are usually controlled by sole proprietors or with few staff, they are mostly unregistered or informal, office space is not always a necessity as some prefer to hawk their products, it is less capital intensive to set up and they can easily change their business location. Small enterprises on the contrary have mostly large staff and require more capital to start up. They are mostly controlled and managed by a group of people or board members.

2.9 Scope of study

Because of the challenges associated with the quantification and measurement of small-scale enterprises and their waste footprints, the scope of this study covers not only measurements of solid waste generation and collection, but also evaluates various challenges and issues raised towards the effective waste management in small-scale enterprises. It should be noted that despite small and micro enterprises being characterized by small employee numbers (usually less than 50 in the South African context), their solid waste generation footprints may be quite extensive, thus contributing significantly to environmental degradation (Redmond, 2008).

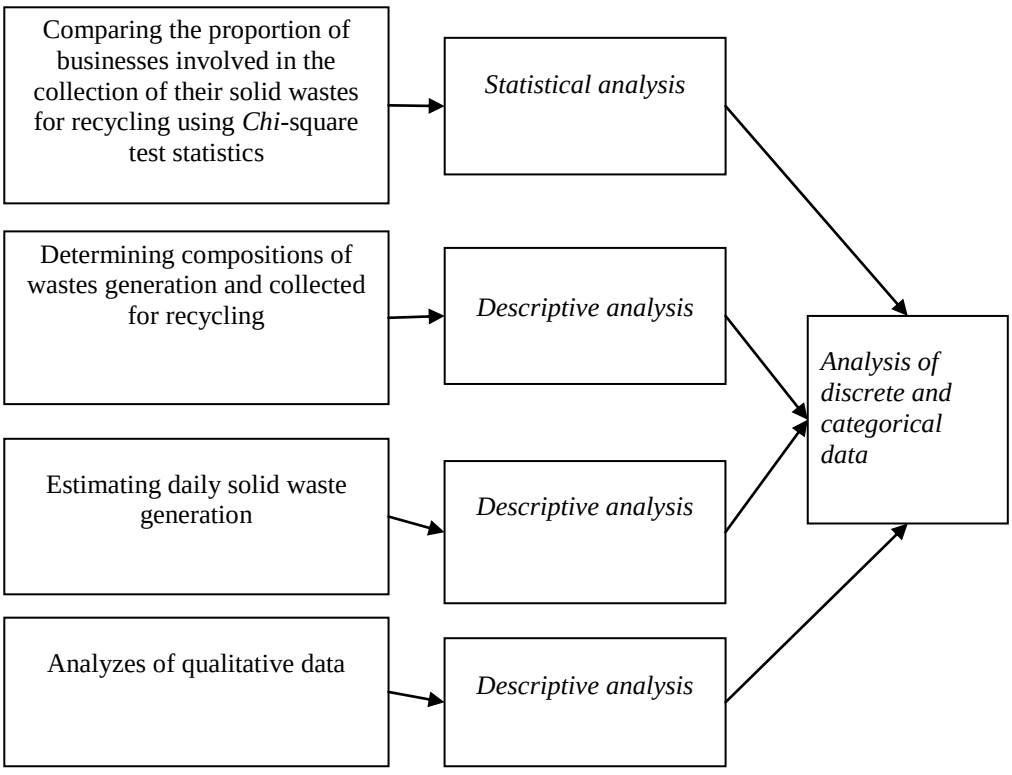

Figure 1.2: Flow chart showing the different analyses carried out in the research, using descriptive and statistical methods

2.10 Strategic measurements and assessments

Some indicators were used to measure solid waste generation and collection in small and micro enterprises. These indicators include waste generation, collection compositions and frequency of waste occurrence in business streams. The illustration shown in Fig 1.2 describes the research analysis carried out in the study, towards achieving the research aims and objectives. These analyses were further defined in sub sections 2.10.1 to 2.10.4.

2.10.1 Solid waste generation and collection compositions

The compositions of solid waste aggregates generated and collected by businesses for possible recycling were determined for each enterprise. These waste aggregates were grouped as '*recyclable'* and '*general wastes'*. The compositions for each waste type were determined according to the occurrence in each business waste stream. Xiao-yan qu *et al.* (2009) recognized the importance of solid waste composition information in their survey of the compositions and generation rates of household wastes in Beijing, China. They stressed the need for waste composition information for the effective handling of waste.

2.10.2 Comparing the proportions of businesses collecting their recyclable wastes using Chi-Square Statistical Method

The *Chi*-square statistical test is used to test the degree of confidence necessary to accept or reject a hypothesis or hypotheses (Linton, 2006). The test also determines if two samples (in this context, businesses) are different enough in some characteristic or some behaviour by measurement of the proportion of their frequencies (Linton, 2006). In this context, it was used to compare the proportions

of small and micro enterprises involved in the collection of their recyclable wastes for recycling purposes. The proportions were analyzed, to find out if there was a relationship or not, in terms of staff numbers and their waste collection attitudes in order to make statistical inferences.

2.10.3 Estimating daily solid waste generation

The daily solid waste generation in small and micro enterprises was determined by daily estimates. This was done to find out how much solid wastes are generated by these enterprises on a daily basis.

2.10.4 Analysis of qualitative and quantitative data

The qualitative data obtained during the survey was used to determine the attitudes and perceptions of business owner(s) / manager(s) in the collection of their solid wastes for recycling purposes. This enabled the assessment of various factors that affected recycling programmes in the area. Quantitative data obtained from the City of Johannesburg was also used to determine the solid waste diversion trends in the city's landfill sites.

A lot of work has been done on people's perception and attitudes towards solid waste recycling, generation, and collection especially at household levels with little work done strategically on small and micro enterprises in South Africa. This has resulted to poor waste data needed for strategic planning. With an increasing number of infrastructural projects in South Africa, particularly in the Gauteng province, solid waste generation rate is expected to increase due to anticipated population increases (Gauteng Provincial Government, 2004). Efforts to manage these wastes are necessary through provision of relevant waste information for future planning. The next chapter looks into more detail, the various steps followed in providing the much needed waste data.

Chapter 3

Data Collection and Research Methods

3.1 Introduction

This chapter presents the various methods and processes followed towards the collection of data needed for the analysis. It describes the study area, the analytical processes and the entire survey method. Data used in this research were based on the following processes:

- A Pilot survey, including brief face to face interviews with owner(s) - manager(s) of small / micro enterprises
- Survey of small / micro enterprises
- Consultations with City of Johannesburg staff
- Analysis of City of Johannesburg (Pikitup) waste records

The Braamfontein study area was selected because of the growing numbers of small and micro enterprises, with little information on their waste generation and management footprints.

3.2 Description of the study area and land-use pattern

Braamfontein is situated at the north western part of the Johannesburg central business district (CBD) (fig 3.1), which is also a major commercial hub in Gauteng province. It suffered the same neglect and decay resulting from decentralization of the various nodes in the city (City of Johannesburg, 2009a), with complete neglect and decay of buildings and major facilities in the area. Recent turn-around efforts was designed to revamp the entire region towards improving business confidence in the area (City of Johannesburg, 2009a).

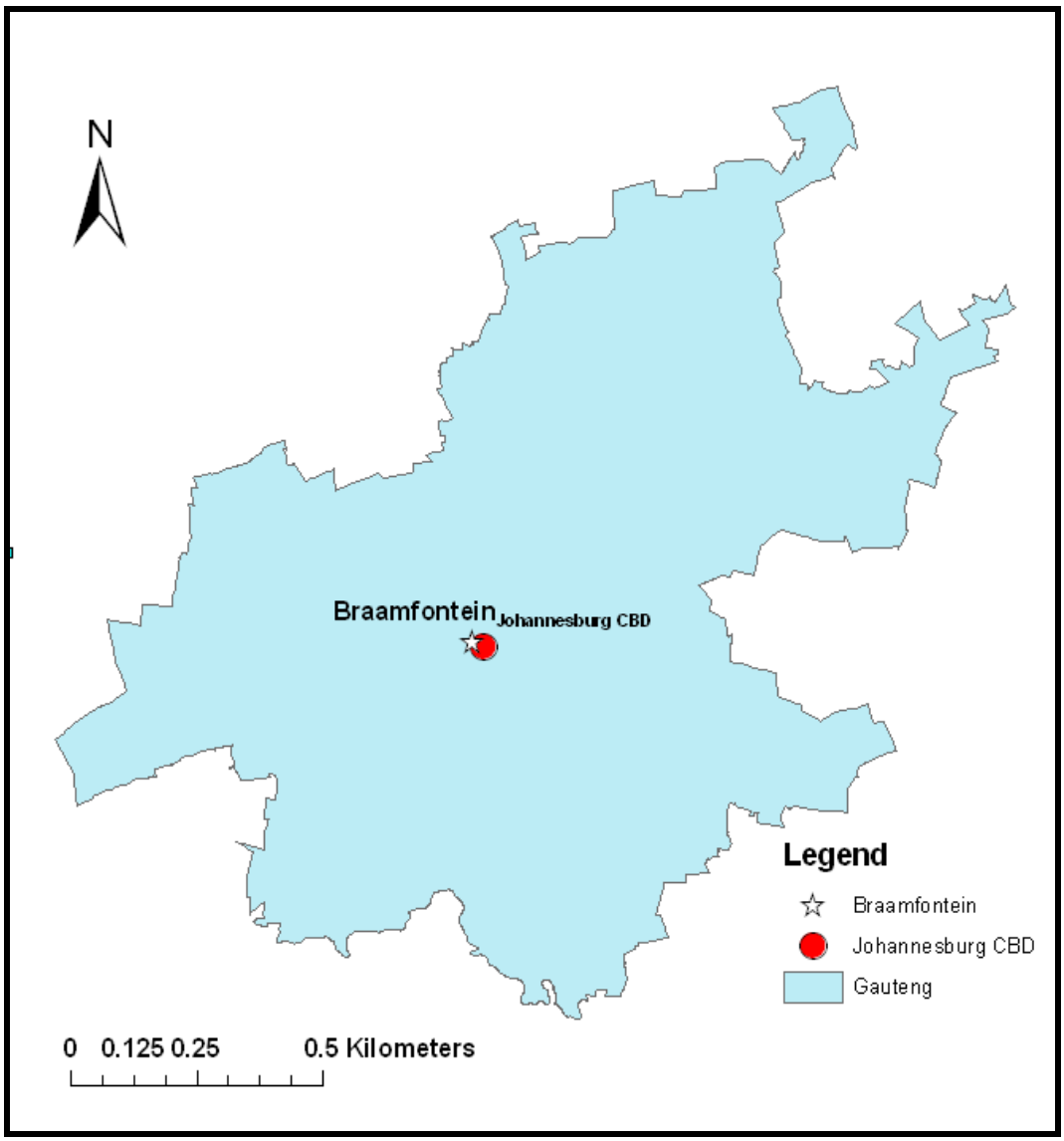

Figure 3.1: Map showing the location of Braamfontein within the Johannesburg CBD (Central Business District)

3.2.1 Spatial developments and growth

Braamfontein is geographically situated these coordinates: 26°11'38.35"S and 28 °1'47.22"E (Google Earth). Braamfontein has an estimated permanent population of about 25,000* people and an additional temporary population of 20,000* students (City of Johannesburg 2003).

*2003 estimate

Braamfontein also has an estimated office space of about 430,000* square metres and these figures are growing as more businesses and educational institutions return to the area. This continues to impact on various management infrastructures including waste, electricity, water, road network among others (City of Johannesburg, 2003). The City of Johannesburg (2008/9) regional draft report suggests that Braamfontein is an economic node of the Johannesburg's central business district (CBD). It boasts of a range of land uses including cultural and creative activities, retail, residential, offices, education facilities, entertainment and local government. Also, it is the fourth largest node for office space in the City of Johannesburg, offering 428 000 sq meters of office space. Braamfontein forms the major corridor link (known as the '*Cultural Arc')* between Newtown and Constitution Hill developments (City of Johannesburg, 2008/9). Braamfontein is ranked fourth in terms of available office spaces in the Johannesburg city and has educational and multinational companies situated within the area. It has also witnessed an increase in business confidence especially in private, commercial and residential sectors (City of Johannesburg, 2006). This has improved the socio-economic standards of the district, making it an ideal destination for small and micro enterprises. Also, the City of Johannesburg (2009*a*) recorded a recent high demand for ground floor retail space especially for small, medium and micro enterprises in the region.

3.2.2 Electricity usage

In terms of electricity consumption, Braamfontein already has little electricity to spare. Most areas in the region are already operating at 50% - 75% capacity, with some areas in the region operating at 100% capacity (City of Johannesburg, 2008/9). This critical demand and use of electricity reflects on the current population, urbanization and energy demand of the district.

* 2003 estimate.

3.2.3 Land-use pattern in Braamfontein

Land use in Braamfontein is mix of administrative, commercial, residential and educational use. Jayne (1996) indicated that major company head offices are now being located in the Braamfontein region. This contributes to increased solid waste generation, due to increased number of employees, students and shopping centres developing in the area.

3.2.4 Recreation and tourist attractions

There are a number of recreational and attraction centres which draw people to Braamfontein on daily basis (City of Johannesburg, 2009*a*). These centres include:

- *Constitution Hill*
- *Johannesburg Planetarium*
- *Life Sciences Museum*
- *Origins Centre*
- *Johannesburg Civic Theatre*
- *University of the Witwatersrand*
- *Mandela Bridge*

3.2.5 Accessibility

Braamfontein can be considered as a small nodal centre because of its strategic link to major suburbs in the city. For instance, Braamfontein is linked to the Johannesburg CBD to the south, while it links the northern suburbs of the city through a network of national and municipal roads. The new Bus Rapid Transport (BRT) system, which began operation in 2010, will enhance accessibility in the district, thus increasing daily population. At the southernmost part of the

Johannesburg CBD, there is a major taxi rank and a train station which are both about a kilometre to Braamfontein. These major transport hubs contribute to the influx of people who visit the area. Other facilities in the area include recreational facilities, parks and entertainment facilities.

3.3 Sampling methodology

Sampling is defined as a means of selection of sets of units from a population, in order to collect information that will enable inferences to be made about a population (Statistics Canada, 2003). Sampling can be divided into two groups namely probability and non probability sampling. Probability sampling requires that samples are selected at random or by chance while in non probability sampling, assumptions are that the samples are a representation of the population it came from (Statistics Canada, 2003). In this research, the former is applied to eliminate bias in the results and to reduce sampling error. Stratified sampling was used to gather the required samples. Stratified sampling is a process whereby homogenous populations of interest are grouped into mutually exclusive groups called strata, whereby independent samples are selected (Statistics Canada, 2003). In this context, only businesses operating in Braamfontein were targeted for the research. These businesses were then grouped according to their staff sizes as described in section 2.9.1.

The spatial distribution of businesses in Braamfontein allows for a comparative analysis to be conducted efficiently. The stratification of businesses into required groups was done, using staff numbers as criteria for stratification, to ensure that equal numbers of random samples were selected in each stratum. Simple random sampling was then used to select the required number (n) of small and micro enterprises needed in each stratum. Townsend (2002) indicated that simple random sampling allows each member of a given population, an equal chance of selection as part of the required sample(s).

Sampling was done along 22 major streets of Braamfontein, which is about 90% of the streets in Braamfontein region. The initial selection of samples for the survey was done through a face to face pilot study of businesses in the district. This helped in determining businesses that were more likely to take part in the survey in order to limit non-response errors, unreturned questionnaires and other factors that might contribute to sampling errors. According to Kitchenham and Pfleeger (2002), it is appropriate to assure precision and reliability of samples by obtaining prior information about the phenomena of study through baseline studies.

3.4 The survey methodology

Survey is defined as an activity that methodically collects information about the characteristics of a population using defined methods and compiling gathered information into a useful summary (Statistics Canada, 2003). The survey method of research was used to collect data from small and micro enterprise owner(s) and manager(s). Small and micro enterprise owner(s)-manager(s) were interviewed, because they were the decision makers in their various businesses. Redmond (2008) argued that the level of managerial involvement in small businesses is related to the size of the business, which influences the implementation of environmental strategies. He explains that management decisions could be implemented effectively if the size of the businesses was smaller compared to large corporate organisations, because policy implementation would be achieved easily. For instance, the implementation of specific projects, in a small business with few staff is expected to be a lot easier to manage in terms of resources, time, coordination, monitoring etc. This also influenced the decision to interview small business owner(s)-manager(s) as they are in the better position to influence decisions.

The face to face interview method was used to increase the response rate of the survey process. This was achieved through scheduled interviews with business

owner(s)-manager(s) in the area. The electronic database of the Braamfontein business directory was also consulted for the selection of businesses that took part in the survey (http://www.braamfonteinbiz.co.za/). This was important because auxiliary information is needed to ensure that representative samples are used for the random selection process. A sample frame consisting of the contact details of owner(s)-manger(s) of 100 small and micro enterprises was created during the pilot study and numbered from 1, 2 , 3…100, prior to the survey process. Rea and Parker (2005) defined a sampling frame as a list, made up the general population from which a researcher can draw up a list of possible members of the population. 60 businesses were selected from the sample, using the simple random sampling method. This was facilitated by the face to face survey method, which ensured that equal representative samples (*30/30*) were obtained for each stratum from the 6th of November 2008 to the 30th of April 2009.

The main objective was to sample as many business samples as possible (*ideally 50/50*), to generate data for both the quantitative and qualitative analyses. Various steps were taken to ensure that the analysis carried out was relevant to the research in terms of data requirements

3.5 Qualitative and quantitative methods defined

Qualitative research describes events and characteristics of people studied without comparing measurements, while quantitative research in concept, focuses on measurements of the characteristics displayed by events and people which the research studies (Murray, 2003). The application of both methods in this research increases the validity of the research and indeed the outcome. The quantitative method was adopted to quantify responses to specific questions and applying statistical analysis to measure independent values generated by each business.

Quantitative analysis applied required using carefully structured open and closed questionnaires distributed within stratified limits. The ‘open ended’ question type

is described as the type of survey question that usually solicits for more information, while the 'closed' type usually is more direct i.e. either 'yes' or 'no' , question formats (Seibert, 2002). Non numeric data captured was analyzed qualitatively. This also required the use of questionnaires.

3.6 Types of solid wastes studied

The types of solid wastes analyzed in this study are of two broad categories namely *recyclable* and categories of *general* wastes. For the purpose of this study, waste categories are defined as the varieties of solid wastes generated by small and micro enterprises on a daily basis. Small-scale enterprise (*small and micro*) owner(s)-manager(s) were asked in the questionnaire, to state and count the types of solid waste materials generated in their business premises (visual assessment), to determine the various daily business waste categories. This was also done to enable the classification of wastes into recyclable and general categories. The categories of wastes outlined below were identified by small and micro enterprise owner(s) and manager(s).

- Paper (which include newspaper, cardboard, packaging paper and other forms of paper materials)
- Metal (Including aluminium cans, scrap and lids)
- Glass (Including wine/ beer bottles, window/door glass and other forms except mirrors and glass material found in car windshields)
- Chemical (Including used photographic and printer cartridges, pesticide containers)
- Bulb (Including used and damaged bulbs and light fittings)
- Plastic (Including cellophane and other forms of plastic wastes)
- Electronic (Ranging from old computer electronic parts to damaged or discarded electronic parts)
- Medical (Including used syringes, drips etc)

- Organic (Including wastes food from restaurants and other waste perishables)
- Battery (Including lead and dry cell, old car and other batteries used electronic gadgets and generated mostly from auto shops, electricians and businesses)

These wastes were further grouped into major recyclable wastes which are: paper, plastic, metal, glass and electronic wastes, while the other group constitutes of other general / non recyclable wastes types which include battery, bulb and other chemical wastes. Recyclable and general wastes are defined in sections 3.6.1 and 3.6.2.

3.6.1 Recyclable wastes

Recyclable wastes can be recycled and their components re-used in making the same or different products. The common types of recyclables include paper, plastic, metal, glass and electronic wastes. Their waste generation and collection compositions were determined, as a measure of recycling performance in small and micro enterprises.

3.6.2 General wastes

General wastes include other business, household and garden wastes, as well as the wastes components which do not pose an immediate threat to the environment (Gauteng Provincial Government, 2004). Categories of these wastes were determined in small and micro enterprises, to estimate the daily generation by compositions.

3.7 Solid waste generation and collection protocol for analyses

Compositions of generated wastes were estimated using some of the waste stream characterization principles of the North Carolina Department of Environmental, Health and Natural Resources (U.S.A) (1992), outlined below:

- **Demographics**: Small and micro enterprises were selected according to the criteria described in section 2.8.1, to ensure that there is a high level of homogeneity in each business group and to avoid a mix of residences and industries.

- **Objective and usefulness of the study**: The outcomes of this study are designed to be of use to the municipality, towards improving small-scale enterprise participation in solid waste collection for recycling purposes in Braamfontein. The aim is to provide preliminary waste generation and collection data for future studies and to conduct research on how to improve waste recycling in small-scale businesses across South Africa.

- **Samples:** Effort was made to select as many businesses as possible (*according to available time and resources*) for the survey. This is as a result of heterogeneous nature of solid wastes.

- **Visual Assessment**: Though not a part of the North Carolina Department of Environmental, Health and Natural Resources Principle, the visual assessment estimation method was used in this study. This is based on the visual assessment of business waste by manager(s) and owner(s). Resource Smart (n.d), suggest that waste analysis based on the visual assessment(s) of waste bins is sufficient in estimating the volume(s) of waste and can be achieved because most offices and businesses have standard waste generation and types. It can also help determine the success of recycling programmes by easily identifying what types of

wastes are collected for recycling (Resource Smart, n.d). For the purpose of this study, visual waste generation assessments were estimated in kilograms (kg).

3.8 Solid waste generation and collection measurements

A comparative assessment approach was used in this study to determine the extent which small and micro enterprises were involved in the generation and collection of their solid wastes for recycling purposes. This approach involves the following assessments:

- Comparative assessments of recyclable waste collection proportions in small and micro enterprises using *Chi*-square test statistics, used to test the level of confidence needed to accept or reject the hypotheses outlined in section 2.8.

- Comparative assessments for categorized wastes using solid waste composition measurements for generated and collected wastes in small and micro enterprises. The frequency of occurrence (*visual assessments*) for each waste type was determined in each business by counting the total number of times each waste type occurred in each business waste stream per day and dividing the frequency of occurrence of each waste by the total number of businesses surveyed. The result is then multiplied by a hundred to get the percentage/composition(s) in the each daily business waste stream. Also the daily compositions for recyclable wastes collected by small and micro enterprise owner(s) and manager(s) were estimated. This was achieved by determining the total number of small and micro enterprises that were collecting each category of recyclable waste listed in column 1 of table 4.4, and dividing this number by the total number of businesses surveyed.

3.9 Waste indicators

Other solid waste generation and collection indicators were used to generate required data for the analysis (both qualitative and quantitative). These include business involvement, perceptions and attitudes to the collection of solid wastes for recycling purposes. Solid waste data was also obtained from the municipality (Pikitup) and was analyzed to determine the current waste diversion trends for the categories of solid wastes in the city of Johannesburg's landfill sites. The next chapter presents the findings of the survey.

Chapter 4

Results and Discussions

4.1 Measuring business involvement in solid waste collection

Solid waste collection estimates, compiled from the survey results provides useful information on small and micro enterprises' involvement in waste collection for recycling purposes in Braamfontein.

Table 4.1: Table showing observed values and responses obtained from the survey of small and micro enterprises

Responses	Small Enterprises (N)	Micro Enterprises (N)	Total (%)
Yes	12	11	38
No	18	19	62
Column Total	30	30	100

* N= 60

Table 4.2: Table showing expected values and responses obtained from the survey of small and micro enterprises

Responses	(N) Small Enterprises	(N) Micro Enterprises
Yes	**11.5**	**11.5**
No	**18.5**	**18.5**
Column Total	**30**	**30**

Chi Statistic: χ^2 = 0.0435,* p = 0.8348, * 0.05 level of significance

4.1.1 *Main findings*

- Table 4.1 suggest that the majority (62%) of small-scale enterprises surveyed in Braamfontein were not collecting their solid wastes for recycling purposes, despite efforts by the South African government in different environmental legislations, guidelines and policies such as NWMS, 1999; NWMS 2010, EPR etc, to encourage recycling and other

sustainable waste management practices across sectors in South Africa. Pikitiup (2007) indicated that only 13% of waste products collected in Johannesburg were recycled and this low recycling level, contributes to the high proportion (50% in 2004 and 29% in 2008) of recyclable wastes materials made available in the city's waste streams (Gauteng Provincial Government, 2004; 2008). Though the process of collecting recyclable wastes from businesses for recycling purposes requires the allocation of time, financial considerations / viable recycling market and level of education (Matete *et al*., 2008), recycling is a continuous and sustainable process that allows for product re-use, geared towards reducing resource dependency, its depletion and environmental impacts of not recycling.

- Further analysis determined the hypothesized relationship between small enterprises and their involvement in solid waste collection, the Chi square test suggest that there is no clear relationship, due to the non-significant values obtained (table 4.2). This test was carried out based on the assumption that small enterprises with large staff numbers and organizational structures were more likely to collect their recyclable wastes for recycling purposes than micro enterprises. It suggest that small enterprises' involvement in waste collection might be inspired by behavioural aspects such as financial incentives, personal satisfaction, knowledge of environmental issues and recycling (Garces *et al*., 2002), rather than staff numbers and organizational structures. This provides opportunities for increased research into behavioural dynamics and other factors associated with small and micro enterprises' participation in solid waste recycling.

4.1.2 *Reasons for the low levels of involvement*

Wilson *et al.* (2006) noted that insufficient waste collections, uncontrolled collection points and improper disposal systems, allowed refuse to become readily available to informal recyclers, who usually collect these recyclable wastes

materials from various stationary street bins, offices, businesses and dumps, transferring them to private recycling companies in exchange for money. This may have a negative impact on small-scale businesses, by influencing decisions made by owner(s) and manger(s) of such businesses, to transfer their waste collection responsibilities to these local waste pickers in Braamfontein.

Similarly, lack of available waste management facilities have contributed to the poor collection and sorting of solid wastes generated in Johannesburg (City of Johannesburg, 2008). Other factors like the low levels of environmental knowledge (Strydom and King, 2009), low demand for certain wastes, lack of separation of waste at source, poor supply chain, high costs associated with transportation of wastes and low collection structures for certain waste types hamper recyclable waste collection efforts in the city (DEAT, 2005b).

4.2 General waste composition(s) in small and micro enterprises

The difficulty in solid waste generation and collection studies is the ability to effectively estimate and quantify solid waste data. It is necessary to note that effective quantification of solid wastes may sometimes be difficult, due to the need for extensive monitoring, weighing, and sorting of waste samples. This proved to be a constraint, as some business owner(s) and manager(s) were not enthusiastic. In view of this, the method adopted here was based on the frequency of occurrence of various categories of waste in each business daily waste stream as determined by business owner(s) and manager(s). Table 4.3 presents these categories

4.2.1 *Main findings*

- Daily compositions of solid wastes generated by small and micro enterprises shown in table 4.3, suggest that *paper, plastic, organic and*

electronic (in order of daily generation compositions) wastes were mostly generated by small-scale enterprises in Braamfontein.

Table 4.3: Table showing the aggregate compositions of general solid wastes generated by small and micro enterprises

Daily wastes variables generated by businesses	Businesses generating particular waste type(s) per day (Small enterprises) (n=30)*	Businesses generating particular waste type(s) per day (Micro enterprises) (n=30)*	Total Number of businesses (N=60)*	Total occurrence in businesses (%)
Paper	28	29	57	95
Metal	6	6	12	20
Glass	7	3	10	17
Plastic	21	22	43	72
Organic	24	17	41	68
Electronic	7	9	16	27
Battery	1	1	2	3
Medical	1	1	2	3
Chemical	3	5	8	13
Bulb	2	2	4	7

*An N/n symbols refer to numbers of surveyed business

- Increasing the collection of these wastes in Braamfontein, particularly *paper* and *plastic* wastes can contribute to waste reduction efforts and limit the amount of recyclable wastes transported from Braamfontein area to different landfill sites in the city. Since opportunity already exists in South Africa for *paper* waste collection (DEAT, 2005b), increased efforts to collect most of the discarded paper waste products from small and micro enterprises premises in Braamfontein is needed. Regarding other categories of wastes, government strategies could achieve efficiency in terms of reduced transportation and collection costs, through collections based on available waste generation information.

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4.2.2 *Reasons for variations in waste generation compositions*

The high waste generation compositions for *paper, plastic, organic* and *electronic wastes,* were as a result of the types of business specializations in Braamfontein. These include commercial activities ranging from fast food franchises, business

centres, administrative and educational institutions etc. These wastes types are common in major cities of developing countries, due to the distribution of similar business activities across such cities (Agamuthu *et al.* 2007). For instance, a study of the north-central predominantly business area of Nigeria, suggest that apart from putrescibles (36% –57%), plastic (6% -10%) and paper (2.1% -11.6%) wastes were mostly generated in both household and non household scenarios (Sha'ato *et al.,* 2007). Similarly, Cadena *et al.* (2009) indicated that the composition for paper wastes was 44.5%, while plastic waste was 50% for two areas in Mexico. Asase *et al.* (2009) found that organic wastes made up to about 64% in Ghana, while Sharholy *et al.* (2008) recorded 40-60% in India.

Other categories of solid wastes generated shows that *bulb, medical* and *battery* wastes had the least values, as a result of the few numbers of medical facilities, electrical and motor repair workshops in the area. Fairly high values for electronic waste is as a result of the increasing levels of electronic wastes generation in South Africa, which is increasing more than any other waste type (DSF, 2008). The advent of computers and modern technology, has also contributed to this rise in South Africa and indeed other developing countries. According to UNEP (2007), electronic wastes made up 0.01% to 1% of generated municipal wastes in developing countries and it is expected to rise in subsequent years. Metal wastes (including aluminium cans / materials and scrap metals) were among the low generated waste types, making up 20% of the waste stream of surveyed businesses. This is also as a result of the administrative, residential and commercial land use characteristics of the area.

4.3 Waste collection compositions for recyclable wastes in small and micro enterprises

Table 4.4 provide responses obtained in the survey in terms of the types of recyclable waste collected for recycling purposes by business participants.

4.3.1 *Main Findings*

Table 4.4 shows that *paper* and *plastic* waste collections were also predominantly high in both enterprises, while *electronic* and *glass* wastes were the least.

Table 4.4: Table showing estimates for solid waste categories collected for recycling

Recyclable wastes variables	Number of businesses collecting each waste type per day (small enterprises)	Number of businesses collecting each waste type per day (Micro enterprises)	Total Number of businesses	Proportion collecting their wastes for recycling (%)
Paper	11	10	21	35
Plastic	6	5	11	18
Metal	1	3	4	7
Glass	1	2	3	5
Electronic	1	2	3	5

Businesses were asked to select the categories of wastes they collected for recycling purposes.
Total businesses sampled: 60

4.3.2 *Reasons for waste collection variations for recyclable wastes*

Businesses involved in recycling, were more interested in collecting *paper* and *plastic* wastes due to the following:

- A viable market for these wastes types in South Africa. For instance, in terms of recycling rates, paper waste collections ranked second at 54.5% in 2007 (NWMS, 2010) after metal wastes, which subsequently increased paper demand by recyclers and its subsequent collection for recycling. Similarly, this high value is a result of a well developed paper recycling industry in South Africa (Liebenberg, 2007), supplying recycled paper products to businesses, offices, etc.

- A high daily generation of such wastes as paper, plastic and metal wastes (Pikitup, 2007), compared to other wastes types.

- Glass waste collections were low, possibly as a result of the low levels of glass waste recycling (26%) in South Africa (Van Der Merwe, 2007). This may have contributed to the reduced demand and subsequent collection of glass wastes by both businesses and recyclers. Liebenberg (2007) also observed that there is general ignorance in terms of general knowledge on the value(s) of waste materials generated in Africa. This also has an effect on the collection of glass wastes, as some business owner(s) and manager(s) do not know if such wastes are recyclable or not. On the contrary, the Gauteng Provincial Government (2008) recently identified opportunities in glass waste collection from restaurants and hotels across the province. This could be harnessed to increase its collection in Braamfontein.

- In terms of electronic and metal waste collection, Widmer *et al.* (2005) observed that the collection of electronic wastes for recycling in South Africa was more common in more formal sectors of the economy. They found that other consumers lacked efficient take back schemes, resulting to the recycling of only about 10% of the generated electronic wastes in South Africa. This problem and the low levels of recycling awareness continue to impact on electronic waste recovery. In terms of metal waste collection, Plastic Federation of South Africa (2008) indicated that metal waste collection for recycling is currently high in South Africa through the '*Collect-A-Can*' initiative. Ideally, this should have a positive effect on the collection potentials for metal wastes (particularly beverage cans) by businesses. However, considering the rather low generation (when compared with other recyclables) of such wastes by businesses in Braamfontein, its recovery is currently low.

4.4 Estimating daily solid waste generation

Daily solid waste generation was determined by weight (kg) estimates in small and micro enterprises. This estimation method was adopted due to the unavailability of a weighing equipment and poor collaboration by business owner (s) and manager(s). Waste generation estimates were made in relation to each enterprise. Small and micro enterprise owner(s) and manager(s) were asked to estimate their daily waste generation in kilograms (kg).

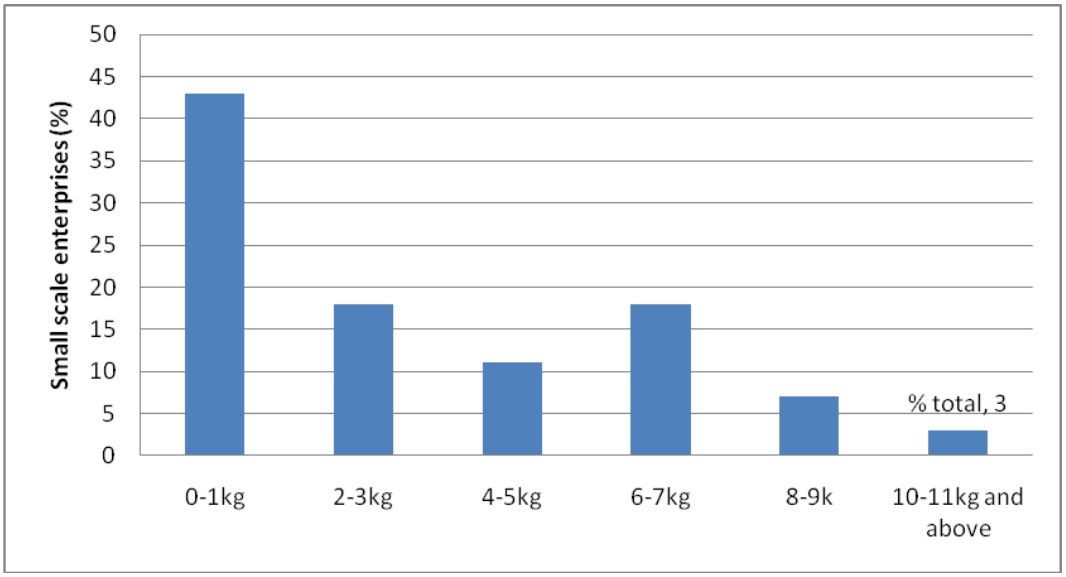

Figure 4.1: Chart showing total daily waste generation estimates for small and micro enterprises

4.4.1 *Main findings*

- The results above suggest that most of the surveyed businesses (*26 businesses or 43 %*), generated between 0 to 1 kg of solid waste per day. Few businesses generated above 10 to 11kg of wastes compared to other categories. This suggests that despite the poor data available for this section of study, most businesses indicated that they were generating within the 0 to 1kg category. Figure 4.1 also suggest that waste generation

patterns for small and micro enterprises in Braamfontein were not far from the daily waste generation trends for developing countries. For instance, in South Africa, an estimated waste generation of 0.8kg/capita/day is observed for more developed areas, with about 3.0kg/capita/day of wastes generated for less developed areas (Karani and Jewasikiewitz, 2006). Daily business waste generation in Nigeria indicates that solid wastes were produced at the rate of 1.08 kg per staff or shop per day (Olorunfemi, 1998). Also, Zerbock (2003) noted a generation rate of about 0.4 to 0.6 kg /person/day in low income countries, while Nair (2003) indicated a rate of about 0.4 to 0.8 kg /person/day in developing countries.

4.4.2 *Reason(s) for the waste generation figures*

Study on waste generation trends in South Africa suggest that the middle class generates 0.7 kg of waste a day (Greben and Oelofse, 2009), while the national average is 0.8kg/capita/day (Karani and Jewasikiewitz, 2007). The values in fig 4.1 did not vary significantly to the estimates made by business owner(s) and manager(s).

4.5 Barriers and problems associated with solid waste collection for recycling in small and micro enterprises

The issues identified were numbered 1 to 9, with 5 corresponding to '*no response'* from businesses. These were designed to understand how small and micro enterprises perceived the idea of collecting their wastes for recycling in order to develop better strategies that will encourage them to collect their wastes and to understand their perception to waste collection for recycling purposes. The responses obtained are shown in table 4.5.

Table 4.5: Ranking of issues raised by business owner(s) and manager(s), regarding their involvement in the collection of their solid wastes for possible recycling

PERCIEVED DIFFICULTIES	RESPONSES PER 60 BUSINESSES	PERCENTAGE (%)
1. No perceived difficulties	18	30
2.Perception based on time issues in the collection and sorting of recyclable wastes	10	17
3.Perception based on small office space	8	13
4. Other logistical issues: (i.e. lack of interest/ economic values)	7	12
5. No response	7	12
6. Perceptions based on low staff participation	5	8
7.Perception based on poor recycling infrastructure	3	5
8.Perception based on high transportation cost and distance	1	2
9.Perception based on low levels of solid waste recycling awareness	1	2
Total	60	100

4.5.1 *Main Findings*

The major findings suggest the following:

- A high number of surveyed businesses did not perceive recycling as a difficult waste minimization strategy to adopt at their premises. In other words, given the right recycling infrastructure and enabling environment, a high number of these businesses may actually collect their wastes for recycling purposes in Braamfontein

- Time constraints in the sorting of their recyclable wastes into separate lots was considered an issue by small and micro enterprises (17% of businesses).

- Lack of large office space was identified as one of the issues that hampered small and micro enterprise participation in waste collection for recycling.

4.5.2 *Possible reasons for observed values*

Results in table 4.5 suggest 2 major areas of concern for Braamfontein business owner(s) and manager(s) towards their participation in waste collection for recycling purposes. These concerns are ***time*** and ***lack of large office space*** for collecting and storing of recycle bins and pre-sourced waste. Time in this context, refers to allocation to resources and responsibilities towards waste collection for recycling, either by staff, owner(s) or manager(s). Businesses are focused on making profits and they may be compelled to allocate more time to their overall objectives rather than environmental practices. Ackroyd *et al*. (2006) suggest that business participation in waste minimization and recycling programmes are constrained by insufficient time and resource allocation on the part of businesses.

In terms of office spaces, small and micro enterprises are challenged in Braamfontein with shrinking office spaces to operate in (City of Johannesburg, 2003). With the increasing costs of rent and electricity, businesses are compelled to settle for small office spaces which cannot contain recycling infrastructures like recycling bins and sorting areas.

4.6 Determining factors to an improved solid waste collection in small and micro enterprises

This section ranks a number of identifiable factors that could improve business performance in waste collection for recycling in Braamfontein.

Table 4.6: Table showing the ranking of the responses obtained, towards an improved participation in solid waste collection for recycling by small and micro enterprises

STRATEGIC FACTORS	TOTAL RESPONSES	PERCENTAGE (%)
Establishing recycling centres in close proximity	39	65
Providing subsidies for recycling	12	20
Buy back of different types of wastes	7	12
VAT cuts on products made of recyclable materials	2	3
Total	60	100

4.6.1 *Main Findings*

- Table 4.6 indicates that most of the businesses surveyed (65%), believed that the establishment of recycling facilities especially in close proximity to their businesses would improve their role in the collection of their recyclable wastes, while introduction of subsidies by the government and relevant municipality would improve their participation in waste collection for recycling. This will enable businesses to reduce both transportation and procurement costs for products made of recyclable materials.

4.6.2 *Possible reasons for observed values*

In terms of locating recycling facilities in close proximity to businesses in Braamfontein, small-scale enterprise owners and managers may have logical ideas, based on perceived reductions in the transportation and other logistical cost of their own waste management. With an improved awareness, availability of waste recycling infrastructures and viable market, small-scale businesses will be encouraged to collect their wastes for recycling purposes. Since businesses are interested in reducing their daily operational costs towards maximizing their

profits, additional costs in waste management systems will limit their role and participation. Perrin and Barton (2001) suggested that for recycling programmes to be effective, there should be available recycling facilities, located at convenient places which would reduce both transportation cost.

4.7 Solid wastes handling in small and micro enterprises

Businesses concluded that their solid wastes were not handled by one system, but a combination of various waste handling and disposal systems. A list of five major solid waste handling systems was identified by the researcher during the pilot study of the area. The purpose was to determine the common handling system(s) in Braamfontein, in order to determine the possibility of improved collections. The values are presented in table 4.7.

Table 4.7: Table showing the ranking of the various solid waste handling and collection systems in small and micro enterprises

WASTE HANDLING SYSTEMS IN BRAAMFONTEIN	RESPONSE COUNT	SURVEYED BUSINESSES	RESPONSE (%)
Collection by Municipality Pikitup	57	60	95
Scavenging	20	60	33
Collection by recyclers	19	60	32
Other types*	8	60	13
Medical Disposal	1	60	2

*Could affect figures, but include a wide range of other handling systems

4.7.1 Main *findings*

- Responses from the survey, suggest that the City of Johannesburg municipality handles a large proportion of business daily wastes in Braamfontein, followed by informal collection and collection by private recyclers. This provides an enabling environment for possible collaboration with the City of Johannesburg municipality, informal recyclers and private recyclers in enhanced collection of recyclable wastes in Braamfontein.

4.7.2 *Possible reasons for observed values*

Pikitup was contracted by the City of Johannesburg to manage the wastes generated in the city. So far, 1.4 million tonnes are collected and disposed yearly in the city's landfill sites, with future prospects of 15% reduction in disposals by 2010, 25% reduction by 2022 and 70% reduction by 2022 (Pikitup, 2007). This reduction is expected to come from various environmentally friendly, waste recycling and management efforts in the city, which has led to an improved role of the municipality in servicing the different areas of the city. Hence in 2007, they collected up to 1999 litres of business wastes (Pikitup, 2007), which is expected to increase as mentioned earlier in this study. This has also contributed to their increased visibility and improved operational capacities, not just in the Johannesburg, but in various smaller districts like Braamfontein.

The increasing number of private recyclers as seen in the result, suggest that there is growing demand for certain waste types like paper and plastic wastes (Pikitup, 2007). Similarly, waste pickers have availed themselves the opportunity of the increasing levels of recyclable waste material in the city, thus driving up the informal collection business. These issues create more waste collection opportunities, which can be tapped into by different waste management stakeholders in Johannesburg (Gauteng Provincial Government, 2008).

4.8 Analysis of municipal waste generation trends

This section presents the solid waste data obtained from the Johannesburg waste management body (Pikitup), to determine the solid waste diversion trends over a five year period (2004-2008) in Johannesburg. Table 4.8 shows the amount of solid waste materials sent to various landfill sites in Johannesburg which include Robinson Deep, Goudkoppies (for Braamfontein region), Marie Louise and Ennerdale landfill sites. According to the City of Johannesburg (2008/9),

Braamfontein is located in region F of Johannesburg and most of the generated wastes in that region are managed by the city's waste management body (Pikitup).

Solid wastes generated in the Braamfontein region are transported to the Robinson Deep and Goudkoppies waste sites (City of Johannesburg, 2008/9). The lifespan of these sites is from 14 to 30 years as indicated in table 4.8, while the life span of the other sites, (Marie Louise and Ennerdale) ranges from 7 to 10 years (City of Johannesburg, 2008/9). The lifespan of the latter suggests that the Robinson Deep and Goudkoppie sites may be under severe pressure in the near future if the rates at which wastes are transported to these landfills are not reduced. The waste diversion values for the categories of generated wastes, both general solid wastes (non recyclables) and recyclables are presented in table 4.8.

Table 4.8: Solid waste generation and recycling data, presented by weight in kg of total waste diversions in all the landfill sites in Johannesburg

YEARS	TOTAL GENERAL WASTE SOLID (kg)	TOTAL RECYCLING WASTE MATERIAL (kg)
2004	884,866,545	2,192,579
2005	1,421,402,259	3,354,271
2006	1,459,385,268	2,148,660
2007	1,496,814,553	0
2008	1,005,358,712	1,807,056

*Waste data supplied by Pikitup, *0 values signify Pikitup error

4.8.1 *Main findings*

Table 4.8 suggest the following:

- There was a 14% increase in the amount of general wastes sent to various Johannesburg landfill sites between 2004 and 2008, while recycling materials disposed at landfills in Johannesburg during that period declined by 18%. This suggests a possible indirect relationship between the quantities of recyclable wastes transported to the city's landfill sites and categories of general wastes.

4.8.2 *Possible reasons for observed trends*

Possible reasons for the increased amount of general wastes within the period of study are as a result of the increasing population (8.2% between 2001 and 2007) and socio-economic development of Johannesburg, bearing in mind that the City of Johannesburg is the most densely populated and urbanized municipality in South Africa, achieving 16% contribution to the national GDP in 2007 and also contributing 5% annual average to the GDP (City of Johannesburg, 2007; 2008; 2009b).

Godfrey and Arendse (n.d) suggested that population growth and improved socio-economic standards contributed to increased waste generation and subsequent transportation of wastes to the city's landfill sites. This has potential implications for waste management in Braamfontein, as the recent revitalization of the district has resulted to increasing population and socio-economic standards (Braamfontein Business Node, 2006).

Similarly, waste minimization interventions made by the South African government and the City of Johannesburg municipality may have contributed to the decline in the amount of recycling waste material sent to landfill sites in Johannesburg during that period. For instance, the city achieved in 2007, a 100% distribution of waste bins across sections of the city, for enhanced collection of wastes across Johannesburg streets, residential areas and offices (City of Johannesburg, 2007). Though the project was not designed only for recyclable wastes, private and informal waste collectors contributed in diverting some of the recyclable wastes collected before ending up as 'actual city recyclable wastes' deposited in the city's landfill sites (Theron, 2010). Also, the City of Johannesburg (2008) identified that waste minimization, recycling and reuse, improved recyclable waste collections through the provision of 8 buy back centres, 48 drop off centres and 19 shopping centres for recyclable waste collections by the municipality. Likewise, pilot curb-side recycling programmes

were launched in few suburbs in the city and recent study suggests that the city achieved 17.7% waste to landfill reductions (City of Johannesburg, 2008).

Despite the roles of the City of Johannesburg in achieving the waste minimization targets, more effort is needed in collecting recyclable wastes from small-scale businesses in Braamfontein area of Johannesburg, towards achieving greater reduction in landfill waste quantities (City of Johannesburg, 2009b). In achieving this in Braamfontein, large numbers of small-scale enterprises need to collect more of their recyclable wastes in Johannesburg. The municipality should also make efforts directed towards understanding the behavioural aspects of manager(s) and owner(s) of these businesses regarding waste collection for recycling purposes. Likewise, future waste management structures should not consider staff numbers or organizational structures in determining participation in recycling, as they play no role in influencing small-scale business participation in recycling. To achieve significant collection of recyclables wastes in Braamfontein, strategies should focus on the collection of recyclable wastes that are generated in large proportions. These include paper and plastic wastes. Enhanced collections of these recyclables will reduce wastes quantities transported to Robinson Deep and Goudkoppies sites, which continue receive these waste categories in high proportions from Braamfontein (City of Johannesburg, 2008b).

4.9 Limitations of study and sources of error

The limitations presented here are issues that affected the analysis:

- Business owner(s) and manager(s) were asked to estimate their daily waste generation. This was as a result of poor co-operation from the Johannesburg municipality and lack of data for the Braamfontein region.

- The researcher also considered dropping-off plastic waste bags / boxes in various business premises to enable the effective measurement of solid waste density from various businesses, but could not accomplish this, as the number of businesses that agreed to have waste bags / boxes in their premises was very few. This limitation affected daily waste generation figures as there is a tendency for over estimation of daily waste figures.

- At some point, it was impossible to determine correctly if the people interviewed and surveyed were actually managers and business owners.

- The researcher could not determine is the responses given were entirely free of biases

- The researcher also could not cross-check responses due to unavailability of previous solid waste data relating to waste collection and recycling in the region.

- Landfill waste diversion data obtained from the City of Johannesburg municipality (Pikitup) showed some level of error. For instance, table 4.8 showed that recycling data for 2007 was not captured by Pikitup.

Chapter 5

Conclusions and Recommendations for Waste Management

5.1 Introduction

This chapter concludes on the findings of the analyses carried out on small and micro enterprises in Braamfontein. It also recommends necessary measures needed to improve solid waste management in Braamfontein.

5.2 *Summary of research findings*

The findings presented are in line with the research objectives:

5.2.1 *Involvement in solid waste collection for recycling*

As a measure of small-scale business involvement in waste collection for recycling purposes, results suggest a general lag across these enterprises in Braamfontein district, which hampers overall recycling efforts in the City of Johannesburg. Despite the high compositions of *paper* and *plastic* wastes in the daily business waste streams, collection of these wastes specifically for recycling purposes remains generally low, allowing for the continued transportation of recyclable wastes to the Robinson Deep and Goudkoppies landfill sites (City of Johannesburg, 2008/9). Similarly, the Gauteng Provincial Government (2008) indicated that 29% of the general wastes collected in the City of Johannesburg still contained recyclable waste streams, which could have been avoided or recovered through recycling. Despite an 18% reduction in the quantities of recycling waste materials transported to various landfill sites in 2008 (Table 4.8), the same cannot be said in 2010, considering that solid waste generation increased in Johannesburg by 10 to 14% in 2010 (City of Johannesburg, 2009/2010) and

considering an annual population growth of 2% per year (Gauteng Provincial Government, 2004).

Attempt to study small enterprises (with higher staff numbers), to determine if they were likely to collect more of their recyclable wastes for recycling, suggest that their involvement in waste collection for recycling was not as a result of high staff numbers or better organizational structures due to low values obtained across both enterprises. In other words, future strategies or studies should therefore focus on how to educate more small-scale businesses on the relevance of recycling to the environment. They should be encouraged to participate by setting up special business collection facilities across Braamfontein to increase collection levels in the area.

5.2.2 *General and recyclable waste compositions*

The results also suggest that opportunity exists in Braamfontein for the collection of *paper, plastic, organic, metal and electronic* wastes from small-scale businesses, due to the high compositions of these wastes in their daily waste streams. This becomes necessary as only 4% of recyclable wastes are recovered for recycling in Johannesburg (City of Johannesburg, 2010). Likewise, the City of Johannesburg (2003d) identified recycling as a strategy that needs to be adopted, to reduce the volume of recyclable wastes sent to Johannesburg landfill sites.

In terms other waste categories, very low opportunities exist in Braamfontein for *glass, electrical (bulb), battery* and *medical waste* collection. However the municipality should provide collection points and alternatives for improved collection of such wastes, as the low collection values recorded might not necessarily mean very low generations. An example is the provision of safe collection facilities for medical and chemical wastes at strategic generation points. Similarly, educational tours would sensitize small and micro enterprises on the characteristics of each of these wastes as they might be involved in illegal dumping of wastes.

5.2.3 *Waste generation estimates*

Despite the poor quality data used for this section of the study, solid waste generation figures, for most businesses surveyed (43%), suggest a daily generation of solid wastes ranging between 0 and 1kg per day.

5.2.4 *Waste trends*

Waste data from Pikitup suggest an increased transportation of general wastes to the City of Johannesburg landfill sites from 2004 to 2008. Further increases in this figure are expected, due to a 10-14% rise in solid waste generation figures for the city in 2010 (City of Johannesburg, 2009/2010). Similarly, data for recyclable waste transportation indicate that more effort is needed in bringing down the levels of recyclable wastes still found in landfills across Johannesburg. About 29% of these wastes (Gauteng Provincial Government, 2008) are still made available in the various waste streams, with recent data suggesting that just about 4% of theses recyclables are recovered for recycling (City of Johannesburg, 2010). The municipality needs to ensure that recyclable wastes are effectively removed from small-scale enterprises, as a step towards achieving government's waste reduction targets.

5.2.5 *Main issue with solid waste collection for recycling purposes by small and micro enterprises*

Time factor could hamper solid waste collection and recycling initiatives in small-scale enterprises across Braamfontein district. In order to increase participation in the collection of recyclable wastes for recycling across small-scale enterprises, the municiplaity should mainstream time factor issue, as a limiting factor that needs to be assessed, for improved and effective participation in recycling programmes by small and micro enterprises in Braamfontein. Waste collection strategies should ideally be easy to adopt, understood and implemented across small-scale

businesses. Matete *et al*. (2008) indicated that time could hinder small business participation in waste recycling programmes if not considered effectively.

5.2.6 *Determinants of solid waste collection in small and micro enterprises:*

Some of factors identified by businesses are as follows:

- **Establishing more recycling and buy-back centres** in the Braamfontein could improve small-scale business involvement in waste collection in Braamfontein. This could be achieved through the provision of more recycling and buy-back centres by the City of Johannesburg municipality, where collected recyclable wastes can be sorted, transported and exchanged for cash, thereby providing jobs, improving the recycling market and introducing a recycling culture in the Braamfontein.

- **Provision of recycling subsidies and value added tax (VAT) cuts on products made of recyclable materials**. This enables businesses to acquire products made with recycling materials at affordable prices, and equally provide incentives for businesses participating in recycling programmes.

5.2.7 *Waste handling systems:*

- The survey data indicate that the City of Johannesburg municipality has greater control of solid waste management in Braamfontein (95%). However, in terms of recyclable waste collections, the City of Johannesburg's municipality focuses mainly on domestic households, which is not ideal (Pikitup, 2007; City of Johannesburg, 2010). Diversifying into sustainable waste collection activities in the commercial sector, such as small-scale businesses in Braamfontein is necessary, due to an already available infrastructure and coverage across Johannesburg.

Likewise, mapping of the various collection systems could provide strategies for mainstreaming of various systems, towards better waste management in Johannesburg.

Based on these conclusions, the municipality needs to strategize and make informed waste management decisions based on the mainstreaming of ideas with various target groups which include stake holders, business owners, managers and employees. This will identify other areas where more effort is needed, in ensuring that small-scale businesses improve their environmental standards. Toward achieving this, the following recommendations are made:

5.2.8 Recommendations and suggestions for future studies

- Having known that only few businesses collect their solid wastes for recycling in Braamfontein, and that recycling has not been effectively implemented by owners and managers of small-scale businesses in Braamfontein region, the City of Johannesburg municipality should devise strategies that will mainstream identified drivers towards better participation by small and micro enterprises in Braamfontein. These drivers include the establishment of more recycling centres in close proximity to businesses across Braamfontein and introducing subsidies and VAT (Value Added Tax) cuts on products made of recycling materials. This will also provide the needed financial incentives for businesses to make profit through the sustainable management of their daily wastes, creating more jobs and ensuring the continuity of recycling as a waste strategy in South Africa.

- A rigorous study of small and micro enterprises is needed in Braamfontein, to supplement the waste information gathered in this study. This will enable effective cross-checking of data for future studies toward

monitoring waste management strategies. The study should seek to determine the actual volumes or quantities of daily solid wastes generated in Braamfontein, using scales or weighing equipments. It should evaluate the economic viability of engaging in waste collection activities by small-scale businesses. The study should consider transportation and time factor issues, as possible constraints to effective waste collection programme.

- Enhanced collection of recyclables, particularly *paper* and *plastic* wastes by the municipality in Braamfontein is recommended. This can be achieved by distributing recycling waste bins at strategic locations in Braamfontein, since paper (26%) and plastic (10%) wastes were considerably higher than other wastes generated in the city's wastes streams (Pikitup, 2007). Likewise, since opportunity also exists for glass waste collection, as determined by the Gauteng Provincial Government (2008), the municipality should devise strategies for increased glass waste collection in Braamfontein region.

- Educating business owner(s) and manager(s) in Braamfontein, through 'open-day' events, organized by relevant waste management organization(s) (i.e. Pikitup) and stake holders is recommended.

- In order to improve small and micro enterprise participation in waste recycling, tax incentives should also be provided for businesses already participating in the collection and sorting of their wastes for recycling.

- There is also a need to promote waste recycling, recovery and re-use, by making inscriptions on products that are recyclable, so that people will know exactly what is recyclable and what is not.

The research provided some relevant solid waste information needed for policy and decision making processes, required for improved collection of recyclable wastes in Braamfontein area of Johannesburg. However, increased solid waste

research is recommended especially through increased collaboration with South African educational institutions, to ensure that a more rigorous and defensible waste data is provided and results compared effectively.

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Appendix A

Sample of Questionnaire

UNIVERSITY OF THE WITWATERSRAND

JOHANNESBURG

<u>QUESTIONNAIRE AIM</u>: The questionnaire seeks to gather data for the analyses of the following research aims. Information will be kept anonymous and in strict confidence.

- To determine the level of involvement of small and medium businesses in solid waste collection for recycling in Braamfontein

- To determine the perceptions and challenges of small and micro enterprises in solid waste collection for recycling

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1. Do you collect your waste for recycling solid waste?

   Tick as appropriate: *yes:* _____ no: _____

2. If no, why?

   _____

   _____

3. Please indicate your staff size _____

4. If you answered '*yes'* to question 1, please list the types of recyclables collected daily for recycling purposes: *(paper, plastic, electronic, glass*)

_____

_____

5. Please list the types of solid waste materials mostly generated in your daily waste stream(s)

_____

_____

_____

6. Please select the best daily waste generation estimate (per kg). Tick one

- 0-1kg_____
- 2-3kg_____
- 4-5kg_____
- 6-7kg_____
- 8-9kg_____
- 10-11kg and above_____

7. What difficulties do you find in keeping your recyclable waste in separate lots / containers for collection?

_____

_____

_____

_____

8. What government initiative do you think would create better opportunities for collecting solid wastes for recycling?

- *Establishment of recycling centres and facilities?* ☐
- *Subsidies for recycling?* ☐
- *Buy back of different types of waste?* ☐
- *VAT Cuts on products made of recycled materials?* ☐

9. How is your daily business waste(s) handled?

- Private collection and transportation to dump site_____
- Collection by private recycling company_____
- Municipality/government_____
- Scavengers_____
- Medical_____
- Other(please specify)_____

10. Any other relevant comments that may be useful.

_____

_____

Thanks for your time and effort.