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Perception and Issues of Solid Waste Management in South Africa, Johannesburg Case Study

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A Research Report Submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg in partial fulfillments of the requirement for the Degree for Master of Science in Development Planning

Johannesburg, 2010

DECLARATION

I hereby declare that this research report is my own original work and that all sources have been accurately reported and acknowledged. It is submitted for the Degree for Master of Science in Development Planning at the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other University.

Signed **Serge Nzalalemba Kubanza**, on this day **06**, in the Month of **December**, Year **2010**

ABSTRACT

Everything we do affects our environment in one way or another. All human activities generate waste, especially our businesses. Inadequate collection and inappropriate disposal of solid waste causes water, land and air pollution, and pose risks to human health and the environment. The aim of this research was to investigate the impact of mismanagement of solid waste on the environment as well as on human health and find out the remedies to the problem. The research was based on the two hypothesises, that poor management of solid waste affects the environment (pollute air, land, water) and pose risks to human health in Johannesburg. To confirm or infirm these hypothesises, interviews were conducted with the local community of Windsor, officials from the Johannesburg Metropolitan Municipality as well as officials from other organisations involved in solid waste management in the city of Johannesburg. Data for the research was collected using a semi-structured questionnaire. It was demonstrated that issues arising out of solid waste management in Johannesburg are many and can be set out as follows: littering, limited refuse removal services in poor areas, unmaintained parks and open spaces that encourage illegal dumping. The outcomes of the research have demonstrated that the impacts of mismanagement of solid waste negatively affects the environment and human health in Johannesburg and improper dumping of waste leads to illnesses such as dysentery, cholera and typhoid fever. As a result, the health of children and adults becomes negatively affected. Furthermore, the consequences of the lack of stringent policies of waste disposal negatively affect working environment and schools as both worker and student cannot perform their tasks optimally due to poor health that is caused by pollution. On the economic side this means lowered productivity and lowered profits for companies because of constant absenteeism amongst workers due to medical reasons.

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I would like to thank my supervisor, Dr. Brian Boshoff for his constant guidance and encouragement. I am also indebted to Dr. Medard Kubanza's family for their assistance, support, advice and encouragement. To all my lecturers, you were more than teachers, but colleagues as well, thanks! To Almighty God for the vision, strength and guidance!

TABLE OF CONTENTS

ABSTRACT ..... **ii**

ACKNOWLEDGMENTS ..... **iii**

TABLE OF CONTENTS ..... **iv**

LIST OF ABREVIATIONS ..... **viii**

LIST OF FIGURES ..... **ix**

LIST OF MAPS ..... **ix**

LIST OF TABLES ..... **x**

LIST OF PHOTOGRAPHS ..... **x**

CHAPTER ONE: **1**

GENERAL INTRODUCTION 1

1.1. Background 1

1.2. Aims of the Study 7

1.3. Problem Statement 7

1.4. Research question 9

1.5. Research Method 9

1.6. Chapter Outline 10

CHAPTER TWO: **11**

LITERATURE REVIEW 11

2.1. Introduction 11

2.2. Theoretical concerns 12

2.2.1. Solid Waste management 13

2.2.2. Waste Generation and Composition 14

2.2.2.1. Domestic Waste 15

2.2.2.2. Commercial Waste 15

2.2.2.3. Institutional Waste 15
2.2.2.4. Industrial Waste 15
2.2.2.5 Street Sweeping 16
2.2.2.6. Construction and Demolition Waste 16
2.2.3. Solid Waste Management Processes 16
2.3. Solid Waste Management Problem 18
2.3.1. Dumping and Landfilling 21
2.3.2. Incineration 23
2.3.3. Recycling and Scavenging 25
2.3.4. Separation and treatment of organic waste 27
2.4. Impact of Mismanagement of Solid Waste on the Environment and on Human health 27
2.4.1. Environmental Concerns 28
2.4.1.1. Pollution 30
2.4.1.2. Vegetation Damage 32
2.4.2. Human Health Concerns 35
2.4.2.1. Pathogens and hygienisation 38
2.4.2.2. Waste Picker's Health 39
2.4.2.3. Discussion 41
2.5. South African Context 42
2.5.1. Institutional Framework 46
2.5.2. Waste disposal and collection 48
2.5.3. Illegal Dumping 49
2.5.4. Landfilling 49
2.5.5. Moving toward sustainability 50
2.5.6. Management of household waste 50
2.5.7. Conclusion 52
CHAPTER THREE: 54
JOHANNESBURG, CASE STUDY DESCRIPTION 54
3.1. Introduction 54

3.2. Background Information on Johannesburg 55
3.2.1. Structure of City Governance 56
3.2.2. Historical Background 56
3.2.3. Demographic information 58
3.2.4. Overview of Solid Waste Management in Johannesburg 59
3.2.4.1. Refuse collection method 59
3.2.4.2. Current Institutional Arrangements 61
3.3. The Solid Waste Management Problem in Johannesburg 65
3.4. The Impact of Mismanagement of Solid Waste on the Environment and on human Health in Johannesburg 71
3.4.1. Environmental Concerns 71
3.4.1.1. Mining Activities 72
3.4.2. Human Health Concerns 73
3.43. Human interaction with the environment 78
3.5. Randburg-Windsor Description 79
3.5.1. Waste collection 80
3.6. Conclusion 82
CHAPTER FOUR 83
DATA ANALYSIS AND FINDINGS 83
4.1. Introduction 83
4.2. Research Methodology 83
4.2.1. Sampling Method 84
4.3. Departmental Description 86
4.4. Solid Waste Mismanagement in Johannesburg 89
4.5. Environmental and Human Health Concerns 92
4.6. Responsibilities for the collection of waste 97
4.7. Government Responsibilities 99
4.8. Summary and Conclusion 100
CHAPTER FIVE 102

CONCLUSION AND RECOMMENDATIONS 102
5.1. Conclusion 102
5.2. Recommendations 105
5.2.1. Alternatives for better waste disposal 106
5.3. Avenues for future research 107
6. REFERENCES LIST 108
APPENDICES: 123
RESEARCH QUESTIONNAIRE 123
Research Description 123
Questions for Municipal and Official Members involved in Solid Waste Management 123
a) General information 123
b). Information related to the issues of solid waste management 124
Questionnaire for the community of Windsor 129
a) General information: 129
b) Questions related to solid waste management 129

LIST OF ABREVIATIONS

ANC: African National Congress

CBD: Central Business District

CDP: City Development Plan

CPU: Corporate Planning Unit

CoJ: City of Johannesburg

EU: Europe

GJMC: Greater Johannesburg Metropolitan Council

HCRW: Health Care Risk Waste

JCC: Joint Coordinating committees

MSW: Municipal Solid Waste

NEMA: National Environmental Management Act

NWA: National Water Act

NWMS: National Waste Management Strategy

RDF: Refuse Derived Fuel

SWDS: Solid Waste Disposal Sites

SWM: Solid Waste Management

TPA: Tonnes per Annum

US: United States

WCED: World Commission on Environment and Development

WHO: World Health Organization

WMH: Waste Management Hierarchy

LIST OF FIGURES

Figure1: Typology of waste (Haukohl and Marxen, 2000)

Figure 2: Integrated waste management system (Sabbas et al., 2001)

Figure 3: Interaction between human activities and the physical, chemical, and biological environments. Model adapted from (Yassi et al, 2001).

Figure 4: Various models for improving the state of human health and the environment.

Figure 5: Respondents interviewed in the local community and official members

Figure 6: Gender of interviewees

Figure 7: Interviewees' qualifications

Figure 8: Local community, municipal and other official member's perceptions on the issues of solid waste

Figure 9: Impacts of poor management of solid waste on the environment & on human health in Johannesburg

Figure 10: Responsibilities for the collection and waste disposal

LIST OF MAPS

Map 1: Map of Greater Johannesburg Metropolitan

Map2: Johannesburg Regional Landfill Locality

Map 3: Diseases Related to Solid Waste Services

LIST OF TABLES

Table 1: Waste Management Option, key Advantages and Disadvantages (Rushton, 2003)

Table 2: Fragmented responsibilities for administering waste management (Source: Whyte, 1995)

Table 3: Allocation of Resources for Waste Management in the Johannesburg Unicity

Table 4**:** Strengths, Weaknesses, Opportunities and Threats of Solid Waste Management in Greater Johannesburg (Walmsley, 1997).

LIST OF PHOTOGRAPHS

Photo 1: waste collection by pikitup.

Photo 2: Higher density landfill of Robinson Deep

Photo 3*. Waste Disposal* ***(Source:*** *Craigie and Fourie, 2005)*

Photos 4-5: Waste mismanagement in Windsor

Photos 5-7: Waste thrown in George Street Windsor.

CHAPTER ONE:

GENERAL INTRODUCTION

1.1. Background

We all were born in the environment, grew up in the environment, live in the environment, and work in the environment. Everything we do affects our environment in one way or another. All human activities generate waste, especially our businesses. So where do we throw this waste of ours? Irresponsible disposal of waste into the environment contributes to environmental degradation. This degradation has an impact on human health, economy, and tourism. We must manage the growing amount of waste we produce. Our quality of life can only improve if attention is paid to caring for the environment we all share by preventing unnecessary waste.

However, the rapid rate of uncontrolled and unplanned urbanisation in our cities has brought environmental degradation. Indeed, one of the main problems concerning urbanisation in our cities has been the problem of waste disposal. A visit to any South African city today will reveal aspects of the waste management problem such as heaps of uncontrolled garbage, streams blocked with rubbish, disposal sites constituting a health hazard to residential areas, and inappropriately disposal of waste. This problem of waste leads us to the need for sustainable cities (Onibokun, 1999).

Sustainable cities are seen as a powerful framework for developing solutions that improve the quality of life on a local level and can also be a vital constituent of responding to the broader global environmental crises (Heberle and Susan, 2008). Many rely upon the definition of sustainable development crafted by World Commission on Environment and Development (WCED) in Our Common Future, where it is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their needs” (WCED, 1987:43); this identifies the synergy between economic development, social equity and the environment. Therefore, sustainable waste

management must be economically affordable, socially acceptable and environmentally effective (McDougall, 2001).

In light of this, sustainable cities become an important policy goal for managing cities, because the social, economic, ecological and institutional development of a city is increasingly interrelated, city management has become a multifarious system such as cities require the use of innovative, sophisticated planning tools that can assist in monitoring current condition and projecting future developments (Rotmans and Asselt, 2000). The past few years have brought examples of considerable innovation among city and municipal authorities in most parts of the world with regard to sustainable development (Satterthwaite, 1997). In Europe and North America, many cities have put in place long-term programmes to improve their environment, reduce resource use and reduce waste. Certain cities in Latin America have also put in place long-term programmes to address environmental problems while in many cities in all regions of the world, there has been considerable innovation by city authorities in addressing environmental problems (Ibid). In this regard, cities nowadays use too many natural resources and produce too much waste. Along with other initiatives and activities, urban management therefore has an important role in contributing to the future sustainability of our cities (Deelstra and Girardet, 2000). Sustainable development is a major source of inspiration for many analyses of solid waste management systems in the developing world (Baud; Grafako; Hordijk; and Post, 2001).

In addition, the concepts of sustainable cities and urban sustainability have gained significant rhetorical ground internationally. From waste management, through to transport and land use planning, local authorities and the urban areas which they govern are increasingly charged with delivering sustainable development (Bulkeley and Betsill, 2005). Despite this near-universal recognition that sustainable cities and sustainable communities are a desirable policy goal, there is less certainty about what this might mean in practice. Therefore, sustainable cities require an economic process to close the open

loop system where consumables are imported into the urban areas and packaging dumped as waste into the bioregion and biosphere (Smit and Nasr, 1992). One of the principal limits to the sustainability of towns and cities is the disposal of some of these by-products, namely waste, water and solid waste. A paradigmatic change in the way wastes are viewed may be starting to emerge globally, and it is important for this change to continue and to be accelerated. Waste needs to be seen as a problem to be disposal of, but as a resource for sustainable development (Ibid). The need to create more sustainable cities reflects the fact that the world's population is increasingly an urban one and that in developing countries, in particular, the majority of citizens now prefer to live in urban areas. Cities are the source of most of our pollution as all our daily activities are concentrated there (Evans, 2005).

In many respects, achieving ecological or environmental sustainability is closely linked to the manner in which we deal with the waste products of society. Visions of what constitutes an ecologically sustainable system for waste treatment have been suggested by some scholars (Klang; Vikman; and Bratteb, 2002). It is also apparent that the mass of waste products released to the atmosphere as molecular waste in the industrialised countries, greatly exceeds the amount of solid waste generated per capita (Klang; Vikman; and Bratteb, 2002). Municipal solid waste management is a major responsibility of local government (Schubeler, 1996). It is a complex task which requires appropriate organizational capacity and cooperation between numerous stakeholders in the private and public sectors. Although it is essential to public health and environmental protection, solid waste management in most cities of developing countries is highly unsatisfactory (Ibid).

A new philosophy of resource management is beginning to transform solid waste management worldwide. Most waste material can be regarded as unused resources, so environmentally sound waste management entails the reduction of waste in production and distribution processes and the enhancement of re-use and recycling. In Northern cities these principles are being translated into practice through government regulation,

stakeholder cooperation and citizens' initiatives (Furedy, 1992). In Southern cities, solid waste management is still focused on improving the conventional engineering system essentially, the collection, transport and disposal of solid waste (Ibid). In the context of South Africa, the issues of solid waste management also embrace imbalances in quality and quantity of services. Improved solid waste management can be effected by re-designing waste collection systems to incorporate and recognise the positive role that can be played by the large networks of informal waste recyclers, garbage pickers and scavengers (Rogerson, 1999).

Myllyla and Kuvaja, (2005) have introduced several definitions in terms of ecological cities such as eco-city and eco-polis for urban areas that aim to cause minimum human disturbance to the natural environment. These terms usually refer to an urban area in which ecological principles create an urban harmony together with existing societal structures. Theories on eco-cities are often interpreted as a criticism of Western culture itself and they are seen to represent alternatives for the recovery of urban planning through ecology, multiculturalism and sense of community. Most cities in the South suffer the double curse of their own poverty plus some very wasteful activities copied from the North (Ibid). Therefore, solid waste has negative consequences for urban landscapes and residents, it is important to understand waste problems within the broader context of urban political economy and the uneven quality of life produced throughout urban environments. With the exception of the emerging literature on urban political ecology of environmental justice, this has mainly focused on provision of urban water in South African cities (Njeru, 2006). Rooted in the apartheid era, South Africa today faces the environment and health consequences of poor practice of solid waste management (Thomas, Seager, and Mathee, 2002). Moreover, the national population is growing, and a process of rapid unplanned urbanisation, underway in recent decades, has given rise to the formation of sprawling informal settlements on the periphery of cities and towns. In Johannesburg inner city areas, a shortage of housing has led to overcrowding. In this respect, the effective management of solid waste may pose problem in the city (Ibid).

Johannesburg as the case study area of this research is the largest city in South Africa (Rooyen, De Wet, Marais and Korth, 2009). It is the provincial capital of Gauteng, the wealthiest province in the South African State (Ibid). The city of Johannesburg was the first municipality in South Africa to form a waste management utility owned by the municipality. In 2002, Johannesburg Council turned its waste management department into a utility called Pikitup. Although Pikitup is owned by the Council, it is registered as a private company, and functions like any other private business (Samson, 2004). To date, the city waste management system still the responsibility of Pikitup. However, the challenge that Pikitup is facing with regard to the collection of waste is that small informal businesses appears spontaneously in urban low-income areas. Every single time that you may pass through these urban low-income areas, it is possible to find pieces of litter scattered or heaped in plastic bags on the ground. Yeoville, Hillbrow and Windsor are examples of the areas where the problem is manifested (Samson, 2004).

During the transition era, the Greater Johannesburg Transitional Metropolitan Council was responsible for providing a refuse collection and disposal service for the areas now integrated into this metropolitan entity. Before the Greater Johannesburg Transitional Metropolitan Council was established, each racially structured local authority in the Greater Johannesburg area had its own system for solid waste management in line with national policy, under apartheid. Metropolitan functions, such as selecting waste disposal sites, were managed by the former Joint Coordinating Committees (JCC). This meant there were four solid waste management system, notably a fully contracted services, with provision of labour and vehicles; a partially contracted service, with the provision of vehicles with driver and assistant, the labour and supervision being provided by the administration; a full service provided by the administration; and a community driven collection service as no service was provided (Onibokun, 1999).

As part of *iGoli 2002*, waste management was targeted for transformation into a utility, and in 2001, the previously independent waste management units of the GJMC, the four

municipal substructures, and Midrand were dissolved and merged to form Pikitup. Since then, the Council has contracted Pikitup to deliver all waste management services for which it bears constitutional and legislative responsibility (Samson, 2008).

However, in the city of Johannesburg some of the areas became strewn with rubbish during the strike by municipal agents for example the municipal strike of 12, April, 2010. Pikitup's refuse collection schedule has been affected. Residents were required to hold back their bins until the strike was over. In fact, this so-called private company "Pikitup", which has been registered as a private company, and functions like any other private company - partakes in the government municipal strikes as well by refusing to play its role of collecting rubbish in the city. On this note, what was the point of the privatization of Pikitup after all? It is difficult to say that Pikitup functions as a private company because during the strike by the government municipal workers, rubbish overflows occurred in the city of Johannesburg.

A clean environment is essential for human health and well-being. The consequences of the poor practice of waste management, directly or indirectly affects our environment and has an impact on human health as well. However, the interaction between the environment and human health is complex and difficult to assess. We must therefore, take into account this relationship between environment and health because by acting on the environment it is possible to create favourable or unfavourable living environments that can affect the health of human well-being. The need to promote and maintain a healthy and sustainable environment should be taken into consideration. Environmental degradation is at the expense of the health and well-being of the current population, but also at the expense of future generations (World Health Organization, 2001). Although related human causalities can be difficult to establish because of the lack of data or measurement tools used, environmental effects on health are increasingly understood. These are of particular concern in vulnerable individuals such as children, the elderly and the poor (Ibid). Although a great amount known about the most common health impacts related to ambient

air pollution, water quality and inadequate sanitation, much less is known about the health impacts of hazardous chemicals during the process of managing solid waste. As a result we must be cautious and analyse at first all parameters during the process of managing solid waste by means of taking into account the impacts that solid waste management can have on the environment as well as on human health. All these above issues lead us to the need for investigating the impact of mismanagement of solid waste on the environment as well as on human health.

1.2. Aims of the Study

Dealing with waste is a major issue in our endeavour to create sustainable societies. This study aims at investigating the impact of mismanagement of solid waste on the environment as well as on human health. It also aims to contribute to the enrichment of literature related to the issue of solid waste management in Johannesburg. The aim of the study also seeks to provide the most appropriate solutions that can help the authorities of the city to improve the manner in which they manage solid waste.

1.3. Problem Statement

Today the problem of managing solid waste is of particular concern in the cities of developing countries. This problem is mostly associated with the growth of cities and rapid urbanization which has major implication for solid waste because human activities have always generated waste (Giusti, 2009). This was not a major issue when the human population was relatively small and nomadic, but has become a serious problem with urbanisation and the growth of large metropolitan. It is the way this waste is handled, stored, collected and disposed of, which can pose risks to the environment and to public health (Giusti, 2009). Poor waste management leads to a major impact on the environment and public health. In this respect, it is important that attention be focused on the issues of solid waste management within the wider context of environmental management and that the issues which are specific to Johannesburg and which most have in common with other cities, are highlighted.

However, issues that are facing solid waste management in Johannesburg are various and can be set out as follows: Littering, illegal dumping, poor management of activities, limited refuse removal services in poor areas, lack of encouragement of waste minimization and recycling in the general public; unmaintained parks and open spaces encourage illegal dumping, poor monitoring and maintenance at landfill sites, all contribute to the challenge (City of Johannesburg, 2009).

Indeed, a bad practice of solid waste management is a permanent threat to the health of the people as well as the environment. Public health and environment have been major concerns in solid waste management. The other undesirable practices of solid waste management pollute air, water and land, fostering the proliferation of disease carrying vectors that directly or indirectly may have an adverse effect on public health, sanitation personnel, and those who scavenge the refuse to salvage saleable or other materials considered to be of some use (Thomas-Hope, 1998).

The problem of disposing of the huge quantities of solid waste, which accumulate as a by-product of our modern society, is of growing importance to the nation. With the marked population increases which have occurred in the past few decades, people are now crowding in on one another to such a degree that it becomes most difficult to hide our refuse. Besides an increase in the total of quantity of waste produced as a result of population increase, the quantity of waste produced per capita has greatly increased because of the changes in our standard of living (Baum and Parker, 1974).

Given the above statement, it is critically important, in addressing all the possible solutions to solid waste disposal problems, to be aware of the impact of solid and liquid waste, in order to minimise their adverse effects on the human environment. A number of serious and highly publicised pollution incidents associated with incorrect waste management practices, led to public concern about lack of controls, inadequate legislation, environmental and human health impact. In light of all these problems mentioned above, it

is important to raise questions about the impact of mismanagement of solid waste on the environment as well as on human health in Johannesburg.

1.4. Research question

Historically, health and environment have been the major concerns in waste management (McDougall, 2001). Waste must be managed in a way that minimises risk to human health. Today, society demands more than this as well as being safe, waste management must also be sustainable. The restriction of land within Johannesburg makes it difficult for disposing waste. During the process of collecting, treating, managing waste, the surrounding environment as well as human health can be affected both, directly or indirectly. The following questions will therefore elucidate the impact of mismanagement of solid waste on the environment as well as on human health:

- What is the impact of mismanagement of solid waste on the environment as well as on human health in Johannesburg?
- How can the authorities of the municipality improve solid waste management in Johannesburg?

1.5. Research Method

This study has necessitated the utilisation of a qualitative research method in the form of a narrative analysis and semi-structured interviews to study various aspects related to the impact of mismanagement of solid waste on the environment as well as on human health. The use of a qualitative research method helped to get information from books and other official documents and from interviews. A literature review conducted with the local community members, municipal and officials. Questionnaires were completed for 40 interviewees. 12.5% of questionnaires were completed by the Pikitup agents; 17.5% by those of environment department; the other 15% by development planning and land use management department agents, and 55% of questionnaires were completed by the local community of Windsor in the Randburg area.

1.6. Chapter Outline

This study has required a process of five chapters. The first chapter provides a general introduction, which includes the background, aims of the study, problem statement, research question and research method.

The second chapter reviews the literature on the issue of solid waste management, drawing from various sources. This chapter is presented as four sections. The first section describes the concept of waste, solid waste management, waste generation and composition, and solid waste management processes. The second section discusses the problems associated with solid waste management. The third section investigates the impacts of poor management of solid waste on the environment as well as on human health. The fourth section examines the issues of solid waste management in the context of South Africa.

The third chapter focuses on Johannesburg, the case study area of the research. This chapter is divided into four sections. The first section provides background information on Johannesburg. The second section examines the problems of solid waste management in the city of Johannesburg. The third section investigates the impacts of mismanagement of solid waste on the environment and on human health. The last section provides information on Windsor-Randburg, where interviews were conducted.

The fourth chapter analyses the data collected in the research and presents the findings of the report. The first section of this chapter explains the method used for gathering data. The second section analyses data according to the socio-economic characteristics of respondents. The chapter then proceeds to address the main fundamental questions related to the impacts of poor management of solid waste in Johannesburg.

The last chapter presents the conclusions of the report as well as recommendations for future research on the topic and for future practice with regard to solid waste management.

CHAPTER TWO:

LITERATURE REVIEW

2.1. Introduction

Since the beginning of time, human beings have exploited the resources of the earth in order to survive. At the same time, they have utilised the natural environment for the disposal of the wastes generated by their activities. Since the amount of wastes generated was relatively small and the available space for the assimilation of wastes was large, the disposal of human and other wastes presented no problem (Filemon and Uriarte, 2008). Accordingly, it started to become a problem only when human beings started living together in communities, groups, tribes, and villages. Thus, as the communities grew and expanded, the land surrounding them could no longer assimilate the waste generated by their activities and serious environmental and health problems began to appear. Gradually, the need to manage the accumulating wastes became apparent. The different communities therefore started to find various ways and means to dispose of their wastes in a manner acceptable to the affected environment (communities) (Filemon and Uriarte, 2008).

To date, the management of solid waste is a crisis in many of the world's largest urban areas, as populations attracted to cities continue to grow. This has led to ever increasing quantities of domestic solid waste while space for disposal decreases. Nowadays municipal authorities are seeking to develop sanitary landfills around the periphery of their cities as a first solution (Rand, Haukohl and Marxen, 2000). So, siting and preparation of a landfill requires the acquisition of large areas as well as good day-to-day operation in order to minimise potential negative environmental impacts which represents a big threat for life of the population (Ibid).

Thus, the first chapter of this research dealt with general introduction, where the background, aims of the study, problem statement, research question and research method have been provided. The current chapter reviews the literature on sustainable cities and

issues of solid waste management within a general perspective, drawing from different sources. Firstly, the chapter starts by defining the concept of waste, solid waste management including its processes as well as waste generation and composition. Secondly, the chapter looks at the theoretical perspective of solid waste management problem. Thirdly the chapter investigates the impact of mismanagement of solid waste on the environment as well as on human health drawing from different perspectives. Finally, the chapter examines the issues of solid waste management with respect to South Africa and then a conclusion ends this chapter.

2.2. Theoretical concerns

Different scholars express various views on the concept of waste. Generally, waste refers to lack of use or value. Waste is a by-product of human activity. Physically, it contains the same materials that are found in useful products, it only differs from useful production by its lack of value (White, Franke and Hindle, 1995). It can be said that a basic way to deal with waste therefore is to restore value to it, at which point it will cease to be waste. The lack of value in many cases can be related to the mixed and, in many cases, unknown composition of the waste (White, Franke and Hindle, 1995).

Moreover, waste can be classified by several of schemes, notably by physical state, which includes solid, liquid and gaseous. Then within solid waste by original use, which includes (packaging waste, food waste); by material (glass, paper, etc); by physical properties (combustible, compostable, recyclable); by origin (domestic, commercial, agricultural, industrial, etc) and by safety level it includes, hazardous, non-hazardous (White, Franke and Hindle, 1995).

In this study, the definition of waste as the product of human activities is adopted because all human activities generate waste and we must manage the growing amount of waste we produce.

2.2.1. Solid Waste management

Solid waste management is the processes comprising of storage, collection, transportation and landfilling. It is a discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid waste in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics, planning, and other environmental considerations and that is also responsive to public attitudes (Tchobanoglous et al., 1993).

In urban areas, solid waste is generated by domestic households, commercial, and industrial enterprises, and health care and institutional activities, as well as on the streets. Street refuse contains a mixture of refuse from many services, because streets are used as dumping grounds by all generators of waste. Where sanitation facilities are lacking and a large animal population roams the streets, street refuse contains a lot of human and/or animal fecal matter. Streets and pavements are also often used for extensive dumping of construction and demolition debris attracting further dumping of solid waste (Da Zhu, Asnani, and Zurbrugg, 2008).

The term municipal solid waste refers to solid waste from houses, streets and public places, shops, offices, and hospitals. Management of these types of waste is most often the responsibility of municipal or other government authorities. Although solid waste from industrial processes is generally not considered municipal waste, it nevertheless needs to be taken into account when dealing with solid waste because it often ends up in the municipal solid waste stream (Da Zhu, Asnani and Zurbrugg, 2008). Municipal solid waste management is an essential public service which benefits all urban residents. It is not feasible to exclude from service those who do not pay, because public cleanliness and safe disposal of wastes are essential to public health and environmental protection. As a result of these characteristics, solid waste management is a public good for which local or metropolitan governments are typically responsible (Cointreau-levine, 1994).

Solid waste management as defined here, involves several disciplines. It means that the problem of solid waste requires the involvement and commitment of everyone because human health can be affected if waste is poorly managed in society and we need to protect the environment as well. Nevertheless, solid waste management needs to be seen as a problem to be disposed of, but as a resource for sustainable development.

2.2.2. Waste Generation and Composition

The quantity and composition of solid waste depends on how developed the community is and the state of its economy. Industrial growth is an important tool for raising the per capita income and welfare of the population. In turn, industrial growth and higher per capita income generate more waste, which, if not properly controlled, causes environmental degradation. This in turn, impacts on the well being of the population. The elements for generation of municipal solid waste appear in Figure below.

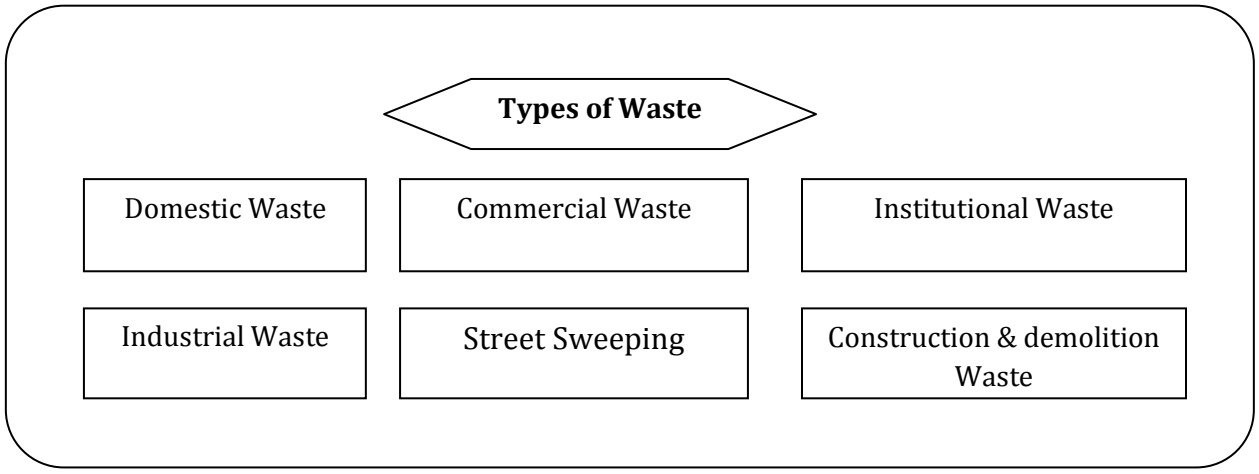


Figure1*: Typology of waste (source: model inspired by Rand, Haukohl and Marxen, 2000)*

2.2.2.1. Domestic Waste

It is waste from household activities, including preparation, cleaning, fuel burning, old clothes and furniture, obsolete utensils and equipment, packaging, newsprint, and garden wastes. In lower income countries, domestic waste dominated by food waste and ash. Middle and higher-income countries have a larger proportion of paper, plastic, metal, glass, discarded items, and hazardous material (Rand, Haukohl and Marxen, 2000).

2.2.2.2. Commercial Waste

Waste from shops, offices, restaurants, hotels, and similar commercial establishments; typically consisting of packaging materials, office supplies, and foods waste and bearing a close resemblance to domestic waste. In lower-income countries, food markets may contribute a large proportion of the commercial waste. Commercial waste may include hazardous components such as contaminated packaging materials (Tchobanoglous et al., 1993).

2.2.2.3. Institutional Waste

This is waste from schools, hospital, clinics, government offices, military bases, etc. It is similar to both domestic and commercial waste, albeit there is generally more packaging material than food waste. Hospital and clinics waste include potentially infectious and hazardous materials. It is important to separate the hazardous and nonhazardous components to reduce health risks (Ibid).

2.2.2.4. Industrial Waste

The composition of industrial waste depends on the kind of industries involved. Especially, industrial waste includes components similar to domestic and commercial source waste, including food wastes from kitchens and canteens, packaging materials, plastics, paper, and metal items. Some production processes, however, utilise or generate hazardous substances. Disposal routes for hazardous wastes are usually different composition of the actual waste type (Rand, Haukohl and Marxen, 2000).

2.2.2.5 Street Sweeping

This waste is dominated by dust and soil together with varying amounts of paper, metal, and other litter from the streets. In lower-income countries, street sweepings may also include drain cleanings and domestic waste dumped along the roads, plant remains, and animal manure (Tchobanoglous, et al, 1993).

2.2.2.6. Construction and Demolition Waste

The composition of this waste depends on the type of building materials, but typically includes soil, stone, brick, concrete and ceramic materials, wood, packaging materials, and the like (Rand, Haukohl and Marxen, 2000).

2.2.3. Solid Waste Management Processes

This point refers to the hierarchy of waste management options, which is headed by source reduction, or waste minimisation. This is the essential requisite for any waste management strategy-less waste to deal with. Next in the hierarchy come a series of options, notably re-use, recycling, composting, waste to energy, incineration without energy recovery and landfill, in some order of preference (White, Franke and Hindle, 1995). It will be argued in this chapter that, albeit useful as a set of default guidelines, using this hierarchy to determine which options are preferable does not necessarily result in the lowest environmental impacts. Different materials in the waste are best dealt with by different processes, so to deal with effectively with the whole waste stream; a range of waste management options is most advantageous. Thus there are no overall “best” or “worst” options; different options are appropriate to different fractions of the waste. Instead of relying on the waste management hierarchy, this chapter looks at the whole waste management system, and attempts to investigate its overall environmental impacts as well as human health impacts. Figure below depicts waste management systems, including all processes from waste generation to land filling.

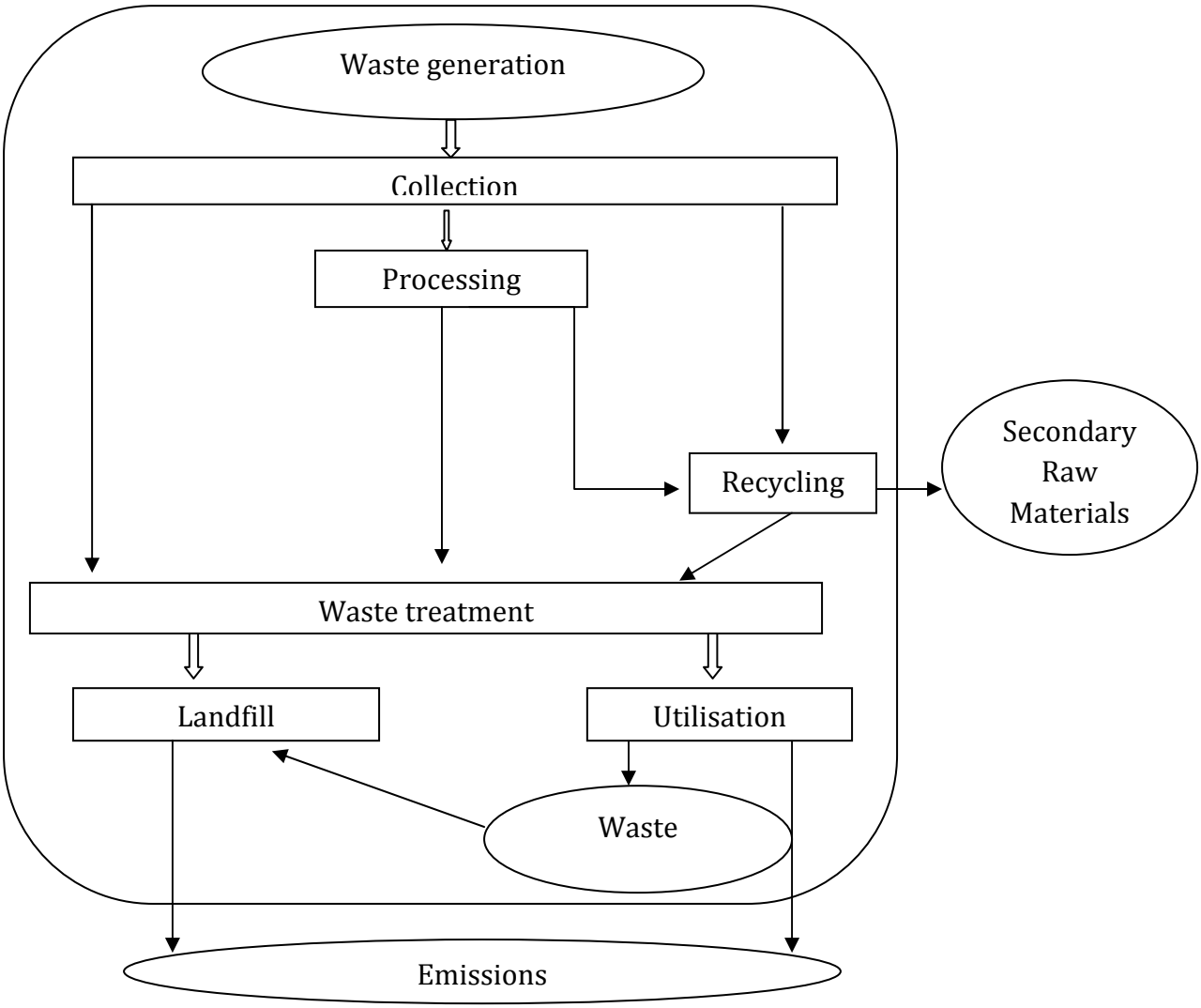


Figure 2: *Integrated waste management system (source: Sabbas et al., 2001)*

The above figure depicts the all processes of waste management systems from waste generation to landfilling. Waste generation is about of all processes which produce waste during the production and distribution of products (industry and commerce) or the consumption of products (households); waste collection, including source separation into different material streams; processing, including such steps as waste sorting, dismantling of products and production of Refuse Derived Fuel (RDF). All these steps serve either to prepare waste for reuse or to suitably modify waste characteristics with a view to final land

disposal; recycling is about the production of secondary materials from waste, for example paper from waste paper, steel from ferrous metal scraps etc.; waste treatment, including several technologies such as thermal treatment, chemical treatment of hazardous wastes, mechanical/biological treatment; waste utilisation, covering all the utilisation options of waste after processing, for example, use of treated bottom ash for road construction, compost for agricultural applications or thermal utilisation of RDF; and Landfilling (Sabbas et al., 2001).

2.3. Solid Waste Management Problem

The first section of this chapter defined the concept of waste, solid waste, municipal solid waste, typology of waste and solid waste management processes. The present section builds upon this process by means of discussing and analysing different problems associated with solid waste management. Waste is an inevitable product of society. Solid waste management practices were initially developed to avoid the adverse effects on public health that were being caused by the increasing amounts of solid waste being discarded without appropriate collection or disposal. Managing this waste more effectively is now a need that society has to address (McDougall, 2001).

Indeed, developing countries have various problems regarding solid waste management. Some scholars provide that in the last two decades, solid waste management projects have been carried out in developing countries in collaboration with external support agencies (Inanc, Idris, Terazono, and Sakai, 2004). Some projects were successful in producing lasting improvements in solid waste management in developing countries. However, many projects could neither support themselves nor expand further when the external agencies discontinued their support (Ibid). A number of technical, financial, institutional, economic, and social factors contribute to the failure to sustain the projects, and these factors vary from project to project (Inanc, Idris, Terazono, and Sakai, 2004). Recently, private finance initiatives have been recommended for solving waste disposal problems, since the public sector in most developing countries cannot afford the high costs of proper waste disposal

facilities (Inanc, Idris, Terazono, and Sakai, 2004). Thus, the high rate of urbanisation in African countries implies a rapid accumulation of refuse. Social and economic changes that most African countries have witnessed since the 1960s have also contributed to increases in waste generated per capita (Onibokun, 1999). In light of this, Thomas-Hope, (1998) argues that waste in solid form has become a major aspect of urbanisation, modern lifestyles and consumer behaviour, production and transportations of the problem, no countries can afford to ignore either the visible presence of solid waste or its impact upon the wider environment and human well-being.

In addition, most cities in developing countries do not collect the totality of wastes generated, and of the waste collected; only a fraction is properly disposed of. Inadequate collection and inappropriate disposal of solid waste represents a source of water, land and air pollution, and poses risks to human health and the environment (Inanc, Idris, Terazono, and Sakai, 2004). Accordingly, in areas that lack refuse collection usually low-income communities residents tend to either dump their garbage at the nearest vacant lot, public space, creek, river, or simply burn it in their backyards. Uncollected waste may accumulate on the streets and clog drains when it rains, which may cause flooding. Waste can also be carried away by runoff water to rivers, lakes and seas, affecting those ecosystems (Inanc, Idris, Terazono, and Sakai, 2004). This situation can be applied to some areas of the city of Johannesburg, where the uncollected waste appeared.

Yet, in the global south, the main problem of solid waste management is the absence of adequate policies, enabling legislation, and an environmentally stimulated and enlightened public. In many cases, government policies on the environment are piecemeal where they exist and are poorly implemented. Moreover, the activities of the state environmental agencies have been hampered by poor funding and inadequate facilities. Successful solid waste management in these countries will require a holistic program that will integrate all the technical, economic, social, cultural, and psychological factors that are often ignored in solid waste programs (Agunwamba, 1998).

Beukering et al., (1999) argue that the increasing amount of waste, both solid and liquid, is being generated as a result of the rapid rate of urbanisation. This in turn, presents greater difficulties for disposal. The problem is more acute in developing countries, such as India, where economic growth as well as urbanisation is more rapid. Effective management of urban waste is required, but urban governments in many countries in the South are constrained by limited finances and poor service delivery.

As indicated earlier, municipal solid waste management is an essential public service which benefits all urban residents. It is not feasible to exclude from service those who do not pay, because public cleanliness and safe disposal of wastes are essential to public health and environmental protection. As a result of these characteristics, solid waste management is a public good for which local or metropolitan governments are typically responsible (Cointreau-Levine, 1994). This does not, however, mean that local government has to accomplish the task of solid waste delivery entirely with its own staff, equipment, and monies. In fact, this is where the role of the private sector comes into play. The following major issues must be considered in discussing the management of solid waste, notably increasing waste quantities; waste not reported in the national municipal solid waste management totals; lack of clear definitions for solid waste management terms and functions as well as lack of quality data (Tchobanoglous et al., 1993).

The level of service for waste collection also varies markedly. In most industrialized countries services have expanded to the extent that over 90 per cent of the population has access to waste collection (Beukering, 1999). This is not the case in developing countries and the failure to provide adequate collection services poses a serious threat to human health in these countries of developing world. Yet, it should be noted that municipal services in developing countries are handicapped by limited finances and an ever-increasing demand on urban services (Beukering, 1999). Moreover, burial in controlled landfills continues to be the most prevalent means of disposing of solid waste including hazardous waste, especially in developed countries. Incineration and recycling also play a

key role in the management of urban and industrial waste. In contrast, in developing countries the prevalent methods of solid waste disposal is through uncontrolled dumping or burning on open ground or city streets. This often results in more pollution and loss of salvageable economic value (Beukering, 1999). This situation brings us in a position in which we are required to examine issues related to dumping and landfilling sites; incineration; recycling and scavenging; separation and treatment of organic waste.

2.3.1. Dumping and Landfilling

In most cities of developing countries, waste management is inadequate. A significant portion of the population does not have access to a waste collection service and only a fraction of the generated waste is actually collected (Schubeler et al., 1996). Systems for transfer, recycling and/or disposal of solid waste are unsatisfactory from the environmental, economic and financial points (Schubeler et al., 1996). Problems of shortage of cover, lack of leachate collection and treatment, inadequate compaction, poor site design, and many pickers working at the site are common (Ibid). Thus, these dump sites are essentially uncontrolled, creating considerable health, safety, and environmental problems.

In light of the aforementioned, it can be argued that the dumping of managed solid waste into uncontrolled sites is the most common form of waste disposal in the developing world and is the result of both limited technical and financial resources. This method of final disposal is environmentally and socially unacceptable as it does little to protect the environment or public health (McDougall, 2001). Pollution of surface and groundwater by leachate, migration of combustible gases, odours and breeding of disease carriers are all common results. Dumps provide very poor living conditions for scavengers and pose significant health risks today and in future (McDougall, 2001).

Although various problems associated with dumping, solid waste disposal nowadays still means dumping in most of developing countries, especially for reasons such as ignorance of the health risks associated with dumping of wastes and/or acceptance of the status quo

due to lack of financial resources to do anything better, or lack of political will, at all levels of government, to protect and improve public health and the environment. Illegal dumping is the place at which solid waste is disposed of in a manner that does not regard environmental and health impacts (Visvanathan et al., 2003).

In most situations, disposal of waste to landfills is the lowest cost option, even in countries with developed economies where landfills are often highly engineered and include multiple liners on the bottom of the landfill. Moving away from a system based on dumping to one based on sanitary landfills represents the most financially realistic option for developing economies to improve waste management. Although the resources for highly engineered facilities are unlikely to be available, simple, low cost options are possible (McDougall, 2001). In light of this, Visvanathan et al., (2003) perceives that sanitary landfills are supposed to be built with optimised and adopted top and bottom liners systems in the developed countries, but most landfills in the developing countries, especially in Asia are merely large but shallow holes in the ground filled with waste. According to them, many of these landfills are located based on convenience rather than hydro-geological studies and consequently have been situated in environmentally sensitive marshlands, abandoned mines, and river beds. Consequently, locations of landfills have to be selected according to set hydro-geological criteria with emphasis on monsoon conditions.

At many dumps there is the problem of the scavengers on the landfill sites who are subjected to different kinds of hazards from the landfill waste as well as from the gas emissions which often contain toxic trace components. The scavengers have to leave the landfill site and other ways of involving them in the recovery of materials from the waste have to be found, where the conditions are more favourable. Under financially very restricted situations adequate landfill sites may reduce the environmental impact of the landfill significantly. Often waste is thrown into rivers, lakes or downhill which creates enormous environmental problems and may result in a low mechanical stability of the dump (Stegmann, 2005). This situation mostly occurs in developing countries.

Yet, in cities of developing countries, the main disposal method for municipal solid waste is open dumping. Very often, landfill sites are swamplands or low-lying areas, with the waste being used for land reclamation. Improper land filling or dumping leads to heavy pollution of surface water and groundwater. Albeit that clay liner is occasionally used, little consideration is given to the water table, groundwater pollution, or gas migration (Stegmann, 2005). There is rarely any controlled disposal of hazardous, biomedical, or slaughterhouse wastes, although certain areas of dumps are usually designated for slaughterhouse and biomedical wastes. Wastes are illegally dumped in water bodies of all kinds, especially by communities that do not receive a municipal waste collection service (Inanc, Idris, Terazono, and Sakai, 2004). However, as stated a bit earlier, most of the existing solid waste landfill sites in developing countries are practicing either open dumping or controlled dumping. Proper sanitary landfill concepts are not fully implemented due to technological and financial constraints. Implementation of a fully engineered sanitary landfill is necessary and a more economically feasible landfill design is crucial, particularly for the developing world (Chong, Matsufuji, Hassan, 2005).

Ultimately, landfills should be sited away from water courses and highly populated areas and built on soils with a relatively low permeability such as clay. Filling should be on a cell by cell basis with, wherever possible, the application of a cover material at the end of each working day. Organic waste and recyclable material should be separated before entering the landfill whenever possible and the site should be fenced or positioned to limit access by trespassers. Implementation of these steps is likely to reduce or eliminate many of the problems associate with dumping (McDougall, 2001).

2.3.2. Incineration

There has been increasing incentive in recent years for disposal of wastes by incineration. The need to recover energy from waste material, coupled with the difficulty in obtaining adequate landfill sites, has created a great deal of interest in this approach (Krause, 1986). In addition, municipal refuse is being considered as a supplementary fuel for existing fossil-

fuel power generating stations and for industrial needs for process steam (Ibid). Heo and Park, (2002) add that incineration is an integral component of waste management in many countries across the world. The relative importance of incineration as opposed to direct landfilling varies substantially from country to country (Heo and Park, 2002). According to Hjelmar, (1996) incineration is often the preferred option in countries with limited availability or accessibility of space for land filling. Switzerland, Japan, France, Germany, Sweden and Denmark are examples of countries in which 50% or more of the un-recycled waste is being or will be incinerated; some of these countries have even passed legislation which will prohibit future land filling of combustible waste (Hjelmar, 1996). There are two different types of incineration facilities: refuse-derived fuel, which involves pre-sorting municipal solid waste to remove glass; and ferrous metals in order to obtain waste with higher calorific value, and mass-burn, in which municipal solid waste is incinerated as they are received (Ferreira, Ribeiro and Ottosen, 2003).

The above paragraph can be explained in this way, on one hand, incineration reduces the volume of the waste and does not produce further problems from leachate and odour. Moreover, this is a sanitary method for treatment of municipal solid waste that does not cause biological problems. On the other hand, incineration has some disadvantages compared with land filling. Incineration requires high energy consumption and leaves a large amount of fly and bottom ash (Heo and Park, 2002). Although incineration reduces the volume of municipal solid waste and provides energy, it is not a final solution since it generates bottom and fly ashes that must subsequently be disposed of. Bottom-ash is collected at the base of the combustion chamber and consists of a slag-type material. However, it is the finer fraction, collected from the flue gas by the air pollution control (APC) devices, and referred to as *fly ash*, that poses the more serious environmental problems (Ferreira, Ribeiro and Ottosen, 2003).

However, in public debates about emissions from refuse incineration plants, the heavy metal problem is mostly discussed very globally, leaving out the fact that in various

emission systems individual heavy metals can occur at greatly differing individual concentrations and hence with varying importance (Vogg, Braunt, Metzgert and Schncider, 1986). Problems connected with heavy metal emissions in a smelting process are basically different from problems of coal combustion and the latter, in turn, cannot be compared with the problems encountered in refuse incineration. There are some a few elements specific to each process which due to their concentrations in the offgas plays a crucial role with regard to emission (Vogg, Braunt, Metzgert and Schncider, 1986). All these problems might impact on the environment, if not on the public health.

2.3.3. Recycling and Scavenging

A significant challenge confronting engineers and scientists in developing countries is the search for appropriate to the collection and treatment, and disposal or reuse of domestic waste (Polpraset, 2007). Solid waste recycling is now becoming a common practice in developed countries as people become more conscious of pollution problems caused by uncontrolled waste generation and disposal (Morris and Dickey 1991). The increasing quantity of solid wastes is a serious environmental problem not only in developed countries but also in the developing countries. Until recently disposal was the only technical and economical option that could be taken in the management of these wastes. The technology for resource recovery and recycling was not considered because of its economic impracticality and its low quality for use as raw material in production (Lohani, 1984).

However, the time has come when recycling needs to be considered as a strong alternative against disposal for the following reasons: firstly, present waste management techniques are not adequate to prevent serious environmental pollution (Lohani, 1984); secondly, there is a need to conserve scarce and expensive resources (Ibid). Furthermore, in most developing countries, the possibility of integrating organised and hygienic scavenging for resource recovery and recycling has been completely neglected (Lohani, 1984).

Scavenging by people occurs at a number of stages within the municipal solid waste management stream. High quality recyclables such as entire glass containers, plastic bottles, metals are often collected door to door by individuals or by the waste collectors themselves (McDougall, 2001). Recyclable materials are also very effectively sorted at the curbside by people searching through garbage containers and by people scavenging at the landfill or dump. It is this litter from scavenging that poses the greatest threat to health, represents the poorest living conditions and as such is most urgently in need of improvement (McDougall, 2001). Additionally, waste disposal sites are invaded by scavengers and animals, paving the way for even more pollution and transmission of diseases. These observations have been noted in many urban areas in developing countries (Mengiseny, and Stephen, 2000). Dump scavenging is problematic for public health since waste pickers are exposed to cuts resulting from the handling of glass and sharp objects (Tevera, 1994).

Further, in high income areas, recovery is mainly carried out by domestic servants who sell the materials to middlemen to supplement their incomes. Metals, particularly, aluminium, are recovered and sold to small-scale recyclers who use them to produce valuable items, such as lamps, cooking pots, and washing pans. Scavenging is undertaken at public containers and dumping sites. Waste pickers sort through waste in public container sites and also, from incoming trucks at dumping sites, which make their activities risky (Boadi and Kuitunen, 2003).

Moreover, with the increasing cost of raw materials, recycling provides a cheaper source of raw materials for manufacturing industries. This has given value to the otherwise worthless municipal solid waste and has encouraged a second look at it before making a decision to dispose (Rotich, Yongsheng and Jun, 2006). Sorting and separation of municipal solid waste is gaining importance in various sectors. A visit to a municipal solid waste dumpsite reveals intense scavenging for recyclables in the disposed waste. Scavenging initially was driven by poverty and a desire to earn a living, but the emergence of recycling

industries has given a boost to search for recyclable materials in the dumpsites (Rotich, Yongsheng and Jun, 2006). But the danger is just about the health implication associated with the management of this solid waste.

2.3.4. Separation and treatment of organic waste

Waste management is an important issue in both developed and developing countries nowadays. Organic wastes, such as used rubber and plastic are among the waste materials that represent problematic wastes on one hand and valuable potential as secondary raw materials on the other hand. To alleviate part of our environmental degradation, it has become imperative to make use of appropriate technologies for recovery of resources from non-conventional sources like organic waste (Huang and Tang, 2007).

Separation of organic waste from municipal solid waste stream represents an opportunity to reduce the quantity of waste entering landfills in developing countries. Correct treatment of this waste will also significantly reduce the pollution and health problems. Separation of organic waste can be done at the households prior to collection, at the landfill prior to final disposal or a combination of both. Motivation of households to collect organic waste is required to ensure a high level of efficiency. Efficient separation of organic material by householders will only be sustained if the source separation is convenient, hygienic and beneficial (McDougall, 2001).

2.4. Impact of Mismanagement of Solid Waste on the Environment and on Human health

In this chapter the first section has dealt with conceptual concerns by means of defining different concepts related to sustainable cities, issues of solid waste management. The second section has related and examined the problems associated with solid waste management where dumping and land filling, incineration; recycling and scavenging; separation and treatment of organic waste have been analysed. The current section investigates the impact of mismanagement of solid waste on the environment as well as on

human health. This section starts by examining the environmental concerns and human health implications as well and finally, a short discussion ends the section.

2.4.1. Environmental Concerns

Solid waste management is a versatile part of environmental hygiene, which if mishandled can lead to an array of environmental problems. Municipal solid waste disposal has become an ever increasing problem mostly in developing countries urban centres, largely due to the prevailing rapid urbanisation process. Despite this growth, there has been less parallel effort to properly manage the solid wastes produced by the urban dwellers. The quantities of solid waste to be collected and transported for disposal have also increased tremendously in recent years (Mato, 1999). In addition, it is clear that where intense human activities is concentrated, such as in urban centres, appropriate and safe solid waste management (SWM) is of highest importance to allow healthy living conditions for the population (Zurbrugg, 2002). The production and disposal of large amounts of waste is seen by many to represent squandering of the earth's resources. Putting waste into holes in the ground certainly appears to be inefficient materials management (McDougall, 2001). The environmental degradation caused by inadequate disposal of waste can be expressed by the contamination of surface and ground water through leachate, soil contamination through direct waste contact or leachate, air pollution by burning of wastes, spreading of diseases by different vectors like birds, insects and rodents, or uncontrolled release of methane by anaerobic decomposition of waste (Zurbrugg, 2002).

According to Pokhrel and Viraraghavan, (2005) the environmental impacts of poor solid waste management lead to the deterioration of surface and sub-surface water quality, as well as air and land pollution. Additionally, the impact depends on the waste composition and disposal practices. The traditional landfill practices produce various landfill gases such as methane, carbon dioxide, carbon monoxide, nitrogen, hydrogen sulfide and ammonia (Pokhrel and Viraraghavan, 2005). Moreover, inevitable repercussions of the practice of solid waste disposal in landfills are gas and leachate generation due primarily to microbial

decomposition; climatic conditions, refuse characteristics and land filling operations (El-Fadel, Findikaki and Leckie, 1997). The migration of gas and leachate away from the landfill boundaries and their release into the surrounding environment presents serious environmental concerns at both existing and new facilities. Besides potential health hazards, these concerns include, and are not limited to, fires and explosions, vegetation damage, unpleasant odours, landfill settlement, ground water pollution, air pollution and global warming (El-Fadel, Findikaki and Leckie, 1997).

Environmental pollution caused by solid waste has been the scourge of society and people at large due to its mismanagement. Mounds of rotting waste have long been an eyesore in many countries to their environments. Even though several solid waste management projects have been implemented to solve the growing solid waste management problem in the context of the developing world, most of these projects are not followed through or poorly carried out due to social, economic and technical problems (Jayawardhana et al., 2003).

Luis, Diaz, Savage and Eggerth, (2005) argue that the organic fraction of municipal solid waste management is an important component, not only because it constitutes a sizable fraction of the solid waste stream in a developing countries, but also because of its potentially adverse impact upon public health and environmental quality. Accordingly, a major adverse impact is its attraction of rodents and vector insects for which it provides food and shelter. Impact on environmental quality takes the form of foul odours and unsightliness. These impacts are not confined merely to the disposal site. On the contrary, they pervade the area surrounding the site and wherever the wastes are generated (Luis, Diaz, Savage and Eggerth, 2005). Unless organic waste is appropriately managed, its adverse impact will continue until it has fully decomposed or otherwise stabilized. Uncontrolled or poorly managed intermediate decomposition products can contaminate air, water, and soil resource (Luis, Diaz, Savage and Eggerth, 2005).

From a sustainability point of view, waste disposal in the form of landfills is the least preferred option in waste management because it is essentially end of pipe solution and it has the most impact on the environment (Suess, 1985). Despite this fact, the bulk of municipal solid waste still finds its way into solid waste disposal sites (SWDS) all over the world 60% in the EU and a little less than that in the US (Smith, Brown, Ogilvie, and Rushton, 2001), as it still is one of the least complicated ways of handling waste in terms of technical expertise and costs. The proportion of municipal solid waste that goes to disposal sites is likely to be higher in developing countries because they have less recycling and re-use capabilities (Ibid). What this says is that, regardless of the fact that landfills are least preferred options for sustainable municipal solid waste management, trends show that they will still be around for quite a while. Especially in developing countries where MSW management is still at the stage where only the effective collection of MSW away from the streets into disposal sites are considered accomplishments which still eludes many municipalities in developing countries (Smith, Brown, Ogilvie and Rushton, 2001).

2.4.1.1. Pollution

Waste disposal and pollution are inextricably linked (Hamer, 2003). The term pollution describes both the act of polluting and the consequences of that act. Waste describes unwanted residues that are usually perceived to be of negative value (Hamer, 2003). Pollution can be defined as the introduction into the natural environment by humans of substances, materials or energy that cause hazards to human health, harm to living resources and ecological systems, damage to structures and amenities or that interfere with the legitimate uses of the environment (Royal Commission on Environmental Pollution, 1984). It is implicit in the definition that pollution only describes situations where unwanted effects occur (Royal Commission on Environmental Pollution, 1984). The majority of waste disposal situations involve pollution of one kind or another. Pollution is mainly a result of poor disposal methods for sewage and household wastes (Hamer, 2003). This takes the form of solid waste contamination of official and unofficial rubbish pits, dumps and open areas. The polluter derives benefit from the environment in being able to

dispose of waste but the costs are borne by the community in health costs, the degradation of renewable resources, and a diminution in the already scarce land area available for other uses and a reduction in the scenic qualities of atolls (Hunt, 1996). However, when the density of population increases, so does the waste stream. Moreover, because of the heavier reliance on imports of the dense urban populations, the character of the waste stream changes to include a higher percentage of non-biodegradable wastes (Hunt, 1996).

Bartone, (1991) contends that most developing country cities are increasingly unable to provide basic environmental infrastructure and services, whether in the megacities or in secondary urban centres. Of particular concern is the strain on natural resources brought by the increasing number of people, cars, and factories. They are generating ever greater amounts of urban wastes and emissions (Bartone, 1991). Currently, the liquid and solid wastes outstrip the capacity of cities to efficiently collect and dispose of them. They also exceed the capacity of regulatory authorities to control them and of nature to assimilate them (Ibid). The environmental consequences translate into direct negative impacts on human health, the quality of life, the productivity of the city, and the surrounding ecosystems. Other environmental problems include air pollution in large cities with poorly ventilated air sheds. In the humid tropics, urban drainage is a problem (Bartone, 1991). Accordingly, flooding is often exacerbated when the drainage system is clogged with garbage. In more heavily industrialized cities, traffic, noise, overcrowding, and stress have sometimes caused severe public health and environmental problems. Bartone, (1991) adds that environmental degradation also threatens the long-term availability and quality of natural resources critical to economic growth. The loss of land and water resources results from the uncontrolled development of erosion prone areas, coastal zones, and wetlands and from the haphazard disposal of toxic industrial wastes. Groundwater depletion and contamination can be serious. Cities with their higher and growing per capita energy use for domestic, industrial, and transport purposes also contribute a disproportionate share of the emissions leading to global warming and acid rain (Ibid).

Zerbock and Candidate, (2003) assert that the decomposition of waste into constituent chemicals is a common source of local environmental pollution. This problem is especially acute in developing nations; where very few existing landfills in the world's poorest countries would meet environmental standards accepted in industrialized nations, and with limited budgets there are likely to be few sites rigorously evaluated prior to use in the future. Additionally, the problem is again compounded by the issues associated with rapid urbanization. As land becomes scarce, human settlements encroach upon landfill space, and local governments in some cases encourage new development directly on top of operating or recently closed landfills (Zerbock and Candidate, 2003). A major environmental concern is gas release by decomposing garbage. Methane is a by-product of the anaerobic respiration of bacteria, and these bacteria thrive in landfills with high amounts of moisture. Methane concentrations can reach up to 50% of the composition of landfill gas at maximum anaerobic decomposition (Cointreau-Levine, 1996).

2.4.1.2. Vegetation Damage

The mismanagement of solid waste has serious consequences. It impacts negatively either on people's immediate home environment or on the wider environment and ecology or on both. At closure, many landfill sites are converted to parks, golf courses, agricultural fields, and in some cases, commercial developments. Vegetation damage at or nearby to such sites is well documented in the literature (El-Fadel, Findikaki and Leckie, 1997). Damage of vegetation appears primarily due to oxygen deficiency in the root zone resulting from a direct displacement of oxygen by landfill gas. In the absence of a gas control measure, landfill gas can migrate upward due to concentration and pressure gradients, and escape into the atmosphere by venting through the landfill cover. During this process, oxygen is displaced and plant roots are exposed to high concentrations of methane and carbon dioxide, the two major constituents of landfill gas. The lack of oxygen causes the death of plants (El-Fadel, Findikaki and Leckie, 1997).

In addition, the plastic materials scattered on land, along the road sides and everywhere are seriously impairing the plant development and animal health. Plastic bags are being used extensively as carry-pack from market as well as domestic waste disposal bag. In urban areas, cattle are raised under semi-intensive system and have free access to scavenge on the heaps of waste and garbage littered on the street, road side and elsewhere (Krishna, Sankhi and Vet, 2007). Table below provides key advantages and disadvantages of waste management option.

Option	**Advantages**	**Disadvantages**
Recycling	Conservation of resource, supply of raw materials to industries, Reduction of waste disposed to landfill and incineration	Diverse range of processes Emissions from recycling process May be more energy used for processes than original manufacture Currently low demand for products Requires co-operation from individuals Odours, noise, vermin nuisance
Composting	Reduction of waste to dispose to landfill and incineration Recovery of useful organic matter for use as soil amendment Employment opportunities	Bio-aerosols—organic dust containing bacteria or fungal spores Emits volatile organic compounds Potential pathway from use on land for contaminants to enter food chain Discharges may contain organic compounds, endocrine disrupting compounds, heavy metals, pathogenic

		microorganisms Odour nuisance Produce hazardous waste
Sewage treatment	Safe disposal of human waste	
Incineration	Protects sources of potable water supply Reduces weight and volume of waste, about 30% is left as ash which can be used for materials recovery Reduces potential infectivity of clinical waste Produces energy for electricity generation	Discharges contaminated waste water Emits toxic pollutants, heavy metals, and combustion products
Landfill	Cheap disposal method Waste used to back fill quarries before Reclamation Landfill gas contributes to renewable energy supply	Water pollution from leachate and run off Air pollution from anaerobic decomposition of organic matter to produce methane, carbon dioxide, nitrogen, sulphur and volatile organic compounds Emission of known or suspected carcinogens or teratogens (*e.g.* arsenic, nickel, chromium, benzene, vinyl chloride, dioxins, polycyclic aromatic hydrocarbons) Animal vectors (seagulls, flies, rats) for some diseases Odour, dust, road traffic

		problems

***Table 1**: Waste Management Option, key Advantages and Disadvantages. Source: (Rushton, 2003).*

Drawing from the aforementioned table, it is clear that environmental monitoring of all potential sources of pollution from different waste management options has been, and is being continuously carried out and thus a great deal is known about the types and amount of substances emanating from them. Whatever the waste management option, it is generally the case that there are usually a large number of different substances and only a few of these are produced in any quantity with many being at extremely low levels.

2.4.2. Human Health Concerns

In developing countries and countries with economies in transition, waste management often emerges as a problem that endangers human health and the environment (Hosetti, 2006). To make matters worse, waste management usually has a low priority on the political agenda of such countries, as they are struggling with other important issues such as hunger, health problems, water shortages, unemployment and even civil war. In such situations, it is easy to understand why waste problems have a tendency to grow steadily (Hosetti, 2006).

The lack of adequate waste collection and disposal systems in developing countries causes public health problems resulting in diseases, which aggravates poverty and leads to negative consequences such as loss of income due to illness, increased spending on health care, and the deprivation of the poor's capability to live in a safer environment (Wolfville and Scotia, 2002). Africans suffer a "higher total burden of disease than their counterparts in other regions, with about 25 percent of the total illnesses attributable to malaria, diarrheal diseases, and respiratory infections (Wolfville and Scotia, 2002)".

Uncollected decomposing garbage, which often is responsible for poor drainage, is at the root of the spread of diseases like malaria, tuberculosis, jaundice, enteric diseases and

respiratory ailments. Wolfville and Scotia, (2002) report that 62 thousands cases of cholera resulting in over four thousands deaths were reported in Angola, the Democratic Republic of Congo, Malawi, Mozambique and Tanzania in 1994. Another 171 thousands cases of dysentery with at least 600 deaths were reported in Malawi, Mozambique and Zimbabwe (Ibid). Poor drainage in some urban areas contributes to the spread of malaria, which annually kills more that 1.5 million people in Africa (Wolfville and Scotia, 2002).

Uncertainty regarding waste generation, waste management practices, data on emissions, exposure characterization and, in particular, the health risk associated with the different types of waste management methods is the main cause of the extensive market failure in the management of solid waste disposal (Guerriero and Cairns, 2009). It is clear that the mismanagement of solid waste disposal can have serious effects on the health and well being of the population. A wide range of toxic substances can be released into the environment from waste disposal, for example, methane, carbon dioxide, benzene and cadmium. Many of these pollutants have been shown to be toxic for human health. In addition, if the waste disposals are illegal, then they are likely to contain highly hazardous compounds resulting from industrial production (Guerriero and Cairns, 2009).

However, an epidemiological study has found that two main health outcomes, cancer and congenital malformations, are statistically associated with waste exposure. Hazardous waste has been shown to influence the likelihood of developing brain, bladder and lung cancer (Dolk et al., 1998). According to them, living close to a waste disposal site is also associated with a significant increase in congenital anomalies. They report an odds ratio of 1.33 for congenital anomalies among those living within 3 km of hazardous waste (landfill) sites in Europe. Dolk et al., (1998) also find a significant increased risk of central nervous system malformations for those individuals living close to toxic waste sites.

Despite important technological advancements, improved legislation and regulatory systems in the field of waste management, and more sophisticated health surveillance, the

public acceptance of the location of new waste disposal and treatments facilities is still very low due to concern about adverse effects on the environment and human health (Giusti, 2009). Further, health issues are associated with every step of the handling, treatment and disposal of waste, both directly or indirectly. Directly, in the sense that via recovery and recycling activities or other occupations in the waste management industry, by exposure to hazardous substances in the waste or to emissions from incinerators and landfill sites, vermin, odours and noisy, human health can be a menace (Giusti, 2009).

Indirect health effects due to the contribution of greenhouse gases from waste disposal activities could be significant. Rising temperatures due to climate change would affect old people with cardiovascular problems and both old and young people with respiratory problems such as asthma. On the positive side, fewer people would die from cold-related illnesses (Giusti, 2009). Accordingly, diseases such as malaria that are spread by vectors such as mosquitoes could become more common. Rising sea levels, flooding and extreme weather events are also likely to cause destruction and casualties (Giusti, 2009). Human exposure to substances released at waste management facilities can be acute in case of a serious accident causing short-term exposure to high levels of potentially hazardous substances, ionizing radiation, bio-aerosols and dusts (Ibid).

In fact, there are some human health risks associated with solid waste management and disposal in all countries to some degree, but certain problems are more acute and widespread in underdeveloped nations. Managing solid waste in society has been a challenge for as long as people have gathered together in sufficient numbers to impose a stress on local resources. In poorer countries waste from homes and industries could be buried, eaten by animals and burned (Hester and Harrison, 2002). Household waste and other waste streams needed to be removed from the human environment to avoid nuisance and public health problems, and the wider environment provided an ample sink for these negative effects of human life (Hester and Harrison, 2002). Growth in population and in individual prosperity have since combined to put greater pressure on the environment, at

the same time as permitting a growth in people's appreciation of that environment. Consequently, waste management policy and practice in industrialized countries developed rapidly in the second half of the 20th century, to ensure that while public and occupational health risks are minimised, environmental resources are protected (Hester and Harrison, 2002).

Groups at risk of developing adverse effects due to direct or indirect exposure to the toxic emissions from municipal solid waste practices include: Waste management workers and communities residents. Potentially, exposed community populations include not only persons residing in the immediate vicinity of combustion facilities, but also persons living downwind from the facilities and persons who live near ash disposal sites and along ash transport routes (Landrigan, 1989).

Luis, Diaz, Savage and Eggerth, (2005) have depicted that a high percentage of workers who handle refuse, and of individuals who live near or on disposal sites, are infected with gastrointestinal parasites, worms, and related organisms. Contamination of this kind is likely at all points where waste is handled. Although it is certain that vector insects and rodents can transmit various pathogenic agents, notably amoebic and bacillary dysenteries, typhoid fever, salmonellosis, various parasites, cholera, yellow fever, plague, and other (Luis, Diaz, Savage and Eggerth, 2005). It is difficult to trace the effects of such transmission to a specific population.

2.4.2.1. Pathogens and hygienisation

The mismanagement of solid waste can carry-out various pathogens agents. This in turn, might cause or impact on human health. However, few waste treatment technologies can be guaranteed to eliminate all pathogenic organisms and agents even albeit solid waste, principally sanitary solid wastes and specified materials from animal slaughter and destruction, have been detected as significant sources of various pathogens (Hamer, 2003). Moreover, it is demonstrated that most screening tests used indicate the possible presence of pathogenic organisms and involve fecal indicator bacteria, in spite of the fact that human

pathogens include bacteria, yeasts, protozoa intestinal and other worms, flukes, viruses and prions and that individual elimination and survival characteristics vary considerably (Hamer, 2003).

In fact, hygienisation processes involve two major facets: the destruction or irreversible inactivation of all pathogens present and the prevention of subsequent recovery of or reinfection with pathogens. As far as biological hygiene processes are concerned, the three major mechanisms contributing to process efficacy are elevated temperatures, effective hydrolytic enzyme production and high residual substrate affinities (Hamer, 2003).

The major concern about air toxins from municipal solid waste incineration practices relates to the carcinogenic or potentially carcinogenic substances which are released during combustion of municipal waste (Levin and al, 1991). The studies performed on cancer risk assessment in communities exposed to pollution from municipal waste incineration addressed different routes of exposure in the risk assessment process. A retrospective epidemiological study was performed on the consumption of medicines for respiratory problems over a 2 year period among residents in a French village at distances of 0.2, 1 and 2 km from a municipal solid waste incinerator (Terblanche, Louise and Nel, 1991).

2.4.2.2. Waste Picker's Health

Waste picker's health is exposed in every stage of handling waste. These waste pickers are the immediate population at risk. Thus, in Accra (Ghana) for example, waste pickers sorted through waste from incoming garbage trucks, before and immediately after unloading. Waste pickers often prevented the compactor from levelling and compressing the newly disposed waste (Johannessen and Boyer, 1999). Elsewhere in Ghana, scavenging was uncommon, as the cost of transporting recyclable materials to recycling industries in Accra and Côte d'Ivoire exceeded the value of the recyclables (Ibid).

Johannessen and Boyer, (1999) maintain that uncontrolled scavenging at controlled and semi-controlled dumps also took place in South Africa. At the Krugersdorp landfill in the North West Province, an entire village of waste pickers had sprung up close to the dump site. More than 600 waste pickers subsisted on income generated from sorting waste, interfering with daily operations by starting fires in order to access metals and glass. Their actions prevented landfill operators from making optimal use of compactors at the tipping face.

Johannessen and Boyer, (1999) add that a more controlled form of scavenging has taken place at the Bisasar Road landfill in Durban. So, registered waste pickers living in a squatter community immediately adjacent to the landfill were allowed into the site after regular hours. Part of the tipping face remained open for the waste pickers at the end of each working day.

Against this background, waste Picker's health is exposed during the process of managing solid waste because human fecal matter is present in every solid waste system. In developing countries the problem varies with the prevalence of adequate sanitary disposal systems such as municipal sewerage or on-site septic systems, outhouses (Zerbock, 2003). In areas where such facilities are lacking, the amount of human fecal matter present in the solid waste stream is likely to be higher. This presents a potential health problem not only to waste workers, but also to scavengers, other users of the same municipal drop-off point, and even small children who like to play in or around waste containers. The usual disease pathways include placing contaminated hands in the mouth or eating food, through vector insects such as cockroaches or mosquitoes, or by directly inhaling airborne dust particles contaminated with pollutants. Survival time for pathogens varies with the requirements of the organism and the media in which they find themselves (Zerbock, 2003).

Waste picker's health is exposed to a number of toxic compounds; some are present in the wastes, and some are formed during the combustion process. Very few studies have been

done on the health effects of mismanagement of solid waste on the workers. A retrospective study done in Sweden, reported an increased mortality from ischemic heart disease and possibly from lung cancer in long-term workers at a municipal solid waste management (Gustavsson, 1989).

2.4.2.3. Discussion

The current waste management problem did not develop overnight. The perception of seemingly endless space for garbage disposal coupled with industrial expansion has contributed to the production of much household and commercial waste, plus an unknown amount of industrial waste. Further, it is observed that the sitting of a municipal solid waste incinerator in a poor or industrialised section of the city often raised questions about inequities and the fair distribution of misery. This problem is often complicated by the fact that poor neighbourhoods, especially in older cities, are frequently located near prime industrial areas. Such areas are often excellent locations for a municipal solid waste incinerator when zoning, land availability, proximity to other industry transportation access, and development costs are considered (Holly, Hattemer and Travis, 1991).

A great deal of attention has been focused on potential human health impacts of municipal solid waste management. Numerous claims and counterclaims have been made about the dangers of various pollutants, especially dioxins and furans, which have resulted in much confusion on the part of the public and regulatory agencies (Holly, Hattemer and Travis, 1991). Amid this confusion, many concerned citizens groups have begun to question and, in some cases, to strongly oppose municipal solid waste incinerator projects based on the potential for adverse health effects (Holly, Hattemer and Travis, 1991).

In the context of developed countries, public awareness of the long term health effects associated with negative environmental externalities is increasing as a consequence of better data collection and the increasing number of epidemiological studies (Guerriero and Cairns, 2009). This public awareness should be the same for developing countries. People should know that there is no price for human health and the mismanagement of solid waste

degrades the environment as well as the well being of the population. Assigning a monetary value to health risks arising from environmental externalities allows all the environmental influences on human health to be formally quantified and should help decision makers deliver optimal policies aimed at reducing the "external cost" to society. There is growing interest in the use of cost benefit analysis for the evaluation of environmental interventions aimed at reducing the health damage associated with health pollution. Despite this, little has been done to quantify the external costs due to environmental hazards on health although they account for a large part of the damage associated with negative externalities.

2.5. South African Context

The previous section has investigated the impact of mismanagement of solid waste on the environment as well as on human health, where the issues related to pollution, vegetation damage, pathogens and hygienisations; waste pickers' health have been taken into consideration. This final section provides information on solid waste management with respect to South Africa.

Fiehn and Ball, (2005) report that over the last decade waste management has been prioritised within environmental management as well as within the various governmental departments regulating these functions. Globally, waste has also become a prominent issue as highlighted by discussions held at the World Summit on Sustainable Development held in Johannesburg in 2002 (Fiehn and Ball, 2005). The Summit promoted development which takes into consideration strategies which are socially, environmentally and economically sustainable. During this last ten year period, the focus on service delivery has been emphasised together with local economic development programmes and poverty alleviation projects (Ibid). Local municipalities have also become more accountable to their communities, ensuring that they have an integrated waste management plan in place to adequately provide an equitable service to all (Fiehn and Ball, 2005). With the increase in economic development came an increase in commercial, industrial, hazardous, mining,

power generation waste and radioactive waste, all which have to be regulated and managed under the National Environmental Management Act (NEMA), the Environment Conservation Act (ECA), and the National Water Act (NWA). Within both the public and the private sector, waste needs to be managed according to the following principles - accountability; affordability; cradle to grave management; polluter pays; equity; sustainable development; integration; open information; subsidiary; waste avoidance and minimisation; co-operative governance; and environmental protection and justice (Fiehn and Ball, 2005).

Greben and Oelofse, (2009) argue that waste generation in South Africa amounts to about 427 million tonnes per annum of which the majority comprises mining waste (approximately 88%) whereas domestic and trade waste represent only 1.5% and sewage sludge about 0.1% (Oelofse 2008). Although the domestic waste contribution seems insignificant in comparison with the vast amounts of industrial waste, the middle class in South Africa generates in the order of 2.7 million tonnes year–1 of domestic waste (Greben and Oelofse, 2009).

Whyte, (1995) argues that in South Africa the waste problem did not catch the attention of the government or the public until recently. He reports that "Public concern about the importation of toxic waste was instrumental in propelling the waste issue into the limelight, especially in the case of mercury recovery from imported waste by the Thor Chemicals plant in Pietermaritzburg, when it was revealed that workers' health was affected and there was serious contamination of the local environment". Cessation of operations was announced while the mission was visiting the plant (Whyte, 1995). Further, in South Africa, national economies generate large quantities of different types of hazardous emissions, effluents, and solid wastes (Whyte, 1995). A wide variety of sources of such "negative resources" can be found in different sectors and at different levels of human activity. In addition, certain waste types, in particular toxic waste, may be imported

or exported, and there are often other forms of trans-boundary flows of pollutants and waste. Other sectors responsible for large waste output include transportation, agriculture, and domestic households. Transportation accounts for a share of urban air pollution (Whyte, 1995).

From Fiehn and Ball, (2005) viewpoint, key issues which face South Africa include the lack of available or current waste information from all sectors, illegal dumping and illegal dump sites, salvaging at waste disposal facilities, use of unpermitted landfills by municipalities, limited environmentally accepted landfill airspace, large portions of the population not receiving a weekly or adequate waste collection service, recycling not generally undertaken or encouraged by municipalities, waste minimisation which is almost exclusively industry driven, government departments' lack of waste databases, lack of regulation and enforcement of legislation and limited waste related legislation (Fiehn and Ball, 2005).

Indeed, the history of solid waste management in South Africa also provides some compelling reasons to review the management and control of pollution. South Africa has a legacy of poor management of solid waste in general and toxic substances in particular and as yet no significant policy to either remedy past failings or to ensure that releases of hazardous chemicals to the environment are properly monitored, controlled and limited to acceptable levels is in place. According to waste management company *Waste Tech*, South Africa is saddled with a waste management problem of historic proportions (Bethlehem and Goldblatt, 1997).

Even if improved management is instituted in the near future, there are significant costs that will probably have to be borne in order to remedy the poor practices of the past. There are between 1200 (Bethlehem and Goldblatt, 1997) and 1600 landfill sites in South Africa (Ibid). A survey of 541 of these sites found that only 92, or 17%, were licensed. Furthermore, although most of these were not hazardous waste sites, nor designed as such, many of them had accepted some industrial waste at some stage. The same study found that almost no landfill sites have records of substances accepted which go back more than

ten years. Even recent information is scanty, as only the sites run by the larger organizations keep a waste acceptance database (Bethlehem and Goldblatt, 1997). Given this state of development, the country has a diverse waste stream, the management of which varies in approach, efficiency and complexity depending on the responsibility of the local authority.

Recent observation, including surveys involving more than sixty landfill sites in three Regional Services Council regions of South Africa, indicate that the general standard of waste disposal in the country falls far short of the universally accepted Sanitary Landfill standards. From the same surveys, however, it was also evident that Sanitary Landfill standards might not necessarily be appropriate or cost effective, in all situations (Ball, 1991). In a paper on waste disposal presented at the Institute's Conference in October 1990, it was concluded that appropriate standards, especially with regard to landfill siting and design, are essential to long term environmental protection (Ball, 1991).

In South Africa, attention needs to be given to developing appropriate environmental epidemiological strategies for studying the potential health effects of mismanagement of solid waste. There is still much uncertainty as to the occurrence of significant environmental health effects and their magnitude. An increase in poverty-related diseases associated with rapid and uncontrolled urbanization is likely to occur in South Africa, especially in the informal peri-urban areas. These sectors of the population are already vulnerable in respect of their risks for nutrition and infectious diseases, and may be subject simultaneously to health hazards associated with poverty as well as with industrialization (Shrinking, 1991).

It is difficult to evaluate to what extent increased exposure to toxic wastes will have on public health in South Africa. At present many environmentally-related diseases go unrecognised and in many cases illnesses are not attributing to their actual causes. With so many others competing causes of death and ill-health in South Africa it will be very difficult

to detect a signal in the context of the present-day public health realities. Despite considerable uncertainty, the challenge will be to determine an acceptable level of risk for hazardous waste exposures, based on a policy of prudence (Shrinking, 1991).

2.5.1. Institutional Framework

In South Africa, responsibility for regulating industry's emissions, effluent, solid waste, and hazardous waste is governed by a myriad of separate laws pertaining to various aspects of their environmental impact (Whyte, 1995). The fragmented legislative framework results in a splintering of responsibility for environmental management. Responsibility for regulating and monitoring the industrial impact is divided among various national government departments as shows the table below.

Requiring Regulation	**Government department responsible**
Domestic and nonhazardous industrial wastes	Local authorities
Hazardous waste landfills	Water Affairs and Forestry
Transportation of hazardous substances	Health
Radioactive fuel cycle	Council for Nuclear Safety
Other radioactive materials	Health
Water Pollution	Water Affairs and Forestry Health
Mining Waste	Mineral and Energy Affairs
Noise Pollution	Local government
Occupational health and workplace safety	Labour
Waste on roads	Provincial administration

Table 2: Fragmented responsibilities for administering waste management (Source: Whyte, 1995)

A large number of separate pieces of legislation exist that regulate, directly or indirectly, waste and pollution management. Likewise, environmental laws and regulations are administered by a host of different government departments at different levels. There are

important areas of waste management for which legislation either does not exist or is not enforced (Whyte, 1995).

Key issues arising from the waste collection status quo from Municipalities in Gauteng (DEAT, 2009). The key issues identified, include the following:

- *No waste collection standards are currently being implemented within the municipalities, with the exception of the photometric standard in Johannesburg.*
- *Local By-laws or ordinances are currently the only "standard" that municipalities use for provision of services.*
- *At the local municipal level, these By-laws are either absent or outdated.*
- *The current definitions of waste terminology as well as the content of the definition need to be addressed to ensure continuity and uniformity of thinking and implementation.*
- *Waste collection systems have been designed around a number of factors including type of waste generated, access, transport distances, storage units, frequency of collection, health hazards, vehicle types, etc.*
- *The issue of a Basic Level of Service for waste collection needs to be clearly defined and the associated costs determined. Relating this to the equitable share component for waste has also proven difficult in the past.*

In addition, Municipalities in Gauteng indicated numerous problems related to service delivery. This includes:

- *Poor equipment and vehicle availability.*
- *Ageing waste management fleet.*
- *Problematic waste types such as building rubble placed in domestic containers causing breakages of vehicle compaction mechanisms.*
- *Insufficient manpower and human resources.*
- *Lack of political buy-in.*
- *Excessive illegal dumping.*
- *Servicing of informal settlements.*
- *Lack of By-law enforcement.*
- *Inefficient turnaround times.*
- *Increase in waste generation related to current resource deficiencies.*
- *Inadequate supervision on operations.*
- *Illiteracy of staff and lack of management skills.*
- *Poor productivity vs. human capability.*

- *Rapidly decreasing landfill space.*
- *Sporadic increase in informal settlements as well as intensive increase in formal housing developments.*
- *Municipal waste related functions are not ring-fenced.*
- *Health and Safety requirements according to the OHSA are not being adhered to*
- *Majority of rural areas remain without a service and these households have to manage their own waste*

2.5.2. Waste disposal and collection

Waste management and pollution control approaches in South Africa to date have, to a large extent, relied on the assimilative capacity of the environment to ultimately dispose of (nonhazardous) waste. In this approach, pollutants are dispersed and diluted in the air, water, and soil up to the level of pollution concentration that is deemed acceptable. In other words, the concentration of pollutants in the natural environment does not exceed a specified maximum permissible level. The problem is that the scientific basis for arriving at that level may be inadequate and local conditions can make permissible levels too high (Whyte, 1995).

Most South African citizens do not have access to waste collection (Department of Environmental Affairs and Tourism Action Plan General Waste Collection, 1999). Moreover, where waste collection services do exist, the standards are unacceptably poor (Ibid). The improvement of waste collection throughout the country needs urgent attention. The National Waste Management Strategy (NWMS) identifies waste collection as a priority. South African charges for waste disposal tend to be much lower than in other countries. With regard to hazardous waste, the charges are higher and reflect the costs of handling, treatment and any potential remediation that may be necessary (Department of Environmental Affairs and Tourism Action Plan General Waste Collection, 1999). Generally the charges in South Africa are directed at covering the cost for the provision of the service. In most municipalities this is put out to tender to private sector operators. Often waste removal is not charged for separately, but is financed through property taxes. Where houses are charged directly some of the criteria are flat rates, household income brackets

or plot size. There is not necessarily any direct relationship between these factors and the charges and the weight or quantity of waste that is disposed of (Department of Environmental Affairs and Tourism Action Plan General Waste Collection, 1999).

2.5.3. Illegal Dumping

Another problem that is facing South Africa in terms of addressing solid waste management is the illegal dumping of waste in open areas. It is not unusual to see beverage cans, cigarette packets, fast food packaging and other waste on streets and in public areas in South Africa (Menell, 2004). There is general apathy towards littering and illegal dumping and a drastic shift in the public mindset is needed in order to change this. Not only is illegal dumping unsightly but it also creates a health hazard and deprives communities of space that could otherwise be used for recreation. Illegal disposal results in high social costs because contamination of water resources, the spread of disease, litter and aesthetic deterioration are all problems resulting from illegal disposal (Menell, 2004). Accordingly, the financial costs of cleaning up illegal dumping exceed hundreds of millions of Rand each year. There are, however, ways to prevent and manage illegal disposal, for example education campaigns, enforcement efforts, positive rewards for legal disposal, careful design of variable rates and free collection of certain hazardous wastes or large appliances would all assist in keeping it down to a minimum (Menell, 2004).

2.5.4. Landfilling

One of the major concerns for South Africa in terms of waste management is the lack of space for landfills. Waste disposal sites, especially those containing hazardous, medical, and veterinarian waste, may result in land pollution problems. Some of the problems associated with waste disposal include the poor design, location and/or inadequate management of many of the disposal sites, leachate, illegal waste disposal sites, a lack of suitable hazardous waste disposal sites and poor town planning. A further problem arises from pickers at landfill sites, who disrupt operations and may be exposed to hazardous waste (White Paper on Integrated Waste Management, 2000).

Department of Environmental Affairs and Tourism, (1999) has admitted that 119 of South Africa's 629 known illegal landfills are in the Eastern Cape. The illegal landfills are a danger to residents. Most residents are unaware that they are living on hazardous landfills that can cause life-threatening health problems such as cancer and birth defects. Most townships have a pit where rubbish is dumped and most sites do not have the required lining to prevent toxic leachate from decomposing refuse leaking into rivers and underground water source (White Paper on Integrated Waste Management, 2000).

2.5.5. Moving toward sustainability

From Whyte, (1995) viewpoints, the most important policy issue is how to reverse decades of economic development and industrial growth in South Africa that are largely unsustainable because they have generally proceeded without the necessary environmental safeguards. Whyte, (1995) adds that too often, in situations of conflict, the environment has lost out. The burden of proof has usually been on those arguing that a particular discharge causes damage, instead of on those arguing that it does not. The tendency has also been to underrate the potential hazard associated with waste and pollution (Whyte, 1995). Accordingly, reversing this trend by adopting the Precautionary Principle in decision-making processes and conflict situations would shift the system toward greater respect for a healthy environment and more balanced interplay between development and the environment. The Precautionary Principle essentially suggests that, in case of doubt, it is prudent to err on the side of environmental quality and safety. Experience from other countries suggests that it makes economic, as well as environmental, sense to practice waste prevention and resource recovery from waste (Whyte, 1995).

2.5.6. Management of household waste

In South Africa, the question of government policy regarding household waste presents a different set of issues. The key problem is one of huge and widely dispersed volumes of

low-toxicity waste rather than small volumes of dangerous waste. Households are important sources of emissions, effluents, and solid waste (Whyte, 1995).

According to Whyte, (1995) the household solid waste management problem depends on socioeconomic conditions. Further, among the richer white segments, the underlying issue has been overconsumption and associated waste generation, such as from the packaging materials used for consumer goods. Whyte, (1995) adds that appropriate strategies are needed to provide incentives for household members to reduce and minimize waste, as well as to separate waste streams for easier collection and recycling. Financial incentives, such as increasing charges for waste collection, can be a very effective way of inducing households and industry to generate less waste, and to put pressure on producers of consumer goods to reduce the amount of packaging materials and to use degradable or recyclable materials (Whyte, 1995).

A review of waste management trends and practices in other similar developing countries indicates that many of them are looking towards innovative solutions to the problems of inadequate and inefficient services provided by government authorities. Numerous examples of the involvement of the private sector in service delivery, the informal sector in waste recovery and private individuals in recycling and composting initiatives, points to the realisation that an effective service can be provided at reasonable cost whilst at the same time providing job creation opportunities and alleviating poverty (Karana and Jewasikiewitz, 2007). Importantly, reference must be made to basic waste management systems, the waste management hierarchy (WMH), appropriate priorities and sustainability of the services rendered, the Principles of ‘‘Proximity’’ and ‘‘Regional Self Sufficiency’’, and the ‘‘Best Practical Environmental Option (Karani and Jewasikiewitz, 2007).

2.5.7. Conclusion

This chapter has reviewed the literature on sustainable cities, issues of solid waste management, drawing from international and local (South Africa) level perspectives. The analysis and the discussions of various approaches with respect to solid waste or mismanagement of solid waste have demonstrated that any solid material that is thrown away or discarded as useless and unwanted is considered to be solid waste. Municipal solid waste is always generated in cities, towns, and villages. At first glance, the disposal of solid waste may appear to be a simple and mundane problem. There is no question that improper disposal of solid waste can cause serious environmental or ecological damage. Air pollution can result from inadequate solid waste incineration, and soil contamination, as well as surface water and groundwater pollution, can be caused by the disposal of solid waste in improperly built landfill. This kind of pollution can lead to a variety of diseases in humans, thereby threatening public health.

There is another connection between improper solid waste disposal and public health. Solid waste can dock rodents and insects, which may act as vectors of infectious diseases such as typhoid, plague, and dysentery. In addition, waste deposited in open dumps causes a variety of nuisances, including odours, fire hazards, and windblown debris. Solid waste disposal in open dumps is no longer an acceptable practice in the United States and in other developed countries, where modern waste disposal methods are designed to prevent the spread of disease and protect environmental quality. But transmission of diseases due to improper waste disposal remains a problem in some areas, particularly in developing countries.

Obviously, problems related to solid waste go beyond merely their proper disposal. In addition to many technical and environmental difficulties, administrative, economic, and political problems must be solved. The effort to address all these problems is usually referred to as the practice of solid waste management. In this context, management encompasses the planning, design, financing, construction, and operation of facilities for

the collecting, transporting, processing, recycling, and final disposal of the residual solid waste material. These elements must be well implemented in order to minimise all environmental and health risks associated with the management of solid waste. The following chapter focuses on Johannesburg, the case study area of the research.

CHAPTER THREE:

JOHANNESBURG, CASE STUDY DESCRIPTION

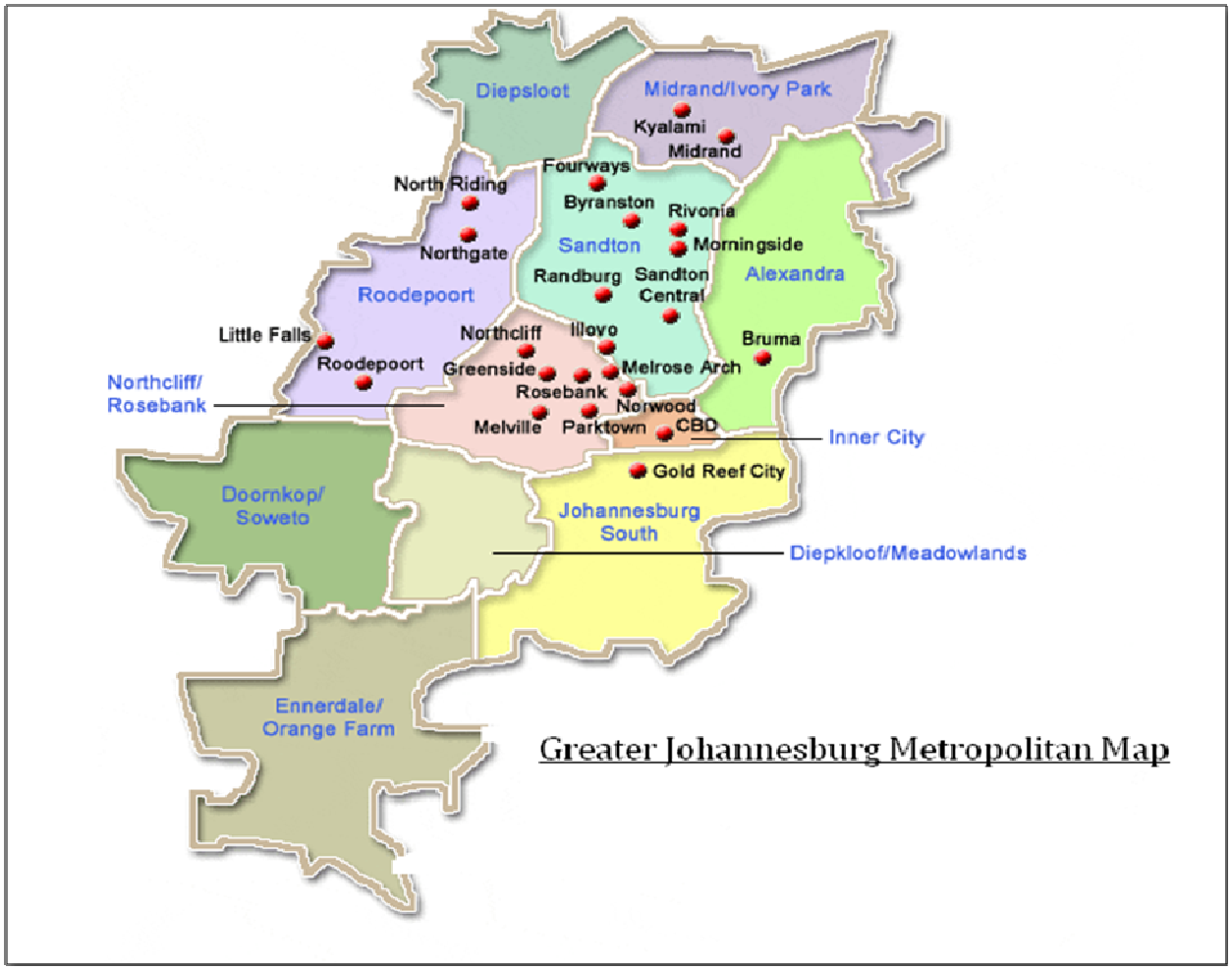
3.1. Introduction

Apartheid in South Africa was built on spatial divisions; separateness was literally taken to mean that whites and blacks were to live apart from each other. In post-apartheid Johannesburg, spatial divisions still exist, though they are no longer based solely on racial differences. In turn, these spatial divisions reinforce existing structures of privilege as they did under apartheid and make it difficult to create a just, democratic, and egalitarian society (Tomlinson, Beauregard, Bremner and Mangcu, 2003). Segregation can also be said to pertain to solid waste management. In this respect, Onibokun, (1999) demonstrates that before the Greater Johannesburg Transitional Metropolitan Council was established, each racially structured local authority in the Greater Johannesburg area had its own system for solid waste management in line with national policy, under apartheid. During this time, garbage was collected only for a portion of the population. The other segments of the population did not benefit from the service of waste collection, especially people of colour (Ibid).

Against this background, this chapter focuses on Johannesburg. The first section provides background information on the commercial hub of South Africa. The section attempts to situate the city in terms of its physical environment. This is followed with a description of the governance structure, historical background, demographic information and the waste collection information. The second section examines the issues of solid waste management in Johannesburg. The third section investigates the impact of mismanagement of solid waste on the environment as well as on human health. The last section provides background information on Windsor-Randburg area, which is the place where research interviews were conducted.

3.2. Background Information on Johannesburg

Johannesburg represents the central urban area in the Gauteng, situated adjacent to the City of Tshwane on the northern border and Ekurhuleni on the east. Local municipalities Mogale City, Randfontein and Westonaria are located to the west, while Emfuleni and Midvaal lie to the south (City of Johannesburg Integrated Development Plan Paper 2005/6). Some 1 753m above sea level, covering 1 620 square kilometers, the City of Johannesburg (CoJ) is neither adjacent to a coastline nor a major river - an unusual situation for a large city, but one which can be attributed to the city's rapid rise given its gold-rush history. Despite the absence of a major natural landmark, the CoJ has a very attractive, mild climate for residents (Ibid). Map below shows the Greater Johannesburg urban areas.



***Map** 1: Map of Greater Johannesburg Metropolitan showing its urban areas, (source: Johannesburg, 2010).*

3.2.1. Structure of City Governance

Unlike many African cities, Johannesburg has a democratic, representative, proactive and interventionist governance structure focused on efficiency, delivery and strategic planning. The Johannesburg 'unicity' is under the political control of an elected ANC (African National Congress) executive mayor and ANC-dominated 'mayoral committee' (Balbo, 2005). The city also has a professional administration under a city manager who is responsible for all administrative and planning functions. The manager's office includes a Corporate Planning Unit (CPU) responsible for developing an integrated medium-term City Development Plan (CDP) and a coherent long-term City Development Strategy for the city of Johannesburg. The city is divided into seven administrative districts ('regions' as shown in map1), each with their own management structures (Balbo, 2005).

3.2.2. Historical Background

The history of Johannesburg reveals that in the long decades of grand apartheid, there was a single (one official) Johannesburg municipality. However, its white population understood it to be theirs and the black population could neither escape nor significantly change the city's role in their lives (Tomlinson, Beauregard, Bremner and Mangcu, 2003). A minority of the white population disagreed with the conception of whites being the sole owners of the city. However, after the 1994 post-apartheid democratic South Africa, love crossed racial divides, blacks made homes in white areas, and white liberals openly voiced their criticism of the unjust former apartheid regime (Tomlinson, Beauregard, Bremner and Mangcu, 2003). Nonetheless, only a few people managed to elude the control of an authoritarian state. The spaces of South Africa had to be clearly and precisely defined. At the commanding heights of apartheid, the truth was widely known if not universally shared. There was a single (one official) Johannesburg, all others were hidden or suppressed (Tomlinson, Beauregard, Bremner and Mangcu, 2003).

Tomlinson et al., (2003) argue that with the election of Nelson Mandela as the country's President in 1994, the final dissolution of grand apartheid began in earnest and the nation embraced a non racial democracy. Moreover, Tomlinson et al., (2003) report that with the extension of civil, political, and social rights to those who had been apartheid's main victims, the bindings that had held multiracialism, tribal affiliations, and class divisions in check were removed. Accordingly, a multiplicity of Johannesburg's came into being. The process of rethinking Johannesburg, of course, was underway prior to 1994. As far back as the early 1980s, with reforms weakening the apartheid state, it seemed possible to remake the city. Tomlinson et al., (2003) add that with non-racial democracy came the extension of rights and a greater sense of belonging for the majority black population.

Further, within ten years of its origins, Johannesburg was the biggest city in the country and was recognized as the largest and most densely populated city in South Africa (Chipkin, 1993). A building boom prior to the turn of the century and an economic expansion following the Boer War (1899-1902) between the British and Afrikaners resulted in a rapid increase in population. Chipkin, (1993:93) draws "that the latter expansion also produced a consolidation of the gold mining industry and the creation of the city's financial district". Chipkin, (1993) relates that during the 1930s depression, the gold standard was abandoned and this led to another surge in investment. However, by 1990 successive waves of economic activity, corresponding largely to the booms and slumps of gold mining produced a city housing the headquarters of most of the country's largest corporations, including the Johannesburg Stock Exchange, and the National Reserve Bank (Chipkin, 1993).

Chipkin, (1993) asserts that the city's most enduring economic upswing emerged out of crisis. On March 21, 1960, in a black township "Soweto" 75 kilometres to the south of the city, police fired on a peaceful crowd protesting the pass laws. Thus, the government responded with draconian measures. Chipkin, (1993:250) reports "that in 1962, the economic situation had been dramatically reversed. Growth reached 9% per annum in

1963. The South African economic miracle, which was to last for a decade, was underway". Johannesburg was booming. Foreign capital flooded into the city and the Johannesburg stock market recorded many new listings, acquisitions, and mergers. Tower blocks mushroomed in the downtown area (Chipkin, 1993).

3.2.3. Demographic information

One form of pressure on the environment would be continued population growth, whether the growth is natural, as a result of migration or as a result of urban sprawl. Migration is one of the key factors that exert pressures at metropolitan level including on service delivery and state of the social/physical environment (City of Johannesburg, 2008). Migration from rural to urban areas of Johannesburg is driven by the belief that the city of Johannesburg is a centre of employment, social interaction, education and prosperity. The anonymity that a large city such as Johannesburg offers also facilitates people's escape from discrimination and exploitation that is often experienced in smaller rural towns (City of Johannesburg, 2008).

The city of Johannesburg occupies 9, 7% of the land surface of Gauteng. More than two thirds of the total of Gauteng resides in Johannesburg (35, 1% in 2001, increasing to 37, 2% in 2007). The city of Johannesburg also accounts for a third of all the households in Gauteng (36, 8% in 2001 and 36, 7% in 2007) (City of Johannesburg, 2008).

In 2007, the city of Johannesburg was home to close on 3, 9 million people. When compared to 2001, this translates to an average population growth rate of approximately 20, 5%. The city's population is therefore expanding at an average rate of 110 480 people per annum. The population density is high at approximately 2 363, 6 persons per km2. However, it should be noted that known high density areas such as Alexandra and Soweto might skew this data, whereas previously known 'white areas' are known to have lower population densities (City of Johannesburg, 2008).

3.2.4. Overview of Solid Waste Management in Johannesburg

In Johannesburg, the legacy of apartheid policies was a highly uneven distribution of resources for the delivery of solid-waste services. This reflected the general inequality of service provision under the apartheid system as a whole (Swilling and Hutt, 1999). Given the overall political context, this was reflected in massive differences in the quality of service between white and black areas, which in turn, were a cause of the sustained rent and service-charge boycotts that social movements mounted. By the time the GJTMC took over solid-waste management, payment for service had still not been made despite calls by local community and political leaders to resume payment (Swilling and Hutt, 1999).

In line with the *Local Government Transition Act* and the agreement negotiated in the Central Witwatersrand Metropolitan Chamber, responsibility for all the solid-waste departments was transferred from the disbanded local authorities to the GJTMC. A joint administrative structure was established in January 1995 comprising department heads, which were charged with responsibility for keeping service provision going until the entire sector could be transformed (Swilling and Hutt, 1999).

3.2.4.1. Refuse collection method

Swilling and Hutt, (1999) reported that every service point in the formal housing areas in the former black townships and white suburbs was issued a standardized bin, and generally each week every property was issued two refuse bags per bin when the full bags were collected. Although, in some areas, collection was less frequent because of capacity problems. This system was generally used throughout the metropolitan region and each area was serviced on a particular day on a regular basis.

In addition, solid waste services in greater Soweto, Randburg, Sandton, Ennerdale, and Alexandra were similar to those provided in the former white areas of Johannesburg. In Soweto, Diepmeadow, Randburg, Sandton, and Ennerdale, the supply of refuse bags to the service user was problematic as these areas did not have the staff infrastructure to deliver

the refuse bags on a weekly basis (Swilling and Hutt, 1999). Allocation of Resources for Waste Management in the Johannesburg Unicity, 2000 is presented in the table below.

Region	**Population**	**Staff: Residents Ratio**	**Budget: Resident Ratio (R per person per annum)**
Diepsloot	45,000	1:228	n/a
Midrand/ Ivory Park	500,000	n/a	n/a
Sandton/ Rosebank	208,000	1:941	100
Northcliff	216,000	1:977	90
Roodeport	225,000	1:709	115
Doornkop/ Soweto	1,100,000 (combined with Diepkloof/Meadowlands)	1:1,450	54
Alexandra	395,000	1:1,204	58
Inner City	180,000	1:549	128
Johannes-burg South	200,000	1:610	115
Diepkloof/ Meadowlands	See Doornkop/Soweto	1:2,000	31
Ennerdale/ Orange Farm	270,000	1:2,842	n/a

Table 3: *Allocation of Resources for Waste Management in the Johannesburg Unicity*

Source: Author's elaboration from GJMC population statistics and 1999-2001 Budget.

Disparities were accentuated by differences in technologies and materials for refuse collection. Residents of the wealthier northern suburbs generally used 85- or 240-litre sealed and wheeled litter bins, which were loaded onto compactor trucks and removed at

once. Conversely, nearly 600 000 people living in informal settlements are generally serviced by 5.5 cubic meter open skip containers located every 200 stands, given that containers were not closed and that lost waste was thrown into them. This constitutes a significant health and environmental hazard which is amplified by insects and rodents attracted by unsealed waste (GJMC, 1999a).

3.2.4.2. Current Institutional Arrangements

Pikitup is responsible for all solid waste management in Johannesburg. Pikitup is a private company, which operates as a municipal entity as its shares are wholly owned by the City of Johannesburg, and renders waste management services within the city in terms of a service delivery agreement entered into with the city of Johannesburg metropolitan municipality (Pikitup, Johannesburg, 2007). It was privatized in 2001 in order to make it more independent and hence more businesslike in its operations. It has also been allowed to set its user fees in order to recover all its costs (Samson, 2008).

Pikitup services mainly domestic households (approx. 658 000), for which it derives the majority (78%) of its income of approximately R700 million per annum (2005/06) as a service fee to the City of Johannesburg. It also renders services to businesses (approx 14 000 customers), for the collection of everyday, bulk container services and the rental of bins, as well as landfill fees (2% of income) (Pikitup, Johannesburg, 2007).

The Pikitup operations include the operation of a vehicle fleet of 550 vehicles and plant (of which approx. 430 vehicles are on a full maintenance lease), the management of 5 landfill sites, some 50 garden sites, a composting plant, an incineration plant and other related infrastructure (Pikitup, Johannesburg, 2007). The area for which Pikitup is responsible, being the metropolitan municipal area of the city of Johannesburg, is serviced by eleven depots of Pikitup, which currently dispose of most of the waste at the five landfill sites which still have remaining airspace (Robinson Deep, Marie Louise, Goudkoppies, Ennerdale and Linbro Park) (Ibid).

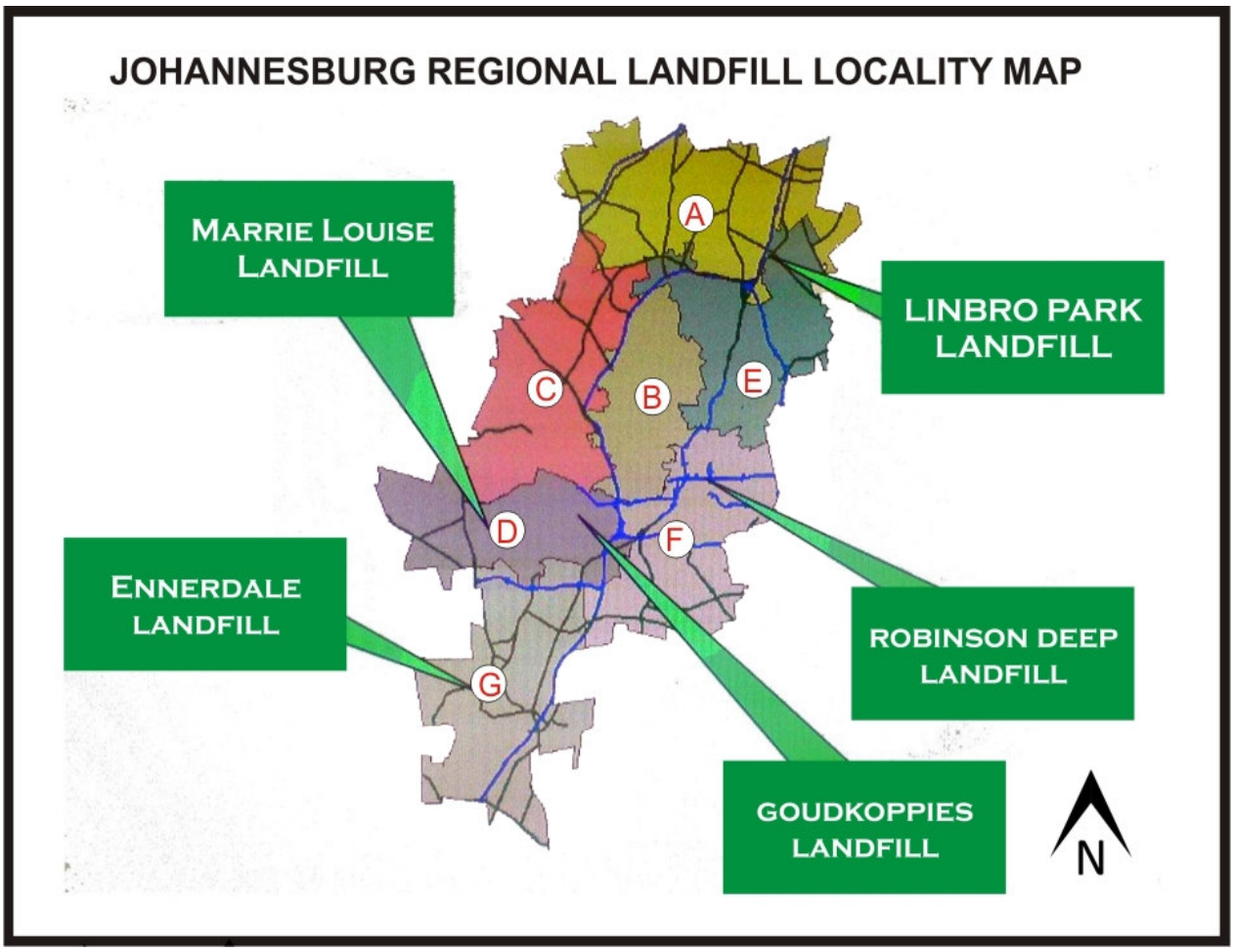
According to Samson, (2008) South Africa had followed an 'end of pipe' waste management philosophy that resulted in a small percentage of waste being recycled, with the remaining bulk of the waste stream being disposed of at landfill sites. With urban real estate at a premium, and the natural resource base under growing pressure, a new national waste management strategy was needed and formulated. Photo below shows the manner in which Pikitup as a company collects waste generated in greater Johannesburg.



Photo 1*: waste collection By pikitup. Source: (City of Johannesburg, 2009)*

The collection of waste as shown on the above picture is facilitated by companies such as Pikitup, which have also formulated and commenced the implementation of its own sustainable integrated waste management strategies to turn Johannesburg into one of the cleanest cities in the world (City of Johannesburg, 2009). However, Pikitup itself has not

been without its challenges. Map below shows the landfill sites where Pikitup disposes the waste produces by the city of Johannesburg.



***Map2**: Map showing Johannesburg Regional Landfill Locality (Source: City of Johannesburg, 2007).*

In light of the above map, it can be said that creating and operating a landfill is a complicated process. It requires in-depth study of the geology of the site, the effect on and proximity of the land to residents, the depth of the water table in the area and the existence of available infrastructure (City of Johannesburg, 2007). It is stated that all landfill sites are managed within the context of the legislative requirements imposed by the Department of Water Affairs and Forestry (City of Johannesburg, 2007). There are five fully operational

landfills, of which Robinson Deep, Marie Louise, Goudkoppies, Linbro Park and Ennerdal. Picture below shows the case of Robinson deep, which is one of the higher density Landfill sites in Johannesburg.



Photo 2: *Photo showing the higher density landfill of Robinson Deep. Source: (City of Johannesburg, 2007).*

So, with regard to illegal dumping, it is probably the bane in the lives of all waste managers. An estimation of illegal dumping collected by the ten depots by 2003 was approximately 247000 tonnes per annum (TPA) (Pikitup/Johannesburg, 2007). The more recent figures indicate that illegal dumping has come down to approximately 196000 tonnes per annum, with the majority of it occurring in Roodepoort and Avalon depots, each approximately 42000 tonnes per annum (Pikitup/Johannesburg, 2007). Pikitup has in the past successfully managed the 100 Spots campaign, in especially Soweto to focus on the most

prolific illegal dumping Spots (Pikitup/Johannesburg, 2007). However, in the business plan of 2006/2007, it is "estimated that there are still at least 2746 illegal dumping sites in Johannesburg, contributing approximately 195000 tonnes per annum to the collection efforts. It is also apparent from the business plan that the collection of illegally dumped waste costs Pikitup approx. R52, 3 million per year, or approx. R270 per tonne. As a comparison, Pikitup charges customers approx. R90 per tonne for disposal at a landfill (Pikitup Johannesburg, 2007)".

Yet, the fees earned at landfills is approximately R12 million per annum. It therefore seems that there is an opportunity, by using appropriate pricing, coupled with clear communication, to produce incentives for customers to dispose of otherwise illegally-dumped building rubble and general waste at landfill sites or other waste processing facilities (Pikitup Johannesburg, 2007). Some thoughts that come to mind are the scrapping of landfill fees, and rather paying customers for delivery of waste to specific waste processing facilities. These problems of illegal dumping leads us in a position in which we are required to examine the problem encountered in dealing with solid waste management in Johannesburg.

3.3. The Solid Waste Management Problem in Johannesburg

The present section examines various problems encountered in dealing with solid waste management in Johannesburg. According to Rogerson, (2001) solid waste and its management have been receiving fresh attention from academics and development practitioners. So, during the 1990s the management of solid waste had re-surfaced as a key element in debates surrounding sustainable urban development in the potential of the informal economy in waste management (Ibid).

According to the City of Johannesburg, (2003) solid waste management has major impacts on the city. This includes impacts on land, water, health and the aesthetic appeal of the city. Efforts have been put in place to address past imbalances in waste services provision in the

city of Johannesburg. Despite these efforts, the City of Johannesburg, (2003) reports "that many households within urban low-income areas in the city of Johannesburg have no adequate solid waste removal, with a considerable number enjoying less than a weekly service". Although poor performance in the recent past is not necessarily cause for alarm in terms of future service provision, serious attention must be paid to correcting the situation. The population affected in terms of solid waste mismanagement is thus without access to regular refuse removal services.

There are poorly designed waste management procedures; uncontrolled littering and dumping within the city of Johannesburg, which exacerbate the problem, increase costs of water treatment and add to levels of pollution in rivers (City of Johannesburg, 2003). In addition, the factors that contribute to the contamination and degradation of the Jukskei and Klip rivers are urbanization and population growth; dysfunctional sewage systems result in the contamination of the river systems by raw sewage; mining particulate matter discharges into rivers and watercourses, including uncontrolled industrial activities. This could result in discharges to storm water drains (City of Johannesburg, 2003). Consequently, the contamination of these rivers presents major health risks to the public and creates a poor perception about the city, which results in the loss of tourism, investment as well as aquatic life and amenity value of rivers.

Common issues at landfill sites include inadequate access control, inadequate drainage and liner design, and the practice of informal salvaging. These problems need to be addressed in the interest of health, safety and environmental protection (City of Johannesburg, 2003). Further, it is important to deal with issues relating to the numerous disused and closed landfills, and to ensure that future planning regarding the closure of landfills is properly undertaken. Particular attention should be given to environmental compliance aspects (City of Johannesburg, 2003). Inadequate levels of service in certain areas, past practices, cost avoidance by industries and the lack of awareness and enforcement results in high levels of illegal dumping and littering. This not only causes degradation of open spaces and

watercourses in particular, but also places a huge cost burden on the city, as litter disposal costs significantly outweigh waste disposal costs (Ibid).

Key issues that are facing the city of Johannesburg in terms of addressing solid waste are diverse, notably lack of waste information collection, capturing and recording systems. Moreover, "there is a lack of reporting requirements, information management and dissemination systems as well as unwillingness of the private sector to provide information (City of Johannesburg, 2005)". Additionally, there is a lack of appropriate waste collection systems for low income and high density areas in the city. Yet, there is inflexibility of current waste collection systems to collect separated waste for recycling. The City of Johannesburg, (2005) reports that poor payments and illegal dumping occurred in Johannesburg, as well as lack of collection services for green and garden waste. Insufficient composting facilities and lack of waste education and awareness represent major issues in Johannesburg. There are also insufficient disposal facilities and airspace as well as co-disposal general hazardous waste, green and garden waste with domestic waste (City of Johannesburg, 2005). Existing landfill sites have not been rehabilitated in accordance with the Department of Water Affairs requirements (Ibid). Unofficial dumping sites appear in Johannesburg and insufficient handling and disposal of medical waste. There is also historical illegally closed dumpsites and shortage of skills and expertise in council and finally, inadequate education and awareness on waste management issues in Johannesburg (City of Johannesburg, 2005).

According to Hall, (1996) the most common sources of litter in greater Johannesburg are the following: The anti-social behaviour of individuals in dropping litter on footpaths, throwing it from vehicles, and dumping household wastes; excessive packaging; the failure of street sweeping services to rid pavements and public areas of litter; inadequate disposal facilities, including a breakdown in litter collection practices or the provision of inappropriate bins. Open bins and collection vehicles may provide an opportunity for litter to be blown into the public domain; the failure by the authorities to enforce effective

penalties to act as a deterrent to offenders; it is obvious that litter is a problem associated with human habitation. It is also obvious that, to a point, the problem rapidly increases with population density and level of development (Hall, 1996).

Some other scholars contend that, there is a large quantity of urban litter (alternatively called trash, debris, flotsam, jetsam, rubbish or solid waste) in Johannesburg that is so often to be seen strewn about in public places, especially in Soweto, Alexandra (Armitage and Rooseboom, 2000). The litter, consisting mainly of manufactured materials such as, cans, plastic and paper wrappings, newspapers, shopping bags, and cigarette packets - but also including items such as used car parts, rubble from construction sites, and old mattresses - accumulates in the vicinity of shopping centres, car parks, fast food outlets, railway and bus stations, roads, schools, public parks and gardens, garbage bins, landfill sites and recycling depots. There it remains until it is either removed by the local authority, or it is transported by the wind and/or stormwater runoff into the drainage system (Armitage and Rooseboom, 2000).

The existence of such litter in the city has a number of impacts: Litter is aesthetically unattractive. There is a potential health hazard to humans associated with, for example, the putrefying contents of bottles and tins, or pathogenic organisms attached to discarded hypodermic needles. Aquatic fauna are at risk of becoming entangled in, or suffocating from, litter ingested in the course of their search for food. Pathogenic organisms or toxins, for example heavy metals, may be taken into the food chain poisoning aquatic life and possibly later impacting on humans. Significant costs are incurred by local authorities in conducting clean-up operations (Armitage and Rooseboom, 2000). The Table below analyses the strengths, weaknesses, opportunities and threats of solid waste management in greater Johannesburg.

Strengths	Weaknesses
• Disposal of solid waste in landfill sites is the most convenient method of waste disposal • GJM has land available for the development of future landfill sites • The climate of GJ ensures that landfill sites are not permanently saturated with rain water • The geology of GJ ensures that landfill sites can be constructed in areas where the water table is sufficiently low	• It is difficult to locate landfill sites close to waste sources • Illegal dumping is rife in many parts of GJM • Formal collection is absent in many areas • Transport distances result in high costs of waste removal • Insufficient recycling programmes and drop off points • Minimum requirements for landfill limit the scope in the location of landfill sites • Poor management of landfill sites has resulted in windblown litter and odours • Landfill sites result in ground water pollution (due to leachate) and surface water pollution (due to surface run-off) • Many of GJ's landfill sites are over utilised • Landfill sites have a negative impact on visibility • Impacts on health include odours, water pollution related diseases and pests such as flies and rats • The non-payment of rates and taxes makes it difficult to supply services to certain areas

Opportunities	Threats
Sustainable recycling programmes will help to reduce the amount of waste required to be disposed of by landfill Practical and creative reuse of landfill sites after rehabilitation and closure e.g. parks, recreation Well planned densification of the city will make waste management more efficient	Rapid population increases will result in the breakdown in success of current waste management practices and place pressure on existing non-hazardous waste disposal sites Unplanned densification within the existing metropolitan boundaries will also place pressure on existing waste management Decreasing waste management budgets and increasing costs will decrease the efficiency of waste management practices "Not in my back yard" attitudes will make it increasingly more difficult to develop waste disposal sites The continued non-payment of rates and taxes will exacerbate existing service provision Urban sprawl will increase the cost of collecting waste and will place pressure on the capacity and management of existing disposal sites

Table 4: *Strengths, Weaknesses, Opportunities and Threats of Solid Waste Management in Greater Johannesburg (Walmsley, 1997).*

To protect the environment, everyone must do their best by making a contribution to living lightly on the planet. Reducing the amount of waste we produce means that less ends up in already overflowing landfills; it reduces the need for new raw materials, and so to helps to preserve the environment from destructive processes. Less waste means less pollution and reducing waste can save money. The section below focuses on the effects of poor

management of solid waste on the environment as well as on human health in Johannesburg.

3.4. The Impact of Mismanagement of Solid Waste on the Environment and on human Health in Johannesburg

In this chapter, the first section provided background information on Johannesburg; the second section dealt with the issues of solid waste management in Johannesburg, and then the current section attempts to investigate the impact of poor management of solid waste on the environment as well as on human health in Johannesburg.

3.4.1. Environmental Concerns

With respect to Johannesburg's state of the environment, air pollution which is the transfer of harmful amounts of natural and synthetic materials into the atmosphere as a direct or indirect action of human activity, in Greater Johannesburg differs according to area, with the worst affected areas being informal settlements. Economic activities that produce waste affect air quality in Johannesburg. Which economic activities introduce pollutants into the atmosphere that pose threats to human health and other life forms on earth (Fuggle and Rabie, 1992).

However, the major areas of concern are high levels of smoke and other pollutants in the poorer urban and informal settlements of Johannesburg without electricity. Therefore, the poor management of solid waste within these areas may negatively impact on air quality standards (Environmental Management Policy for South Africa, 1998). Furthermore, there is also the concern of water pollution with respect to mismanagement of solid waste on the environment. The dense population, along with the growing industries in Johannesburg impacts negatively on the quality of the water (Ibid). Consequently, the Jukskei River is likely to be one of the most rivers affected in South Africa as a whole and Johannesburg in particular (Eastern Metropolitan Local Council, 1997). In this regard, possibly the most serious related water problem is that of blocked and leaking sewers in Soweto and some

parts of Johannesburg' CBDs. The pollution of underground water is resulting from on site sanitation systems, leaking sewerage pipes, bacteriological and chemical water quality including poorly managed landfill sites in the city of Johannesburg (City of Johannesburg, 2000).

There is also the concern of land pollution with respect to the impact of mismanagement of solid waste on the environment. This is due to overcrowding of Johannesburg that causes exploitation of land beyond its capacity and leads to land pollution. This exceeds the capacity of sewer systems and landfill sites (City of Johannesburg, 2000). Sewage problems mainly exist in large parts of Alexandra and Soweto townships. To the South and Southwest of Johannesburg, dust pollution from mine dumps are the main sources of environmental degradation, whilst the CBD experiences continuous overflowing of sewers, basically in Hillbrow, Newtown and Jeppestown (Ibid). All these activities reduce the quality of the environment. The main sources of land pollution were identified as informal settlements, waste disposal sites, mining activities and other activities in the CBD (City of Johannesburg, 2000).

3.4.1.1. Mining Activities

Johannesburg City has its roots in gold mining. The consequential legacy is a proliferation of mine tailings in a broad belt spanning the South of the CBD and abutting the residential areas to the South (City of Johannesburg, 2009). Whilst relatively less mining is taking place now than in the past, older mine dumps are being reworked and shifted as the gold price and technology make this process viable. However, natural decomposition of the iron pyrites contents of these tailings leads to acidic leachate contamination of the area's surface water (City of Johannesburg, 2009).

According to the City of Johannesburg, (2009) dust from the mine dumping, another environmental pressure, faces local communities, specifically in situations where no or inadequate mitigation measures have been applied to tailing services. With the improvement in extraction technology, many of the mine tailings have been and are being

reprocessed for its residual gold content. Consequently, exposed land may become available for development where there are no shallow mines or where radioactive contaminated soil is not a mitigating factor (City of Johannesburg, 2009).

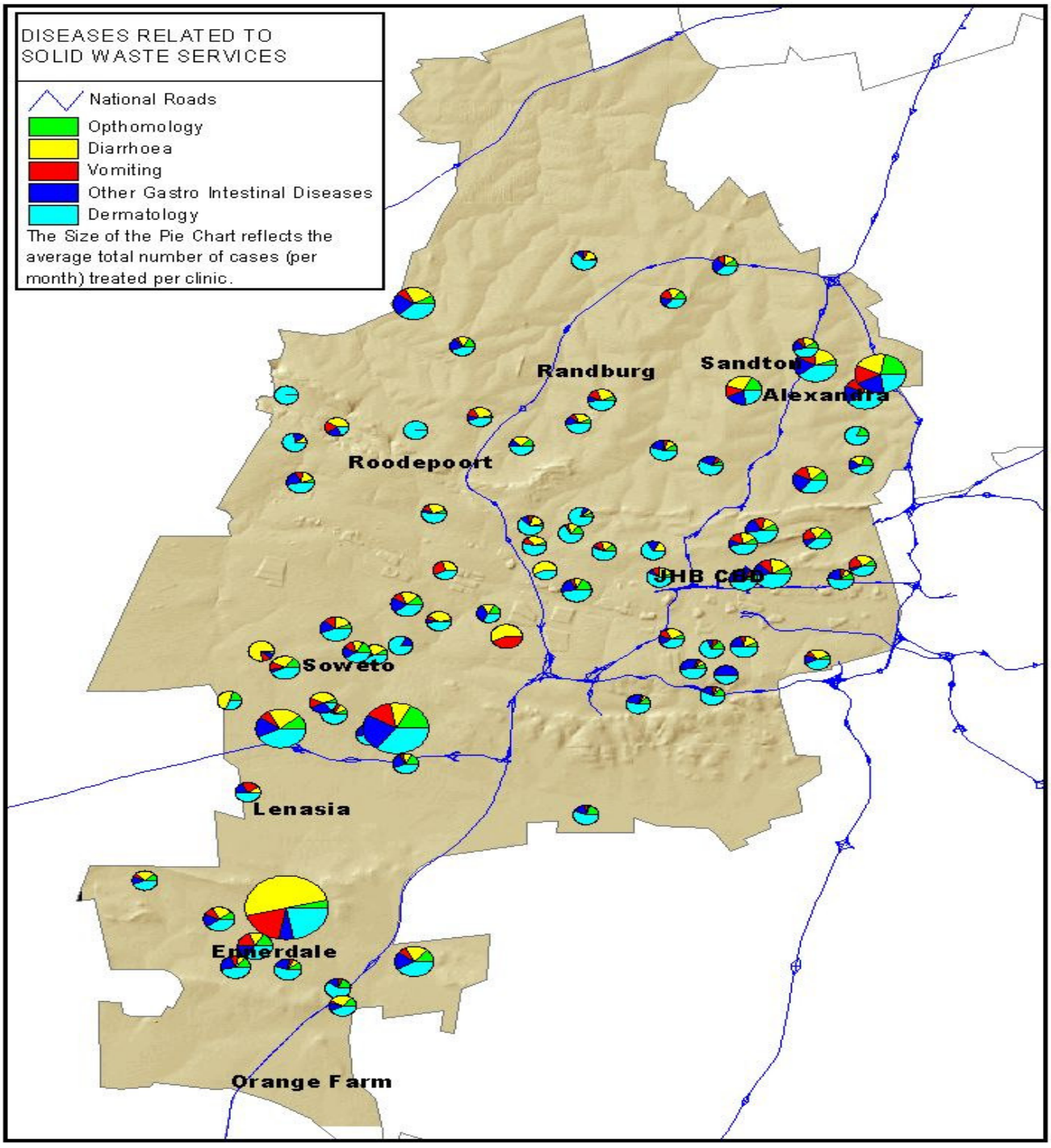
3.4.2. Human Health Concerns

Health surveillance which concerns the identification, monitoring and evaluation of human health risks and hazards, and instituting remedial and preventive measures are necessary because the poor management of the amount of wastes we produce affects negatively the health of human well-being (City of Johannesburg, 2010). Further, waste pickers' health can be in danger, especially during the processes of managing this waste. The control of vectors, such as rodents, pests and insects, their habitats and breeding places and instituting remedial as well as preventive measures is important. Surveillance and prevention of communicable diseases related to poor management of solid waste entails investigating all food and water-related outbreaks of disease and health and hygiene promotion of all environmentally induced diseases. It does not include immunisation. Water quality management entails monitoring and sampling to ensure safe drinking and recreational water. Waste management refers to monitoring waste storage on site and the safe disposal thereof, and includes medical and hazardous waste (City of Johannesburg, 2010).

However, an increase in environmental health-related diseases appeared as a result of inadequate waste management services annum (City of Johannesburg, 2003). The inappropriate storage and disposal of organic waste attracts rodents and insects, which may increase the frequency of gastro-intestinal and parasitic diseases. One of the most frequent environmental health complaints from the Alexandra area is related to mice, rats and bedbug infestations. It is calculated that the cost of health expenditure related to poor waste management is estimated at R33 million per annum with an associated economic productivity loss of R36 million per annum (City of Johannesburg, 2003).

The households in the city of Johannesburg that do not currently receive a refuse disposal service is an estimated number of 114 172 (Stats SA, Community Survey 2007). These households are typically situated in poorer areas and often in informal settlements. Infrequent collection of general household waste results in decomposition of waste within residential areas. These waste dumps are attractive feeding and breeding sites for flies. Apart from the health risks as a result of higher levels of pathogens, dump sites pose a safety risk due to sharp objects and possible hazardous materials (City of Johannesburg, 2003).

Unmanaged general waste dumps contributes to pollution of surface water and soil, either through litter reaching surface water streams and storm water systems. In addition to direct risks to human health, odour problems and aesthetic degradation associated with stockpiles of waste, impacts on quality of life. Human health can manifest in a variety of ways by hazardous waste that is not managed correctly. Exposure to hazardous compounds in waste may be either directly through skim contact or ingestion or indirectly through pollution of environmental media (City of Johannesburg, 2003). Map below shows diseases related to solid waste services in Greater Johannesburg.



Map 3: Diseases related to solid waste service . *Source: City of Johannesburg, 2000*



Photo 3. *Waste Disposal* ***Source:*** *(Craigie and Fourie, 2005)*

The consequence associated with non-sustainable waste management in Johannesburg is difficult to quantify. However, potential consequences may be identified to include the following: Long term effects of pollutants entering the surface or groundwater resources, air and soil affecting the fitness for use, and availability of the resource for use. More specifically, pollution of watercourses and groundwater, by leaching of pollutants from waste, are inappropriately disposed of or, where waste management service provision is

inadequate, is particularly evident for dense urban informal settlements (City of Johannesburg, Solid Waste Management, Annual Report, 2003)

Pollution of watercourses and groundwater, by leaching of pollutants from waste residue deposits, particularly mine and power station waste dumps. Air pollution by dust is released particularly from mine residue deposits but also from general and hazardous waste sites and HCRW incinerators. Nuisance from odours of waste degradation in landfill sites and waste disfiguring the environment, especially plastic bags and littering, where waste service provision is limited.

According to the City of Johannesburg, Solid Waste Management, Annual Report, (2003) increased waste management costs to provide safe and effective long-term disposal sites for increasing waste loads, including treatment of wastes, to render them less environmentally available and effective closure and rehabilitation of historically inadequate waste sites. Increased pressures through the negative societal impacts of inadequate service provision, fosters illegal waste dumping, littering and abuse of open spaces. Increased health and environmental risks are associated with inadequate waste collection, disposal services and informal salvaging on landfill sites. Poverty encourages salvaging on waste sites for recyclables, refuge materials, fuel and food; reduced recreational value of land and water resources by inadequate waste services; reduced tourism and investment by negative impressions of widespread littering, illegal waste dumping and perceived ineffective management of general and hazardous waste. Environmental risks as many waste sites which do not meet the Minimum Requirements stipulated by DWAF, requiring upgrading to the specifications, or closure and rehabilitation

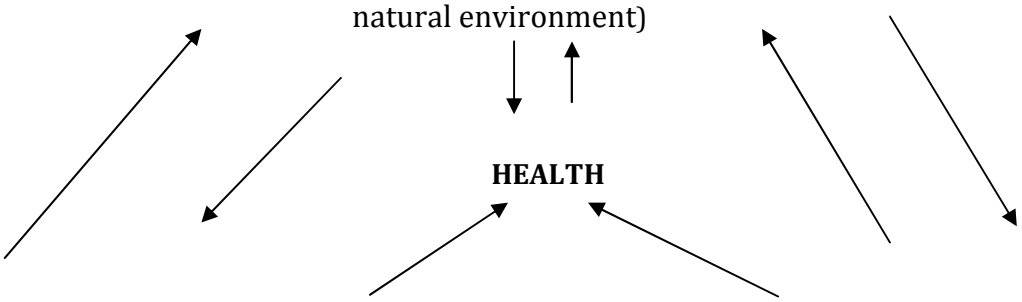
3.43. Human interaction with the environment

Human health ultimately depends on a society's capacity to manage the interaction between human activities and the physical, chemical, and biological environments. It must do this in ways that safeguard and promote human health, while at the same time protecting the integrity of the natural systems on which a healthy environment depends. The physical and biological environments include maintaining a stable climate and continued availability of safe environmental resources (soil, fresh, water, clean air) (Yassi et al., 2001). It also includes continued functioning of the natural systems that receive the waste produced by human societies without exposing people to pathogens and toxic substances and without compromising the well-being of future generations (Yassi et al., 2001).

The idea of an inextricable link between human health and the environment has long been recognised. Figure below provides the scale and nature of human activities.

The Scale and nature of human activities

(Agricultural, industrial, and energy production, the use and management of water and wastes; urbanization; the distribution of income and assets within and between countries; the quality of health services; and the extent of protection of the living, working, and natural environment)



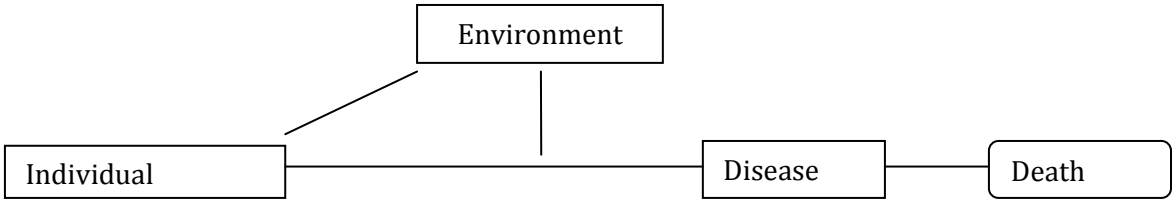
Physical and chemical environment

(Air, water, food and soil chemical of composition, including radiation; including temperature, humidity, and seasonal changes.)

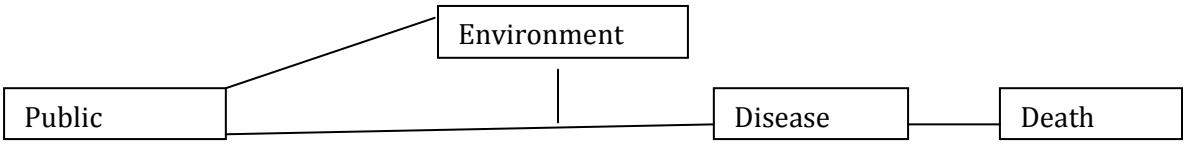
Biological Environment

(type and distribution pathogens and vectors, climate as well as their precipitation habitats)

Figure3*: Interaction between human activities and the physical, chemical, and biological environments. Model adapted from (Yassi et al, 2001).*



a) Clinical intervention model



b) Public health intervention model

Figure 4: *Various models for improving the state of human health and the environment*

The commitment and support of individual members of the public will be essential for success. Members of society must be constantly reminded that they can reduce the production of solid waste by recycling newspapers, plastics, glass bottles, and metal. They can reduce the consumption of energy by car pooling, by minimising home heating and cooling costs through the installation of storm windows and other weatherproofing measures, and by conserving alternatives (Moeller, 2005). The following section provides background information on Randburg-Windsor, where research interviews were conducted.

3.5. Randburg-Windsor Description

Randburg is a suburb of northern Johannesburg, Gauteng, South Africa. It is a prosperous area and although previously a "white" area it is now open to all races and cultures in the post apartheid era. It has also been a pioneering region – for instance Sanlam Shopping

Centre, now known as Randburg Square, was the first shopping mall in South Africa, and Randburg also pioneered pedestrian malls (Randburg history, 2005).

Between the 1850's and 1860's, Boer pioneers settled on what is now called metropolitan Randburg. There were four farms in the area: Boskop, Driefontein, Klipfontein, and Olievenhoutspoort which were sub-divided among the earlier settlers heirs. In 1906, Daniel Brink inherited a portion of the Driefontein land for farming. He constructed Randburg's first windmill, "in Milner Street" in 1924 (Randburg history, 2005).

In 1972 the town council formulated its first master plan for Randburg's development, in accordance with the town's motto "Planning for People". This plan has laid the foundations for Randburg's tremendous growth and development (Regional Spatial Development Framework 2008/9: Administrative region B). Despite this huge growth, more opportunities are arising in the Western side of Randburg, which is now being developed at a rapid pace. Randburg is a Regional Node that has been in decline for a number of years. Through the Randburg Revitalization Strategy, the City of Johannesburg is encouraging new retail, office and residential development within the node in order to promote its redevelopment (Ibid).

Going along with Windsor, its official population was comprised of 50 000 habitants in 2007, but there were thousands more in terms of undocumented and illegal immigrants mainly Nigerians, Zimbabweans, Congolese and Zambians (Laurette, 2007). Apart from the aforementioned problems, the area is troubled by illegal businesses, and vagrants. The commercial areas are dominated by noisy nightclubs and drinking establishments that are busy around the clock. Bottles, glass, cigarettes, rubbish, needles, and human waste litter the streets (Laurette, 2007).

3.5.1. Waste collection

In general, waste management in urban area of Johannesburg is undertaken by the city's waste utility, namely "Pikitup". Key general waste minimisation activities in the city of

Johannesburg in general and Randburg in particular include: composting of garden greens, kerb side recycling and waste material recovery (Gauteng Department of Agriculture, Conservation Environment and Land Affairs, 2008).

Illegal dumping has recently become an increasing problem for Pikitup throughout the city. The growth in this unscrupulous practice is unfortunately not limited to a specific area or suburb (City of Johannesburg, 2006). Solid waste management problems are spread out over Johannesburg, including Windsor community. These problems are similar but differ from one area to another. This issue affects all residents of the area, irrespective of their socio-economic background. The same issues apply to the Windsor Community (City of Johannesburg, 2006).

The uncollected waste can affect human health in a variety of ways. Exposure to hazardous compounds in waste may be either directly through contact or ingestion or indirectly through pollution of environmental media. Illegally dumped material poses health risks in whichever area it is dumped. If illegal dumping does occur, this waste should be collected and disposed of as soon as possible, to avoid the negative impacts that may result.

3.6. Conclusion

This chapter focused on Johannesburg. The profile of Johannesburg, structure of city governance, historical background, and demographic information as well as the manner in which waste is collected in the city of Johannesburg has been provided. The second section scrutinized the solid waste management problem in Johannesburg. The section illustrated that there are issues such as lack of waste information collection, capturing and recording systems in the city of Johannesburg. Additionally, lack of reporting requirements, as well as information management and dissemination systems; illegal dumping and poor management of the activities have been manifested in the city of Johannesburg. The section has analysed the strengths, weaknesses, opportunities and the threats of solid waste management in greater Johannesburg.

The section 3 investigated the impacts of poor management of solid waste on the environment as well as on human health in Johannesburg. Land pollution with respect to the impact of mismanagement of solid waste constitutes one of the environmental concerns in Johannesburg. Sewerage problems mainly exist in large parts of Alexandra and Soweto townships. To the South and Southwest of Johannesburg, dust pollution from mine dumps are the main sources of environmental degradation, whilst the CBD experiences continuous overflowing of sewers, basically in Hillbrow, Newtown and Jeppestown. In this section, it has been observed that inappropriate storage and disposal of organic waste attracts rodents and insects, which may increase the frequency of gastro-intestinal and parasitic diseases. This issue constitutes major concerns for human health. Finally, the section has analysed the interaction between humans and the environment.

The last section provided background information on Windsor-Randburg. Some others information such as the demographics of Windsor has been provided. Ultimately, it is important to educate people about the negative effects of illegal dumping on the environment and general health. The following chapter focuses on research findings and data analysis.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1. Introduction

This chapter is based on research data analysis and findings. The chapter begins by explaining the methodology used for gathering data, followed by fieldwork design and departmental description (Pikitup; Environment and Development Planning). Firstly, an analysis of the data based on general information (socio-economic characteristics) is made. Secondly, the questions associated with the problems of solid waste management in Johannesburg are analysed. Thirdly, the impacts of poor management of solid waste on the environment and on human health are evaluated. Fourthly, a recommendation for responsibility for the collection and disposal of solid waste in Johannesburg being distributed to everyone who resides within the city is made. Finally, the government's key role with regards to the problems of managing solid waste in the city of Johannesburg is addressed. A conclusion sanctions the chapter.

4.2. Research Methodology

There are diverse ways to approach the analysis of data. There are no absolute methods of gathering data in qualitative research (Weingand, 1993; De Vos 1998; Labeloane, 1998). In other words, these methods are flexible and unique. They do not have fixed steps which need to be followed or replicated for gathering data (Labeloane, 1998: 189). For example, there is an interpretative approach, which emphasizes the role of patterns, categories and basic descriptive units. Dey (1993) contends that despite differences in the various approaches to qualitative analysis, all such approaches seek to make sense of the data produced through categorisation and connection. Dey (1993) describes his approach to the analysis of qualitative data by using an omelette analogy. He suggests that, just as one cannot make an omelette without breaking and then beating the eggs, one cannot undertake data analysis without breaking down data into bits and then beating the bits together. He suggests that the core of qualitative analysis consists of the description of the

data. Qualitative research occurs in real-life situations and it is in real-life situations that respondents can provide in-depth information about phenomena (Krueger, 1988). In qualitative research, the researcher is in a position to communicate personally with the respondents and to discover how they see reality in real-life situations (Labeloane, 1998).

For this study, a qualitative research method in the form of a narrative analysis and semi-structured interview were used to gather information in relation to solid waste mismanagement. The purpose of the data collection was to find out people's views with respect to the impacts of poor management of solid waste on the environment and on human health. This method helped to test people's understanding of the problem of solid waste mismanagement. It also helped to determine whether their perceptions on the impact that the mismanagement of solid waste can have on the environment, as well as on human health is reliable. The selection of a qualitative research method is necessitated by its ability to document real events. Recording what people say with words, observing specific behaviour and studying written records; allows one to determine the real problem behind the issues of solid waste mismanagement.

4.2.1. Sampling Method

This is a study concerning sustainable cities and the issues of solid waste management in South Africa, focusing on Johannesburg as a case study. The ideal for this study would be to interview samples of the population of Johannesburg scattered throughout its seven regions to collect data relating to the issues of solid waste mismanagement. Nevertheless, given the constraints of time, material and financial resources, it was difficult for the researcher to follow such a procedure.

Alternatively, the researcher resolved to delineate the field of investigation in some departments that deal with urban and solid waste management in Johannesburg, notably Pikitup; the Johannesburg Environmental and Development Planning Departments. Interviews with the local community members of Windsor-Randburg were also conducted.

Thus, it is believed that the selected departments and community are likely to provide viable information needed to validate the extent of our subject.

In addition, sampling is a process of systematically selecting cases for inclusion in a research project. Probability sampling was selected for this study. This is a random process where each element has an equal probability of being selected.

The methodology used to obtain data for this study was the questionnaire interview approach, where there was an interviewer who asked predefined questions and an interviewee who responded and answered questions as posed. The questioning and answering was based on predefined questions with expected responses to particular parameters or elements of the content in terms of closed and open-ended questions. This methodology can be limiting but allows for uncontrolled responses that reflect a number of issues that might be relevant to the specific subject under research. Those questionnaires were divided into two parts. The first part contained questions related to socio-economic characteristics. The second part included fundamental questions that examined the impact of mismanagement of solid waste on the environment as well as on human health. Questionnaires were completed for 40 interviewees. 12.5% of questionnaires were completed by the Pikitup agents; 17.5% by the employees of Environmental Department under the City of Johannesburg Metro Centre; the other 15% by Development Planning and Land Use Management Department agents, and 55% of questionnaires were completed by the local community of Windsor in the Randburg area. The Figure below illustrates the design of the fieldwork by means of depicting the number of people interviewed in each sector.

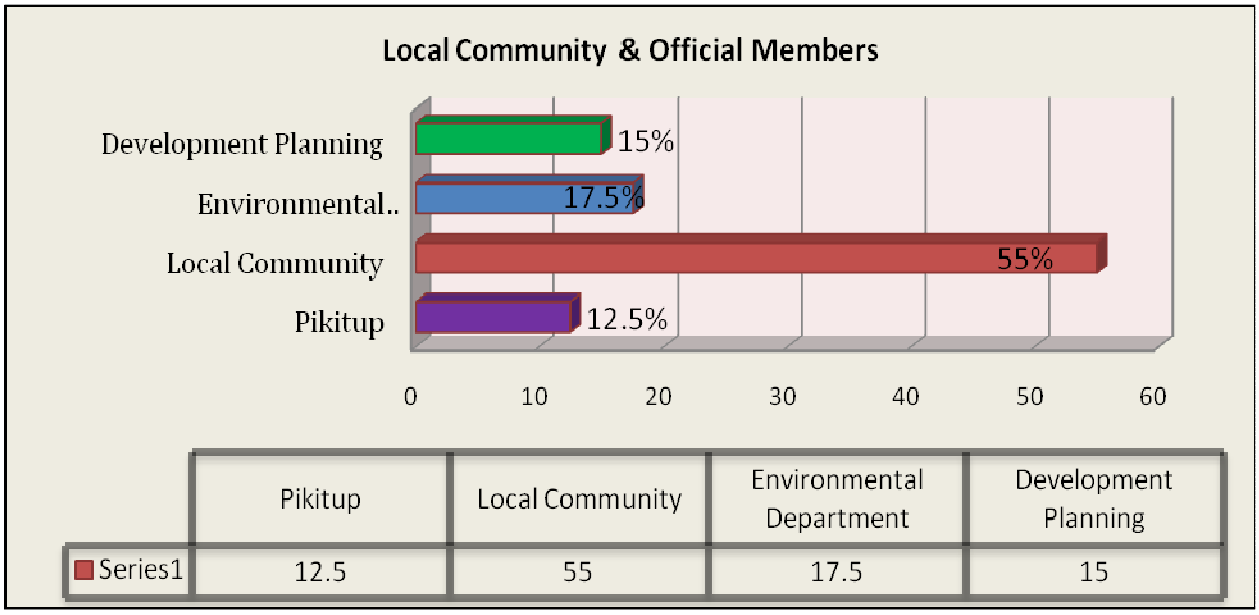


***Figure 5**: Respondents interviewed in the local community and official members*

The above figure depicts that most of the interviews were conducted in the local community of Windsor-Randburg; representing 55% of the overall samples. The other 45% of the interviews were conducted by municipal and other official members involved in solid waste management in Johannesburg.

4.3. Departmental Description

The Johannesburg Departments of Development Planning and Land Use Management prioritize economic growth, health and community development; a safe, clean and green city, as well as governing and managing the city (this is according to the manager responsible for the Land Use Management Department). The departments do not deal with solid waste management. The departments' interest emerges when there is a need to develop a new landfill site in the city. However, before any attempt is made at developing the so-called "new landfill site", the department responsible for solid waste management (Pikitup) must submit an application for consent in the Department of Land Use Management (Ibid).

In the same light, the private entity responsible for disposal of municipal waste in an environmentally acceptable manner (namely Pikitup), stated that the purpose of Pikitup is "to provide innovative and sustainable waste management solutions that exceed stakeholder expectations". A senior specialist in Waste Information Management and Regulation said that the Environmental Department under the City of Johannesburg Metro Centre leads and directs waste regulation, information management; development and implementation of the waste policy plan.

However, questionnaires were distributed to all peoples interviewed in the aforementioned departments and the local community. For those who could not complete these questionnaires for various reasons, including not knowing how to read, write or lack of time, a verbal interview was conducted.

The analysis begins by presenting data from socio-economic characteristics and then went on to the main fundamental questions related to the issues of solid waste management in Johannesburg. The characteristics of the samples include: Gender, profession, qualification, etc. Figure below shows samples according to gender.

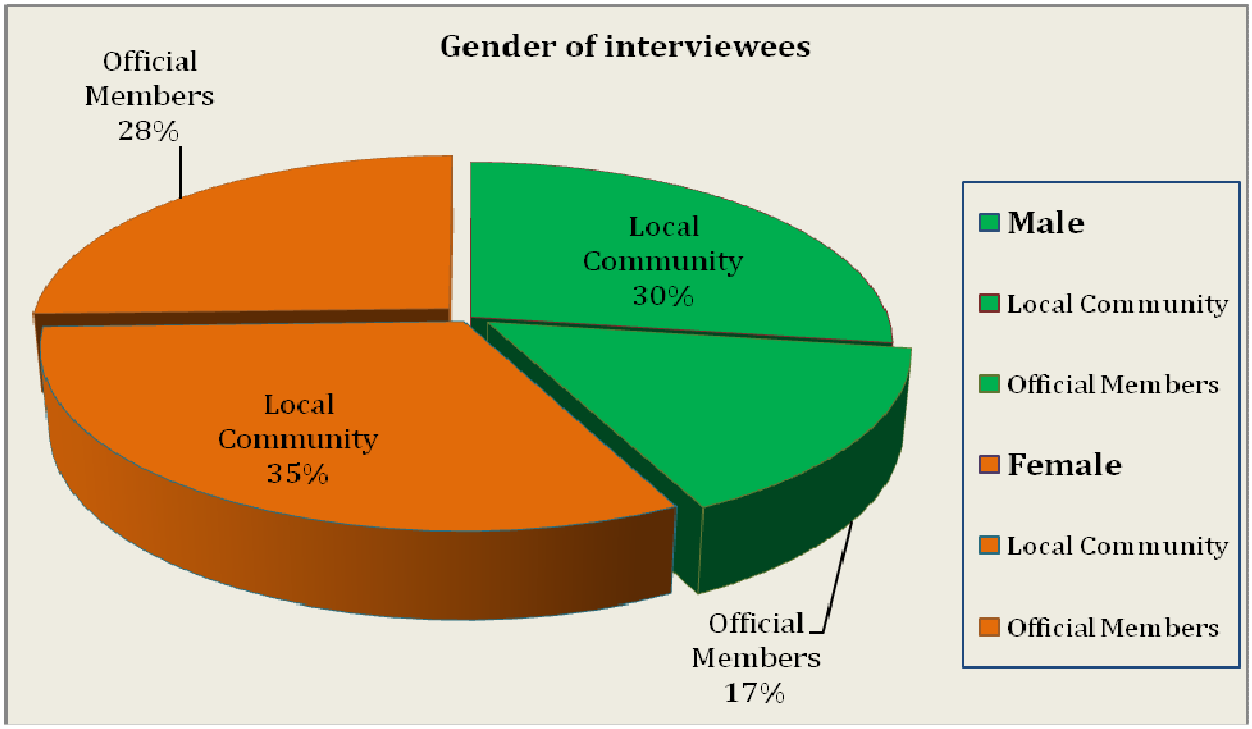


***Figure 6**: Gender of interviewees*

In figure2, a total of 47 % of men were interviewed, of which 30% represents men interviewed from the local community of Windsor and 17% represents the number of men interviewed from the municipality and other official spheres, notably Pikitup; Environment; Development Planning and Land Use Management Departments. Similarly, a total of 53% of women were interviewed. 35% represents women interviewed from the local community and 28% represents the numbers of women interviewed from the municipality and other official spheres, namely "Pikitup". Thus, figure below shows respondents' qualification.

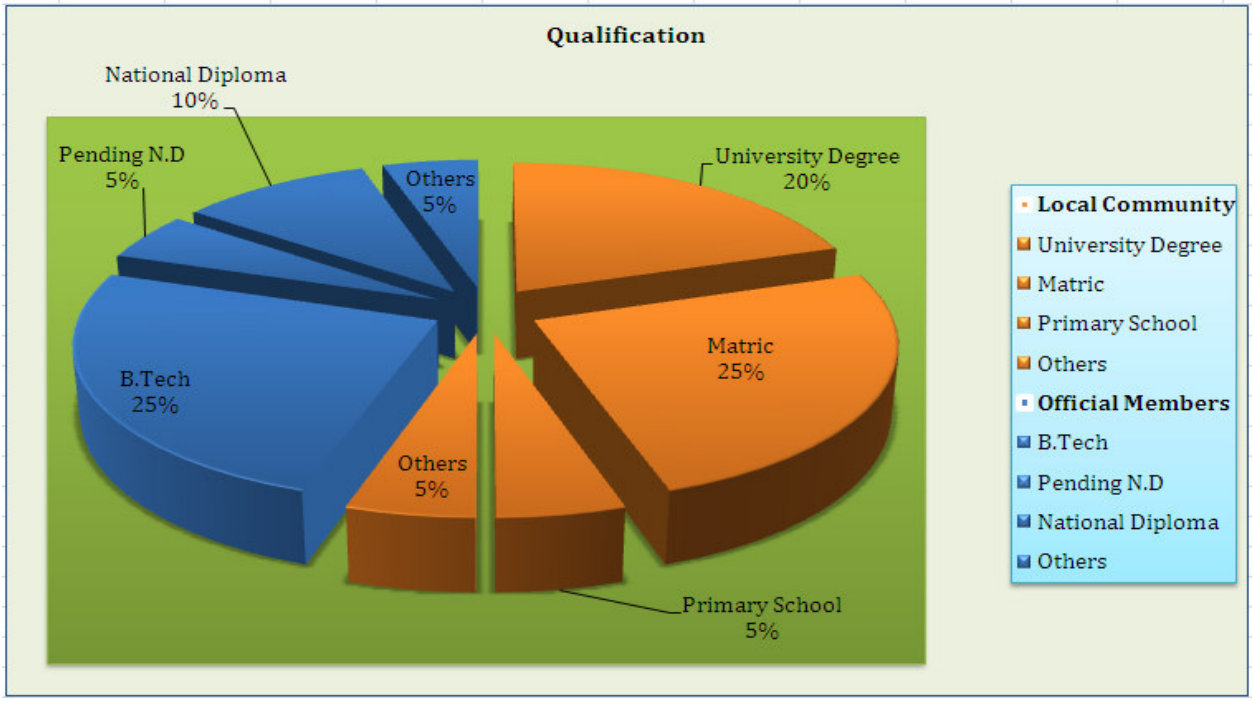


***Figure 7**: Interviewees' qualifications*

This figure depicts that most of the respondents interviewed in the local community did not attain a tertiary education. 25% of them matriculated; while only 20% of them have got University/College qualifications. While 25% of the respondents interviewed from the municipality and other official members have got B. Tech degrees and 10% of them have got National Diploma's. The other 10% of the interviewees got to either Masters level or are waiting National Diploma and/or Masters Degree.

4.4. Solid Waste Mismanagement in Johannesburg

The respondents interviewed in the Johannesburg environmental department perceived that solid waste mismanagement is about the irresponsible manner in which the population handles waste. Other interviewees contended that it is the handling method of solid waste –from its generation to its disposal – which is inappropriate. From this; it can be deduced that the mismanagement of solid waste stems from lack of knowledge about how waste can be best managed and that this leads to wrong decisions being made. The other interviewees point out that improper disposal of municipal waste in Johannesburg

has a serious and dangerous impact on the environment and on the health of its residents. Garbage thrown in the street or in open spaces creates a public health hazard. Rubbish that is burned in the open rather than disposed of properly creates pollution and releases toxic fumes into the environment. Improper disposal of solid waste appears in Windsor-Randburg. Photo 3 and 4 below show garbage thrown in Duchesse and Countesses Street in Windsor-Randburg.



***Photos 4-5**: Waste mismanagement in Windsor.* ***Source:** Pictures taken by the researcher*

The mismanagement of solid waste as shown on the above pictures is critical to the health and well-being of people living in the areas. The people interviewed in Windsor reported that a large amount of rubbish is left uncollected on the streets of Windsor. Uncollected waste creates myriad of related health and infrastructure problems by acting as a feeding ground for pests that spread disease and clog drains. Pikitup does collect the waste in

Windsor once a week on Wednesday. So, according to the local community of Windsor, the weekly collection is insufficient. The collection twice a week is recommended as the population has increased greatly over the past two years. However, 20% of the respondents from the local community of Windsor argued that the cause of this waste thrown on open dumpsites and on the streets is mainly due to human activities, households waste and over population within the community. People do not care for their environment, even if the waste that results from their daily activities poses a threat to their lives. Figure 5 below depicts the issues associated with solid waste management in Johannesburg.

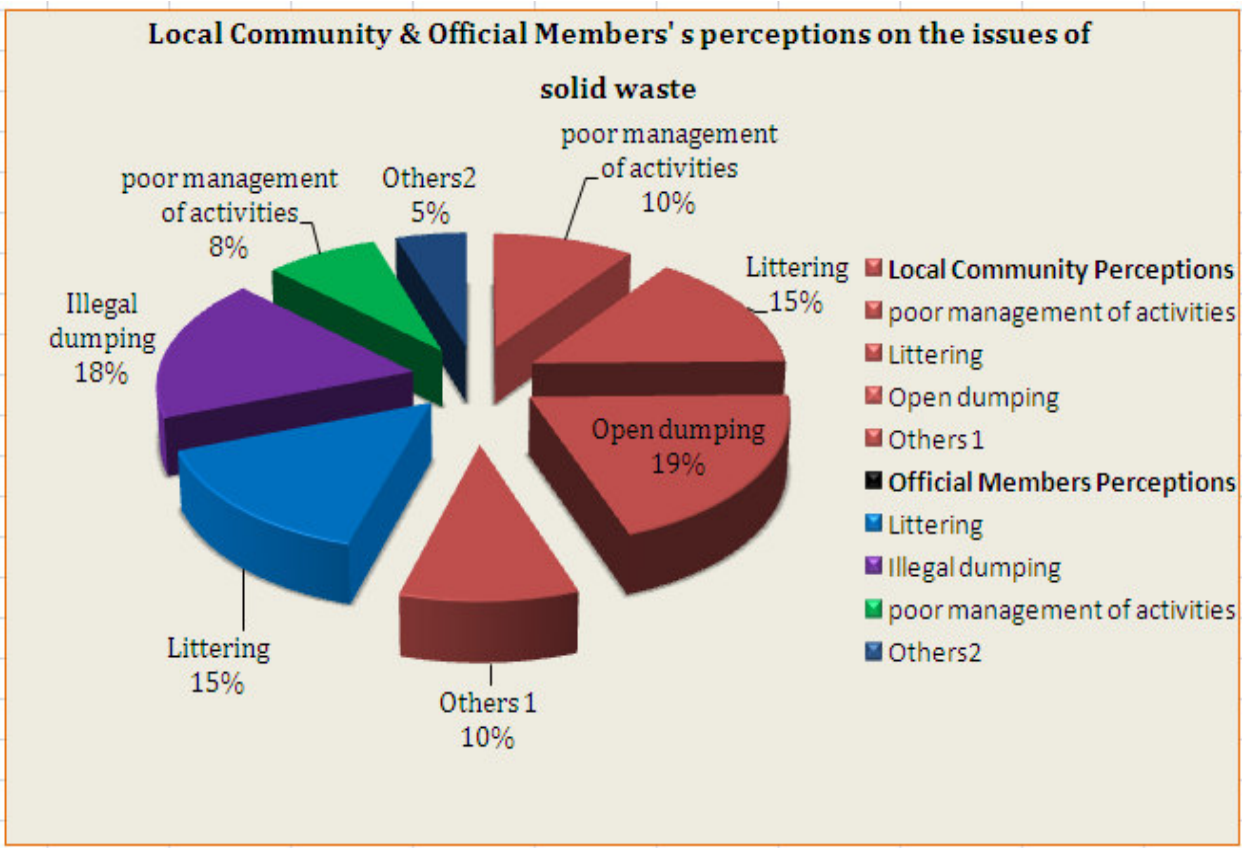


***Figure 8**: Perception of the local community and official members on the issues of solid waste*

In this figure, it is observed that the general issues encountered in dealing with solid waste management in Johannesburg are illegal dumping and open dumpsites. The issue that appears in Windsor is that most rubbish is disposed of by means of open dumping manner. 20% of the respondents interviewed in Windsor reported that most of the waste in their area is thrown in an open dumping. However, apart from the problem associated with financial resources, waste management infrastructure; awareness in relation to waste management; poor management of activities, 18% of the respondents interviewed reported that the issues encountered in dealing with solid waste management in Johannesburg is mainly illegal dumpsites and uncontrolled littering.

4.5. Environmental and Human Health Concerns

Environmental health refers to those aspects of human health, including quality of life, that are determined by physical, biological, social, and psychosocial factors in the environment. Respondents interviewed from the Johannesburg departments of development planning and land use management argued that the effects of poor management of solid waste, negatively impacted on the environment and the health of residents. The respondents stated that solid waste, when improperly disposed of, is an environmental hazard to the immediate areas. Improper dumping leads to illnesses such as dysentery, cholera and typhoid fever. As a result, the health of children and adults becomes negatively affected. Furthermore, some of this waste can also be damaging to the atmosphere. It can be argued that the consequences of the lack of stringent policies of waste disposal can also be felt at work places and at schools as both worker and student cannot perform their tasks optimally if their bodies are weak. On the economic side this means lowered productivity and lowered profits for companies because of constant absenteeism amongst workers due to medical reasons. Ill health can also impede employees' ability to work and thus lead to loss of income (World Bank, 2001). This can deepen poverty amongst poorer households within the city. Pictures 5 and 6 below taken in George Street/Windsor-Randburg show young girls playing with garbage thrown along the Street. This is dangerous for their present and future health.



Photos 6-7: *Waste thrown in George Street Windsor. Source: Photos taken by the researcher*

Interestingly, most of interviewees are aware that the mismanagement of waste can lead to the destruction of the ecosystem and may cause diseases. Most of the respondents interviewed in the Department of Environment reported that improper disposal of waste may pollute air and therefore, this air pollution can lead to formation of acidic rain. In the same light, Hamer (2003) argues that the majority of waste disposal situations involve pollution of one kind or another. Pollution is mainly a result of poor disposal methods for sewage and household wastes. This takes the form of solid waste contamination of official and unofficial rubbish pits, dumps and open areas (Hunt, 1996). According to Hunt, (1996) the polluter derives benefit from the environment in being able to dispose of waste but the costs are borne by the community in health costs, the degradation of renewable resources, and a diminution in the already scarce land area available for other uses and a reduction in the scenic qualities of atolls. This may serve a lesson for the city of Johannesburg, unless the problem of handling solid waste is dealt with properly.

The other respondents acknowledged that the mismanagement of solid waste affects drainage and when solid waste is dumped in drainage channels and gutters, it blocks the flow of the sewerage and storm water. Consequently, this may cause flooding. The people interviewed from the Department of Environment also reported that the mismanagement of solid waste affects soil drainage which hinders the growing of crops. Toxic waste for example, if consumed by animals can be very dangerous to life and worse still if this waste is dumped in water bodies. Aquatic life can also be in danger.

Wolfville and Scotia, (2002) argue that the lack of adequate waste collection and disposal systems causes public health problems resulting in diseases, which aggravates poverty and leads to negative consequences such as loss of income due to illness, increased spending on health care, and the deprivation of the poor's capability to live in a safer environment. In this respect, Giusti, (2009) emphasises that diseases such as malaria that are spread by vectors such as mosquitoes could become more common. Rising flooding and extreme weather events are also likely to cause destruction and casualties. Giusti, (2009) highlights that human exposure to substances released at waste management facilities can be acute in case of a serious accident causing short-term exposure to high levels of potentially hazardous substances, ionizing radiation, bio-aerosols and dust. Figure below describes the effects of the mismanagement of solid waste on the environment as well as on human health in Johannesburg.

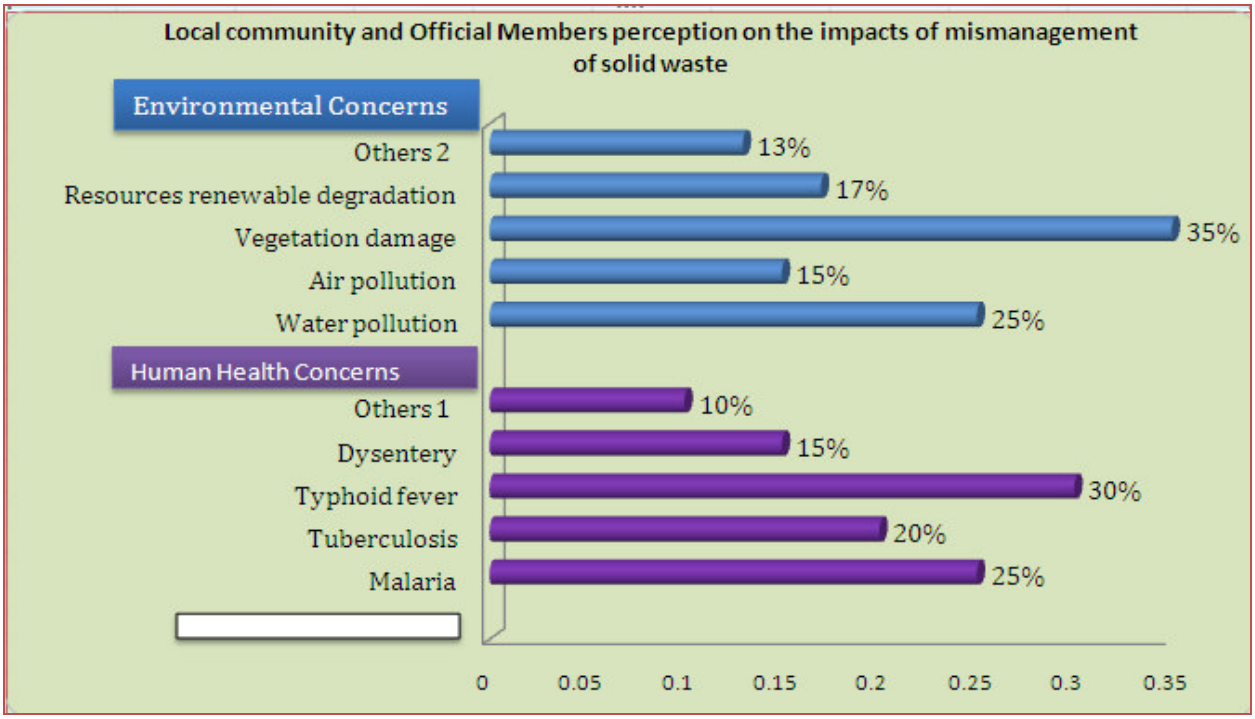


***Figure 9**: Perception on the* impacts *of poor management of solid waste on the environment & on human health in Johannesburg*

In this figure, 35% of the respondents perceived that the effects of mismanagement of solid waste damage vegetation. The other 30% of the respondents interviewed stated that poor solid waste management affects human health and therefore, there is possibility for people to contract typhoid fever. The other interviewees went in-depth to explain that poor solid waste management leads to the death of animals, especially domestic animals. Death of animals like cattle leads to poverty and the death of animals like dogs, leads to insecurity in homes. Poor solid waste management also displays an unattractive scenario of the environment. This can affects the tourism industry, as the tourist may not get attracted to visit the city in particular and the country in general. This was the assertion of the respondents interviewed in the Department of Environment under the city of Johannesburg Metro Centre.

A Senior Specialist on Waste Policy and Programs reported that "the mismanagement of solid waste leads to the spread of diseases in such a way that when waste like broken bottles are dumped anywhere, they collect water in them and this may become a breeding ground for mosquitoes. Waste like human stool causes diseases when poorly dumped, as the flies will carry the germ from the stool".

Most of the interviewees argued that poor management of solid waste can also lead to human injury. For example, when a person is walking and steps on the broken bottles or nails or even pins, they can get injured which may lead to bleeding. Uncontrolled dumping of solid waste can lead to wastage of land where we find lots of land being used as dumping sites for waste. These same pieces of land are later on neglected by the inhabitants of the area. This is according to the respondents interviewed from the municipality and other official members involved in solid waste management in the city of Johannesburg.

The other respondents reported that improper management of solid waste is one of the main causes of environmental pollution and degradation. They explained that this improper management of solid waste is not because the city of Johannesburg lacks waste management regulations and proper disposal facilities. Rather improper management occurs as a result of people's unwillingness to respect the existing regulations.

From Savage et al.,'s (1998) viewpoint, poor waste management poses a great challenge to the well-being of city residents, particularly those living adjacent the dumpsites due to the potential of the waste to pollute water, food sources, land, air and vegetation. The poor disposal and handling of waste thus leads to environmental degradation, destruction of the ecosystem and poses great risks to public health.

Goorah, Esmyot, and Boojhawon, (2009) conceive that uncontrolled dumping greatly endangers the immediate health of both informal sector waste workers and nearby inhabitants, typically the poor residents of informal urban settlements, through direct hand-to-mouth contamination and inhalation of volatile chemicals and other pollutants.

Goorah, Esmyot, and Boojhawon, (2009) add that uncontrolled dumping has adverse effects for all urban residents - impacting the public health of the city at large through water supply, air and soil contamination. Alternatively, authorities of the municipality must consider the public health impact of their current solid waste management strategies as well as the health benefits and cost-effectiveness of alternative strategies for upgrading solid waste management.

Thomas-Hope, (1998) argues that other undesirable practices of solid waste management pollute air, water and land, fostering the proliferation of disease carrying vectors that directly or indirectly may have an adverse effect on public health, sanitation personnel, and those who scavenge the refuse to salvage saleable or other materials considered to be of some use. The findings indicate that diseases such as typhoid fever, malaria, dysentery, tuberculosis and other endemic diseases are associated with the mismanagement of solid waste.

4.6. Responsibilities for the collection of waste

Most of the respondents reported that responsibilities for the collection and waste disposal in the city of Johannesburg must be shared. Not only the government is required to play their role of collecting the waste generated in society, but also the members of local community must take their part. Most of the respondents interviewed from the local community of Windsor reported that the local council is responsible for the collection and disposal of waste in their area. Therefore, the members of the community must find out when bins are collected, how to report a missed collection, what can be recycled and how to dispose of bulky items. Thus, 20% of the respondents interviewed from the local community perceived that the collection and disposal of waste in the city of Johannesburg as a whole and Windsor as a local community in particular is the duty of the municipality. From this argument, it can be deduced that, residents tended to shift the blame to local authorities for not improving the service. This was the assertion of the respondents interviewed from the local community of Windsor during the investigation. Municipality

and other official members stated that it is a constitutional requirement for the municipality to collect the waste generated in greater Johannesburg. They reported that waste management is a collective effort that needs everyone to play their part to ensure that, all is met. In other words, everyone must be involved in their area to contribute to this constitutional requirement; this represents 15% of the respondents interviewed from the municipality and other spheres of government. Figure below shows the responsibilities for the collection and disposal of solid waste.

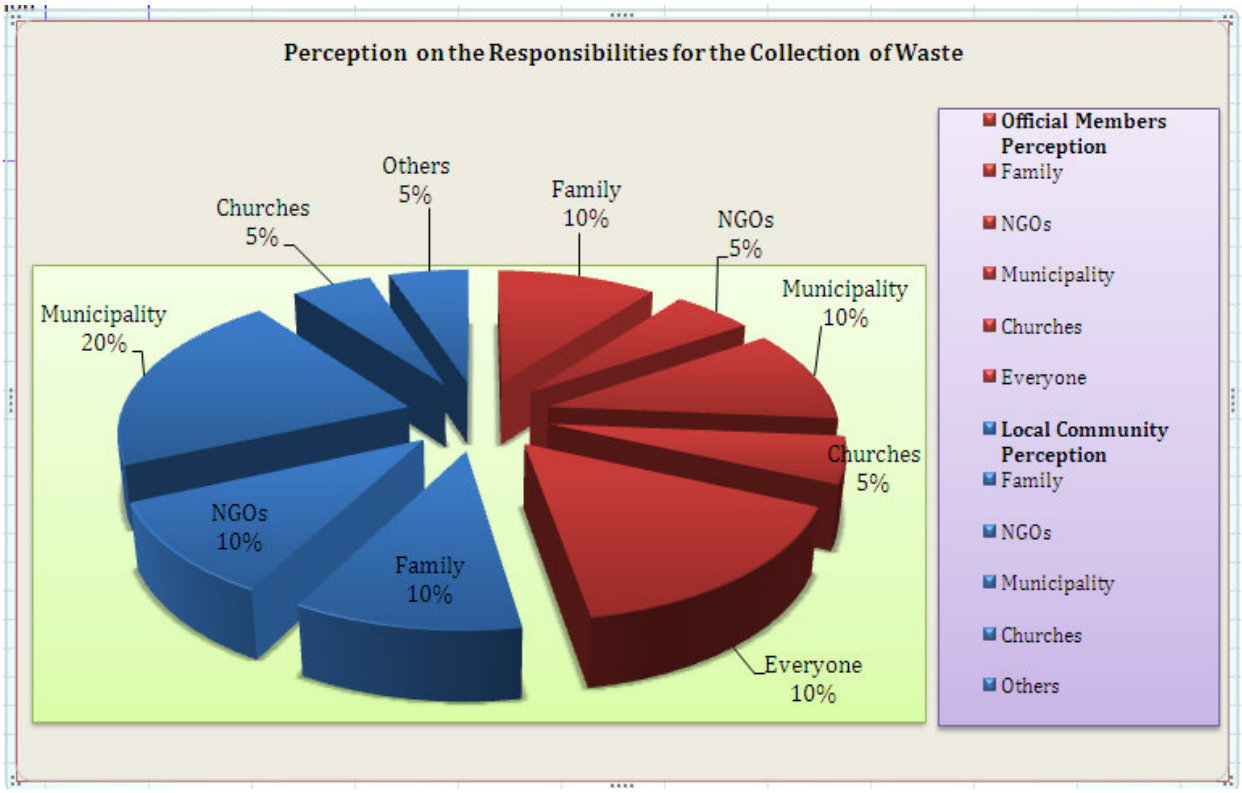


Figure 10: *Perception on the collection and waste disposal*

In light of the above figure, it is obvious that Pikitup is responsible for the collection and disposal of all residential, commercial, yard and bulk waste within Johannesburg city limits to ensure the health, welfare, safety and sanitation of the community. The purpose should be to provide the citizens of Johannesburg with an effective and efficient solid waste

service in an environmentally and economically responsible manner. Thus, two interviewees in Windsor said that "the whole of Windsor community must participate in line with the collection and disposal of waste generated in our area because we shall be the victims of the neglected waste around and above all the municipality must make it an aim to keep our community safe".

4.7. Government Responsibilities

Most of the respondents interviewed asserted that the government should keep on playing their role of educating people in being responsible for the waste they generate themselves. This education should be done throughout the media, schools, churches, and other organisations. The government should also provide regulatory framework for solid waste. However, the local community also has a responsibility to ensure that they handle waste without adverse impact on the environment. The members of the local community can also support the systems put in place by the city of Johannesburg.

The members of the community have a vital role to play in terms of reducing, recycling and re-using their waste at source (point of generation). Everyone who generates waste must ensure that it is disposed of at the right and designated areas. Most of the members of the local community of Windsor propose that the government should create a program involving the unemployed to assist with keeping Windsor clean on days when the Pikitup trucks do not come for collection. They suggested that the government must set up bigger bins that can hold waste. Other interviewees suggested that the government must exert their control on how municipalities use the state resources to do their job. The government should use subcontractors who are willing to do tasks. The community must use plastic bins to keep waste. They also must put the bins out on the scheduled days when waste management trucks come for collection. The members of the community should help each other about the risks caused by uncontrolled waste and illegal dumping sites.

4.8. Summary and Conclusion

This chapter has presented an analysis of the empirical data collected by the research. The chapter has analysed the impact of solid waste mismanagement on the environment and on human health in Johannesburg. The collection of the data was conducted through a qualitative method of research. This method was necessitated by its ability to document real events. The analysis presented in this chapter has demonstrated that poor management of solid waste negatively affects the environment and human health. Improper management of solid waste is one of the main causes of environmental pollution and degradation. This chapter has identified people's unwillingness to respect the existing regulations and the lack of proper disposal facilities as the main reasons for improper management of solid waste.

From the environmental assessment, it was depicted that the waste thrown into open dumpsites exposed the residents around it to unacceptable levels of environmental pollutants, which had adverse impacts on their health. Such factors increase the risk – especially amongst children and adolescents living around the dumpsites – of contracting illnesses. There is an increased risk of infections such as upper respiratory tract infections, chronic bronchitis, asthma and fungal infections. A link may be drawn between declining health levels amongst the city's population and possible decreases in productivity. Illness may decrease people's ability to perform their tasks adequately or may lead to increased absenteeism in their places of employment. Furthermore, ill health may lead to crises at household level as individual employees may lose income or, in some instances, may lose their jobs as a result of ill health. In this respect, the World Health Organisation, (2006) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution. Most of these environment related diseases are however not easily detected and may be acquired during childhood and manifested later in adulthood. As a result we must be cautious and analyse at first all parameters during the process of managing solid waste by means of taking into account the impacts that solid waste management can have on the environment as well as on human health.

The organic fraction of municipal solid waste is an important component, not only because it constitutes a sizable fraction of the solid waste stream in a developing country but also because of its potentially adverse impact upon public health and environmental quality. A major adverse impact is its attraction of rodents and vector insects for which it provides food and shelter. Impact on environmental quality takes the form of foul odours and unsightliness. Impacts are not confined merely to the disposal site. On the contrary, they pervade the area surrounding the site and wherever the wastes are generated, spread, or accumulated. Unless organic waste is appropriately managed, its adverse impact will continue until it has fully decomposed or otherwise stabilised.

There is general apathy towards littering and illegal dumping and a drastic shift in the public attitude is needed in order to change this. Not only is illegal dumping unsightly but it also creates a health hazard and deprives communities of space that could otherwise be used for recreation. Illegal disposal results in high social costs because of the contamination of water resources, the spread of disease, litter and aesthetic deterioration (Menell, 2004). When there is inadequate waste removal, the problems with sanitation are intensified. This means that the inadequate waste removal negatively affects the environment and the health of residents in one way or another etc. Inadequate waste collection poses particular problems for children, who tend to play wherever there are interesting opportunities for exploration and who may be drawn to wade or play in standing water and drainage ditches or to scavenge in piles of garbage (Bartlett, 2003). As noticed earlier, Pikitup is responsible for the collection and disposal of waste in Greater Johannesburg. For disposal of municipal solid waste, landfills are used, and for treatment of health care risk waste (HCRW) incineration is conducted. Residual waste gets disposed of at the landfill.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

This is a study of sustainable cities and on the issues of solid waste management in South Africa, focusing on Johannesburg as a case study. Its purpose is to investigate the impacts of mismanagement of solid waste on the environment as well as on human health. The outcomes demonstrated that solid waste management problems are spread out over Johannesburg. It was demonstrated that poor solid waste management within the city impacts adversely on the environment and on the health of residents. It was observed that it is the way this waste is produced; stored, collected and disposed that poses risks to the environment and to public health.

The research findings also support Thomas-Hope's, (1998) arguments that poor practices of solid waste management pollute air, water and land, fostering the proliferation of disease carrying vectors that directly or indirectly may have an adverse effect on public health, sanitation, personnel, and those who scavenge the refuse to salvage saleable or other materials considered to be of some use to them. The findings indicate that diseases such as typhoid fever, malaria, dysentery, tuberculosis and other endemic diseases are associated with the mismanagement of solid waste.

The findings of the research also echo Wolfville and Scotia's, (2002) view that the lack of adequate waste collection and disposal systems causes public health problems resulting in diseases, which aggravates poverty and leads to negative consequences such as loss of income due to illness, increased spending on health care, and the poor becoming deprived of the opportunity to live in a safer environment. Examples of this include malaria moving southwards. The spread by vectors such as mosquitoes could also occur in South Africa. Human exposure to substances released at waste management facilities can be acute in

case of a serious accident causing short-term exposure to high levels of potentially hazardous substances, ionizing radiation, bio-aerosols and dusts (Giusti, 2009).

It was demonstrated that issues arising out of solid waste management in Johannesburg are many and can be set out as follows: littering, illegal dumping, limited refuse removal services in poor areas, lack of encouragement of waste minimization and recycling in the general public; unmaintained parks and open spaces encourage illegal dumping, poor monitoring and maintenance at landfill sites. They contribute intensively to the challenge. Most of these issues are demonstrated in figure 5. Further, improper management occurs as a result of people's unwillingness to respect the existing regulations. The population lacks the will to protect the environment.

In general, the majority of waste disposal situations involve pollution of one kind or another. Pollution is mainly a result of poor disposal methods for sewage and household waste. This takes the form of solid waste contamination of official and unofficial rubbish pits, dumps and open areas (Hunt, 1996). The polluter derives benefit from the environment in being able to dispose of waste but the costs are borne by the community in health costs, the degradation of renewable resources, and a diminution in the already scarce land area available for other uses.

As stated earlier in chapter one, we were all born in the environment and we are all living in the environment. Everything we do affects the environment in one way or the other. Therefore, all our daily activities produce waste. We must also manage the growing amount of the waste we produce. This problem of waste has led to the need for sustainable cities amongst many other factors. Thus, despite the near-universal recognition that sustainable cities and sustainable communities are a desirable policy goal, there is less certainty about what this might mean in practice. Therefore, sustainable cities require an economic process to close the open loop system where consumables are imported into the urban areas and packaging dumped as waste into the bioregional and biosphere (Smit and Nasr,

1992). It was claimed that one of the principal limits to the sustainability of towns and cities is the disposal of some of these by-products namely waste, water and solid waste.

A review on sustainable cities, issues of solid waste management, drawn from various sources was focused on chapter two. Firstly, the chapter defined the concept of waste, solid waste management including its processes as well as waste generation and composition. Secondly, the chapter looked at the different approaches of managing solid waste, where the issues associated with dumping and landfills, incineration, recycling and scavenging, separation and treatment of organic waste have been discussed. Thirdly, the chapter investigated the impact of mismanagement of solid waste on the environment as well as on human health drawing from different perspectives. Finally, the chapter set out the issues of solid waste management with respect to South Africa.

The third chapter presented a description of Johannesburg, the case study area. The first section provided background information on Johannesburg. The previously mentioned section situated the city of Johannesburg in terms of its physical environment. Following that was a description of the governance structure; its historical background; its demographic information, as well as waste collection information. The second section examined the present issues of the management of solid waste. The third section investigated the impact of mismanagement of solid waste on the environment as well as on human health. The last section provided background information on Windsor-Randburg area.

Research data analysis and findings were based in chapter four. The chapter explained method used for gathering data, followed by fieldwork design and departmental description. Firstly, an analysis of data based on general information (socio-economic characteristics) was made. Secondly, the questions associated with the problems of solid waste management in Johannesburg were analysed. Thirdly, the impacts of poor management of solid waste on the environment and on human health were evaluated.

Fourthly, a recommendation for responsibility for the collection and disposal of solid waste in Johannesburg being distributed to everyone who resides in the city was made. Finally, the key role of the government with regard to the problems of managing solid waste in the city of Johannesburg was addressed.

In the light of this summary and conclusion, it is important to take into account the following recommendations.

5.2. Recommendations

The problems facing the city of Johannesburg with regard to the management of solid waste are not impossible to solve but they need a concerted effort from all sectors of society. The management of solid waste in the city of Johannesburg should be the responsibility of every resident. An all inclusive approach (accountability; affordability; polluter pays; equity; sustainable development; integration; the availability of information; subsidiary; waste avoidance and minimisation; co-operative governance; and environmental protection and justice) should be adopted in order to achieve any meaningful and lasting solutions.

However, local authorities should undertake management reforms to bring an end to unsightly areas of uncollected or illegally dumped solid waste. This would involve minimization of waste reaching the drop-off points, in the first place. Community involvement through neighbourhood groups of people from middle and higher income groups and business individuals is necessary to improve the urban environment. Clean neighbourhood groups should mobilize financial resources and engage private groups or hire private trucks to occasionally collect and dispose the waste generated in their community. The other measures include cultivation of a sense of clean environment through clean community awareness programmes. These can go a long way in sensitizing people to keep the environment clean. Regular activities such as clean-up of the neighbourhoods, schools, parks and roadsides can be effective in changing the attitudes even among the poor communities.

The above experiences should also apply to the Windsor community. The consciousness of its residents in terms of their responsibilities as members of the community should be raised. Windsor community action for solid waste management should include direct participation by the residents. Garbage should have a monetary value, everything sells-newspaper, plastic cans, glass bottles, old clothes, old shoes. Instead of people throwing these items into the garbage bins, voluntary organizations could arrange delivery of special boxes to the households and industries to be collected at set times.

Voluntary organizations could undertake programmes for better re-use and recycling of solid material. Such programmes would create new jobs; cut pressure on the city's limited resources available for waste management; reduce total demand for energy; and reduce the health hazards of people involved in the collection of re-usable and recyclable materials from the dumpsites. Moreover, some policy measures such as banning the use of polyethylene bags, and severe penalties for polluters of water and air should be undertaken.

The central government should play an important role in establishing a policy framework that supports good solid waste management practices at the local level. The purpose of this policy should be of enabling legislation (to protect public health, the environment and ensure safe handling practices); regulations and standards (permits, licenses, inspections for landfills, emissions from incinerators, etc.); enforcement (financial and criminal penalties); solid waste planning (recycling and waste reduction targets); market incentives for recycling (beverage container deposits, minimum percent recycled content).

5.2.1. Alternatives for better waste disposal

When planning for the adoption of solid waste technologies, solid waste management authorities should consider the following, among other, issues:

The planning, construction and implementation of new sanitary landfills is costly and lengthy, and small to medium-scale solid waste management practices will be needed in

the interim; The tendency for municipalities to import expensive "end-of-pipe" technologies, such as collection vehicles and processing plants, often leads to additional unsustainable costs in training, repair and site maintenance; dump-upgrading, involving such measures as landfill liners, mandated landfill disposal standards, and low-cost remediation, along with improved waste minimization strategies may prove to be cost-effective alternatives to the development of expensive new solid waste management sites.

In general, the proper management of municipal solid waste is determined by the attitudes of people towards waste, such as the ability to refrain from indiscriminate dumping. Socio-economic characteristics may determine attitudes such as the ability/willingness to recycle municipal solid waste. These attitudes, however, may be positively influenced by awareness-building campaigns and educational measures. In a word, it is the desire of the people that can keep the city clean.

5.3. Avenues for future research

Very few studies have been done on the health effects of mismanagement of solid waste on the workers (waste pickers). A retrospective study done in Sweden, reported an increased mortality from ischemic heart disease and possibly from lung cancer in long-term workers at a municipal solid waste management (Gustavsson, 1989). There is little on potential problems resulting from environmental exposures from composting and very little on recycling. Also, research can be carried-on (more on the government's role, community perceptions, and willingness of the community to manage the waste produce in their area).

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APPENDICES:

RESEARCH QUESTIONNAIRE

Hello, my name is Serge KUBANZA. I am a master's student in development planning at Wits University, currently in my final year. I am conducting research that includes a survey on the ***Issues of Solid Waste Management in South Africa, A case study of Johannesburg***. As a general requirement of the Department of Town and Regional Planning, students in their final year of Master of Science in Development Planning are required to conduct a research in an area of their interest. The information required in this questionnaire is important and will be used to find out the effects of mismanagement of solid waste on the environment as well as on human health in greater Johannesburg.

Please be assured that this is a confidential research/interview, if you feel uncomfortable, you may stop the interview at your own discretion. Your contribution is valued and greatly appreciated, thank you for your co-operation.

Research Description

Human activities have always generated waste, this was not a major issue when the human population was relatively small and nomadic, but now it has become a serious problem with urbanization and the growth of large metropolitan areas. It is the way this waste is produced, stored, collected and disposed that can pose risks to the environment and public health. The purpose of this research is to find out the impact of poor management of solid waste on the environment as well as on human health. The information collected will allow the researcher to provide appropriate solutions with respect to the issues of solid waste management in Johannesburg.

Questions for Municipal and Official Members involved in Solid Waste Management

a) *General information*:

Title: Mr. ☐ Ms. ☐ Mrs. ☐ Dr. ☐ Others……

Job title: ……

Name of Employer: ……

Job Description: ……

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Mission of the organisation: ……

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Years employed by the organization: ……

Qualifications……
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Work Experience: ……
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b). Information related to the issues of solid waste management

1. What do you understand by solid waste mismanagement?
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2. Are there any problems associated with solid waste management in Johannesburg?
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3. What are the general issues encountered in dealing with solid waste in Greater Johannesburg?

   A) Littering ☐ b) illegal dumping ☐ c) poor management of activities ☐

   d)Others……
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4. How has and is your department addressing the problems of solid waste management in Johannesburg?

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5. What would be the impact of mismanagement of solid waste on the environment?

   a) Vegetation damage ☐ b) water pollution ☐ c) Air pollution ☐
   d) Land pollution ☐
   e) Degradation of renewable resource (e.g. water, forest, fruit etc) ☐
   e)Others……
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6. Do you think that if solid waste is not well managed, human health can be in danger? If so, explain?

   a) People will contract diseases ☐ b) People's health will be degraded ☐ c) people may die ☐

   d)Others……
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   ……
   ……
   ……

7. What are common health risks or diseases generated by solid waste mismanagement in greater Johannesburg?

   a) Malaria ☐ b) Tuberculosis ☐ c) Jaundice ☐ d) Typhoid fever ☐

   e)Others……
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8. What efforts are in place by the department to ensure that solid waste mismanagement does not impact negatively on people's health?

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9. Do you know of any other undesirable practices of poor solid waste management that may affect ecosystems (Plants, Animals, Birds, Fishes, etc.)? If so, explain?

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10. Can you identify some areas that show the mismanagement of solid waste in Johannesburg?

a) Windsor ☐ b) Hillbrow ☐ c) Yeoville d) CBD ☐ e) Rosettenville ☐

f)Others.....
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10b. If one of these above areas or another, what the issues are in this particular location?

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10c) Do you think that solid waste management problems are spread out over Johannesburg or Only in few locations?

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11. Which departments deal with solid waste management in Johannesburg?

a) Pikitup ☐ b) Environment Dept ☐ c) Develop planning & urban Mgment ☐
d)Others……
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12. If Pikitup or another entity how does it actually collects the waste in the city of Johannesburg?
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13. Does it actively perform its function well, in collecting garbage in the city of Johannesburg and how does it transport, and where does it dispose solid waste?
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14. Which method does Pikitup use to manage solid waste in Johannesburg? Is it landfill; dumping, incineration or other? Please explain?
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14b) Do they reduce or recycle solid waste in Johannesburg? ……
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15. What do you think can assist Pikitup to deal more efficiently with the problems of solid waste management in greater Johannesburg?
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16. What can the central of other tiers of government do to assist your department to deal effectively and sustainably with problems of solid waste management in greater Johannesburg?

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17. Do you foresee any role that could be played by local communities or others in the management of solid waste in greater Johannesburg? If so, how?

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18. Who do you think should be responsible for the collection and disposal of waste in Johannesburg and why?

    a) Family ☐ b) Municipality ☐ C) NGO ☐ d) Churches ☐ e) Others

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19. What role do you think the government should play in solid waste management in greater Johannesburg?

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Thank you very much for your time and participation in the study!

Questionnaire for the community of Windsor

a) General information:

Title: Mr. ☐ Ms. ☐ Mrs. ☐ Dr. ☐ Other. ……

Area location:……

Street name……

Gender: a) Male ☐ b) Female ☐

Nationality……

Level of education: a) No schooling ☐ b) 7 years/Primary schooling ☐
c) Matric or equivalent ☐ d) University degree ☐ e) Other……..

b) Questions related to solid waste management

1. What is the reason for waste in Windsor?

   a) Human activities ☐ b) Households ☐ c) Industries ☐ d) Street sweeping ☐
   e)Other……
   ……

2. Is waste collected in Windsor? If so, which company or department collects the waste in your area and how many times per week and how do you feel about the service?
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3. Is there any illegal dumping of waste within Windsor? If so, what type of dumping?

   a) Open dumping ☐ b) Landfilling ☐ c) other……..

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4. What is your feeling about the illegal dumping of waste in your area?
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5. Do you think there is anything you can do about it? If so, what?

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6. What are the possible effects of poor management of solid waste in Windsor?

   a) Diseases ☐ b) Environment degradation ☐ c) Human health problem ☐
   d) Air pollution ☐

   e)Other……
   ……

7. What are common health risks or diseases generated by solid waste mismanagement in Windsor?

   b) Malaria ☐ b) Tuberculosis ☐ c) Jaundice ☐ d) Typhoid fever ☐

   e)Others……
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8. Are there any environmental concerns associated with the mismanagement of solid waste within your area?
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9. Who do you think should be responsible for the collection and disposal of waste in Windsor and why? A) Family ☐ b) NGO ☐ C) Municipality ☐ d) Churches ☐
   e)Other……
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10. What do you think the government can do to improve solid waste management in your area?
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11. Is there something or someone, other than the government who can help to improve solid waste management in Windsor? (Who would that be? What could they do?)
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12. What could your contribution be with respect to the issues of solid waste management in your area?
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Thank you very much for your time and participation in the study!