

A Review of Municipal Solid Waste Management Systems in Polokwane City Limpopo Province

TC Maluleke



orcid.org/0000-0002-8224-6201

Dissertation accepted in fulfilment of the requirements for the degree *Master of Science in Geography and Environmental Management* at the North-West University

Supervisor: Dr C Roos

Graduation November 2021

32479484

PREFACE AND ACKNOWLEDGMENTS

Research done by N.V. Mudau in 2015 entitled “A process mapping appraisal of municipal waste management system compliance in Limpopo Province, South Africa” calls for further, more detailed research on waste management systems at a local government level in the Limpopo Province.

This research reports on the review of municipal solid waste management systems in the City of Polokwane, Limpopo Province. Although some research has been done in the Limpopo Province to understand waste management systems and waste-related practices, research which focuses on the flow of waste – from generation to final disposal - in the City of Polokwane, is limited.

Firstly, I would like to give thanks to Almighty God for the wisdom, courage and strength. I would also like to express my gratitude to my supervisor, Dr Claudine Roos, for the useful comments, remarks and guidance through the learning process of this master thesis. Furthermore, I would like to thank my parents Khazamula Richard & Lilian Basani Maluleke for the support through this study. Thank you to the Polokwane Local Municipality general workers for participating in the surveys related to this research, and waste managers who have willingly shared their precious time during the process of interviewing. Lastly, Dzivhani Mutondi Penicious (field assistant), - thank you for your assistance.

ABSTRACT

Waste management in South Africa faces numerous challenges, including a growing population and economy, which cause an increase in the generation of waste. Limited human and financial capacity, the absence of infrastructure and equipment, coupled with the declining levels of capital investment and maintenance, present a challenge to most South African municipalities as far as municipal solid waste management is concerned. Previous research reports on the challenges faced with regards to waste management in the Limpopo Province, highlights the need for further research at a local municipality level. This study aimed to evaluate the municipal solid waste management system in Polokwane Local Municipality, with a focus on identifying challenges and gaps, to, ultimately, make recommendations for improvement.

In order to achieve the objectives of the study, a mixed method (qualitative and quantitative) research approach was adopted. Primary data was collected through observations, interviews with waste managers, and survey questionnaires with general workers. Secondary data was collected from literature review and evaluation of the Polokwane Local Municipality integrated waste management plan (IWMP) and integrated development plan (IDP), as well as supporting documents.

The results of the study indicate that some challenges exist with the implementation of national waste management legislation as it relates to the storage, collection, transportation and final disposal of waste, which may influence the municipality's waste management system performance. When comparing the IWMP goals to the goals of the National Waste Management Strategy (NWMS), the results revealed a gap linking all of the goals, especially Goals 3 and 7. Observations revealed challenges with regards to insufficient receptacles for waste storage, with limited to no separation at source, as well as insufficient operations at the landfill site, with inadequate daily cover, irregular inspection of vehicles at the access gate leading to incorrect data being reported to the SAWIS system. Interview with waste management officers revealed that financial management, equipment management, labour management, and institutional behaviour are the main factors influencing waste management systems within the municipality. Surveys completed by general waste workers indicated that a lack of adequate human resources, and insufficient basic waste management awareness and skills are cause for concern. An improvement in human resource capacity, with a focus on training was recommended.

Keywords: waste management, municipal solid waste, Polokwane local municipality, waste hierarchy.

ABBREVIATIONS AND ACRONYMS

ARF	Advance Recycling Fees
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DLG	Department of Local Government
DOJ	Department of Justice
DRS	Deposit Refund Schemes
DST	Department of Science and Technology
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
ERP	Extended Producer Responsibility
GDP	Gross Domestic Product
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IWMP	Integrated Waste Management Plan
MEC	Member of the Executive Council
MFMA	Municipal Finance Management Act
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NEMA	National Environmental Management Act 107 of 1998
NEMAQA	National Environmental Management Air Quality Act 39 of 2004
NEMWA	National Environmental Management: Waste Act 59 of 2008
NWMS	National Waste Management strategy
WFD	Waste Framework Directive

PET	Polyethylene Terephthalate
PLM	Polokwane Local Municipality
PPP	Public Private Partnerships
RSA	Republic of South Africa
SALGA	South African Local Government Association
SAWIS	South African Waste Information System
SBU	Strategic Business Unit
SDBIP	Service Delivery and Budget Implementation Plan
UNEP	United Nations Environment Programme
WMH	Waste management hierarchy
WMS	Waste management system

KEY DEFINITIONS

Disposal - means the burial, deposit, discharge, abandoning, dumping, placing or release of any waste into, or onto, any land (National Environmental Management Waste Act, Act 59 of 2008).

Landfill – means an appropriately designed, engineered and authorised waste disposal facility (City of Polokwane Integrated Waste Management Plan, 2016).

Minimisation - when used in relation to waste, means the avoidance of the amount and toxicity of waste that is generated and. in the event where waste is generated, the reduction of the amount and toxicity of waste that is disposed of (National Environmental Management Waste Act, Act 59 of 2008).

Municipal solid waste - refers to solid waste from houses, streets and public places, shops, offices, and hospitals (Da Zhu *et al*, 2008).

Municipal solid waste management system - refer to collection, sweeping, storage, transfer, treatment, and final disposal of waste (Da Zhu *et al*, 2008).

Qualitative method - refers to an exploratory research that is carried out to gain a thoughtful of fundamental reasons, opinions, and drives (Creswell, 1994).

Quantitative method - refers to research method that quantify the problem by means of producing data that can be converted into useable statistics, the study shall integrate the two forms of data (Creswell, 1994).

Recycling - means a process where waste is reclaimed for further use, which process involves the separation of waste from a waste stream for further use and the processing of that separated material as a product or raw material (National Environmental Management Waste Act, Act 59 of 2008).

Re-use - means to utilise articles from the waste stream again for a similar or different purpose without changing the form or properties of the articles (National Environmental Management Waste Act, Act 59 of 2008).

Waste - means any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 to this

Act but it excludes explosives waste. (National Environmental Management Waste Act, Act 59 of 2008).

Waste management – includes the importation and exportation of waste, the generation of waste, including the undertaking of any activity or process that is likely to result in the generation of waste, the accumulation and storage of waste, the collection and handling of waste, the reduction, re-use, recycling and recovery of waste, the trading in waste, the transportation of waste, the transfer of waste, the treatment of waste and the disposal of waste (National Environmental Management Waste Act, Act 59 of 2008).

Waste (management) hierarchy - is recognised as promoting management of wastes in the order of preference: avoidance, reduce, reuse, recycle, and recover and disposal (NWMS, 2011; City of Polokwane IWMP, 2016).

Waste separation – refers is a practice that prevent recyclable waste from entering the landfill, and promoting National Waste Management Strategy Goal 1 to promote waste minimization, reuse, recycling and recovery (DEA, 2019).

Waste transfer facility - means a facility that is used to accumulate and temporarily store waste before it is transported to a recycling, treatment or waste disposal facility (National Environmental Management Waste Act, Act 59 of 2008).

TABLE OF CONTENTS

PREFACE AND ACKNOWLEDGMENTS	I
ABSTRACT	II
ABBREVIATIONS AND ACRONYMS	III
KEY DEFINITIONS	V
CHAPTER 1 INTRODUCTION	1
1.1 Background	1
1.2 Problem statement and rationale for the study	1
1.3 Research aim and objectives.....	3
1.4 Scope of the research	3
1.5 Assumptions and limitations of the research.....	4
1.6 Contribution of the research.....	5
1.7 Structure and outline of the dissertation	5
1.8 Chapter summary	6
CHAPTER 2 METHODOLOGY	7
2.1 Introduction	7
2.2 Study area	7
2.2.1 Population size	8
2.2.2 Economic situation	8
2.2.3 Waste management.....	8
2.3 Research design.....	9
2.4 Data collection	10

2.4.1	Secondary data collection.....	10
2.4.1.1	Analysis of the Polokwane LM IWMP and IDP	10
2.4.1.2	Literature review	11
2.4.2	Primary data collection	11
2.4.2.1	Observations	11
2.4.2.2	Interviews	11
2.4.2.3	Survey questionnaires	12
2.4.2.3.1	Demographic profile of survey participants	13
2.5	Data analysis	13
2.6	Ethical considerations	14
2.7	Methodological limitations	14
2.8	Chapter summary	15
CHAPTER 3	LITERATURE REVIEW.....	16
3.1	Introduction	16
3.2	Components of a municipal solid waste management system	16
3.2.1	Waste generation and storage.....	17
3.2.2	Waste collection and transportation	18
3.2.3	Waste separation.....	19
3.2.4	Waste recycling	21
3.2.5	Waste disposal	23
3.3	The role of municipalities in solid waste management.....	25
3.3.1	Providing waste management services.....	25

3.3.2	Integrated planning processes, including IWMP development	25
3.3.3	Collecting data and reporting to SAWIS.....	25
3.3.4	Competent and dedicated waste managers.....	26
3.3.5	Public awareness campaigns	26
3.3.6	Implementing and enforcing waste minimization and recycling	26
3.3.7	Providing political stability and support	27
3.3.8	Financial management and procurement.....	27
3.4	Current approach of municipal solid waste management in South Africa	28
3.4.1	Command and control-based approaches/instruments	28
3.4.1.1	Environmental law	29
3.4.1.1.1	The Constitution of the Republic of South Africa (DOJ, 1996).....	30
3.4.1.1.2	National Environmental Management Act 107 of 1998 (DEA, 1998)	30
3.4.1.1.3	National Environmental Management: Waste Act 59 of 2008 (DEA, 2009)	31
3.4.1.1.4	Municipal Systems Act 32 of 2000 (DLG, 2000).....	32
3.4.1.1.5	Municipal Structures Act 117 of 1998 (DLG 1998)	32
3.4.1.1.6	National Environment Management: Air Quality 39 of 2004 (DEA, 2005).....	33
3.4.1.2	Regulations	33
3.4.1.3	Norms and standards	34
3.4.1.4	Authorisations and permits	35
3.4.1.5	Municipal by-laws	35
3.4.2	Fiscal/economic approaches/instruments	35
3.4.2.1	Levies and taxes.....	36

3.4.2.2	Pricing	39
3.4.2.3	Incentives and disincentives	39
3.4.3	Agreement-based approaches/instruments	40
3.4.3.1	Co-operative agreements	40
3.4.3.2	Public-private partnerships	41
3.4.4	Civil/voluntary approaches/instruments.....	41
3.4.4.1	Public participation	42
3.4.4.2	Information systems (SAWIS).....	43
3.4.4.3	Education and training	43
3.5	Municipal waste management in the Polokwane Local Municipality	43
3.6	Challenges in Municipal Solid Waste Management in South Africa and the Limpopo Province	44
3.6.1	Financial Management	44
3.6.2	Equipment management.....	45
3.6.3	Labour management.....	45
3.6.4	Institutional behaviour	46
3.7	Strategies to improve solid waste management systems	46
3.7.1	Capacity-building and awareness-raising.....	46
3.7.2	Recycling and recovery of waste	47
3.7.3	Improved collection and transportation of waste	47
3.7.4	Expansion of sanitary waste disposal and landfill management.....	48
3.7.5	Integrating waste management and social aspects.....	48
3.8	Chapter summary	49

CHAPTER 4 RESULTS/DATA ANALYSIS AND DISCUSSION	50
4.1 Introduction	50
4.2 Results related to RO1: Evaluating the municipal waste management system and levels of compliance to national legislation of Polokwane City	50
4.2.1 <i>Status quo</i> of waste management practices in Polokwane City	50
4.2.1.1 Separation of waste at source	51
4.2.1.2 Waste storage, collection, transportation and disposal	52
4.2.1.3 Fleet management.....	53
4.2.1.4 Littering and illegal dumping	53
4.2.2 Organisational and institutional matters	54
4.2.2.1 Development and enforcement of by-laws	56
4.2.2.2 Enforcing offenses and penalties	56
4.2.2.3 Financial management and procurement.....	56
4.2.3 Alignment of the IWMP with the 2011 NWMS goals.....	57
4.2.4 Evaluating the levels of compliance to national legislation	60
4.2.4.1 Compliance of waste collection services to legal requirements/standards	60
4.2.4.2 Compliance of waste transportation to legal requirements/standards	61
4.2.4.3 Compliance of waste disposal infrastructure to legal requirements/standards	61
4.2.4.3.1 Compliance of transfer stations to legal requirements/standards	62
4.2.4.3.2 Compliance of the Weltevreden landfill site to legal requirements standards	62
4.2.5 Summary of results related to research objective 1	64

4.3	Results related to RO2: Examining the flow of waste from generation source to final destination	65
4.3.1	Waste generation and storage (including separation of waste at source).....	65
4.3.2	Waste collection and transportation	67
4.3.3	Waste transfer and processing	69
4.3.4	Waste disposal	70
4.3.4.1	Access control, infrastructure and equipment	70
4.3.4.2	Storage of fluorescent tubes	72
4.3.4.3	Waste reclamation activities	73
4.3.4.4	Operational issues	74
4.3.5	Illegal dumping	75
4.3.6	Summary of results related to research objective 2	76
4.4	Results related to RO3: Evaluating the perceived factors that influence municipality waste management system performance	77
4.4.1	Results from interviews with waste officers.....	77
4.4.1.1	Flow of municipal solid waste	77
4.4.1.2	Waste collection services	78
4.4.1.3	Implementation and enforcement of waste minimisation and recycling	78
4.4.1.4	Level of awareness and education with regards to pollution and illegal dumping.....	78
4.4.1.5	Command and control instruments in PLM	79
4.4.1.6	Fiscal/economic instruments in PLM.....	80
4.4.1.7	Challenges encountered by municipality when managing municipal solid waste	80

4.4.1.7.1	Financial management	80
4.4.1.7.2	Equipment management.....	81
4.4.1.7.3	Labour management.....	81
4.4.1.7.4	Institutional behaviour	82
4.4.1.7.5	Other challenges	82
4.4.1.8	Strategies to improve solid waste management systems and save airspace in landfill	82
4.4.2	Results from surveys with general workers.....	83
4.4.2.1	Waste management training	83
4.4.2.2	Waste collection	84
4.4.2.3	Most common challenges during waste collection and waste disposal	84
4.4.2.4	Seriousness of illegal dumping	85
4.4.3	Summary of results related to research objective 3	85
CHAPTER 5	CONCLUSIONS AND RECOMMENDATIONS	87
5.1	Introduction	87
5.2	Conclusions.....	87
5.2.1	Conclusions related to RO1: Evaluating the municipal waste management system and levels of compliance to national legislation of Polokwane City	87
5.2.2	Conclusions related to RO2: Examining the flow of waste from generation source to final disposal	89
5.2.3	Conclusions related to RO3: To evaluate the perceived factors that influence municipality waste management system performance.....	90
5.3	Recommendations for improvement.....	91
5.3.1	Recommendations to improve storage of waste and separation at source.....	91

5.3.2	Recommendations to improve collection and transportation of waste	91
5.3.3	Recommendations to improve community awareness and education	92
5.3.4	Recommendations to improve the landfill site	92
5.3.5	Recommendations to address the illegal dumping of waste	92
5.3.6	Recommendations to improve law enforcement	93
5.4	Recommendations for future research	93
BIBLIOGRAPHY		94
ANNEXURE 1: ACKNOWLEDGMENT LETTER FROM MUNICIPALITY.....		102
ANNEXURE 2: ETHICAL CLEARANCE CERTIFICATE.....		103
ANNEXURE 3: INTERVIEWEE CONSENT FORM.....		104
ANNEXURE 4: INTERVIEW QUESTIONNAIRE FOR WASTE MANAGERS.....		107
ANNEXURE 5: QUESTIONNAIRE FOR GENERAL WORKS.....		109
ANNEXURE 6: LANDFILL OBSERVATION CHECKLIST.....		111

LIST OF TABLES

Table 2-1: Research design and methodology	9
Table 2-2: Demographics of respondents	12
Table 4-1: Alignment of the City of Polokwane IWMP with the 2011 NWMS goals	57
Table 4-2: Characteristics and level of compliance of the Weltevreden landfill site to landfilling requirements (City of Polokwane IWMP, 2016)	63

LIST OF FIGURES

Figure 2-1: Location of Polokwane Local Municipality in South Africa (A) within Limpopo Province (B) under Capricorn District Municipality (Leso <i>et al.</i> , 2016).	7
Figure 3-1: Components of a municipal solid waste management system (Researcher's own compilation, 2020)	16
Figure 3-2: Summary of waste management governance approaches (Nel & Alberts, 2018).....	28
Figure 3-3: Waste Management Hierarchy (NWMS, 2011).....	31
Figure 4-1: Approved Waste Management Organisational Structure (City of Polokwane IWMP, 2016).....	54
Figure 4-2: Proposed Waste Management Organisational Structure (City of Polokwane IWMP, 2016).....	55
Figure 4-3: Examples of non-compliant waste storage practices in the City of Polokwane	66
Figure 4-4: Examples of fluorescent tubes and other hazardous waste types being stored with general wastes.....	66
Figure 4-5: Examples of recyclable materials in the City of Polokwane	67
Figure 4-6: Kerb-side collection in the City of Polokwane CBD	68
Figure 4-7: Street cleaning practices in the City of Polokwane	68
Figure 4-8: Garden waste being lost from a vehicle during transportation.....	69
Figure 4-9: Signage at Webster and Ladanna garden refuse transfer stations	69
Figure 4-10: Examples of non-compliant waste in the City of Polokwane transfer station	70
Figure 4-11: Signage, access control and weighbridge at the Weltevreden landfill site	71
Figure 4-12: Weigh bridge at the Weltevreden landfill site	71
Figure 4-13: Example of a road sign at the landfill site indicating the waste offloading area	72
Figure 4-14: Example of lighting tubes being stored and crushed at the landfill site	73

Figure 4-15: Reclaimed cardboard, plastic bottles and building material (timber)	74
Figure 4-16: Building rubble disposed of on site	75
Figure 4-17: Fire observed at the Weltevreden landfill site	75
Figure 4-18: Some examples of illegal dumping in the PLM	76
Figure 4-19: Illegal dumping site after clean-up	76

CHAPTER 1 INTRODUCTION

1.1 Background

Waste generation is an unavoidable part of human activity. The problems linked with waste can be traced back to the very beginning of civilization, when humans gathered in communities (Ogola *et al.*, 2011). Wastes generated then were enclosed and disposed of by natural processes; however, as the human population increased, the quantity of waste produced has increased as well, which requires proper management, since natural process alone are unable to decompose waste.

Municipal solid waste, also referred to as urban solid waste, typically comprises of household waste (Da Zhu *et al.*, 2008), together with commercial wastes, are collected by a municipality within a given area. The waste may be in solid or semi-solid form and generally excludes industrial hazardous wastes, but mostly includes human and animal excrement, as well as household hazardous chemicals and sometimes sharps (Miller & Spoolman, 2009). These harmful substances may cause disease and injury, more especially amongst children, waste pickers, and employees in the waste management division (Da Zhu *et al.*, 2008).

According to the Constitution of the Republic of South Africa, municipalities are responsible for rendering waste services (which includes collection, transportation and disposal of waste) (DOJ, 1996). Therefore, in South Africa, the management of municipal solid waste management falls within the jurisdiction of local governments and is one of the municipalities' largest single budgetary items. However, when the local municipality has the necessary knowledge and capacity to deal with waste management, it is perfectly situated to effect change and must therefore be proactive in finding waste management solutions (DEA, 2009). However, according to the Africa Waste Management Outlook (UNEP, 2018), most African municipalities *"often do not have the technical or financial capacity to provide efficient services to all residents, with public waste management services frequently characterized as inefficient and expensive"*.

Solid waste collection and transportation are usually the costliest components of a municipal waste management system (Ogola *et al.* (2011). With solid waste expected to increase significantly over the next century, considerable strain will be placed on already strained municipal waste infrastructure (UNEP, 2018).

1.2 Problem statement and rationale for the study

Waste management in South Africa faces numerous challenges, which include a growing population and economy, which means increased volumes of waste generated. This puts

pressure on waste management services, infrastructure and facilities, which are already in short supply (DEA, 2011b). The Department of Environmental Affairs (DEA, 2012b), recognises the importance of establishing effective waste management strategies, policies and programmes to address these issues, many of which need to be aimed at municipal waste management.

The National Waste Management Strategy (NWMS) (DEA, 2011b) seeks to address waste management challenges in the country by focusing on implementing the waste management hierarchy, with the ultimate aim of diverting waste from landfill. To achieve this, the strategy proposes the integration of the waste management hierarchy into waste management services, and suggests the separation of waste at source (DEA, 2011b). The NWMS also promotes access to a basic level of waste services for all citizens and provides objectives for municipal waste management services in the country. Furthermore, the strategy aims to establish effective compliance with and enforcement of the National Environmental Management Waste Act (NEMWA) to ensure that everyone adheres to the regulatory requirements for waste management, and builds a culture of compliance. Many of the goals and objectives of the NWMS falls within the jurisdiction and responsibility of local municipalities to address and execute. However, the majority of local municipalities in South Africa, encounter challenges of operational implementation and achievement of compliance against legislation and national minimum standards for municipal waste management (Mudau, 2015), with a number of issues continuing to present obstacles towards effective waste management.

The absence of infrastructure to implement the waste management hierarchy, such as facilities to separate waste at source, material recovery facilities, buy back and recycling centres, as well as the growing pressure on outdated waste management infrastructure, with declining levels of capital investment and maintenance, presents a challenge to most South African municipalities (Mudau, 2015). In areas where waste management alternatives (to landfilling) are available, they are many times too expensive and outweigh the relatively inexpensive cost of landfilling (DST, 2014), which generally makes landfilling the most common waste management option in the country (although it is the least preferred in terms of the hierarchy). Although estimates put the number of waste handling facilities in South Africa at more than 2000, significant numbers of these are unpermitted (DEA, 2011b) and there are currently too few adequate, compliant landfills and hazardous waste management facilities, which hinders the safe disposal of all waste streams and increases the occurrence of illegal dumping.

Similar to the majority of local municipalities in South Africa, local municipalities in the Limpopo Province encounter challenges of meeting legal requirements and the level of services prescribed by minimum standards (Mudau, 2015). The operative implementation of the waste management

hierarchy, and monitoring and evaluation in order to deliver an effective operational system, remain challenging (Ogola *et al.*, 2011).

A study completed by Mudau (2015) highlights the challenges regarding municipal waste management in the Limpopo Province, and recommends further, more detailed studies focusing on the individual components of municipal waste management systems, specifically recommending research in the Polokwane Local Municipality (PLM). The City of Polokwane IWMP (2016) mentions that the PLM faces challenges of effective execution and accomplishment of waste management systems compliance against national minimum standards for municipal waste management, and there are no formalised waste avoidance initiatives underway in PLM. This study aims to evaluate the municipal solid waste management system in Polokwane Local Municipality, with the aim of identifying gaps, and ultimately providing recommendations for improvement.

1.3 Research aim and objectives

The aim of this research is to review and evaluate the elements of the municipal solid waste management system (which includes waste collection, transportation, separation, recycling and disposal) in Polokwane City (Polokwane Local Municipality) and to suggest recommendations aimed at improving solid waste management systems within the City.

The research objectives include to:

- Research objective 1: Critically evaluate the municipal waste management system and levels of compliance to national legislation of Polokwane City;
- Research objective 2: Examine the flow of waste from generation source to final destination; and
- Research objective 3: Evaluate the perceived factors that influence municipality waste management system performance.

1.4 Scope of the research

The study was limited to an evaluation of the municipal solid waste management system in the Polokwane Local Municipality, Limpopo Province. Related issues that are outside municipal solid waste, such as industrial and hazardous waste management were not included in the scope of the research.

The scope of **research objective 1** – *evaluating the municipal waste management system* – is limited to evaluating and understanding:

- The *status quo* as it relates to waste management services and infrastructure in Polokwane City;
- Institutional and organisational matters as it relates to waste management in Polokwane City; and
- The level of alignment between Polokwane City's integrated waste management plan (IWMP) (and associated IDP) and the goals of the National Waste Management Strategy (NWMS).

The evaluation of the level of compliance in this study relates to waste-related legislation and regulations applicable to the South African local authority context. Determining the level of compliance requires a prior understanding of the municipality as an institution and in what manner it responds to environmental regulations in the form of the national minimum standards, as well as provincial and local regulations. As far as compliance to legislation is concerned, the study focused on determining the level of compliance of waste-related services (such as waste collection and transportation) and waste-related infrastructure (such as landfill sites) to legal requirements.

The scope of **research objective 2** – examining the flow of waste from generation to its final destination – was based on observations conducted from **August to October 2020**. The scope of observations included waste generation and storage, separation of waste at source, collection and transportation, and final disposal. The observations also focused on factors which may influence the flow of waste, such as illegal dumping and waste reclamation (“picking”).

Research objective 3 (perceived factors influencing municipal waste management performance) mainly focused on the insights of municipal officials responsible for waste management and general workers (responsible for litter picking and street sweeping) in Polokwane City. The research focused on determining the success factors and challenges experienced within Polokwane City, also focusing on the types of governance instruments (command and control, fiscal, civil, voluntary) implemented by the municipality.

The study was conducted in the period **February 2020 to November 2020**.

Where comparisons are made with the National Waste Management Strategy (NWMS), the 2011 version of the strategy is applicable. The final updated NWMS was only available in 2020. It could not be reasonably expected that the documents reviewed during this study could contain any information that is aligned with the 2020 version of the NWMS.

1.5 Assumptions and limitations of the research

Municipal solid waste research in the Limpopo Province is limited and has mainly focused on flow of waste from the source of generation to final disposal. Research specifically relating to the

separation and recycling of municipal solid waste in the City of Polokwane is limited. As a result, the researcher has inferred from national and international best practices and induce these findings to the Limpopo context. The findings of the study were based on the collection of primary data (based on observations and interviews), as well as secondary data obtained from the City of Polokwane IWMP, dated March 2016.

1.6 Contribution of the research

The waste management system performance is conveyed regularly as a whole system, with little regard to the subtleties of its components. This study aimed to provide an evaluation of the components of the waste management system of the Polokwane Local Municipality. Although the findings of the research are applicable to a specific municipality in South Africa, it may be generalizable and may be applicable to other municipalities in the country, as well as other developing countries. In the majority of South African municipalities recycling activities are limited to the contributions of informal waste reclaimers, with limited formal recycling taking place. However, provision should be made to reduce waste disposal of waste to landfill. The research may also provide knowledge of potential opportunities within the developing country context, to ultimately encourage good waste management practice within South African municipalities.

1.7 Structure and outline of the dissertation

The dissertation consists of five chapters.

Chapter 1: Introduction - Provides the background to the municipal solid waste worldwide, it likewise provides the motivation of the study, research problem, the aim and objectives and it moreover provides the outlining of the study.

Chapter 2: Methodology - Outlines a brief overview of the study area, the research methodology applied during the study, sampling methods, data collection, data analysis and limitation of the study.

Chapter 3: Literature Review - Emphases on a literature review of municipal solid waste. The chapter gives background to waste generation, waste collection and transportation, disposal, international, national and local policies and legislation, strategies to improve solid waste management systems and the current approach of municipal solid waste.

Chapter 4: Data Analysis and Discussion - Affords the results of the study in the form of expressive statistics and discussion.

Chapter 5: Conclusion and Recommendations - Summarise the findings and make recommendations grounded on the findings of the study.

The Bibliography is presented after Chapter 5. Annexures are also appended (in the last part of this dissertation) and referred to in text, where applicable.

1.8 Chapter summary

This chapter highlighted background of the study, problem statement and rationale for the study and research aim and objectives also giving the overview of structure and outline of the dissertation. Chapter 2 will give detailed description of the study area, the procedures used in conducting the research and the method used for data collected, as well as data analysis techniques.

CHAPTER 2 METHODOLOGY

2.1 Introduction

This chapter discuss a detailed description of the study area, the procedures used in conducting the research, the method used for data collected, and further discusses the data analysis methods that were used.

2.2 Study area

The Polokwane Local Municipality (PLM) is situated in the northern part of South Africa, centrally within the Limpopo Province and the Capricorn District Municipality. The Municipality covers an extensive area of 377 579 hectares. It is the administrative capital of Limpopo and is also the economic hub of the province, (Abrahams, 2017). The PLM accounts for a total population of 812,000, or 60.0% of the total population in the Capricorn District Municipality, which is the most populous region in the Capricorn District Municipality for 2017, (City of Polokwane, 2020a). Polokwane is still 70% rural, its urban node is a growing, modern city. Linked to this primary node are the two smaller, formal towns of Seshego and Mankweng. On the outskirts of these urban areas are four clusters of settlements, namely Seshego, Sebayeng/Dikgale, Mankweng and Aganang (Abrahams, 2017).

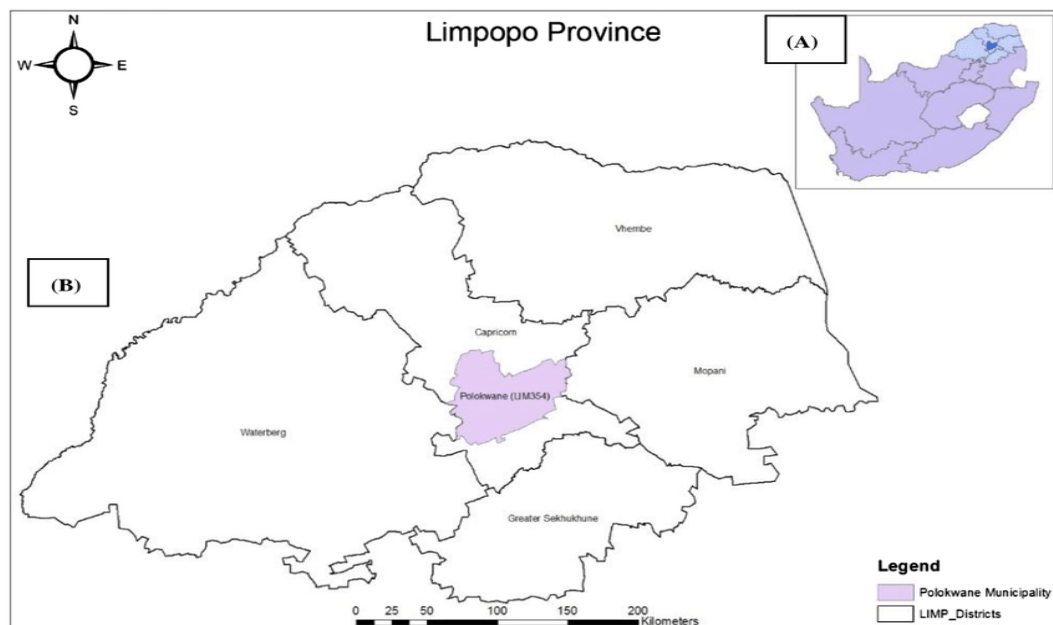


Figure 2-1: Location of Polokwane Local Municipality in South Africa (A) within Limpopo Province (B) under Capricorn District Municipality (Leso *et al.*, 2016).

2.2.1 Population size

PLM has a population of about 812 000 people, and housed 1.4% of South Africa's total population in 2017. Between 2007 and 2017 the population growth averaged 1.59% per annum which is very similar to the growth rate of South Africa as a whole (1.56%). Compared to Capricorn District Municipality's average annual growth rate (0.99%), the growth rate in Polokwane's population at 1.59% was close to double than that of the district municipality (City of Polokwane, 2020a).

2.2.2 Economic situation

Polokwane is both the capital city and the economic hub of Limpopo Province. Its role as an administrative and financial centre and its central location as a transport hub, dominate its sectoral contribution to the local economy (Abrahams, 2017). The municipality has the Polokwane International Airport where various commercial flights enter and exit the town of Polokwane and there are three major malls in the municipality (City of Polokwane IWMP, 2016).

The primary sectors of agriculture and mining, though they contribute a small percentage to the economy, are in decline. The secondary sector manufacturing and construction is fairly small but significant in Polokwane. It has been 'holding its own' but is struggling to increase its contribution, (Abrahams, 2017). In terms of the local context, the Polokwane 2030 Economic Growth and Development Plan will seek to provide insight on the way forward for the municipality to ensure that development is holistically proactively conceived, rather than exclusively and in an interventionist manner (Polokwane Municipality, 2014).

2.2.3 Waste management

Waste management as a critical constituent of the urban development process is not considered a priority in Polokwane (Mudau, 2015). The prioritization of needs by municipal waste management directorates, such as sorting of waste at source, is not appropriate for an efficient waste management system. PLM has no waste minimization strategy in place (City of Polokwane IWMP, 2016). The National Waste Management Strategy (DEA, 2011b) and the Polokwane Declaration of Intent (September 2001) sets a clear mandate for the prioritisation of waste avoidance in South Africa.

The PLM offers a high level access to waste management in the urban areas. PLM is divided in to three waste service areas and their surroundings namely; Polokwane City, Seshego and Mankweng. Households are responsible for their own bags, and instructed to place full bags on the kerbside for collection as per a specific refuse collection programme. Compactors are used to collect the waste (City of Polokwane IWMP, 2016). Waste collected in the main urban area of

Polokwane is disposed of at the Weltevreden landfill site, however problem being experienced currently is that waste management is not being informed of new development in the municipality.

2.3 Research design

The researcher has used a mixed method research approach to collect data to address the research objectives. Mixed methods research is an approach to inquiry that syndicates or associates both qualitative and quantitative methods. It consists of philosophical assumptions, the use both qualitative and quantitative approaches, and the mixing of both approaches in a study (Creswell, 2009). Table 2-1 outlines the research design of this study.

Table 2-1: Research design and methodology

Research Objective	Methodology	Justification
Research objective 1: To critically evaluate the municipal waste management system and levels of compliance to national legislation of Polokwane City.	Review and analysis of the PLM Integrated Waste Management Plans (IWMP), and Integrated Development Plan (IDP), supported by a wider literature review and observations.	Information presented in the IWMP enabled the researcher to gain an understanding of the waste management practices within the context of Polokwane Local Municipality. The IWMP contains an action plan with various targets to be achieved by municipality which complies with national standards.
Research objective 2: To examine the flow of waste from generation source to final destination.	Observations were applied to note the flow of waste from generation source to final destination, and the researcher took photographs and notes at various sites within the PLM.	Observation fosters an in depth and rich understanding of a phenomenon, situation and setting of area of study. Furthermore observation is an essential part of gaining an understanding of naturalistic setting.
Research objective 3:	Semi-structured interviews were conducted with waste management officers and	Interviewing the officials and distributing surveys to general workers provided better

Research Objective	Methodology	Justification
To evaluate the perceived factors that influence municipality waste management system performance.	semi-structured questionnaires (surveys) were distributed to general workers responsible for waste management within the PLM.	understanding of the waste management systems used within the PLM as they are the key informants and they encounter challenges on daily basis.

This approach involves collecting both, qualitative and quantitative data. The qualitative data can assume any of the forms, such as document (literature review), interviews and observations, documents, and records. A field survey provides a quantitative data or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. (Creswell, 1994).

2.4 Data collection

Both primary and secondary data have been used to collect data and acquire information related to the research objectives (Refer to Table 2-1).

2.4.1 Secondary data collection

The researcher reviewed the Polokwane Local Municipality IWMP (2016) and IDP (2020/21), and supporting literature, such as the Service Delivery and Budget Implementation Plan (2019/2020) as secondary data to understand and appreciate different viewpoints and debates on municipal solid waste management.

2.4.1.1 Analysis of the Polokwane LM IWMP and IDP

Data collection began with an analysis of City of Polokwane IWMP (2016) to understand the *status quo* of waste management in PLM, description of the services that are being provided or that are available for collection, minimization, re-use, recycling, treatment and disposal of waste, and also to check level of compliance to national standards (National Waste Management Strategy, Waste Classification and Management Regulation, National Norms and Standards for the Storage of Waste, National Waste Information Regulations, National Pricing Strategy for Waste Management, Norms and Standards for Sorting, Shredding, Grinding, Crushing, Screening or Baling of General Waste, and National Norms and Standards for Disposal of Waste to Landfill). City of Polokwane IDP 2020/21 was analysed to check see whether IWMP actions have been budgeted for.

2.4.1.2 Literature review

The main aim of the literature review was to gain an understanding of existing research and to determine the *status quo* of waste management in PLM. The literature review included studies of other South Africa, African and other developing context municipalities, which have engaged innovation to improve their solid waste management. Two studies provided key insights into waste management in the Limpopo Province, and more specifically in Polokwane. These included: “*A Review of Solid Waste Management Practices in Polokwane City, Management of Municipal Solid Wastes: A Case Study in Limpopo Province*” (Ogola *et al.*, 2011), and “*A Process Mapping Appraisal of Municipal Waste Management System Compliance in Limpopo Province, South Africa*” (Mudau, 2015). Based on lessons learned from other municipalities, the researcher has used literature to make recommendations to improve waste management. Literature was obtained from academic search engines available on the North-West University library platform and online platforms such as Google Scholar, Semantic Scholar and Research Gate. The type of sources used included, academic journals, online articles, theses, government and organizational reports.

2.4.2 Primary data collection

The sections below outline the primary data collection methods.

2.4.2.1 Observations

The researcher observed the flow of waste from generation source to final destination. The researcher followed PLM municipal waste collection truck during refuse removal up to final disposal. The researcher used a notebook to take notes of the process and a camera was used to take photos of the process from point of generation within the city to landfill site. Photographs of the activities were taken during the course of the process in order to record the distinctive range of activities involved in from waste collection to final disposal. An observation checklist (drafted from legislation, minimum requirements and the conditions of the landfill permit) was used at Weltevreden landfill site to observe the activities at the landfill (Annexure 6). The observation checklist focused on classification and ownership of the site, permit status, operational aspects, access control and signposting, waste acceptance, final cover, general site maintenance, burning of waste, etc. (Annexure 6).

2.4.2.2 Interviews

The researcher conducted semi-structured interviews with four (4) waste managers to understand the PLM waste management system, the perceived factors that influence the municipality's waste management system performance and strategies to improve waste management practices. Due to COVID-19 convenience sampling was used to select participants. Open-ended questions were

used during the interview to encourage full, meaningful answer from waste managers (Annexure 4). Interview questions focused on gathering information on education and years of experience; establishing any issues regarding the flow of waste, waste collection, public-private partnerships, implementation and enforcement of waste minimisation and recycling, education and awareness, command and control instruments, fiscal/economic instruments and strategies to improve solid waste management systems. They were also asked to rank and discuss challenges related to financial-, equipment- and labour management, as well as institutional behaviour, and invited to comment on any other challenges (Annexure 4).

The interviews with waste managers were conducted in a closed municipal office to allow for privacy and to minimize interruptions. The researcher used a notebook to record the responses from interviewee. Responses were not audio-recorded.

2.4.2.2.1 Demographic profile of interview participants

Table 2-2 contains the demographic information of the interviewed participants, such as their position, highest qualification and years of experience, as reported by the participants. The respondents were (at the time of the interviews) all working within the waste management field in the PLM, with between 4 to 9 years of experience. They are representative of 27% (four of fifteen) of senior employees (officers, supervisors or superintendents) working within the waste management department. Some of the officers that were invited to interview did not respond or indicated that they were not available, mainly due to COVID-19 restrictions.

Table 2-2: Demographics of respondents

Respondent	Position at PLM	Highest qualification	Years of experience in profession
Respondent 1	Waste Education Officer	Degree	4 – 8 years
Respondent 2	Waste Management Senior Superintendent	Degree	9 years and above
Respondent 3	Waste Management Senior Superintendent	Honours Degree	4 – 8 years
Respondent 4	Landfill Operations Supervisor	Honours Degree	9 years and above

2.4.2.3 Survey questionnaires

A survey comprising of semi-structured questions (questionnaire) on municipal solid waste were designed and distributed to general workers to understand the day-to-day operational challenges

that they encounter while executing their tasks (linking to RO3). The questionnaire contained both open-ended and closed questions.

A survey was used, instead of interviews, due to time constraints, because it is a more rapid means of gathering information from larger stakeholder groups (Liyanage & Perera, 1998). The questionnaires were divided into two sections: Section A for general information such as gender, age and working experience; and Section B focused on waste-related training, sufficiency of resources to render waste collection services, frequency and means of waste collection (separated or mixed), common problems encountered during litter picking, perceptions around illegal dumping, problems encountered during waste disposal (Annexure 5). The questionnaires were completed anonymously to maintain confidentiality.

The questionnaires were randomly distributed by hand to a sample of 40 general workers within the PLM responsible for street sweeping and kerb-side waste collection. They are representative of 25% (40 out of 160). All 40 agreed to participate in the research (100% response rate). The researcher assisted the respondents to complete questionnaires (since some were illiterate or required further clarification). Their demographic profile is presented in Section 2.4.2.3.1 below.

2.4.2.3.1 Demographic profile of survey participants

The sections below contain demographic information of the survey participants (general workers), such as age, gender, their position, and years of experience.

Twenty-four (60%) of the respondents were female and 16 (40%) were male. The respondents were from different age categories, with seventeen (42%) of the 40 participants being between 18 and 35 years of age, 18 (45%) being between 36 and 49 years of age, and only 5 (13%) being 50 years old and above. The nature of work performed by the participants consisted of kerb-side waste collectors (40%, mainly males) and street sweepers (60%, mainly females).

The majority of the respondents were employed as part of EPWP (Expanded Public Works Programme). The aim of the EPWP is to provide poverty and income relief through temporary work for the unemployed to carry out socially useful activities. As such, 65% of participants (working as part of the EPWP) have three months of working experience, while 35% (mostly permanent PLM employees) had more than 5 years of working experience.

2.5 Data analysis

Data collected through interviews and surveys were analysed by coding and data clustering, with similar responses organised into categories. An observations report was compiled using notes and photos taken during observation. Field surveys were analysed through the use Microsoft

excel 2016. Excel was used to create frequency and percentage tables to analyse and represent data and summary of responses for open question.

2.6 Ethical considerations

According to the North-West University (NWU, 2018), ethical considerations should be acknowledged and taken into consideration during research. The study was conducted based on secondary data gleaned from the literature, supported by interviews and observations. The study involved human participants, but did not include any sensitive respondents (i.e. children, persons with disabilities, etc.). The research proposal was submitted to the Scientific Committee of the Environmental Management Research Group (EMRG) in the Unit for Environmental Sciences and Management of the North-West University, Potchefstroom Campus for consideration. The scientific committee found that the project proposal was in accordance with the scientific method and adhered to the required standards as set out in the Academic Rules for Master's and Doctoral Students at North-West University. The Scientific Committee concluded that the proposed methodology posed a low ethical risk. An expedited review by the Faculty of Natural and Agricultural Sciences (FNAS) concluded that the study was of low ethical risk (NWU-01458-20-A9) (See Annexure 2).

When engaging with human participants, the researcher ensured that each questionnaire was accompanied by an informed consent form requesting the respondents' consent to participate in the study. The consent form comprised of the purpose of the study, benefits and ensured participants about their confidentiality and anonymity (See Annexure 3). The participants were not requested to disclose any personal information on the questionnaires, and participants were informed that their participation was voluntary.

2.7 Methodological limitations

The study was carried out in the period of disaster management (COVID-19) and it was difficult to find respondents (waste management officers) as some were working from home, with strict access control conditions to their offices. It was also difficult to access waste management by-laws, since at the time of this study it was only available in hardcopy was not yet uploaded to municipality's website. When conducting the surveys with general workers, the majority of the participants were very restrained when providing information regarding waste management processes, hence the researcher spent much time and skill in clarifying the very important purpose of this study to collect the necessary information from the participants.

2.8 Chapter summary

This chapter elaborated on the methodology that was used in conducting the research, providing an overview of the methodological design, data collection, data analysis, ethical considerations, as well as the methodological limitations. The next chapter, Chapter 3 provides the literature review, to provide context to the research.

CHAPTER 3 LITERATURE REVIEW

3.1 Introduction

This chapter presents the literature review, which aims to provide context to the research. The literature further aims to address research objective 1, which aims at *critically evaluating the municipal waste management system and levels of compliance to national legislation of Polokwane City*.

The literature review chapter provides an overview of: (a) the components of a municipal solid waste management system; (b) the role of municipalities in solid waste management; (c) the current approach of municipal solid waste management in South Africa; (d) municipal waste management in the Polokwane Local Municipality; (e) challenges in municipal solid waste management in South Africa and the Limpopo Province, and finally (f) the strategies to improve solid waste management systems.

3.2 Components of a municipal solid waste management system

Municipal solid waste management systems consist of several functional elements, which include waste generation, waste collection and transportation, as well as processing and transformation, transfer and processing, and, finally, disposal of solid waste (Haghi, 2010). Each of these elements will be discussed in the sub-sections to Section 3.2 of this dissertation to provide a basic understanding of these components. Emphasis is placed on understanding the developing country context, since the study area, Polokwane Local Municipality, is located in South Africa, which is a developing country.

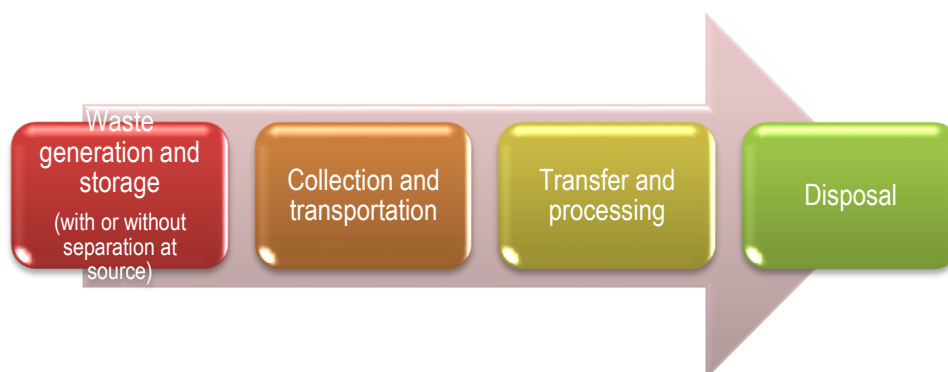


Figure 3-1: Components of a municipal solid waste management system (Researcher's own compilation, 2020)

3.2.1 Waste generation and storage

Waste generation occurs at the source of waste where it encompasses activities in which materials are identified as no longer of value to the generator of waste¹ (Nkosi, 2014), and as such are being thrown away. Municipal solid waste is generated by domestic households, commercial and industrial enterprises, and institutional activities (Da Zhu *et al.*, 2008). According to the South African Waste Information System (SAWIS), approximately 42 million tonnes of general waste was generated in South Africa in 2017. The largest contribution of the total quantity of general waste (generated in 2017) consisted of biomass from sugar mills, sawmills and paper and pulp industry (35%), organic waste (16%), construction and demolition waste (13%), scrap metals (8%), and commercial and industrial waste (7%). Approximately 1.8 million tonnes (approximately 4%) comprised of municipal (domestic) waste (SAWIS, 2018).

There are several factors which may influence the types and quantities of domestic waste generated by households. These include population growth, as population grow there is an increase in the consumption of natural resources and consequently the quantity of waste generated, however urbanisation is a key driver as waste generation rate tend to be much higher in urban areas, this is because on average residents in urban areas are richer (SAWIS, 2018). Moreover, economy as waste generator is linked to production of goods and services, provinces with a higher Gross Domestic Product (GDP) are likely to place greater stress on waste management.

Generally, income level is a factor influencing the amount of waste generated by households (Ogola *et al.*, 2011), with higher income groups generating more waste than lower income groups (for example high income households produce approximately 5.1 kilograms of waste per person per day, while low income households produce approximately 1.42 kilograms of waste per person per day) (Hoornweg & Bhada-Tata, 2012).

Generated waste is temporarily stored (usually in bins or skips), after which it is collected, normally by means of kerb-side collection. Waste storage infrastructure may have a significant impact on waste collection systems (Nkosi, 2014) and the future recycling potential of waste, where in South Africa, separation of waste at source rarely takes place. In South Africa, approximately 12,9% of metropolitan households self-reported that they recycled, followed by 10,8% of households across urban areas, and 3% of households in rural areas. Of the rural

¹ In the South African context, the definition of waste reflects on whether an article is unwanted, rejected, discarded or of no further use to the generator of the waste. Meaning that although an article may have use value, it is considered to be “waste” if the generator has no further use for it.

households participating in the Census survey, recycling was generally more common in households on farms than households in traditional areas (StatsSA, 2016).

3.2.2 Waste collection and transportation

Collection is generally the most expensive element of a waste management system, accounting for between 50 and 70 percent of the costs for waste management. These costs include those associated with hauling the waste to a disposal location, where it may be processed for re-use, recycling or recovery, or where it is destined for final disposal (Agamuthu & Masaru, 2014).

Waste collection systems are similar in most developing countries, wherein households place their day-to-day refuse into a waste container (bin). Refuse is then collected (usually by means of kerb-side collection) and either conveyed to a waste transfer facility (where waste could be prepared for processing, such as a materials recovery facility, or where waste is collected from the facility for disposal) or directly to a disposal facility (usually a landfill) (Ogola *et al*, 2011). The frequency of waste collection may differ in different municipalities. For instance, in Ba-Phalaborwa Local Municipality collection of waste including electronic waste, is once a week (Tshimbana, 2014), while in municipalities such as Tzaneen waste collection is more frequent (up to two times per week) and in municipalities such Thulamela Local Municipality waste collection is problematic (less than once in two weeks) (Mudau, 2015).

The South African minimum standards for waste collection, however, specifies minimum waste collection frequencies of not less than once in a week. The standards aim to redress past imbalances in waste collection services, however municipalities will use the standards to determine the level of service to provide and to select options for waste collection, separation at source, provision of receptacles, collection vehicles, and health and safety standards (DEA, 2011). Numerous municipalities struggle to meet weekly waste collection services to all households (CSIR, 2011). The 2002–2016 South African Census survey (StatsSA, 2016) indicate that in 2016 only 59% of households received waste collection services. The National Waste Management Strategy (NWMS) identifies the provision of waste collection services as one of its objectives, where it aims at ensuring the effective and efficient delivery of waste services of 95% of urban households and 75% of rural households (DEA, 2011b).

Waste collection remains a challenge in developing countries due to, *inter alia* restricted budgets, the geographical location of waste disposal or processing sites relative to the sources of waste generation, and waste collection vehicles not being able to access the areas where waste was generated, especially in informal areas (Agamuthu & Masaru, 2014). In Thulamela and Makhado municipalities the frequency of waste collection was as low as once per month, partly due to problems of accessibility (Mudau, 2015). According to Ginindza & Muzenda, (n.d) inhabitants are

exposed to odours, flies due to municipal vehicles experience a lot of breakdowns during collection, and as a result of inconsistent waste collection patterns it has led to illegal dumping in open spaces and around waste skips.

Waste collection systems need to provide for the collection of separated waste in order to give effect to the waste management hierarchy as proposed by the NWMS (DEA, 2011b).

3.2.3 Waste separation

The National Waste Management Strategy (NWMS) aims to promote waste minimisation, re-use, recycling and recovery of waste, and has set the objective of diverting 25% of recyclables from landfill sites for re-use, recycling or recovery (by 2016). The NWMS seeks to achieve this by *“initiating separation at source programmes by all metropolitan municipalities, secondary cities and large towns”* (DEA, 2011b). It is estimated that approximately 4.9 million tonnes (11%) of general waste was recycled in 2017, taking into account the waste recycled as reported into the South African Waste Information System (SAWIS, 2018). This is still far from the 25% target set by the NWMS.

Separation at source programmes need to be supported by *effective and efficient delivery of waste services* (Goal 2 of the NWMS) by promoting access to at least a basic level of waste services for all and integrates the waste management hierarchy into waste services (as discussed in Section 3.2.2), including separation at source.

Separation at source generally refers to the practice of setting aside (or separating into categories) post-consumer waste materials at household, commercial and industrial level, from a generally mixed waste stream (DEA & DP, 2019). Waste is separated, at the point of generation, into various categories, such as organic, recyclable (paper, plastic, glass and metals) and non-recyclable wastes (UNEP, 2018). Separation of waste at source plays a key role in achieving the diversion of waste away from landfill by providing clean recyclables not contaminated by other waste. This provides for easier and more efficient collection of recyclable wastes, with a lower chance of rejection by recycling processors, because the waste is cleaner and therefore has higher value (DEA & DP, 2019).

Initial solid waste sorting has been implemented in some developing countries. These initiatives have had limited success for several reasons, including the lack of community awareness, lack of local technical skills, and the lack of technology, treatment facilities and infrastructure to process separated solid waste, which makes sorting at source pointless as all solid waste eventually ends up being disposed of at landfills (Agamuthu & Fauziah, 2011b; UNEP 2018). Furthermore, there is typically also no enabling regulatory environment (legal requirements) for

separation at source in African legislation, and incorporating separate collection of recyclables into existing collection systems can be challenging as collection vehicles may not be adapted for separate collection systems (UNEP, 2018). Source separation of recyclables without any significant financial benefit can be challenging as it is considered time consuming by households, however, the easier it is for communities to dispose of recyclables, the more likely they are to take part in the initiative (CSIR, 2011; Oelofse, 2018).

In most African cities and towns waste management consists of uncontrolled dumping of mixed waste in open dumpsites (UNEP, 2018), with very limited separation of waste. Some successes have, however, been reported, within the African context. At the City of Johannesburg (CoJ), for example a source separation project has been piloted in the Waterval region. This pilot has adopted a three-bag system where waste was separated into the following categories: paper and other dry recyclables (plastic, tins and glass) and residual waste (Rasmeni & Madyira, 2019). In the 2014/15 financial year, 20 808 tonnes of dry waste (i.e. paper, plastic, glass, cans) were successfully diverted away from landfill sites by means of the separation at source programme, compared to 15 000 tonnes in the previous financial year (Pikitup, 2015). Polokwane Local Municipality is initiating programmes to supply different coloured bags/bins for various waste types to encourage waste separation (City of Polokwane IWMP, 2016). In other areas, separation of waste at source initiatives have been less fruitful. Some challenges were, for example, reported in the Thulamela Local Municipality, where they have placed colour-coded bins at designated public places, which was unsuccessful, because the bins had no separate divisions inside (Mudau, 2015).

In South Africa, the informal activities of waste pickers (persons reclaiming recyclable wastes from mixed waste streams) contribute to the separation of waste at source (Agamuthu & Fauziah 2011a; Oelofse, 2018). The waste types collected by waste pickers is largely determined by what they can sell and/or use. It was revealed that the buy-back centres buy paper, cardboard boxes, plastic bottles and in some instances, scrap metal (Schenck & Blaauw, 2011), which are the main waste streams separated by waste pickers. According to DEA, (2016b) it was estimated that, in South Africa there were approximately 62 147 waste pickers, with approximately 36 680 collecting waste from landfills and about 25 467 trolley pushers, collecting waste via kerb-side collection. Although these activities are largely informal and do not form part of the formal separation at source activities of municipalities, some examples of integration or support exist. For example, in City of Johannesburg (CoJ), Pikitup provides assistance to informal waste reclaimers through the establishment of cooperatives or non-profit organisations which collect recyclables from the separation at source (SAWIS, 2018).

According to Oelofse (2018), local governments should put favourable policies and incentives in place for the promotion of waste minimization through the 3Rs (reduce, reuse, and recycle). Waste separation at source should be promoted to make waste recycling and recovery easier and more affordable, and to ensure collection of clean recyclable waste streams with higher value (UNEP, 2018). The separation at source must be implemented in line with the municipality's IWMP and waste by-laws in order to mitigate against increasing waste generation, landfill airspace depletion, environmental degradation and pollution as a result of illegal dumping, littering etc. (DEA, 2018a). Low-cost technologies for recycling and recovery of secondary resources, combined with social innovation, appear to be the most effective technologies within the developing country context. (UNEP, 2018).

3.2.4 Waste recycling

As mentioned earlier, the NWMS aims to promote waste minimisation, re-use, recycling and recovery of waste, and has set the objective of diverting 25% of recyclables from landfill sites for re-use, recycling or recovery (by 2016) (DEA 2011b). Recycling is the practise of collecting and reprocessing a resource so that it can be prepared into new product (Miller & Spoolman, 2009). Generally, there are three types of recycling, namely primary, secondary and tertiary recycling. Primary or closed-loop recycling is where waste is recycled into new products of the *same types*, for instance collecting aluminium cans, melting them down and use the aluminium to make new cans (Goodship, 2010). Secondary recycling is where waste is converted into different products, for example using an aluminium can into other aluminium products. Tertiary recycling involves the recycling of waste into new products, for instance glycolysis of Polyethylene Terephthalate (PET) into diols and dimethyl terephthalate that can then be used to make virgin PET (Merrington, 2017).

The NWMS sets targets for industries, such as paper and packaging, lighting and electronic products, to recycle their waste, mostly through extended producer responsibility schemes, by focusing on the entire sector. At a municipal level, however, individuals and households have a role to play, especially as far as separation of waste at source is concerned (refer to Section 3.2.5).

Waste recycling presents an opportunity to save resources, reduce the environmental impact of waste by reducing the amount of waste disposed at landfills, and create employment opportunities (DEA, 2012b). This also helps in saving energy, the production of products from recycled material uses less energy than the production of the same product from raw materials and reduces methane emissions (landfill gas) (DEA & DP, 2019). According to UNEP (2018), recycling and re-use can reduce the financial, social and environmental expenses associated with waste collection and disposal, and therefore their place at the top of the waste management hierarchy.

In the South African context, district municipalities are responsible for the implementation and enforcement of appropriate waste minimisation and recycling initiatives and may delegate actions to local municipalities. For that reason, municipalities can integrate recycling targets into their integrated waste management plans (IWMPs) and give effect to actions as part of municipal waste collection schedules (CSIR, 2011; Afrika *et al.*, 2016). While separation at source, to encourage recycling, could be done at a municipal level, waste is mostly recycled by industry (private sector recycling).

In South Africa, waste recycling is more established in provinces, and mostly metropolitan municipalities, with the largest urban populations and least common in the more rural provinces (StatsSA, 2016). According to South African Census information (2016), the Western Cape had the highest percentage (20,3%) of urban households that sorted waste for recycling, followed by Gauteng at 12,7%, while only 1,2% of urban households recycled waste in the Limpopo Province. In the Western Cape, in the Overstrand Local Municipality, recycling takes place at the Hermanus MRF, and it is facilitated by Walker Bay Recycling (Overstrand IWMP, 2015). The Walker Bay Recycling Centre has a buy back facility that is used by young and old, the incoming recyclables are weighed, a number allocated and then paid for in cash (CSIR, 2011). They also chip garden waste and compost it at the Karwyderskraal landfill. This collective effort of recycling and garden waste chipping and composting amounts to an average of 23% of the total generated waste stream being diverted from landfill (Overstrand IWMP, 2015).

In South Africa, examples exist of government encouraging waste recycling, by presenting waste buyback centres, garden waste drop-off centres, separation of different waste streams, these inspiration efforts have so far been relative unsuccessful (DEA, 2012b). In the Limpopo Province, for example, Thulamela Local Municipality (TLM) have colour coded bins at designated public places but this is fruitless because the bins have no separate divisions inside, resulting in recycling program failure (Mudau, 2015), however, some informal waste reclamation takes place, with TLM allowing informal waste pickers to recover recyclable material from Thohoyandou Block J landfill site (Nefale, 2018) – which is also not ideal.

Apart from the participation in initiatives (such as the separation of waste at source – as mentioned in Section 3.2.3), equipment and infrastructure plays a very important role in the recycling of waste (Miezah *et al.*, 2015), which could present challenges in developing countries. Charging excessive fees at the drop-off sites might discourage the use of these facilities (CSIR, 2011). Complex recycling processes and technologies may be challenging within the developing country context.

3.2.5 Waste disposal

According to the National Environmental Management Waste Act (59 of 2008) (NEMWA), *disposal* means the burial, deposit, discharge, abandoning, dumping, placing or release of any waste into, or onto, any land (DEA, 2009). In South Africa, the most common means of waste disposal is through landfilling (either general or hazardous waste landfill sites), while incineration is used for waste streams, such as health care risk waste (HCRW) and other wastes prohibited from being landfilled.

Incineration which is one of the ways in which the volume of waste is reduced by means of controlled combustion are used for some waste streams (Vaughn, 2009; Maluleke, 2014). Incineration (also referred to as thermal treatment) is largely governed by the National Environmental Management Air Quality Act (Act 39 of 2004) (NEMAQA), which requires an atmospheric emissions licence. Since landfilling is the most common means of waste disposal in South Africa, the remainder of this sections will focus on landfilling.

Landfilling refers to the deposition of waste on land, whether it be the filling in of excavations or the creation of a landfill above grade (DWAF, 1998). According to NEMWA, waste disposal requirements are determined through assessing the waste in terms of total and leachable concentrations to determine the waste type (Type 0 to 4) (DEA, 2013b). The National Norms and Standards for the Disposal of Waste to Landfill (GNR. 636 of 2013) (DEA, 2013b) provides the landfilling requirements for different waste types, as well as waste disposal restrictions and prohibitions. These Norms and Standards further provide the landfill design requirements for Class A to Class D landfill sites, of which Class A has the strictest barrier requirements, which make them expensive to establish, construct and operate.

The disposal of waste to land requires authorisation in terms of the National Water Act (36 of 1998) (water use licence) and the NEMWA (waste management licence). Requirements for the establishment of landfill sites are outlined in the NEMWA waste management licence application form, and guidance is also provided in the Minimum Requirements for waste disposal by landfill (DWAF, 1998). The selection of sites for landfill establishment should be grounded on obtaining large adequate pieces of land, located in areas which have soil characteristics that will minimize the likelihood of ground water pollution, and does not meet the fatal flaw criteria (distance from wetlands, ground water depth, distance airstrips, distance from communities, etc.) (CSIR, 2011). Landfill sites require access control and signposting, and it must be well fenced off, and informal waste pickers, children and domestic animals should not be permitted onto any landfill site (CSIR, 2011). This is, however, a challenge within the South African context, with many landfill sites being accessed by informal waste pickers.

Goal 2 of the NWMS aims at *establishing effective compliance with and enforcement of the NEMWA*, by ensuring that everyone adheres to the regulatory requirements for waste management, and builds a culture of compliance. However, according to DEA, (2012b), there are many landfill sites that are operating, whilst non-compliant with licence conditions, resulting in poor levels of operation and negative impacts on the environment.

According to the latest State of Waste Report (SAWIS, 2018), the national list of licenced waste management activities indicate that there are 791 licenced treatment facilities in South Africa, however majority of these licenced facilities are dump sites or landfills. In Limpopo, for instance, it was found that all local municipalities (excluding Musina Local Municipality have licensed sites), however challenges arose on landfill sites operations whereby there are no proper operation and maintenance of landfills, no compaction (fire), lack of skills and competent staff at landfill sites and non-compliant landfill liners (LEDET, 2016). A lack of formalised, compliant waste management practices at landfill sites can result in unregulated management practices, for example disposal occurring outside formal waste systems, and these embrace illegal dumping, uncontrolled burning, the operation of illegal dumpsites, and unlicensed landfills (Rodseth *et al.*, 2020).

Illegal dumping is the most common waste management option for unserved areas, however it can occur across both served and unserved areas (Rodseth *et al.*, 2020). In South Africa, the ratio of household waste disposed of via illegal dumping ranges from an estimated 5% for unserved rural households to 27% in metros.

Although the waste management hierarchy advocates that waste disposal should be considered as the last resort, waste disposal by landfill remains the most dominant method of disposal in South Africa. In 2016, 41.7 million tonnes of general waste was disposed of to landfill (SAWIS, 2018). The reliance on landfilling (in the absence of other options in many areas in South Africa), coupled with the relatively low pricing for landfilling, have limited the incentive to devise alternative methods for dealing with waste (DEA, 2012b).

Approximately 805,193 tonnes of general waste (1.9% of the waste generated in South Africa) was disposed to landfill in the Limpopo Province in 2016 (DEA, 2018a). Moreover, lowering disposal fees discourages illegal dumping, but might place an extra fiscal burden on the waste management sector (Adeleke *et al*, 2021). According Maluleke, (2014) PLM attempts to monitors illegal dumping and compliance to landfill licence conditions. The City of Polokwane IWMP (2016) indicates that there is inadequate law enforcement, and that the municipality is planning on training personnel in law enforcement (City of Polokwane IWMP, 2016).

3.3 The role of municipalities in solid waste management

The Constitution of the Republic of South Africa allocates the responsibilities of providing waste management services to municipalities, however in exercising these powers and responsibilities municipalities must establish appropriate institutional arrangements that will deliver effective and efficient waste management services (SALGA, 2015). The sub-sections below discuss the role of local municipalities as it relates to solid waste management.

3.3.1 Providing waste management services

According to the NEMWA (as echoed by the NWMS), municipalities need to promote access to at least a basic level of waste services for all and integrates the waste management hierarchy into waste services, including separation at source. Reasonable waste collection services must be provided to all households within the jurisdiction of the municipality. In areas where travelling distances and the resulting costs may render regular waste collection services impractical, the municipality, through by-laws, must allow for more feasible alternative ways of waste handling, such as on-site disposal (DEA, 2011b). Municipalities must provide clear guidelines to households regarding types of waste, the sorting of the waste, appropriate containers, and removal schedules for each type of waste and community involvement in recycling must be encouraged (DEA, 2011a).

3.3.2 Integrated planning processes, including IWMP development

According to Municipal Systems Act, municipality must undertake developmentally oriented planning so as to ensure that it strives to achieve the objects of local government set out in section 152 of the Constitution, moreover the general impartial of integrated environmental management is to promote the integration of the principles of environmental management set out in section 2 into the making of all decisions which may have a significant effect on the environment (DLG, 2000).

Goal 5 of NWMS seek to achieve integrated waste management planning thereby all municipalities have integrated their IWMPs with their IDPs, and have met the targets set in IWMPs (DEA, 2011b). According to the City of Polokwane IWMP (2016), municipalities have a duty to develop and submit plans for integrated general waste management to the respective provincial environmental departments. Moreover, it is important that the approved IWMP must be included in the Municipal IDP (DEA, 2009).

3.3.3 Collecting data and reporting to SAWIS

According to the NWMS (DEA, 2011b) waste planning requires accurate information on waste flows. The National Waste Information Regulations (DEA, 2012c) requires that on waste

quantities and flows from certain municipally-owned waste management facilities need to be reported into the South African Waste Information System (SAWIS), which will contribute to an accurate national waste balance. Municipalities are required to capture routine data on the tonnages of waste generated, recycled and disposed of on a monthly and annual basis (SAWIS, 2018).

3.3.4 Competent and dedicated waste managers

Municipalities must designate a waste management officer from their administration to co-ordinate waste management matters (DEA, 2009). Municipalities should capitalise in attracting suitably qualified graduates to the waste management sector as waste management particularly landfill operations, is highly technical and requires people with specific technical skills and sound scientific background (CSIR, 2011). Bench-marking waste management functions and knowing what expertise is required to perform these functions will assist municipalities in drafting appropriate job descriptions and specifications for recruiting new employees. In the context of integrated pollution and waste management, it is a responsibility of the municipality to establish links with tertiary education institutions and other training institutions to ensure training of pollution and waste managers, inspectors, educators and information officers (DLG, 2000).

3.3.5 Public awareness campaigns

According to Oelofse & Godfrey (2008), members of the public are often uninformed of the lifecycle of waste and the subsequent pollution impacts of daily household activities, such as putting out the bag or bin of waste for collection. The NWMS (DEA, 2011b) seeks to involve communities and people as active participants in implementing a new approach to waste management. As a result, the municipality must create awareness amongst households about the types of waste collection services provided, separation at source (which includes the separation of recyclable and re-usable waste from non-recyclable waste streams), the unacceptability of illegal dumping and littering, measures to be taken against individuals that litter and dump waste illegally, the cost of cleaning up illegal dumping and littering, and the consequences on household waste collection rates; and the advantages of reporting illegal dumping activities (DEA, 2011a).

3.3.6 Implementing and enforcing waste minimization and recycling

Goal 1 of NWMS seek to promote waste minimisation, re-use, recycling and recovery of waste, however all metropolitan municipalities, secondary cities and large towns have to initiate separation at source programmes (DEA, 2011b). According to the strategy, separation at source must be encouraged and reinforced in line with the relevant industry waste management plans. In addition, all metropolitan and secondary cities need to enforce that all domestic waste must be sorted at source. Municipalities need to promote separation at source to make waste recycling

and recovery easier and affordable, and to ensure collection of clean recyclable waste streams with higher value (UNEP, 2018).

3.3.7 Providing political stability and support

According to Municipal Structures Act (DLG, 1998), all spheres of government and all organs of state must co-operate with, consult and support one another. A stable political environment is beneficial to good municipal service delivery, however the relationship between councillors and municipal officials are important as well as it can be enhanced by targeting politicians and councillors in awareness creation programmes (CSIR, 2011). For the purpose of effective co-operative government municipalities must strive to enhance co-operation, mutual assistance and sharing of resources among themselves. However they should also find solutions for problems relating to local government in particular and facilitate compliance with the principles of co-operative government and intergovernmental relations Municipal Systems Act (DLG, 2000).

3.3.8 Financial management and procurement

Goal 6 of NWMS seek to ensure sound budgeting and financial management for waste services, hence all municipalities that provide waste services have to conduct full-cost accounting for waste services and have to implement cost reflective tariffs (DEA, 2011b). Again full-cost accounting sets the basis for managing waste services as a financially sustainable service for all, hence municipalities need to apply to enable them to accurately project the costs of expanding the service.

According to the Municipal Finance Management Act (Act No. 56 of 2003), standard procurement procedures have to be followed, decent relationships amongst councillors and officials are necessary to ensure the smooth and continuous consecutively of the procurement procedure, as such all capital expenditure desires to be correctly motivated by the waste manager (DLG, 2004). The cost implications must be weighed against the benefits to the municipality. According to CSIR, (2011) it is significant for municipality to consult with the relevant technical personnel who are well-informed and experienced in the field when compiling tender specifications for the procurement of waste associated equipment and machinery as this will safeguard that purchased merchandise will be appropriate for the intended purpose.

The next section summarizes the current approaches to municipal solid waste management in South Africa.

3.4 Current approach of municipal solid waste management in South Africa

This section presents some of the main governance approaches undertaken to manage waste in South Africa. These include command and control-, fiscal/economic-, agreement-based-, and civil/voluntary-based approaches (Figure 3-2).

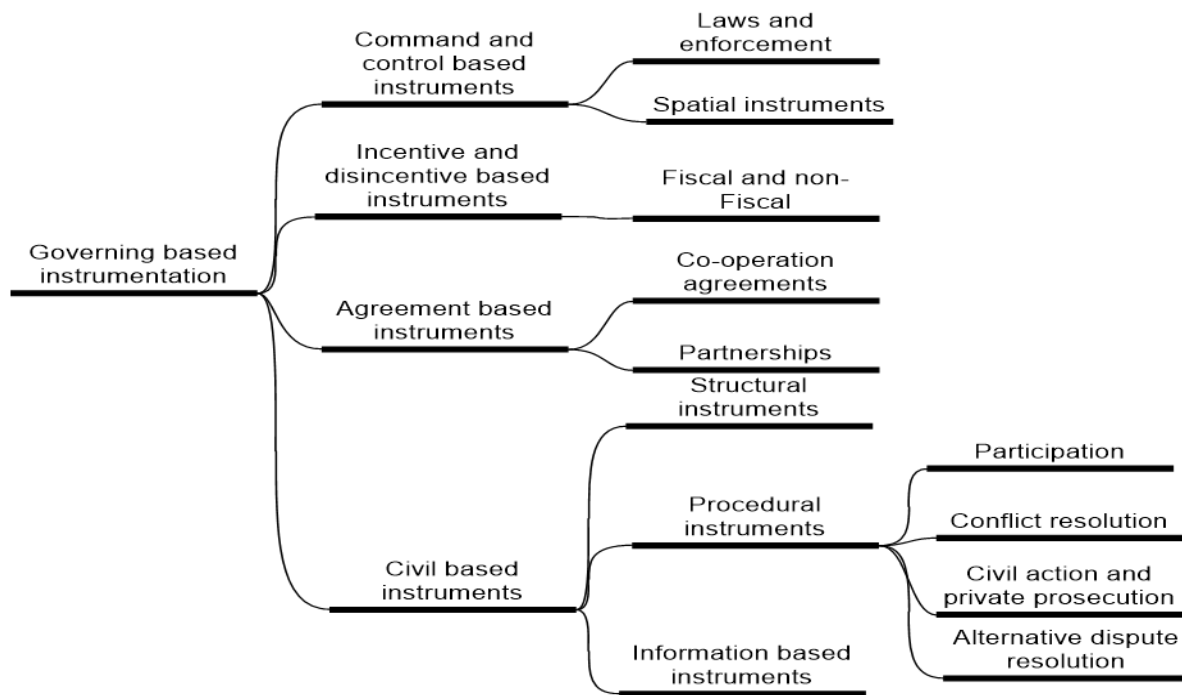


Figure 3-2: Summary of waste management governance approaches (Nel & Alberts, 2018)

3.4.1 Command and control-based approaches/instruments

Command and control instruments involve direct regulation and rely primarily on the application of regulatory instruments, such as standards, authorisations, municipal by-laws and permits and norms and standards (Godfrey & Nahman, 2007). South Africa largely relies on command and control approaches. According to DEAT (2000), command and control instruments involve direct regulation and rely primarily on the application of regulatory instruments, such as standards, permits and land-use controls. Permits provide for standardisation of certain processes, and are subject to the accomplishment of specific conditions. Permits and licences facilitate the enforcement of integrated pollution and waste management, and lastly, permits can be withdrawn in cases of non-compliance.

Local government (municipalities) plays the role of both regulator and regulated within the command and control integrated waste management context. They are responsible for regulating activities within their jurisdiction (for instance enforcing by-laws applicable to waste management), but they also undertake activities that are regulated by other spheres of government (i.e. most

municipalities own landfill sites which are regulated by permit conditions from provincial or national spheres of government).

According to SALGA (2015), municipalities as waste service authorities, must develop waste management policy with a focus on waste minimization, have the duty to pass and implement by-laws with respect to the waste management services, set waste charges and implement incentive mechanisms for waste reduction, regulate and monitor external waste service providers, and report on waste management by ensuring that services comply with minimum national standards and with policies and by-laws.

As mentioned earlier, municipalities are also regulated by national and provincial spheres of government, where they will monitor the compliance and enforcement based on indicators such as the number of enforcement actions against non-compliant facilities.

3.4.1.1 Environmental law

The NEMWA is the main act regulating waste management in the country. The National Waste Management Strategy (NWMS) is a legislative requirement of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). The aim of the NWMS is to achieve the objects of the NEMWA (DEA, 2011b). The Act provides for specific waste management measures to provide for the licensing and control of waste management activities, and provide for the remediation of contaminated land. The legislative context as it relates to municipal waste management is further elaborated on in the sub-sections below.

Compliance and enforcement is guided by the National Environmental Compliance and Enforcement Strategy, which provides the short to medium term strategy to improve compliance and enforcement (SAWIS, 2018). Compliance and enforcement aligns with Goal 8 of NWMS which seeks to establish effective compliance with and enforcement of the NEMWA (DEA, 2011b).

According to SAWIS (2018), compliance monitoring is undertaken by environmental management inspectorates (EMIs) to determine whether or not, facilities are compliant with the conditions of their licence and regulations. Inspection of these facilities requires to ascertain the level of compliance of the facility with each permit or licences and environmental authorisation. In 2017 to 2018 the inspection of municipal landfill sites indicated the poor management of the sites resulting in negative environmental impacts and negative impacts on health and wellbeing of surrounding communities (DEA, 2018b). Forty-nine of the 75 sites inspected were less than 50% compliant to license/permit conditions and only sixteen sites achieved 70% and above.

The sub-sections below highlight the relevant South African legislation applicable to waste management.

3.4.1.1.1 The Constitution of the Republic of South Africa (DOJ, 1996)

The South African Constitution (DOJ, 1996), Bill of Rights is a clause signifying the right of everyone to have environment that is not harmful to their health or well-being (section 24a). The clause that environment should be protected, for the benefit of present and future generations, (DEA, 2010), through reasonable legislative and other measures that include prevent pollution as contained in Section. 24b.

As per Schedule 5b of the Constitution, municipalities should provide waste management services, which include waste removal, storage and disposal services. Municipalities are expected to facilitate local solutions such as material recovery facilities and buy-back centres, rather than provide the entire recycling infrastructure themselves (Bhangwandin, 2013).

3.4.1.1.2 National Environmental Management Act 107 of 1998 (DEA, 1998)

The Act provides for co-operative, environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith, (DEA, 1998). The National Environmental Management Act 107 of 1998 provides instruments for integrated waste management. It also places a duty of care on any juristic person who may cause significant pollution or degradation of the environment, requiring them to institute measures to either prevent pollution from occurring, or to minimise and rectify the pollution or degradation where it cannot reasonably be avoided (DEA, 2012a). The Act state that waste is avoided or where it cannot be altogether avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner (DEA, 1998).

The general objective of the Act is to promote the integration of the principles of environmental management set out in section 2 into the making of all decisions which may have a significant effect on the environment (DEA, 1998). The Act further aims at identifying, predicting and evaluating the actual and potential impact on the environment, socio-economic conditions and cultural heritage. The risks and consequences and alternatives and options for mitigation of activities, with a view to minimizing negative impact. As well as maximizing benefits, and promoting compliance with the principles of environmental management set out in Section 2.

According to NEMA section 28 every person who cause has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring. Should a person fail to comply, or inadequately comply with a directive under subsection 4, the Director-General or provincial head of department may take reasonable measures to remedy the situation. However, the Director-General or Provincial Head of Department may recover all costs incurred as a result of it acting under subsection 7 from any or all of the following persons any person who is or was responsible for or who directly or indirectly contributed to, the pollution or degradation or the potential pollution or degradation (DEA, 1998). The polluter pays principle is enforced by NEMA section 2 subsection 4 which affords that those accountable for harming the environment pay for the costs of remedying pollution, environmental degradation and resulting adverse health effects and of preventing, controlling or minimising further pollution (DEA, 1998). However, these measures are only effective when they impose liability on licence holders for fully remedying any environmental harm caused directly or indirectly (CER, 2013).

3.4.1.1.3 National Environmental Management: Waste Act 59 of 2008 (DEA, 2009)

The NEMWA seeks to reform the law regulating waste management in order to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development. It also provides for institutional arrangements and planning matters, and for national norms and standards to regulate the management of waste by all spheres of government - which includes local government being the municipality where solid waste management is administrated (DEA, 2009). The objects of Act are also to develop, promote and ensure the effective delivery of waste services (DEA, 2012b). The waste hierarchy is also clearly visible in the 2011 National Waste Management Strategy for South Africa (Figure 3.3).

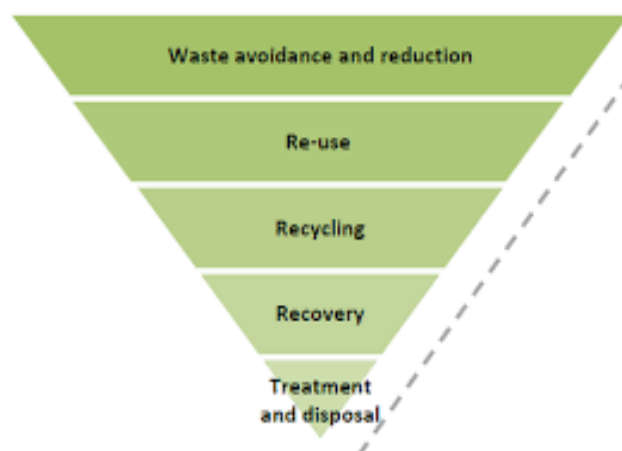


Figure 3-3: Waste Management Hierarchy (NWMS, 2011)

The National Domestic Waste Collection standards (2013) provides minimum expectations for the collection of waste and rendering of waste management services by local municipalities. Local municipalities must exercise its executive authority to deliver waste management services, including waste removal, waste storage and waste disposal services, in a manner that does not conflict with section 7 or 8 of the NEMWA (DEA, 2009). Each municipality must exercise its executive authority and perform its duty in relation to waste services, including waste collection, waste storage and waste disposal services, by adhering to all national and provincial norms and standards, integrating its waste management plans with its integrated development plans and ensuring access for all to such services (DEA, 2011b).

The Act also places extensive emphasis on the development of an integrated waste planning system, (DEA, 2012b), through the development of interlocking integrated waste management plans by all spheres of government and industry waste management plans for specified waste generators.

3.4.1.1.4 Municipal Systems Act 32 of 2000 (DLG, 2000)

The Act seeks to provide for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and ensure universal access to essential services that are affordable to all (DLG, 2000). Furthermore, the Act aims to provide for community participation and to establish a simple and enabling framework for the core processes of planning. According to this Act, (DLG, 2000) municipality must develop culture of municipal governance that complements formal representative government with a system of participatory governance, and must for this purpose to encourage, and create conditions for, the local community to participate in the affairs of the municipality, including in the preparation, implementation and review of its integrated development plan in terms of chapter 5 and under IDP that's where budget for waste management detailed. The IDP must reflect an assessment of the existing level of development in the municipality, which must include an identification of communities which do not have access to basic municipal services (refuse removal included).

3.4.1.1.5 Municipal Structures Act 117 of 1998 (DLG 1998)

The Municipal Structures Act strives to provide for the establishment of municipalities in accordance with the requirements relating to categories and types of municipality, to establish criteria for determining the category of municipality to be established in an area and to define the types of municipality that may be established within each category (DLG 1998). It, furthermore,

provides for an appropriate decision of functions and powers between categories of municipality; to regulate the internal systems, structures and office-bearers of municipalities.

District municipalities have the functions and powers including integrated development planning for the district municipality as a whole including a framework for integrated development plans for the local municipalities within the area of the district municipality and taking into account the integrated development plans of those local municipalities (DLG 1998). District is also responsible for solid waste disposal sites serving the area of the district municipality as a whole.

3.4.1.1.6 National Environment Management: Air Quality 39 of 2004 (DEA, 2005)

The Act strive to reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development; to provide for national norms and standards regulating air quality monitoring, management and control by all spheres of government; for specific air quality measures; and for matters incidental thereto (DEA, 2005). The Act mostly to give effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

In local standards, municipality may in terms of a by-law to identify substances or mixtures of substances in ambient air which, through ambient concentrations, bioaccumulation, and deposition or in any other way, present a threat to health, well-being or the environment in the municipality or which the municipality reasonably believes present such a threat. An in respect of each of those substances or mixtures of substances, establish local standards for emissions from point, non-point or moveable sources in the municipality this comprises landfills (DEA, 2005).

In part 6 the Act state the control of dust whereby the Minister or MEC may prescribe measures for the control of dust in specified places or areas, either in general or by specified machinery or in specified instances, this comprises landfills as well. The Minister or MEC may as well prescribe steps that must be taken to prevent nuisance by dust or other measures aimed at the control of dust.

The next few sections will specifically focus on the NEMWA and command and control approaches provided for in terms of the NEMWA.

3.4.1.2 Regulations

According to the NEMWA as amended, the Minister may make regulations regarding the identification and categorisation of waste, the manner in which particular waste types must be

dealt with and managed, the manner in which priority waste must be dealt with and managed, the requirements for monitoring of compliance with this Act or any licence issued in terms of this Act and the exercise of the duty of care. Such regulations have been made in respect of waste management and are elaborated on in *Section 3.5* of this dissertation.

3.4.1.3 Norms and standards

The NEMWA allows for an integrated system of norms and standards across the three spheres of government, however the drafting of certain norms and standards at a national level are mandatory, while others are voluntary (DEA, 2011b). The Minister may, by notice in the Gazette, set national norms and standards for the minimisation, re-use, recycling and recovery of waste, including the separation of waste at the point of generation, extended producer responsibility and the regionalisation of waste management services (DEA, 2009). Municipalities need to keep these requirements in mind when setting by-laws.

According to the NEMWA (DEA, 2009), municipalities must exercise its executive authority to deliver waste management services, including waste removal, waste storage and waste disposal services, in a manner that does not conflict with Section 7 or 8 of the Act. Minimum standards for waste collection are provided for in the *National Domestic Waste Collection Standards* (GN 21 of January 2011) (DEA, 2011a). NEMWA seeks that vehicles used for the collection and transportation of waste shall not be used for any other purpose while collecting and transporting waste and health issues must be considered (DEA, 2011a). Waste should be collected and transported in secured vehicles to prevent littering during transportation, and again non-compatible vehicles must be phased out. NEMWA concedes that waste minimisation is encouraged, hence the frequency of waste collection should not inspire illegal dumping or cause irritation in terms of odours and volumes of waste being stored, and moreover non-recyclable waste must be removed at least once a week (DEA, 2011a).

There are several norms and standards, which may be applicable to the management of waste by municipalities. These include, but are not limited to, the *National Norms and Standards for Assessment of Waste for Landfill Disposal* (GNR. 635 of August 2013), *National Norms and Standards for disposal of waste to landfill* (GNR. 635 of August 2013); *Norms and Standards for the Storage of Waste* (GNR. 926 of November 2013); *Norms and standards for the sorting, shredding, grinding, crushing, screening or baling of general waste* (GNR. 1093 of October 2017), etc. Moreover, other discretionary norms and standards can be identified and developed by means of checking extent of the environmental impact and impact on availability of landfill space (DEA, 2011b).

3.4.1.4 Authorisations and permits

The NEMWA provides for a licensing regime specific to waste management activities, with the purpose to ensure that specific conditions regulate identified activities that may have a detrimental effect on the environment (DEA, 2011b). Prior to the enactment of the NEMWA, waste management activities were regulated in terms of the Environment Conservation Act (ECA), which has mostly been repealed and replaced by the NEMA, as well as the National Water Act (NWA). Section 20 of the NEMWA requires that listed waste management activities are conducted in accordance with an environmental authorisation (in this case, a waste management licence). Listed waste management activities are gazetted in GNR. 921 of November 2013, as amended.

The disposal of waste to land requires authorisation in terms of the National Water Act (36 of 1998) (water use licence) and the NEMWA (waste management licence) as stated in Section 3.2.5 of this dissertation. The NEMWA stipulates that the waste management activity is to be regulated by a national department; a provincial department responsible for environmental affairs; or a statutory body, excluding any municipality, performing an exclusive competence of the national sphere of government. Municipalities need to apply for authorisation from provincial departments for general waste management activities, while hazardous waste are regulated by the national department responsible for environmental affairs.

3.4.1.5 Municipal by-laws

Municipal by-laws set standards for separating, compacting, and storing solid waste, managing and directing solid waste disposal, and controlling litter (DEA, 2011c), however these by-laws must be based on national standards. By-laws are drafted and approved by council, and puts the necessary institutional and legal frameworks in place that will enable municipalities to achieve their duties and aims. Moreover, by-laws should be in line with the departmental objectives stated in the integrated development plan (IDP) to ensure that waste management by-laws are in place, compliance monitoring of the by-laws will also need to be implemented. Municipalities need to ensure that by-laws are updated to support the enforcement of regulatory measures (DEA, 2011b).

3.4.2 Fiscal/economic approaches/instruments

Economic instruments seek to warrant that the economic costs of environmental damage are suppressed by those responsible for initiating the damage through the market mechanism (Godfrey & Nahman, 2007). Fiscal instruments support Goal 1 of NWMS that seeks to ensure comprehensive budgeting and financial management for waste services by necessitating that all municipalities that provide waste services need to conduct full-cost accounting for waste services and need to implement cost reflective tariffs (DEA, 2011b).

3.4.2.1 Levies and taxes

The use of economic instruments further aligns with Goal 6 of NWMS, which aims for municipalities to provide waste services and implement cost reflective tariffs (DEA, 2011b). In South Africa the selection of economic instrument is based on *polluter's pays principle*, whereby the generator of waste is responsible for the cost of managing the waste generation and its potential impacts on the environment (SAWIS, 2018).

According to the *National Pricing Strategy for Waste Management* (DEA, 2016a), upstream instruments including product, material and input taxes, advance recycling fees and deposit-refund schemes, may be implemented by national government in the absence of other management measures. An example of this is the implementation of the plastic bag levy in South Africa. The effectiveness of these levies are, however, questioned (as illustrated by the plastic bag regulation example).

South Africa introduced a plastic bag levy in 2003 in an attempt to reduce plastic bag consumption (SAWIS, 2018). The regulations were not deemed successful, because citizens got accustomed to paying the relatively low fee for plastic bags. As a result, the plastic bag levy was increased by 50% in April 2018.

Since the inception of the levy in 2003, National Treasury has been collecting the plastic bag levy (DEA, 2017b), and the money is allocated to the National Revenue Fund where a portion is allocated to DEA for the regulation of the thickness of plastic bags. The collected levy is not stipulated and can only be allocated to recycling programmes following submission to the National Treasury of an approved and clear business plan on the implementation of such programmes. Although the money is also used to support recycling initiatives through the establishment of necessary infrastructure for recycling in the country (DEA, 2017b), the production and use of plastic bags continues to rise. As illustrated by this example, the regulation of products through levies need to be carefully considered, following a life cycle approach.

Deposit refund schemes (DRS) essentially combine product tax and a recycling subsidy. The objective of a deposit refund system is to encourage the return of used products for recycling purposes (DEA, 2016a). The deposit element of a DRS is improbable to have the same incentive effect as a product tax, as consumers know that the higher costs connected with purchase can be counterweighed upon return of the item. Moreover, the determination of the preliminary deposit is rather to inspire return and to finance the payment of refunds, afterward the refund element comes into play by creating an incentive to return the product. DRS systems have been applied to a range of products, from beverage vessels to batteries, tyres, bright light bulbs, and end-of-life vehicles (ELVs). According to *National Pricing Strategy for Waste Management* (DEA, 2016a)

they can be executed by either the private or public sector or via some form of joint public-private partnership.

Advance recycling fees (ARFs) are a special type of product tax that are based on the estimated costs of collection, processing and recycling; revenues from which are often used to cover the costs of recycling (DEA, 2016a). These fees may be noticeable to the consumer as a distinct line item on the bill, comparable to sales tax or they can be measured upstream on producers and later incorporated into the product price as product taxes, they are generally measured per unit of the product sold, but they can also be evaluated on a weight basis.

The main difference between ARFs and product taxes is that ARFs are projected primarily to raise incomes to cover recycling costs, with possible secondary benefits in terms of reducing demand, while product taxes are intended principally to reduce demand by guaranteeing that external costs are internalised in product prices (DEA, 2016a). The level of the ARF is determined centred on the estimated costs of collection, treatment, recycling, re-use and recovery of the product, as a result the incentives provided by an ARF depend mainly on what is done with the revenues. According to DEA, (2016) revenues ARFs can be utilised either to cover the expenses of managing waste or to cover infrastructure expenses in a lump-sum manner or used to fund financial incentives to consumers, collectors or processors per unit or on a weight basis of material returned, collected or recycled, therefore increasing the quantity of materials supplied for recycling.

Downstream instruments (volumetric tariffs and disposal taxes) are typically implemented as a tax in line with the overall fiscal and taxation policy of government, these taxes are either implemented by municipalities in the case of volumetric tariffs or national government in the case of disposal taxes (DEA, 2016a).

Waste disposal taxes could also suppress the external costs of waste disposal into the disposal fees, thereby raising the cost of disposal comparative to waste prevention, recycling and recovery, and in turn making the latter relatively more financially feasible (SAWIS, 2018). However, where it is not feasible to monitor the quantity of waste collected from individual waste generators, a substitute is to apply the environmental tax at the disposal. Nevertheless, in the instance of landfill taxes, the level of the tax should preferably be based on the external costs per tonne of waste disposed of to landfill (DEA, 2016a).

The aims of volumetric charging for waste collection services (pay-as-you-throw) are two-fold initially is to ensure that waste generators are charged per unit of waste set out for collection thereby creating incentives for a reduction in waste generation (DEA, 2016a). Again, having established volumetric charging, it is then possible to incorporate the external costs associated

with waste generation and disposal, in the form of an environmental tax. True volumetric tariffs or pay -as- you -throw schemes have been implemented mainly in developed countries. In developing countries, waste collection tariffs tend to be flat periodic payments aimed at cost recovery rather than at reducing waste generation (DEA, 2016a).

A carbon tax is a means by which government can interfere by way of a market based instrument to suitably take into account the social costs resulting from carbon emissions (National Treasury, 2018a). International focus on mechanisms to mitigate global greenhouse (GHG) emissions has always included the notion of carbon pricing among a range of measures. This is one of the stated reasons for government's persistence in introducing a carbon tax into the South African economy, namely as part of government's mix of measures to spur domestic mitigation efforts (Parker *et al*, 2018). According to *Carbon Tax Bill and Customs and Excise Amendment Bill* (National Treasury, 2018a) the introduction of a carbon price will change the comparative prices of goods and services, creating emission-intensive goods more expensive relative to those that are less emissions intensive. Nevertheless, this provides a powerful incentive for consumers and businesses to regulate their behaviour, subsequent in a reduction of emissions, moreover carbon tax assurances a maximum cost per unit of pollution in the sectors covered by it. Nevertheless, if a carbon tax flounders environmentally, the tax can be raised or calculated in a way that it will rise automatically in response to emission trends.

As mentioned earlier, extended producer responsibility (EPR) regulations were published in November 2020 (GNR.1184 of November 2020). The purpose of these regulations is to provide the framework for the development, implementation, monitoring and evaluation of extended producer responsibility schemes by producers, importers and brand owners in terms of section 18 of the Act to ensure the effective and efficient management of the identified waste streams and to encourage and enable the implementation of chemicals and waste economy and circular economy initiatives (DEFF, 2020). According to the EPR regulations (DEFF, 2020), the extended producer responsibility scheme must as a minimum include requirements for cleaner production measures that must include as a minimum but not limited to design for recyclability; and waste minimization, waste reduction including as a minimum but not limited to composition of products volume of products or weight of products to be restricted and reduced with associated timeframes.

Industry taxes or levies are based on those that environmentally damaging materials and inputs can create incentives for producers to re-assess the materials and inputs used in production, making fewer damaging materials or inputs more attractive (DEA, 2016a). However, in order to meet the criterion of economic efficiency and to conform to the producer pays principle, the size of the levy needs to be related directly to the environmental damage. According to section 13 of the NEMWA (as amended) waste management charges may differ on the basis of the

characteristics of the waste disposed of, the volume of the waste disposed of, the toxicity of the waste disposed of, the nature and extent of the impact on the environment caused by the waste disposed of, as well as the extent of approved deviation from prescribed waste standards or management practices (DEA, 2013b). Moreover, discrepancy rates could be functional to products on the basis of the toxicity or degree of hazard of its mechanisms, its recycled gratified, the use of compound materials, or the ease with which the product can be pull apart and the components recycled (DEA, 2016a).

3.4.2.2 Pricing

The objective of the *National Pricing Strategy for Waste Management* is to implement economic instruments as part of a basket of policy instruments which will reduce the generation of waste, the increase in the diversion of waste away from landfill towards avoidance, minimisation, re-use, recycling and recovery, support the growth of a South African secondary resources economy from waste; and reduce the environmental impact of waste (DEA, 2016a). Pricing can offer a more cost-effective and dynamic form of regulation than the traditional command and control approach. The under-pricing of waste services makes the wrong set of incentives, weakens waste minimisation efforts, and eventually undermines the polluter pays principle (DEA, 2011b). This is because waste generators are billed the same amount regardless of waste quantities, or how many bags are collected, as a result there is still no incentive to reduce waste generation at the margin (Nahman & Godfrey, 2010).

The *National Pricing Strategy for Waste Management* suggests a volumetric tariffs instrument that puts a price on each unit of waste collected from waste generators thereby providing an incentive for the household to reduce the amount of waste generated or put out for collection, and to seek alternatives such as recycling or reuse (DEA, 2016a). Municipalities have a task to develop tariff for recovery and recycling as per national waste management pricing strategy (City of Cape Town, 2017). Eventually, the flexibility depends on how the waste collection process is prearranged, a system is much more effective and price-elasticity is more flexible if waste collection uses a weight-based pricing system and if compostable waste is priced (Bela & Gradus, 2016). Moreover, studies have revealed that there is illegal disposal relative to the fixed pricing and two-tier pricing (Usui & Chikasada, 2012).

3.4.2.3 Incentives and disincentives

Economic incentives that affect waste flows operate at these key points in the system, the collection tariff, the gate fee for disposal, fines for illegal dumping and littering and incentives for material recovery (Eberhard, 2018). These incentives work in different directions. However the consequent increases in disposal fees will discourage waste generation (DEA, 2011b), and

consequently reduce waste to landfill and encourages reuse, material recovery and recycling (Eberhard, 2018). Low collection tariffs crowd out opportunities for the private sector to undertake competitive collection of waste, but high collection costs can also increase incentives for illegal dumping (Eberhard, 2018), however City of Cape Town reflected on removing gate fees to reduce illegal dumping (City of Cape Town, 2017).

According to DEA (2016) product taxes are related to the end product itself based on its embodied waste, therefore creating incentives for consumers to reduce their procurements of waste generating products - for example by reducing consumption or looking for environmentally benign replacements and indirectly dropping waste generation.

3.4.3 Agreement-based approaches/instruments

Implementing the waste management hierarchy and achieving the objects of the NEMWA will require coordinated action by many players, including households, businesses, community organisations and the three spheres of government (DEA, 2011b). Agreement-based approaches may provide a means of achieving certain waste management measures and services.

3.4.3.1 Co-operative agreements

The Constitution of South Africa obliges the spheres of government and organs of state to exercise their powers and functions in a jointly supportive and cooperative way. A co-operative agreement requires a contract to ensure that both parties have the same understanding of what they agreed to (CSIR, 2015). There are numerous international agreements (treaties and conventions) which relate to waste management which South Africa has agreed to. However, a number of non-binding agreements and protocols are also relevant to waste management.

Cooperatives across all sectors in South Africa particularly the waste and recycling sector encounters several challenges comprising poor access to and being slow adapters of technology and challenges associated with poor support from the different levels of government (Muswema *et al*, 2018). Access to recyclables, from informal collectors at kerbside and landfill who have no interest in being formalised or integrated, and from large established businesses contracted by municipalities to render waste and recycling services as a lower-risk solution to the municipality (Godfrey *et al*, 2015). An again the trial appears to be the low Rand value of the collected material and the distances to processing facilities and markets (Muswema *et al*, 2018). In South Africa, there are number of institutions mandated to support co-operatives, which includes financial support comprising of incentives, investment, micro-finance, grants, etc. and again non-financial support including networking platforms (Godfrey *et al*, 2015).

According to Godfrey *et al.* (2015), the success of cooperatives can be seen as obtaining recognition to work in the waste and recycling sector from municipalities, successfully negotiating and securing contracts to collect waste or recyclables, acquiring premises from which to work, job creation in the community, raising awareness in the community of the importance of waste management and recycling. Co-operatives that have been incorporated into municipal solid waste management systems, have extended their services to also include city cleansing (illegal dumping clearing and litter collection), and, moreover, have recognised opportunities for growth in extending their services into higher value-add opportunities such as recycling, buy-back centres and material recovery facilities (Godfrey *et al.*, 2015).

3.4.3.2 Public-private partnerships

Implementing the waste management hierarchy and achieving the objects of the NEMWA, as well as rendering specific waste management services may require the establishment of public-private partnerships. Public-private partnerships can be explained as partnerships between a public sector institution or organisation, and a private company or party.

The costs and essentials of a sustainable waste management system are massive and therefore require input and participation from its wide-ranging stakeholders (City of Polokwane IWMP, 2016). It is significant for municipalities to form partnerships with different stakeholders to try and sustain and promote good waste management practices for all their community members. Municipalities and local stakeholders need to play an active role in launching such partnerships and participatory community projects (DEA, 2011c). According to City of Cape Town (2017) engaging informal communities on their waste management needs and finding solutions to key challenges helps encouraging and formalising partnerships between various participants that could lead to self-sustaining projects or beautification projects.

According to Esmann (2017), the formal PPP establishment procedure relates to PPPs where the private actor is to provide municipal services, as we know municipal services such as drinkable water supply, domestic sewage treatment and disposal systems. However, PPPs have contingent liabilities which are known as liabilities that government acquires through the provisions in the PPP agreement, nevertheless PPP will only have a monetary effect if a contract is dismissed (National Treasury, 2018b). PPP projects wherever the unitary payment is to be completed by a public-sector institution make contingent fiscal obligations to compensate the private sector if the contract is terminated before its expiry date.

3.4.4 Civil/voluntary approaches/instruments

According to Godfrey & Nahman (2007), civil/voluntary approaches is the approach which is mostly adopted by industry, and have been used in numerous countries as a significant

complementary approach to pollution reduction. Nevertheless, it is rarely a replacement for direct government control (i.e. command and control approaches).

3.4.4.1 Public participation

Goal 4 of NWMS seeks to ensure that people are aware of the impact of waste on their health, well-being and the environment by involving communities and people as active participants in implementing a new approach to waste management (DEA, 2011b). According to UNEP (2018) the success of solid waste management relies deeply on allowing governance environment determined by social, economic and psychological factors, comprising public participation, public attitudes and behaviour.

In order to complete an IWMP, the public participation process as designated in Section 29 of the Municipal Systems Act must be followed. Municipality must develop a culture of municipal governance that complements formal representative government with a system of participatory governance, and must for this purpose encourage, and create conditions for, the local community to participate in the affairs of the municipality, including in the preparation of IWMPs (DLG, 2000). Implementation and review of its integrated development plan (IDP) in terms of Chapter 5 through political structures for participation in terms of the Municipal Structures Act. However, the mechanisms, processes and procedures for participation in municipal governance established in terms of this Act. Moreover, the other appropriate mechanisms, processes and procedures established by the Municipality and councillors (DLG, 1998). The municipality must establish suitable mechanisms, processes and procedures to support the local community to participate in the affairs of the municipality and obligation for this purpose provide for the receipt processing and consideration of petitions and grievances lodged by members of the local community, also notification and public comment procedures, when appropriate (DLG, 2000).

Public participation is also required during the waste management licence application process. According to DEA, (2012d) in order to assist potential, interested and affected parties (I&APs) and environmental assessment practitioners (EAPs) to understand what is required of them and their role maybe be DEA requires there be a public participation. The public participation process anticipated in this regulation must provide access to all information that reasonably has or may have the potential to influence any decision with regard to an application unless access to that information is protected by law. Public participation must include consultation with the competent authority, every state department that administers a law relating to a matter affecting the environment relevant to an application for an environmental authorisation. Moreover all organs of state which have jurisdiction in respect of the activity to which the application relates and all potential, or where relevant, registered interested and affected parties (DEA&DP, 2011). Public

participation provides all stakeholders the opportunity to obtain clear, accurate and understandable information about environmental impacts of proposed activities or processes (DEA, 2012d).

3.4.4.2 Information systems (SAWIS)

The South African Waste Information System (SAWIS) was established by Department of Environmental Affairs (DEA) in 2005, as a system used by government and industry to capture routine data on the tonnages of waste generated, recycled and disposed of in South Africa on a monthly and annual basis (SAWIS, 2018). According to the NWMS, waste planning obliges accurate information on waste flows, as a result comprehensive information on waste flows from each waste management facility need to be reported into the SAWIS, which will contribute to an accurate national waste balance (DEA, 2011b). The SAWIS is regulated by National Waste Information Regulations, with the aim to standardise the collection of data and information to fulfil the objectives of the national waste information system as set out in section 61 of the Act.

3.4.4.3 Education and training

According to *Africa Waste Management Outlook* (UNEP, 2018), South Africans have a low awareness and negative outlook concerning waste management, and the perceptions of where the responsibility lies for waste management. General awareness and level of education are driving factors influencing illegal dumping and pollution (SAWIS, 2018). Hence NWMS introduced Goal 4 that seeks to safeguard that people are aware of the impact of waste on their health, well-being and the environment and it aims that 80% of municipalities should run local awareness campaigns (DEA, 2011b). The establishment of sound training is an elemental step in waste management, hence training would contain a blend of bottom-up approaches that include modified training programs for diverse tiers of waste management staff, raising their awareness, and providing them with the acquaintance for comprehensive waste separation and handling (UNEP, 2018).

The Department of Environmental Affairs introduced three National Youth Service Pilot programmes which were implemented from 2008 – 2011. The vision, goals and objectives of the Youth Environmental Service are in line with the mandate and objectives of the Department of Environmental Affairs as well as the vision, goals and objectives of the National Youth Service (DEA, 2012b).

3.5 Municipal waste management in the Polokwane Local Municipality

This section provides a brief overview of waste management in the Polokwane Local Municipality. A full account of the entire waste management system is provided in the Results and Discussion

chapter of this dissertation, since the evaluation of the waste management system of Polokwane is an objective of this research.

According to the City of Polokwane IWMP (2016), the estimated number of households in the Municipality is 178 001, and approximately 79 032 of the households' waste is collected by the PLM (with 55.6% of households not receiving waste removal services). This is a shortcoming which requires urgent attention. In PLM there are four cooperatives responsible for waste collection in the city (Ogola *et al*, 2011; Mudau, 2015).

PLM have twelve compactors to collect and transport waste in the residential areas, three load ladders that collect solid waste from the skips in the factories and around residential areas, seven grabs that collect waste from the transfer stations and illegal dumping areas and three multi-lifts for waste bins in the industrial area (Mudau, 2015).

According to City of Polokwane IWMP (2016), waste is disposed at Weltevreden landfill site, which is the only authorised disposal facility within the PLM boundary that handles the entire waste streams generated. The landfill site has been licensed as a G:M:B site which allows disposal of dry industrial waste, dry domestic waste, builder's rubble and garden waste (Ogola *et al*, 2011). The landfill site has the weighbridge where actual volume of waste generated is being recorded (Mudau, 2015). Recycling mainly takes place through informal reclaiming practices, with limited recycling infrastructure being available. According to Mudau (2015), there are weaknesses in the internal institutional structure of the municipal waste management system. These aspects are elaborated on in the Results and Discussion chapter of this dissertation.

3.6 Challenges in Municipal Solid Waste Management in South Africa and the Limpopo Province

In South Africa, municipalities encounter four comprehensive challenges namely: financial management, equipment management, labour management and institutional behaviour (Godfrey & Oelofse, 2008). Many of these challenges are also faced within the Limpopo Province (Mudau, 2015).

3.6.1 Financial Management

In South Africa waste generation and management challenges increases under the pressure of rapid population growth and industrialization (Ginindza & Muzenda, n.d). According to DEA (2011b) waste management suffers from an unescapable under-pricing which means that the expenditures of waste management are not fully cherished by consumers and industry, and waste disposal is preferred over other options. Non-payment of waste services by citizens and businesses consequently has a direct impact on a municipality's capability to render services

(UNEP, 2020). According to DEA (2011d) municipalities are anticipated to provide services to poor households even if they cannot afford to pay.

Municipalities set tariffs for waste management services which includes collections, city cleansing and disposal fees, as such municipalities should be able to recover the costs of rendering waste management services (UNEP, 2020). State of waste report shows that municipal solid waste services are mostly under-priced and consequently not adequate to cover the costs to carry out the services. According to SAWIS (2018), most municipalities' financial provision for waste management exceeds their budgeted revenues.

3.6.2 Equipment management

According to the CSIR (2011), transport is an expensive feature of providing the waste management service, as a result numerous municipalities struggle to meet their legal mandate of providing at least a weekly waste collection service to all households due to limited budgets. Poor management of existing fleet for waste collection is the central cause of problems, however waste collection trucks that are not well serviced leads to regular breakdowns (UNEP, 2020). Common reasons raised for not doing regular maintenance service on trucks is that spare parts used for repairing the equipment are not readily available and the vehicle fleet are old and require maintenance and replacement (Ginindza & Muzenda, n.d). Vehicle failures are an indication of other problems including vehicle age, poor road conditions, overloading and lack of routine maintenance (CSIR, 2011). Moreover, the breakdown of municipal waste collection vehicles results in inconsistent collection services.

3.6.3 Labour management

According to DEA, (2011b) there is limited understanding of the main waste flows and national waste balance since the submission of waste data is not compulsory, and where data is available, it is often unreliable and contradictory. Again in some countries, state officials "are not even aware about the strategies of service delivery that exist. There is a dire need for capacity building and training among municipal staff (Oelofse & Godfrey, 2008). Municipal services failure can frequently be attributed to staff with insufficient experience, lack of mentoring or the incorrect formal training and qualifications to perform the required job. For instance, an environmental health practitioner being utilized to operate a wastewater treatment facility. However, it is not possible to always recruit staff with the ideal qualification and experience for a specific position in a municipality (CSIR, 2011).

Furthermore, the failure of the waste management laws and regulations is mainly owing to ineffective provisions and authorisations to deal with lawbreakers and the inability or unwillingness of officials to enforce laws (UNEP, 2018). Hence enforcement officers need to know

what their accountabilities are under legislation and what actions can be taken under varying circumstances, therefore they should be equipped to know when to act, what process to follow and be able to understand why it is important to act (Oelofse & Godfrey, 2008).

3.6.4 Institutional behaviour

According to CSIR (2011) most municipalities do not provide waste containers to all waste generators, particularly the indigent households who cannot afford to buy such containers for themselves. Hence the lack of containers may result in littering and illegal dumping as people pursue to clear their households of the gathered waste. However, clearing of illegal dumping cost up to 30 times extra compared to upfront correct disposal (UNEP, 2020). Again, transporting waste to drop-off sites has a cost insinuation for the waste generator, also the excessive fees at the drop-off sites might discourage the use of these facilities (Oelofse & Godfrey, 2008). Moreover, many municipal landfill sites are not permitted and permitted sites do not continuously operate according to their permit conditions, hence poorly operated landfill sites impact on the environment and can cause nuisances to societies living close-by (CSIR, 2011). According to Kubanza & Simatele (2019), the City of Johannesburg have challenges in effectively managing waste management processes, in the face of swift urban change, which is many times a result of lack of political will and knowledge. And lastly, major legislative regulations, guidelines and strategies assume that what works fine for one municipality will also work fine in another, nevertheless that is not certainly the case, as local situations between municipalities differ (Oelofse & Godfrey, 2008; CSIR, 2011).

3.7 Strategies to improve solid waste management systems

This section discusses the ways to improve waste management and will be discussed in the context of adding developing countries to adopt best practices in relation to waste management, waste collection and transportation, waste minimization and disposal.

3.7.1 Capacity-building and awareness-raising

According to Da Zhu *et al* (2008), on no account municipal effort can make a city clean unless its inhabitants cooperate and take an active part in waste management. As a result, inhabitants must be informed, educated, and encouraged not to litter on the streets so they develop the habit of storing their waste and separating at source. There is a crucial need to raise awareness and change public attitude concerning waste generation, waste management, uncontrolled dumping and open burning of waste, along with the associated health and environmental impacts (UNEP, 2018).

Creating awareness within communities' aid in improving municipal solid waste management, for it increases the ability of persons to act responsibly, and make informed choices with regards to waste generation and disposal (Oelofse & Godfrey, 2008). It also provides a useful tool for measuring and comparing service delivery whereby communities are afforded opportunity to raise their view (Godfrey, 2008). According to Dlamini *et al* (2017), it has been established that the supply of waste separation and storage facilities are linked to increased community participation rates in recycling programs. Moreover, government should develop more inclusive models and strategies aimed at promoting community participation in solid waste management (Kubanza & Simatele, 2019).

3.7.2 Recycling and recovery of waste

Waste recycling is highly dependent on two factors; the availability of recycled goods supplies and the market for those goods. Ways in which waste can be recycled which includes source separation wherein households and businesses separate their recyclable items from other waste at the source where they are created and enlisting material into slight containers or bins by type such as paper, glass, plastic (Davidson, 2011).

As stated in earlier, local governments should put favourable policies and incentives in place for the promotion of waste minimization through the 3Rs (reduce, reuse, and recycle) (Oelofse, 2018). Waste separation at source should be promoted to make waste recycling and recovery easier and more affordable, and to ensure collection of clean recyclable waste streams with higher value (UNEP, 2018). The provision of solid waste equipment, protective clothing and infrastructure can trigger a cultural transformation involving increased recognition of the waste pickers' activities (Simatele *et al*, 2017). Lastly, funding and technical expertise provided by international donor agencies may have a noticeable influence on the South African waste and recycling landscape (Godfrey & Oelofse, 2017).

3.7.3 Improved collection and transportation of waste

According to Da Zhu *et al*. (2008), waste that is stored and segregated at households or other establishments needs to be collected following a fixed schedule, and door-to-door collection also requires cooperation and participation of citizens. Collection requires PPP moreover the impartial of PPP will develop a replicable and financially viable model to manage waste and reduce the quantity of solid waste disposed in landfills (Mohana *et al*., 2016). Moreover, it is vital not to mix waste that was separated by the households if not, efforts to separate waste at source will have no effect (Da Zhu *et al*, 2008).

According to UNEP (2018), best practice involves waste collected from households and businesses by collection vehicles and transported to transfer points and treatment facilities, with

final remaining waste going to sanitary engineered landfills. Moreover, the selection of suitable collection vehicles must meet the requirements of local conditions. According to Da Zhu *et al* (2008), the transport of waste needs to be managed and monitored centrally or through a large decentralized arrangement. Therefore municipal officers ought to ensure the efficiency of the arrangement. To have effective waste management there should be contracting or sub-contracting of the waste collection and transportation services by local municipality under the PPP. Local authorities typically subcontract the waste collection and management services to formal private companies (Agamuthu & Masaru, 2014).

3.7.4 Expansion of sanitary waste disposal and landfill management

According to Luong *et al.* (2013) and Regassa *et al.* (2011), in developing countries, waste is generally disposed at open dumping sites, unsanitary landfills also uncontrolled disposal site and some dumped in this single place without separation of even organic waste. As a result, there is continuous burning of the dumped waste due to internal ignition by the waste itself. Open dumping of waste has potential to cause irreversible damage to the environment by polluting land, water, and air; harmfully affecting human health and depressing people's quality of life (Da Zhu *et al*, 2008). In order to manage waste effectively, we need to expand sanitary waste disposal and enhance landfill management. One key consideration while replacing existing open dumpsites with sanitary landfills is to make the waste pickers part of the solution from the beginning of the project (C40 Cities Climate Leadership Group, 2016). An engineered landfill is now a must for all municipal authorities, and they need to invest in one either by participating in a regional facility or by involving the private sector to set up the facility and paying tipping fees for the disposal of waste as may be mutually agreed on (Da Zhu *et al*, 2008).

3.7.5 Integrating waste management and social aspects

The National Waste Management Strategy aims to grow the contribution of the waste sector to the green economy, while also considering the human and social elements of waste management amongst others (DEA, 2011b). According to UNEP (2018), the informal sector plays a key role in the collection systems and recycling, therefore informal sector should get access to recyclables at kerbside and at landfill however they should be formalised or integrated in waste management. Moreover, improving the living standard of informal waste collectors and approving participatory waste management can contribute to the creation of public ownership for the waste management system by directly involving citizens (C40 Cities Climate Leadership Group, 2016). Lastly, special emphasis should be placed on the integration of these informal actors into the urban waste management programmes and strategies (Simatele *et al*, 2017).

3.8 Chapter summary

This chapter revealed the municipal solid waste management systems, current approaches, strategies of improving waste management, by laws, policies and legislations and further revealed that municipal solid waste is a main challenge that is encountered by many countries, developed countries and developing countries. However, waste is mostly unavoidable, but it can be minimised, for municipal solid waste poses a serious threat to the environment and human health. The challenges of solid waste rapid increase have to be properly managed for the benefit of both present and future generation. The major challenge encountered by the South African municipalities is lowly management of the generated solid waste. Provided solid waste is dealt with from the source, then rapid increase of solid waste can decline severely.

CHAPTER 4 RESULTS/DATA ANALYSIS AND DISCUSSION

4.1 Introduction

In this chapter, an analysis of data related to the four research objectives are provided:

- *Research objective 1: To critically evaluate the municipal waste management system and levels of compliance to national standards of Polokwane City;*
- *Research objective 2: To examine the flow of waste from generation source to final destination;*
- *Research objective 3: To evaluate the perceived factors that influence municipality waste management system performance; and*

The following sub-sections will interpret and discuss the results related to each of the research objectives. The delineation of the scope of each of the research objective (Section 1.4 of this dissertation) need to be kept in mind when interpreting the results of the study.

4.2 Results related to RO1: Evaluating the municipal waste management system and levels of compliance to national legislation of Polokwane City

The following sub-sections discuss the findings related to research objective 1. The section commences by providing the *status quo* of waste management practices in Polokwane City (Section 4.2.1), followed by an overview of the institutional and organisational matters of the municipality (Section 4.2.2). The level of alignment between the Polokwane City IWMP and tariff, against the NWMS goals are also reported on (Section 4.2.3). Finally, this section reflects on the level of compliance of the municipality's waste-related services (waste collection and transportation) and waste disposal infrastructure (transfer stations and waste disposal facilities) (Section 4.2.4).

4.2.1 *Status quo* of waste management practices in Polokwane City

The PLM is a municipality that is presently undergoing major challenges with regards to waste disposal and waste minimisation, however, IWMP highlights the elements that need to be improved. The IWMP contents are generally reflected in the IDP and SDBIP.

Elements that need to be address (as included in the IWMP, IDP and SDBIP) include:

- The extension of Weltevreden landfill site and reduction of waste volumes disposed at the landfill site;
- Acquisition of 6 and 9 m³ skips;

- Renovation of the Seshego- and Westernburg transfer station and plans to build the Mankweng and Molepo village transfer stations;
- Procurement of educational and awareness equipment and “no dumping” signs as part of addressing illegal dumping (City of Polokwane SDBIP 2019/2020; City of Polokwane IDP 2020/21).

According to City of Polokwane IWMP (2016), 44.4% of the households receive waste collection services from the municipality, while 55.6% of residents have no access to household waste removal services. A lack of adequate waste collection vehicles (excluding urban compactor trucks) and long turn-around times for repairs leads to challenges in rendering effective waste collection services.

PLM has only one operational disposal facility (Weltevreden landfill site) that handles the entire waste streams generated by PLM. There are presently four operational transfer stations in PLM. There are limited drop-off centres in the municipality, and twelve formal recycling initiatives exist, with less than 3.4% of waste being reclaimed for recycling purposes (City of Polokwane IWMP, 2016). Moreover, the Weltevreden landfill site does not charge any gate (disposal) fees, and as a result, waste disposal to landfill remains the preferred option within the municipality, with very little efforts towards waste avoidance and minimisation (City of Polokwane IWMP, 2016; City of Polokwane, 2020a). Illegal dumping is cause for concern, with many areas in the municipality being subjected to illegal disposal practices.

Lastly, there is shortage of personnel for waste-related services, such as refuse removal, awareness and education, and law enforcement. This is elaborated on in Section 4.2.2 which focuses on institutional and organisational matters.

The following sub-sections to section 4.2.1 elaborates on the *status quo* of waste-related matters in Polokwane City.

4.2.1.1 Separation of waste at source

Section 17 of the NEMWA requires that any person who is undertaking any activity involving re-use, recycling or recovery of waste should make sure that the activity is less harmful to the environment than the disposal of such waste. It further states that the municipality may require any person to separate their waste and use various approved receptacles.

In cases where the municipality has provided separate receptacles for recyclable materials, no person may use other receptacles for recyclable materials. Currently, Polokwane City has no formal separation at source programmes in place, and the municipality has not yet provided households or industries with separate receptacles. Should households or businesses wish to separate waste at source, they may use any receptacles available to them (Polokwane Waste Local Municipality Management Bylaws, 2019).

Not having formal separation at source programmes in place may mean that the municipality is missing out on opportunities to divert waste away from landfill. According to CSIR (2011), municipal waste separation at source programmes (with the municipality also providing dedicated receptacles or bag systems for the separation of waste at source) may significantly reduce the amount of waste being disposed to landfill.

4.2.1.2 Waste storage, collection, transportation and disposal

Households are not provided with waste storage bins by the municipality. Polokwane Local Municipality Waste Management by-law (2019b), state that *the owner of the premises shall be responsible for the supply of pre-determined type of container required by municipality*. However, according to the City of Polokwane IWMP (2016), PLM plans to start supplying households with different coloured bags/bins for various waste types to encourage waste separation. At the time of this research, this has not yet been implemented.

Apart from informal small businesses (like street vendors and car washes), businesses and industries do not receive door to door refuse collection services, and skips and containers are positioned strategically within the CBD and industrial areas. These skips are provided by the municipality and are subject to ruling prices or at hiring tariff determined by council.

The bylaws and IWMP provide for urban and rural households to receive waste collection services once a week. However, there is currently limited waste collection taking place in the rural areas.

Collection of business waste are done daily (commencing at 09h00). Any collection of business waste outside the collection schedule should be done upon request from the municipality, and at an additional tariff determined by municipality.

Polokwane Local Municipality Waste Management by-law states that *any person transporting waste within the jurisdiction of the municipality must remove or transport waste in a manner that would prevent nuisance or escape of materials and not permit waste transported to become detached, leak or fall from the receptacles or vehicle transporting it* (City of Polokwane, 2019b). The management of Polokwane City's waste collection fleet is further discussed in Section 4.2.1.3.

According to the City of Polokwane (2019b), only waste generated within the municipal boundaries may be disposed at the municipal waste disposal sites. Any person who, for the purpose of disposing waste, enters a waste disposal site controlled by the municipality or service provider on behalf of municipality shall enter disposal site at an authorised access point only and shall give all required particulars with regards to the composition of waste. Vehicles are subjected to being weighed at the disposal site for the purpose of providing information to the National

Waste Information System. The municipality or service provider responsible for waste management, reserve the right to inspect any load arriving at disposal site.

The Weltevreden landfill site is operated by a waste contractor (public-private partnership). More information on waste disposal is provided in Section 4.2.4 and 4.3.4 of this dissertation.

4.2.1.3 Fleet management

Polokwane Municipality has a Fleet Management Services unit. The unit is responsible for providing Fleet Management operational support to the municipality through effective provision of roadworthy vehicles, procurement and disposal, vehicle contracts management, vehicle administration (licensing and registration), maintenance and repairs coordination, vehicle allocation and utilization monitoring, as well as fuel management (City of Polokwane IWMP, 2016).

The municipality has a total fleet of 460 vehicles, of which 80 are non-functional and uneconomical to repair. The municipality intends to dispose about 127 units of the old municipal fleet due to ageing. Of the municipality-owned fleet, 155 vehicles are operational and 98 vehicles old fleet is to be retained. The municipality owns 25 waste management vehicles for services in the Polokwane area, which includes: nine compactor trucks, nine bakkies, four trucks and three grab and load luggers (City of Polokwane IWMP, 2016). The fleet is ageing and financial resources to replace vehicles are limited (City of Polokwane, 2020a).

During the 2018/2019 financial year, the municipality have incurred a high maintenance expenditure pattern on fleet maintenance, and even though there was an increase in fleet maintenance cost, the budget allocation for maintenance remained the same (City of Polokwane, 2019a). The budget allocation could not cater for the overall financial year and this hampered Strategic Business Units (SBU's) to render consistent and frequent waste collection services.

Three services providers (public-private partnerships) render fleet services in Mankweng, Seshego and the Polokwane city.

4.2.1.4 Littering and illegal dumping

The Polokwane Local Municipality Waste Management by-law (2019b) stipulates *that no person shall throw, deposit or spill any waste onto any public place and again no person shall without permission of the municipality allowed to dump, deposit or allow waste disposal anywhere in a public place, street or any drain*. Penalties and fines are applicable to littering and illegal dumping. Yet, littering and illegal dumping is prominent in the City of Polokwane, as discussed in Section 4.3 of this dissertation.

4.2.2 Organisational and institutional matters

According to NEMWA (DEA, 2009), each municipality authorised to carry out waste management services by the Municipal Structures Act, 1998 (Act No. 117 of 1998), must designate in writing a waste management officer from its administration to be responsible for co-ordinating matters pertaining to waste management in that municipality. The City of Polokwane has appointed a Waste Management Officer (WMO) as required in terms of NEMWA. The WMO designated in terms of Section 10(3) of NEMWA, is responsible for ensuring that the dedicated waste management staff and the services provided by these staff members meet the requirements of the Waste Management Policy and are compliant with waste-related legislation (City of Polokwane IWMP, 2016). The WMO is also responsible for the coordination of waste management activities to ensure integration.

The City of Polokwane's Waste Management Section consist of 170 approved posts (137 are occupied and 33 are unoccupied) (Figure 4-1). Approximately 160 Expanded Public Work Programme (EPWP) workers have also been deployed on a temporary basis to assist with the refuse removal and street cleaning. Figure 4-1 outlines the approved Waste Management Organisational Structure (which excludes staff responsible for education and awareness).

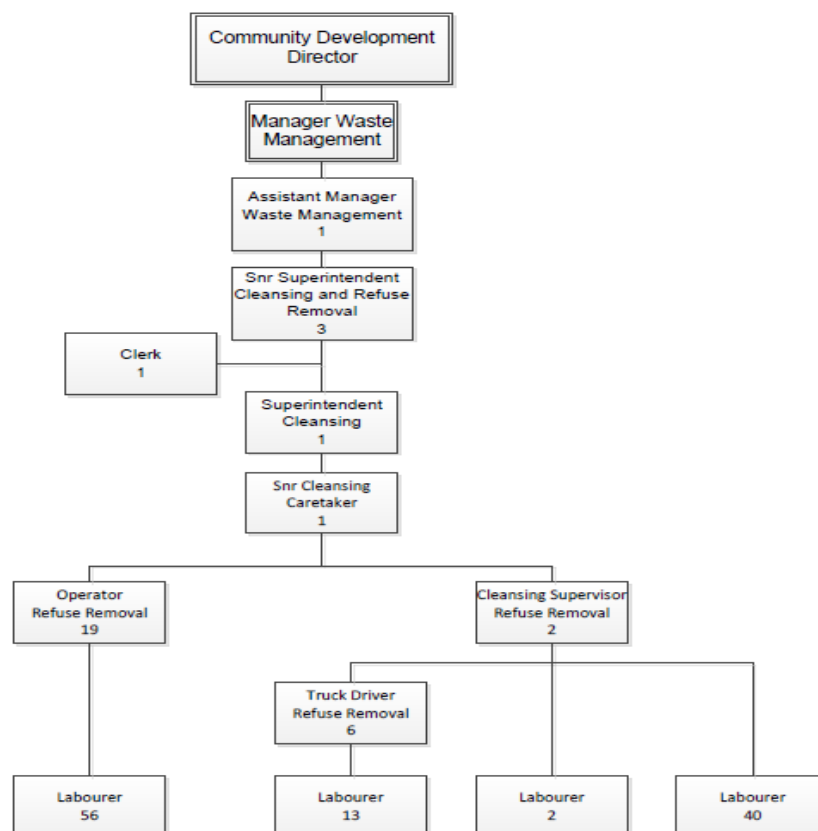


Figure 4-1: Approved Waste Management Organisational Structure (City of Polokwane IWMP, 2016)

Figure 4-2 outlines the proposed, updated Waste Management Organisational Structure that is considered for the future. PLM seeks to optimise the efficiency of the waste management system in terms of infrastructure, equipment, human resources and the development of skills and capacity by assessing the institutional arrangements.

However, no provision is made for law enforcement activities in either of the organisational structures (Figure 4-1 and 4-2). According to the City of Polokwane IWMP (2016), there should also be a clear split between the number of labourers responsible for refuse removal and street and side walk cleaning (as indicated in Figure 4-1 with 111 labourers expanded to 300 labourers in Figure 4-2).

According to Mariwah (2012), institutional capacities of the actors have an influence on the existing mechanism for the collection and disposal of municipal solid waste. Moreover, the capability of a solid waste management system to consistently and reliably achieve its goal depends largely on operation and maintenance. As stated by Wolsink & De Jong (2000), organisational changes need to create better institutional capacity to achieve environmental goals within the waste sector. In the case of PLM organisational change will signify better service provision. Public-private partnerships exist with four service providers: three for fleet management and one for managing operations at the waste disposal site.

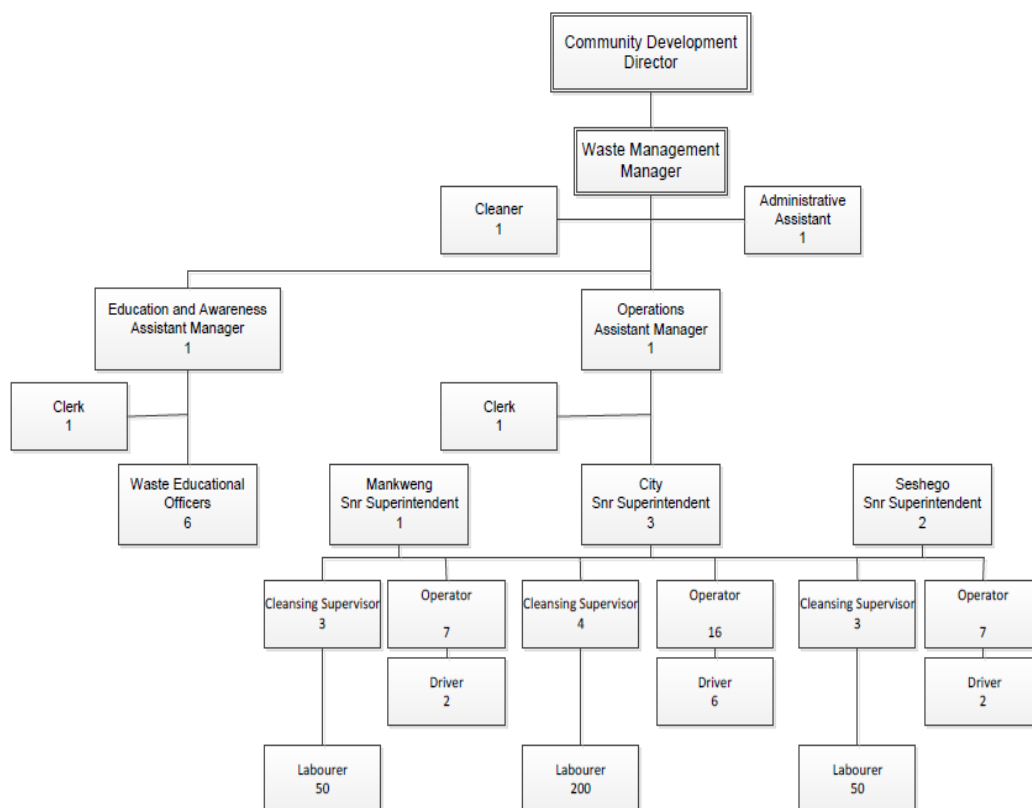


Figure 4-2: Proposed Waste Management Organisational Structure (City of Polokwane IWMP, 2016)

4.2.2.1 Development and enforcement of by-laws

The City of Polokwane has developed a Polokwane Local Municipality Waste Management by-law dated 2019. The by-law regulates the removal of domestic, garden, bulky and building waste (collection and transportation). By-laws also regulate waste disposal and transfer stations, littering and dumping, waste recycling and waste information. It makes provision for appeals, offences and penalties. Enforcement of the by-laws are not clearly provided for.

4.2.2.2 Enforcing offenses and penalties

According to City of Polokwane (2019b), *any person who breaches any provision of the by-laws or fails to obey with any provision of these by-laws shall be guilty of an offence and shall be liable to a fine and again on conviction the contravener shall be accountable to sentence for a period not exceeding 12 months or to both fine and sentence.* However, there is inadequate resources to enforce Polokwane Local Municipality Waste Management By-laws (offenses and penalties). To improve compliance by the PLM residents to these by-laws, penalties relating to illegal dumping and any other offenses need to be clearly communicated.

4.2.2.3 Financial management and procurement

According to City of Polokwane (2020a), R3.5 million (compared to R89 million in the previous financial year) was lost to irregular and fruitless expenditure due to contracts appointed in the previous financial years (2017/2018). The IDP does not indicate which of the fruitless expenditure was due to waste-related services and contracts. According to General Report on National and Provincial Audit Outcomes (PFMA, 2017/2018), fruitless expenditure refers to expenditure that was made in vain and might have been avoided had realistic care been taken. Such expenditure includes the payment of inflated prices, and the cost of litigation that may possibly have been avoided. According to the Municipal Finance Management Act (Act No. 56 of 2003), standard procurement procedures have to be followed, decent relationships amongst councillors and officials are necessary to ensure the smooth and timeous consecutively of the procurement procedure, as such all capital expenditure desires to be correctly motivated by the waste manager (DEA, 2011c).

According to Lohri *et al.* (2014), revenue can be generated from tariffs collected and can be distinguished by type of waste generator. There are three different customer types: residential-, institutional- and commercial customers. It is estimated that the City of Polokwane is currently owed approximately R1 billion by rate payers. It is uncertain what portion of this amount is related to waste services.

The deepening crisis of uncollected revenues continue to weaken the municipality's ability to fully upgrade and renovate its ageing infrastructure. The rising municipal debt is a strong sign that its

revenue collection environment need to be reformed to improve its efficiency and effectiveness (City of Polokwane, 2020a).

Properly managed operational expenditures (also referred to as running costs) are crucial for a municipality to function properly. These costs include expenditures to ensure that waste collection services can be consistently provided, which includes the costs related to the maintenance of assets and their depreciation (Lohri *et al.*, 2014).

4.2.3 Alignment of the IWMP with the 2011 NWMS goals

According to DEA (2011b), municipalities are required to align their IWMPs to the 2011 NWMS targets where possible in order to contribute to the attainment of the goals and target set in the NWMS. However, there are gaps identified in City of Polokwane IWMP, 2016 whereby not all of the goals of the strategy were incorporated into the reviewed IWMP.

Table 4-1: Alignment of the City of Polokwane IWMP with the 2011 NWMS goals²

NWMS (2011) goal	IWMP alignment	Comments
Goal 1: Promote waste minimisation, re-use, recycling and recovery of waste	Goal 1 of the City of Polokwane IWMP aims to promote recycling and recovery of waste, which is aligned with Goal 1 of the NWMS (2011). The objectives linked to Goal 1 of the City of Polokwane IWMP is to: • Establish community drop-off centres with skips/containers for different waste streams at municipal facilities. • Separation or segregation of waste stream at source to reduce the waste disposed to landfill by 20%. • Encouragement of co-operatives responsible for recycling and implementation of appropriate economic instruments and other financial incentives. • Reuse of garden waste and building material. • Develop waste avoidance guidelines.	The waste management <i>status quo</i> in the City of Polokwane does not currently allow for this goal to be achieved sufficiently: • PLM has insufficient community drop-off centres for recyclable items. • There is limited separation or segregation of waste streams at source and most of the waste generated by households ends up being disposed of at the landfill site. • According to the City of Polokwane IWMP, (2016) there is limited recycling initiatives.

² The 2011 NWMS instead of the 2020 NWMS was used for comparison, since the 2016 IWMP would not have incorporated the 2020 NWMS objectives.

NWMS (2011) goal	IWMP alignment	Comments
		A concept document has been developed to address waste avoidance issues, but the municipality have not yet implemented these initiatives.
Goal 2: Ensure the effective and efficient delivery of waste services	Goal 2 of the City of Polokwane IWMP, is to ensure the effective and efficient delivery of waste services, which is also perfectly aligned with Goal 2 of the NWMS (2011). The objectives of the City of Polokwane as it relates to this goal are: - Creating funded and filled new posts for waste management. - Community-based services should be rendered to areas where the municipality have no capacity. - To achieve no illegal dumping	The waste management <i>status quo</i> in the City of Polokwane does not currently allow for this goal to be achieved sufficiently: - Currently there are inadequate human resources due to vacant and unfunded critical posts - Bins placed in the street for collection are damaged or overflowed with waste. - There is insufficient law enforcement and services to prevent illegal dumping.
Goal 3: Grow the contribution of the waste sector to the green economy	This goal is mostly applicable to private industry, and the City of Polokwane has no specific goals relating to Goal 3 of the NWMS	
Goal 4: Ensure that people are aware of the impact of waste on their health, well-being and the environment	Goal 6 of the City of Polokwane IWMP focuses on education and awareness, which is aligned with Goal 4 of the NWMS (2011). The objectives related to this goal includes: Develop and implement a communication and public awareness plan that encourage minimisation, reuse, recycling, and recovery and discourage illegal dumping	Currently PLM is working with two schools in the area, which does not meet the 80% target of the NWMS

NWMS (2011) goal	IWMP alignment	Comments
	and littering, thereby minimise the negative impacts of waste on the environment including the quality of life of the people themselves. • Develop and implement awareness and education programmes for the broader community.	
Goal 5: Achieve integrated waste management planning	Goal 5 of the City of Polokwane IWMP aims to ensure the safe and proper disposal of waste, with a focus on integrated waste management planning. This goal is aligned with Goal 5 of the NWMS (2011) and has the following objectives: • Develop and implement a waste treatment and disposal strategy that will include but not limited to the following: ○ Compliance of all waste treatment and disposal facilities with relevant legislation for their development and permitting, operation and closure. ○ Addressing long term capacity needs of the municipality. ○ Explore alternative treatment and/or disposal options.	• The City of Polokwane have developed their IWMP in 2016, the IWMP has been integrated into the IDP and the SDBIP. • Currently there is inadequate disposal facilities for rural areas. • Currently airspace is limited on the Weltevreden landfill site (Average 2 years).
Goal 6: Ensure sound budgeting and financial management for waste services	Goal 4 of the City of Polokwane IWMP provides for sound budgeting and financing of waste management services, which is aligned with Goal 6 of the NWMS (2011). The objectives linked to Goal 4 of the IWMP includes that: • Tariffs should be developed for all the waste management activities. • The municipality must be able to determine the economic sustainability of the municipality and therefore establish long terms priorities.	• The municipality has approved a tariff structure for waste but no tariffs are currently charged at landfill, and transfer stations.

NWMS (2011) goal	IWMP alignment	Comments
Goal 7: Provide measures to remediate contaminated land	Currently, the City of Polokwane IWMP is not aligned with Goal 7 of the NWMS.	• PLM should make provision for this goal in its IWMP.
Goal 8: Establish effective compliance with and enforcement of the NEMWA	Goal 7 of the City of Polokwane IWMP aims at achieving compliance and enforcement, while Goal 3 aims to ensure that legislative tools are developed to deliver on the Waste Act and any other applicable legislation. These goals are aligned with Goal 8 of the NWMS (2011). Objectives include: • Enforcement of waste by-laws and relevant legislation. • Keeping accurate record and efficient data management of waste volumes and waste types collected, recycled and disposed.	• Waste by-laws have been approved but not yet implemented. • There is insufficient record of waste volumes or its characteristics at all the disposal facilities because there is no proper checking of incoming waste.

The NEMWA requires that all municipality must integrate their IWMP into IDP in order to ensure waste management provision. It can be concluded, from Table 4-1, that Goal 3 and Goal 7 of the NWMS is not addressed in City of Polokwane IWMP (2016) while the other goals are partially addressed.

4.2.4 Evaluating the levels of compliance to national legislation

This section reflects on the level of compliance of the municipality's waste-related services (waste collection and transportation) and waste disposal infrastructure (transfer stations and waste disposal facilities) to the requirements of the NEMWA and its regulations.

More supporting information is provided in Section 4.3 of this dissertation, which focuses on the flow of waste – from generation to final disposal.

4.2.4.1 Compliance of waste collection services to legal requirements/standards

The NEMWA *National Domestic Waste Collection Standards* requires that reasonable waste collection services must be provided to all households within the jurisdiction of the municipality. However, in PLM only 44.4% of households receive waste collection services from the municipality. Again, the waste collection standards states, in Section 4 that in areas where

travelling distances and the resulting costs may render regular waste collection services impractical, the municipality, through by-laws, must allow for more feasible alternative ways of waste handling, such as on-site. PLM only have four operational transfer stations which does not cover the jurisdiction of the municipality.

Section 4.6 of *National Domestic Waste Collection Standards* state that non-recyclable waste must be removed at least once a week and recyclable waste must be removed at least once every two weeks, bulk containers must be collected once filled up or within 24 hours of being reported as full, however not less than once a week. Waste deposited at communal collection points must be collected within 24 hours of receptacles being reported as full. It is further required that the frequency of waste collection must not encourage illegal dumping or cause a nuisance in terms of odours and volumes of waste being stored. Currently, the weekly waste collection from households (in serviced areas) and the daily collection from industrial areas are deemed to be adequate. The concern, however, is the relatively low number of households receiving waste collection services, as mentioned above.

Section 4.1 of the *National Domestic Waste Collection Standards* specifies that that all domestic waste must be sorted at source in all Metropolitan and secondary cities. Separation of waste at source is provided for in the PLM Waste by-law and planned for in the IWMP. However, currently, no household separation at source initiatives have been implemented in PLM.

4.2.4.2 Compliance of waste transportation to legal requirements/standards

According to the *National Domestic Waste Collection Standards* (DEA, 2011a), collection vehicles used for the collection and transportation of waste must not be used for any other purpose while collecting and transporting waste. Waste must be collected and transported in closed vehicles to prevent littering during transportation (DEA, 2011a; City of Polokwane, 2019b). Moreover, maintenance schedules must be adhered to and roadworthiness of vehicles ensured where applicable in order to ensure a reliable waste collection service. At the time of this research, PLM was, generally, in compliance with these requirements for the transportation of waste. Waste is collected in vehicles where the potential of it being blown away is limited. PLM has a Full Maintenance Lease (FML) agreement with Fleet Africa for the use of specifically selected vehicles over a set period of time and distance. However, because of the ageing of vehicles, some are too expensive to fix, which contributes to problems with waste collection and transportation.

4.2.4.3 Compliance of waste disposal infrastructure to legal requirements/standards

The sub-sections to Section 4.2.4.3 reflects on the level of compliance of municipality-owned waste infrastructure of the City of Polokwane to legal requirements.

4.2.4.3.1 Compliance of transfer stations to legal requirements/standards

According to City of Polokwane, (2019b), Polokwane transfer stations are not open for person running waste management businesses (such as garden service or refuse removal) but strictly limited to members of the public. Transfer stations in Polokwane exceed the 100 m³ size capacity and in terms of category C of GNR 921 and needs to be registered and comply to the *Norms and Standards for the Storage of Waste* (GNR. 926 of 29 November 2013). Section 6 of National Norms and Standard for the Storage of Waste (DEA, 2013c) highlights that waste storage facilities may be located within a residential area and must be located in such way that is easily accessible by public.

All transfer stations in PLM are located within residential areas, which is good because they are readily accessible to the public. However, nuisance, especially odours, to the public needs to be managed. The sorting, shredding, and grinding of general waste at an area with an operational capacity of more than 1000 m² is listed in Category C of the list of waste management activities (GNR. 921 of Nov 2013), requiring that transfer stations with sorting, shedding, baling and crushing capabilities should be registered and operated in terms of the *Norms and Standards for Sorting, Shredding, Grinding, Crushing, Screening or Baling of General Waste* (GN. 1093 of 11 October 2017) (DEA, 2017a).

Both of these norms and standards require that the waste storage/sorting facility must have effective access control to prevent unauthorised entry and that records in terms of volumes, source and nature of waste received are maintained and reported. Moreover, it should operate within its design capacity and waste containers should be not be overloaded.

According to the City of Polokwane IWMP (2016), waste stored at transfer stations are deposited directly on the floor or ground surface. No scales or weigh bridges are available, which makes it challenging to estimate and record waste quantities present at these facilities.

4.2.4.3.2 Compliance of the Weltevreden landfill site to legal requirements standards

The Weltevreden landfill site is located approximately 3km southeast of the Polokwane city's southern suburbs. The landfill site has only two years' lifespan remaining and limited efforts are made by the PLM to extend the lifespan in terms of focusing on reclamation of recyclable wastes (City of Polokwane IWMP, 2016). According to City of Polokwane IWMP (2016) despite the availability of a weighbridge there is insufficient record of waste volumes or its characteristics at all the disposal facilities in terms of SAWIS reporting which lead to non-compliance.

According *National Norms and Standards for Disposal of Waste to Landfill* (DEA, 2013b) waste which, in the conditions of a landfill, is explosive, corrosive, oxidizing and compressed gases

(household hazmat) are prohibited or restricted from landfill disposal. Yet, these wastes are still being disposed to landfill in PLM. According to City of Polokwane (2019b), waste such as tree stumps, branches, concrete blocks, rocks and general builders waste shall be reduced to manageable sizes as deemed fit by the municipality, prior to disposal. The Polokwane Local Municipality Waste Management By-laws, (2019) provides for the municipality or its service provider(s) to inspect any load arriving and this may include hand held test instrument and a laboratory analysis of waste involved. The municipality is, however, not compliant with these requirements. There is no proper inspection of vehicles at the access gate nor on the landfill site, and a site inspection confirmed that big portions of building rubble is disposed of at the landfill site.

Polokwane Local Municipality Waste Management By-laws (2019), requires that waste generators should pay the applicable tariff in respect of waste disposed or comply with prior arrangements before leaving disposal site. However, currently waste generators are not charged any gate fees (City of Polokwane, 2019b).

Although the Weltevreden landfill site is licensed in terms of the (now repealed) Environmental Conservation Act (No.73 of 1998) (licence dated November 1998), the City of Polokwane IWMP concludes that the landfill site is mostly non-compliant to its licence conditions. Table 4-2 provides information on the characteristics of the landfill site, which includes information related to the site's compliance to its licence conditions.

Table 4-2: Characteristics and level of compliance of the Weltevreden landfill site to landfilling requirements (City of Polokwane IWMP, 2016)

Requirements	Current status at Weltevreden landfill site
Position of site	S 23°56'49.5" E 29°29'35.9" Accessible from Silicon Road
Permit to operate	Yes Permit No:16/2/7/A700/D3/Z2/P319 dated November 1998
Year issued	1998
Classification	G:M:B
Type of operation	Trench method
Size	Approximate 40 ha
Air Space availability	2 years
Cover material available	Excess building rubble
Operated	Selema Plant hire/ Mascon JV
Compliance to permit conditions	
Permit condition	Level of compliance

Requirements	Current status at Weltevreden landfill site
Condition 2.1 Regulatory compliance	Non-compliant. For example, operational conditions indicate that waste disposed of on site may not be reclaimed, however, there are reclaimers on site, and again non-compliant with regards to waste acceptance, as indicated earlier.
Condition 2.2 Daily cover	Partially compliant. Construction and demolition wastes such as crushed concrete are used to cover waste, however there is evidence of waste not covered on a daily basis.
Condition 2.3 Access control	Compliant. The site is fenced with an entrance gate to prevent any unauthorised entry. However, as mentioned earlier, the presence of reclaimers on the site (which is not allowed in terms of the licence conditions) is cause for concern.
Condition 2.4 Buffer	Compliant. An open piece of land surrounds the site.
Condition 2.5 Type of equipment	Compliant. Equipment is operated and supplied by contractors.
Condition 2.6 Ablution facilities	Compliant. There are ablution facilities available on site.
Condition 2.7 Guardhouse	Compliant. A functional guardhouse is located on the site.
Condition 2.8 Storm water management	Compliant. There is landfill cap drainage in place.
Condition 2.9 Leachate management	Compliant. There are currently no visible leachate generated by the site.
Condition 2.10 Record keeping	Non-Compliant. Insufficient records of waste received and waste recycled are submitted to the municipality by service provider on a monthly basis.
Condition 2.11 Recycling	Informal reclamation activities take place on site.
Additional requirements	Level of compliance
SAWIS reporting	Non-Compliant. PLM has implemented a waste information system, where data is captured and reported into the SAWIS system but data is insufficient.
Implementing disposal restrictions and prohibitions (<i>GNR. 636, Norms and Standards for the Disposal of Waste to Landfill, DEA 2013c</i>)	Partially compliant. Although certain waste streams are prohibited from being disposed at the landfill site, inadequate inspection of vehicles and the landfill site may pose a problem. The disposal of waste tyres is prohibited on the site and is sufficiently enforced at the landfill site.

4.2.5 Summary of results related to research objective 1

The results and discussion in this section was based on objective 1 which was centred on evaluating the municipal waste management system and levels of compliance to national standards. The results highlight the gaps and non-compliance with regards to waste management, which includes:

- Only 44.4% of the households receive waste collection services from the PLM which is much lower than Goal 2 of NWMS (which aims at 95% of urban households and 75% of rural households);
- PLM does not have any formal waste separation at source programmes, hence less than 3.4% of waste is reclaimed for recycling purposes – mainly from the landfill site;
- Currently the organisational structures at PLM make no provision for law enforcement activities;
- There is currently a gap with the linking all of the goals, especially Goals 3 and 7, of the NWMS with IWMP;
- There are insufficient resources (personnel and equipment) which is hindering the effective and efficient delivery of waste services;
- Insufficient records of volumes, sources and the nature of waste received at transfer stations are kept. Waste storage practices do not comply with legal requirements and good practice, with waste being scattered around and stored on bare soil instead of waste containers; and
- The Weltevreden landfill site is currently non-compliant to permit conditions and waste disposal prohibitions.

4.3 Results related to RO2: Examining the flow of waste from generation source to final destination

This section discusses the findings related to research objective 2, which was to examine the flow of waste from generation to disposal (Refer to Figure 3-1 in Chapter 3). This was achieved through on-site observations conducted during 9 to 24 September 2020. Areas visited during the observation process included waste collection points in the CBD, as well as selected commercial areas and residential areas, Ladanna and Webster waste transfer stations and Weltevreden landfill site. Significant observations made were captured on photographs and included in the sub-sections below. The site visit to the landfill site was supported by an observation checklist (See Annexure 6). All other observations made were guided by the researcher's knowledge of legal and other requirements related to waste management.

4.3.1 Waste generation and storage (including separation of waste at source)

Observations made during the research revealed that the majority of waste generated in the areas included in the study was municipal solid waste, which includes metals (mostly cans), paper, glass, plastic, organic waste (mostly food and garden waste), inert waste, and building rubble.

Household waste is generally stored in wheelie bins, street bins in public areas (i.e. those with high pedestrian traffic), and in skips in industrial and commercial areas. Most of these waste

receptacles were observed to be overflowing – either because of its capacity or because of irregular waste collection services (Figure 4-3 left).

Skips located within commercial areas in the CBD were mostly damaged. Although the burning of waste in public areas is prohibited in the City of Polokwane's Waste Bylaws, evidence of waste burning activities (ash next to skips) were observed (Figure 4-3 right).



Figure 4-3: Examples of non-compliant waste storage practices in the City of Polokwane

Observations in the commercial areas of the CBD revealed that, generally, no waste separation is taking place at PLM. Hazardous waste types (such as fluorescent tubes) are stored and collected with non-hazardous waste (Figure 4-4). Separation of these wastes during storage would be the first step towards preventing these waste types from being collected and disposed with general waste.



Figure 4-4: Examples of fluorescent tubes and other hazardous waste types being stored with general wastes

According to the *Municipal waste management - good practices* by the CSIR (2011), waste collection systems must provide for the collection of separated waste as required by the NEMWA (Act No. 59 of 2008). However, as mentioned earlier, the municipality has not implemented any formal waste recycling programmes and has no formal programmes in place to ensure the separation of waste at source. Similar to hazardous waste being stored with general waste, recyclable materials are also not separated from non-recyclable materials (Figure 4-5).



Figure 4-5: Examples of recyclable materials in the City of Polokwane

Recyclable materials are, however, reclaimed informally by waste pickers. These informal waste collectors in PLM reclaim recyclable wastes (such as cardboard, cans, plastics and glass) and sell it to different recycling companies in PLM. According to UNEP (2018), informal waste pickers may be exposed to wide-ranging chemical, biological, physical and health risks. It was observed that most waste pickers did not wear any PPE while reclaiming waste, which might result in wound infections from sharp objects and contaminated materials.

4.3.2 Waste collection and transportation

In Polokwane Local Municipality, refuse is collected by means of kerb-side collection and transported directly to the Weltevreden landfill site (Figure 4-6). Section 4.6 of the *National Domestic Waste Collection Standards* state that bulk containers must be collected once filled up or within 24 hours of being reported as full. Waste from bulk containers in the PLM CBD is currently being collected once per day.



Figure 4-6: Kerb-side collection in the City of Polokwane CBD

Daily street and sidewalk cleaning takes place in the CBD area (Figure 4-6), which prevents undesirable materials from ending up in storm water drains.



Figure 4-7: Street cleaning practices in the City of Polokwane

Waste from households are also collected via kerb-side collection once per week. However, as mentioned earlier, only about 44.4% of households receive regular waste collection services. Building-related waste and rubble are not collected by the municipality for disposal.

As mentioned earlier, waste collected from the CBD and households are transported to the Weltevreden landfill site for disposal. The Polokwane Local Municipality Waste Management by-law (2019) states that any person transporting waste within the jurisdiction of the municipality must transport waste in a manner that would prevent nuisance or escape of materials. It further requires that during transportation, no waste should become detached, leak or fall from the receptacles or vehicle transporting it. Observations made during the research revealed some instances of waste being blown from vehicles transporting the waste (Figure 4-8).



Figure 4-8: Garden waste being lost from a vehicle during transportation

4.3.3 Waste transfer and processing

Two (2) transfer stations, the Webster and Ladanna garden refuse transfer stations, were visited during the study. According to Section 8 of *National Norms and Standards for Storage of Waste* (DEA, 2013c), waste storage facilities must have effective access control to prevent unauthorised entry. Signage is also required at these waste storage facilities (in at least three official languages applicable in the area must be displayed at each entrance of the facility showing hours of operation, the name and telephone numbers). Both Ladanna and Webster Garden refuse transfer stations have such signage (Figure 4-9).



Figure 4-9: Signage at Webster and Ladanna garden refuse transfer stations

The garden waste transfer stations in PLM are within residential areas, which makes it accessible to the public. There are no scales or weigh bridges to weigh the waste being transferred to these sites. Therefore, the volumes of waste being reported is expected to be inaccurate. Moreover, dumping of general waste at the Webster garden transfer station was evident, although only garden waste is allowed at these sites (Figure 4-9). This general waste are transported together with garden waste to landfill for disposal.

Waste should be contained in containers, where loss of containment should be prevented, however, waste was stored directly on the ground surface in many instances (Figure 4-10).



Figure 4-10: Examples of non-compliant waste in the City of Polokwane transfer station

4.3.4 Waste disposal

It was observed that waste collected from households and from the CBD was being disposed of at the permitted waste disposal site, Weltevreden Landfill. Compliance of the landfill site to its permit conditions were discussed in Section 4.2.4.3.2. The sub-sections below outline the observations made during the site visits to the Weltevreden landfill site.

4.3.4.1 Access control, infrastructure and equipment

The permit conditions of the landfill site require signposting at the gate (indicating the types of waste allowed and the operating hours of the site), access control and adequate fencing, and that a weigh bridge must be present at the landfill site. The required signage, as well as access control and a weigh bridge were present at the Weltevreden landfill site (Figures 4-11 and 4-12). However, although access control is in place, waste pickers are still allowed access to the landfill site (which is in non-compliance with the conditions of the waste permit, which prohibits waste reclamation from the site).



Figure 4-11: Signage, access control and weighbridge at the Weltevreden landfill site

Precise weight data for waste is necessary to accurately report on and charge for waste disposal. Although a weigh bridge is present at the entrance to the site (Figure 4-12), vehicles offloading waste at the landfill site is not consistently weighed and allowed to enter the landfill site without weight data being captured this is due to incompetence's of the landfill officials.



Figure 4-12: Weigh bridge at the Weltevreden landfill site

Moreover, gate fees for the disposal of waste at Weltevreden Landfill Site should be implemented at R58.03 per tonne (City of Polokwane, 2020b). It was, however, observed that people are disposing of waste for free, with no payment collected at the landfill site. The cashier house is completed, however, no payment is collected as it is classified as a high risk area to collect cash.

The Weltevreden landfill site has the necessary road signs indicating where waste should be disposed of. (Figure 4-13).



Figure 4-13: Example of a road sign at the landfill site indicating the waste offloading area

There was also an employee present (referred to as a “spotter”), who monitored the vehicles entering the site and to direct vehicles to the current and preferred tip/work place suitable for that vehicle. The disposal of prohibited or restricted items (such as flammable wastes), however, remains an area of concern, which causes questions to arise around the effectiveness of monitoring being done at the site.

4.3.4.2 Storage of fluorescent tubes

Different types of lighting tubes contain chemicals and materials which may be harmful to people or the environment and need to be properly disposed of. As mentioned earlier, fluorescent and other light tubes are mostly stored and transported with other waste types. This may lead to breakage of these tubes during transportation.

Where possible, lighting tubes are removed from trucks at the weigh bridge, crushed in the skips bin ((Figure 4-12 left) and stored in drums (Figure 4-14 right), waiting to be transported for final disposal/treatment. The disposal of lighting tubes is prohibited from landfill disposal, according to GNR. 636 the *Norms and Standards for the Disposal of Waste to Landfill*.



Figure 4-14: Example of lighting tubes being stored and crushed at the landfill site

4.3.4.3 Waste reclamation activities

The Department of Environment, Forestry and Fisheries (DEFF) in collaboration with the Department of Science and Technology (DST) have recently published guidelines on waste picker integration into formal municipal waste management systems (DEFF & DST, 2020). However, waste pickers in South Africa are generally not provided for in waste management systems of municipalities. Furthermore, waste reclamation activities are generally prohibited from landfill sites in terms of the conditions of waste management licences or permits.

Pickers living off landfill sites are a reality for most South African municipalities (CSIR, 2008; DEFF & DST, 2020). The conditions and activities at landfill sites may be detrimental based on health and safety risk they pose. The use of heavy equipment in landfill operations poses safety risks to pickers, and the liability of any incidents arising on these facilities lies with the municipality.

Although it is not allowed in terms of the permit conditions of the Weltevreden landfill site, waste pickers are involved in waste sorting and reclamation at the landfill site. The most common recyclable items reclaimed by the waste pickers from the landfill site include: plastic bottles, cardboard, cans, and building material (timber and bricks) (Figure 4-15).



Figure 4-15: Reclaimed cardboard, plastic bottles and building material (timber)

4.3.4.4 Operational issues

The Weltevreden landfill site is approaching the end of its lifespan in approximately 2 years (2023). Siting a new landfill site is challenging, due to limited land being available (the area surrounding the current landfill site is mainly used for housing). Hence, means of prolonging the life span of the existing landfill site is extremely important. This may be achieved by means of waste reclamation, which would, ideally, require separation of waste at source. As mentioned before, the PLM currently has no formal waste reclamation or recycling programmes in place. Waste is largely reclaimed by waste pickers – either during kerb-side storage (prior to collection) or from the landfill site.

Building rubble removal is not formally addressed in the PLM IWMP or waste by-laws. It is mostly illegally dumped or offloaded at the waste disposal site, with no initiatives for reusing or recycling it. It was observed that smaller portions of building rubble, such as tiles, are crushed and used as cover material. The larger portions of building rubble are, however, dumped at the landfill site, in an area classified for “risk waste” (Figure 4-16). These current practices are unwanted, since it takes up landfill space.



Figure 4-16: Building rubble disposed of on site

Fires must be avoided at landfill site, because they are problematic to control due to the presence of landfill gas and because of their potential impact on air quality (CSIR, 2008). The making on any fires on the Weltevreden landfill site is prohibited in terms of the licence conditions of the site.

Dumping of undetected flammable materials and the disposal of refuse that is still burning on arrival may cause fires. Furthermore, some hazardous substances may ignite when mixed. Figure 4-17 provides evidence of a landfill fire observed on 11 September 2020 at the Weltevreden landfill site.



Figure 4-17: Fire observed at the Weltevreden landfill site

4.3.5 Illegal dumping

Observations made during the research identified several areas of illegal dumping (in residential areas and the CBD) and instances where waste streams are left at areas not designated for waste collection. Illegal dumping was observed, even in the presence of “no dumping” signs (Figure 4-18).

As mentioned earlier, the PLM has capacity issues when it comes to compliance and enforcement. This was clearly visible from the several instances of illegal dumping observed.



Figure 4-18: Some examples of illegal dumping in the PLM

The City of Polokwane IWMP (2016) indicates that illegal dump sites are cleared by the municipality and that “no dumping” signs are erected to inform the public that this is an offence. Although some cleared illegal dumping site were observed during the research, no signs were observed at any of the sites, and in many instances illegal dumping re-occurred after the clean-up actions (Figure 4-19).



Figure 4-19: Illegal dumping site after clean-up

4.3.6 Summary of results related to research objective 2

The results and discussion in this section, was based on research objective 2 (which focused on examining the flow of waste from generation source to final destination). The results highlight the gaps, compliance and non-compliance with regards to waste management, which includes:

- Challenges with regards to insufficient receptacles for waste storage. Several instances of waste receptacles which were overflowing with waste due to limited capacity were noted. In many instances it also resulted in littering;

- Waste is mostly stored as mixed waste, with limited to no separation at source;
- Some instances of non-compliance during the transportation of waste, with waste being blown away, leaking and falling from vehicles transporting materials;
- Inadequate storage of waste at transfer stations, where waste was not stored on impervious surfaces;
- Insufficient operations at the landfill site, with inadequate daily cover, irregular inspection of vehicles at the access gate. Landfill fires were observed, and big portions of building rubble were inappropriately being disposed of at the landfill site. Vehicles were not consistently monitored and weighed, which may lead to incorrect data being reported to the SAWIS system; and
- Gate fees are provided for, but not currently collected at the landfill site.

4.4 Results related to RO3: Evaluating the perceived factors that influence municipality waste management system performance

This section discusses the findings related to research objective 3, which aimed to evaluate the perceived factors that influence municipality waste management system performance. Section 4.4.1 provides the results from the interviews with the waste managers, while Section 4.4.2 provides the results from the surveys conducted with the general workers.

The results and discussion include institutional behaviour, financial, equipment and labour management, together with the challenges encountered by both groups of participants (waste officers and general workers).

4.4.1 Results from interviews with waste officers

In this section, an analysis of information collected during interviews with four waste management officer's sampled convenience is presented.

4.4.1.1 Flow of municipal solid waste

Waste management officers were requested to explain the flow of waste (from generation to final disposal) within PLM. All of the waste management officers agreed that the PLM has a very basic waste management system with the flow of waste being linear: storage, collection, transportation and disposal (Figure 3-1). Measures to implement a circular system (where waste is separated and re-used, recycled, recovered and/or treated as alternatives to disposal) within PLM is limited.

Generated waste is temporarily stored (usually in bins or skips), after which it is collected, (normally by means of kerb-side collection). Scattered waste is collected by street sweepers and stored in bins or skips for collection. After collection, the waste is disposed of at the landfill site. Transfer stations for garden waste are available.

The responses of interviewees correlated with the information from the IWMP, as well as observations made by the researcher during the study.

4.4.1.2 Waste collection services

Section 4.2.1.2 of this dissertation provides the *status quo* of waste collection services within PLM. Waste management officers were asked to comment on the adequacy of the municipality's waste collection service (ranking: very satisfied, slightly satisfied, and not satisfied). Three officials were slightly satisfied and one official was not satisfied waste collection services.

Public-private partnerships currently exist with four service providers (three for fleet management and one for managing the operations at the Weltevreden landfill site (City of Polokwane IWMP, 2016). The waste management officers were requested to confirm that the public-private partnerships (as outlined in the IWMP) were still in place. The waste management officers indicated that there are PPP which are assisting PLM to render waste management having three fleet management (Seshego, Mankweng and City) and Selema Plant Hire/Mascon JV operating Weltevreden landfill site.

4.4.1.3 Implementation and enforcement of waste minimisation and recycling

Waste minimisation and recycling present an opportunity to save resources, reduce the environmental impact of waste by reducing the amount of waste disposed at landfills and creating employment opportunities. The waste management officers were asked "*how the municipality is implementing and enforcing waste minimisation and recycling*". The respondents indicated that:

- *No formal separation at source and recycling is taking place within the PLM waste management system;*
- *Reclaimers (waste pickers) are allowed to reclaim waste from the landfill site (although this is a challenge, because it is prohibited in terms of the permit conditions);*
- *The waste reclaimed by the waste pickers from the landfill site is weighed, recorded and reported into the SAWIS system; and*
- *There are approximately twelve buy-back recyclers buying recyclable waste from waste pickers.*

4.4.1.4 Level of awareness and education with regards to pollution and illegal dumping

PLM (similar to many other municipalities in the country) is characterised by a lot of illegal dumping. The City of Polokwane IWMP (2016) has indicated that inadequate awareness and education of the public may be a cause for illegal dumping. The waste management officers were asked about the level of awareness and education (of the public) with regards to illegal dumping. The respondents indicated that:

- *The level of awareness and education of the public on illegal dumping (and waste management in general) is limited;*
- *The municipality has limited capacity to implement waste awareness and education programmes;*
- *An awareness campaign should be initiated to make communities aware of health and environmental impacts of illegal dumping;*
- *The PLM has embarked on waste management programmes with the aim of changing the attitudes and behavioural practices of communities, where two schools are currently included in the programme; and*
- *Enforcement of fines for illegal dumping is currently limited.*

4.4.1.5 Command and control instruments in PLM

Command-and-control instruments (through the enforcement of legislation and regulations) are one of the most commonly used instruments to regulate waste management in South Africa (Godfrey & Nahman, 2007). The waste management officers were requested to indicate “*what command and control instruments the PLM are using to regulate waste management*”. The interviewees noted that:

- *PLM has developed waste management by-laws where they regulate activities of households and industries within the municipality (although the enforcement of by-laws is challenging due to capacity constraints);*
 - *PLM is enforcing Section 28 of the NEMA through the by-laws, whereby every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring.*
- *With regards to rendering waste collection services, PLM needs to approve the application for any person who wishes to render waste collection service (if it is not the municipality) and it is subject to renewal annually;*
- *PLM specifies the type of receptacles/containers which need to be used for the storage of waste; and*
- *PLM is also regulated by provincial and national spheres of government:*
 - *Compliance of the Weltevreden landfill site is monitored (audited) during the wet and dry seasons to determine regulatory compliance (and found to be non-compliant); and*
 - *Conformance to the National Domestic Waste Collection Standards (2013) is evaluated – where removal, storage and disposal services are monitored.*

4.4.1.6 Fiscal/economic instruments in PLM

As noted earlier, economic instruments are increasingly being implemented for regulating waste management in the developing world (Nahman & Godfrey, 2010). To this extent, waste management officers were asked to elaborate on the *“fiscal/economic instruments that are being used to reduce the generation of waste”*. The interviews revealed that:

- *The PLM depends only on pricing (municipal waste tariffs) and the polluters pay principle (through enforcement of penalties/fines by means of by-law enforcement for illegal dumping, for instance);*
- *Generators are billed the same amount, regardless of the quantities of waste being generated (no volumetric tariffs/taxes) – which does not encourage any waste reduction by waste generators;*
- *Provision is made for the collection of gate fees at the landfill site, however, it is not currently collected due to logistical and security issues;*
- *Concerns exist regarding raising landfill tariffs too high, which may lead to illegal dumping;*
- *No incentives currently exist for reducing waste generation within the PLM waste management system; and*
- *Private waste recycling companies buy recyclable waste from waste pickers, which provides for financial incentive of the waste reclaimers, outside of the formal municipal waste management system.*

4.4.1.7 Challenges encountered by municipality when managing municipal solid waste

The waste management officers were requested to rank the seriousness of and elaborate on the challenges encountered with: (a) financial management, (b) equipment management, (c) labour management, and (d) institutional behaviour. They were also invited to elaborate on any other challenges that they are facing with the management of municipal solid waste. The sub-sections below highlight the responses of the participants.

4.4.1.7.1 Financial management

When asked to elaborate on financial management challenges, the waste management officers indicated that financial management is a *serious* challenge and that:

- *PLM is unable to recover the costs of rendering waste management services;*
- *Non-payment of waste services by citizens and businesses consequently has a direct impact on a municipality’s capability to render services (the landfill site does not charge any gate fees, therefore, the municipality only depends on collection tariffs).*

- *PLM's financial provision for waste management exceeds their budgeted revenues. A feasibility study to expand the landfill site had a capital budget of R 6 000 000, which was not provided for in the budget;*
- *The municipality does not have sufficient revenue to replace broken, stolen and vandalised bins (which leads to illegal dumping); and*
- *The cost of cleaning up illegal dumping spots are expensive and the municipality should rather ring-fence funds for education and awareness (to prevent illegal dumping).*

4.4.1.7.2 Equipment management

The waste management officers interviewed noted that equipment management is *slight* challenge in PLM, and elaborated that:

- *The vehicle fleet is old and require maintenance and replacement;*
- *PLM is in partnership with three fleet management companies (public-private partnerships) to do regular maintenance services of trucks;*
- *PLM has no proper route planning system in place to maximise equipment utilisation; and*
- *There is currently a lack of enhancement of asset management and lack of prioritisation of management needs in terms of equipment.*

4.4.1.7.3 Labour management

The respondents noted that labour management is currently a *serious* challenge within PLM. The participants further responded that:

- *The Waste Management Section consists of 170 approved posts of which 137 posts are occupied and 33 posts are unoccupied;*
- *Inadequate capacity (shortage of staff for waste removal and law enforcement) may add to the problem of illegal dumping;*
- *Provision for Law enforcement officers should be made and they need to know what their accountabilities are into legislation and what actions can be taken under varying circumstances. They should be equipped to know when to act, what process to follow and be able to understand why it is important to act. Currently in PLM, officers did receive training, but there is inadequate capacity to effectively enforce waste-related legislation; and*
- *PLM depends on the Expanded Public Work Programme (EPWP) workers, who are deployed on a temporary basis, to assist with refuse removal and street cleaning. Currently, there are 160 EPWP workers, many of which require upskilling.*

4.4.1.7.4 Institutional behaviour

The respondents regarded institutional behaviour as being a *serious* challenge within PLM and noted that:

- *Illegal dumping and littering remain a problem within PLM, even though waste containers are available to industries and businesses;*
- *With regards to recycling and reuse, currently there is no formal programmes for waste separation at source, and as a result reclamation is mainly done at the landfill site;*
- *The Weltevreden landfill site prohibits the reclamation of waste from the landfill, however, reclaimers are allowed to reclaim waste from the landfill; and*
- *As mentioned earlier, no gate fees are charged for waste disposal at the Weltevreden landfill site (which does not encourage waste reduction by generators).*

4.4.1.7.5 Other challenges

The interviewees were requested to elaborate on any other waste management challenges encountered within the municipality. The officers highlighted that enforcement and implementation are currently the two biggest challenges:

- *The implementation of the IWMP is a serious challenge in PLM (due to financial constraints, capacity issues, institutional behaviour, etc.);*
- *A “greenest or cleanest” concept document has been developed addressing waste avoidance issues, but the municipality has not yet implemented it;*
- *Waste Management officers are trained to enforce the law but are not yet enforcing laws or by-laws; and*
- *A cashier office is available at the landfill, but no gate fees have been implemented yet. Security issues regarding cash payments was a concern. A coupon-system was being considered, but not yet implemented.*

4.4.1.8 Strategies to improve solid waste management systems and save airspace in landfill

Lastly, the waste management officers were requested to report on the *“strategies that the municipality has to improve solid waste management systems and ultimately save airspace in their landfill”*.

According to Taiwo *et al.*, (2008), if waste management strategies and targets are to be met, significant resources from different spheres of government, the private sector and the public may be required. The success of the implementation of strategies may depend on the availability of financial resources to develop the essential human skills and incentives for waste minimisation

and recycling, as well as penalties and fines will have to be introduced or if existing need to be enforced.

The respondents indicated that:

- *The IWMP provides for specific waste avoidance and reduction targets. Implementation is, however, a concern;*
- *The PLM reports to the SAWIS to track the amount of waste generated, recovered, recycled, treated, and disposed of. The accuracy of volumes reported to the SAWIS, however, needs to be improved.*
- *The PLM intends to increase and extend waste recycling within selected pilot areas, to identify new waste streams for recycling. This includes the implementation of new recycling initiatives, as well as the identification and development of appropriate mechanisms to promote sustainable waste separation at source; and*
- *According to City of Polokwane IWMP (2016), waste reduction can only be achieved through public awareness and education campaigns to ensure the much needed support of the general public. In PLM, education and environmental awareness need to be intensified to phase-out the throw-away culture;*

4.4.2 Results from surveys with general workers

In this section, an analysis of data collected from general workers is presented. A discussion of the findings will be based on the responses from 40 randomly sampled general workers who participated in the survey. Socio-demographic information gathered were reported in Chapter 2 (Methodology) to indicate the representative nature of the participants.

4.4.2.1 Waste management training

Work orientation and induction provides new employees with brief and accurate information to make them more comfortable in executing their task. General workers were asked about the training they received with regards to waste management, with the options being: (a) waste handling, (b) waste characterisation, (c) other, and (d) none (Annexure 5). The majority of participants (29 out of 40, or 73%) indicated that they have not received any training regarding waste management, while the remaining 11 participants (27%) indicated that they have received waste handling training. The relatively large percentage of respondents who have indicated that they have not received any waste-related training is cause for concern.

4.4.2.2 Waste collection

Participants were requested to elaborate on five questions specifically aimed at gathering more information on waste collection (Annexure 5):

- *Is there sufficient resources to collect waste within your municipality;*
- *Is waste separated during waste collection;*
- *How do you collect municipal solid waste;*
- *How often does the municipality collect municipal solid waste; and*
- *Is the collection of municipal solid waste satisfactory?*

40 of the 40 participants (100%) indicated that they have sufficient resources to render waste collection services. All of the participants indicated that waste was not separated during collection (which concurs with the observations made during this research as reported in Section 4.3.1 of this dissertation). Kerb-side waste collectors indicated that waste was mostly collected from bins or near bins, whereas street sweepers indicated that they gathered scattered waste. All of the participants also indicated that they participate in waste collection services on a daily basis.

When requested to indicate their agreement with the level of satisfaction of the municipality's waste collection services, two participants (5%) strongly agreed and seven (17%) agreed that the collection services were satisfactory. Twenty-two participants (55%) fairly agreed that the services were satisfactory, while eight (20%) of the participant disagreed and one participant (3%) strongly disagreed that the services rendered were satisfactory. From these results it can be concluded that the majority of general workers deemed the waste collection services to be satisfactory. They were not requested to elaborate on their responses (i.e. justifying their reasons for responses).

4.4.2.3 Most common challenges during waste collection and waste disposal

General workers were requested to state common problems they encountered during waste collection (litter picking): (a) sharp objects; (b) negative attitudes of community; or (c) other. Fourteen participants (35%) indicated that sharp objects (which includes broken glass) is the most common problem, while 26 participants (65%) indicated that negative attitudes from community is a serious challenge (mainly with reference to illegal dumping, or disposing waste next to bins). Some mentioned that it may be due to low levels of public awareness and education (as discussed in Section 4.4.1.4).

General workers were also requested to state common challenges encountered at the waste disposal facility: (a) lack of proper place to dispose; (b) exposure to health hazard; or (c) no spotters present on the site to prevent illegal waste disposal. Only sixteen of the 40 participants could respond to this question, since the other 24 do not regularly access the landfill site as part

of their day-to-day duties. All sixteen (100%) of the respondents indicated that the most common challenge they encounter at disposal facility is exposure to health hazards. They elaborated that the disposal of hazardous waste with general waste, as well as the fact that no daily covering of waste causes nuisance and potential breeding of pests, were their biggest concerns.

4.4.2.4 Seriousness of illegal dumping

Participants were asked an open-ended question “*How serious is illegal dumping of waste in your municipality?*” All forty participants indicated that illegal dumping of waste is serious or very serious in the PLM. They indicated that even when illegal dumping sites are cleaned up, that dumping reoccurs very soon after clean-up efforts. Some mentioned that “no dumping” sign boards may help to prevent illegal dumping, other mentioned that the municipality should do more to fine persons who illegally dump waste, and others mentioned that education and training is necessary (also refer to Section 4.4.1.4).

4.4.3 Summary of results related to research objective 3

The results and discussion in this section, was based on research objective 3 which aimed to evaluate the perceived factors that may influence the municipality's waste management system performance. The results highlight the gaps and challenges with regards to waste management, which includes:

- The flow of waste in PLM is linear (generate-store-transport-dispose) and does not include separation of waste at source and formal measures to achieve a circular economy, and implementation of waste minimisation, re-use and recycling measures are limited;
- Waste management officers and general workers were generally satisfied with the frequency of waste collection services in PLM;
- Public awareness with regards to waste disposal and illegal dumping is limited;
- Command and control instruments (such as waste by-laws) exist within the PLM, however, enforcement remains an issue;
- Fiscal/economic instruments (such as the collection of gate fees) have been provided for, but are not yet implemented
- Several challenges exist with financial-, equipment-, and labour management within PLM and institutional behaviour remains a problem;
- Strategies proposed for the improvement of waste management within PLM included focused strategies on waste avoidance and separation at source, as well as a focus on public education and awareness;
- A large portion of general workers indicated that they have not received any waste-related training;

- They indicated that they face challenges with negative public attitudes when it comes to waste collection (waste being scattered, illegally dumped, or disposed of next to bins); and that health hazards related to waste disposal is a concern; and
- All general workers indicated that illegal dumping is a serious problem within PLM.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions and recommendations from both primary and secondary data collection. The aim of this research was to review and evaluate the elements of the municipal solid waste management system, which includes waste collection, transportation, separation, recycling and disposal in Polokwane City (Polokwane Local Municipality) and to suggest recommendations aimed at improving solid waste management systems within the PLM. The research objectives were as follows:

- 1. To critically evaluate the municipal waste management system and levels of compliance to national legislation of Polokwane City;*
- 2. To examine the flow of waste from generation source to final destination; and*
- 3. To evaluate the perceived factors that influence municipality waste management system performance.*

The next sections provide the main conclusions related to RO1 to RO3 (sub-sections to Section 5.2), while Section 5.3 provides recommendations for improvement, as well as recommendations for future research.

5.2 Conclusions

The discussion on the conclusions is done per research objective mentioned above. The section is, therefore divided into three sub-sections.

5.2.1 Conclusions related to RO1: Evaluating the municipal waste management system and levels of compliance to national legislation of Polokwane City

In addressing the first objective of the study, data was collected through review and analysis of the PLM IWMP, IDP and SDBIP with the aim of evaluating the municipal waste management system *status quo*, organisational and institutional matters, alignment of the IWMP with the 2011 NWMS goals, and evaluating compliance to national waste-related legislation.

As far as establishing the *status quo* of the PLM waste management system, it was found that only 44.4% of the households receive waste collection services from the PLM, which is much lower than Goal 2 of NWMS (which aims at 95% of urban households and 75% of rural households). Furthermore, PLM does not have any formal waste separation at source programmes, thus, less than 3.4% of waste is reclaimed for recycling purposes – mainly, informally (by waste reclaimers) from the landfill site. These findings are not surprising based on

the findings by Mudau (2015) (who did research on: *A Process Mapping Appraisal of Municipal Waste Management System Compliance in Limpopo Province, South Africa*), who also found that internal institutional structures of municipal management need enhancement, and that the low levels of education and awareness as well as a lack of monitoring and enforcement of waste disposal by landfill regulations, present challenges in municipalities in the Limpopo Province (Mudau, 2015).

The findings also revealed that the current organisational structures at PLM make no provision for law enforcement activities. The lack of enforcement is evident by the several instances of illegal dumping observed in the PLM. As stated by Mariwah (2012), adequate organisational structures and sufficient allocation of human resources play a key role in waste-related law enforcement, and the implementation of other waste-related measures and initiatives. To this extent, the study found that insufficient resources (personnel and equipment) is hindering the effective and efficient delivery of waste services, and the implementation of awareness programmes/initiatives in the PLM.

When comparing the IWMP goals and objectives to those of the National Waste Management Strategy (NWMS), it was found that the PLM IWMP is mostly aligned with the goals of the NWMS, but that there is currently a gap with aligning with Goals 3 and 7 of the NWMS. Alignment of local objectives with the NWMS plays a vital role in ensuring the achievement of national objectives at a local government level. The alignment of the goals of the PLM IWMP with the NWMS is a first step towards achieving the national waste-related goals of our country. However, the actual implementation of these goals are critical, and actions related to the goals need to be provided for in the IDP and SDBIP of the municipality to ensure operationalisation.

Lastly, the research objective 1 aimed at establishing the level of compliance of waste management to the requirements of national and local legal requirements. Waste storage practices did not comply with legal requirements and good practice, with waste being scattered around and stored on bare soil instead of waste containers/bins, and no records of volumes, sources and the nature of waste received at transfer stations are kept. Lastly, the Weltevreden landfill site was non-compliant to permit conditions and waste disposal prohibitions. Compliance to legal requirements play an important role towards the performance of waste management systems. Poor legal compliance, coupled with weak enforcement of legislation may cause several issues, and adverse impacts on the receiving environment (which includes the health and wellbeing of humans).

5.2.2 Conclusions related to RO2: Examining the flow of waste from generation source to final disposal

The second research objective was to examine the flow of waste from generation (source) to its final disposal with the ultimate aim of collecting more information on the waste management system (including performance) of the PLM. In addressing the second objective of the study, data was collected through observations, which were supported by an observation checklist and documented evidence (notes and photographs).

Challenges with regards to insufficient receptacles for the storage of waste were observed. Several instances of waste receptacles which were overflowing with waste due to limited capacity were noted. In many instances it also resulted in littering.

Waste is mostly stored as mixed waste, with limited to no separation at source. Waste mainly ends up in landfills as mixed waste due to the municipality failing to divert waste from entering the landfill through waste recycling, and recovery initiatives. Waste separation at source plays an important role towards achieving Goal 1 of the NWMS (DEA & DP, 2019).

Several instances of non-compliance waste transportation were noted, with waste being blown away, leaking and falling from vehicles transporting materials. These non-compliant transportation practices may lead to pollution of the environment.

The observations made at the Weltevreden landfill site revealed several non-compliant practices. The operational practices at the landfill site is insufficient, with inadequate daily cover, irregular inspection of vehicles at the access gate. Landfill fires were observed, and big portions of building rubble were inappropriately being disposed of at the landfill site. Furthermore, vehicles were not consistently monitored and weighed, which may lead to incorrect data being reported to the SAWIS system. Lastly, gate fees are provided for, but not currently collected at the landfill site.

In summary, the “flow” of waste within the PLM is linear, with a focus on storage, transportation and dumping. Minimal formal efforts are being made to transform the flow of waste from a linear to a circular economy. One of the first steps towards achieving a circular economy would be to focus efforts towards formalising waste separation at source within the municipality (DEA & DP, 2019). Separation at source is important to the circular economy as it reduces the negative impacts of resource extraction and use on the environment and contribute to restoring biodiversity and natural capital (DEFF, 2020).

5.2.3 Conclusions related to RO3: To evaluate the perceived factors that influence municipality waste management system performance

In addressing the third objective of the study, data was collected through semi-structured interviews with waste management officers, and survey questionnaires with general workers.

It was revealed that majority of general workers did not receive any training regarding waste management (waste handling inclusive). It was found that common challenges during waste collection were the handling of sharp objects and community attitude, which may lead to non-compliant waste disposal and illegal dumping. The participants generally perceived waste collection frequency as being satisfactory, but perceived illegal dumping as being a major issue within the municipality. The need to educate the community about waste management was highlighted by both groups of participants (general workers and waste management officials).

Findings of the observations made (RO2) were supported by the findings made during the interviews (to determine the perceived factors influencing waste management system performance). Waste management officers indicated that the flow of waste in PLM is linear (generate-store-transport-dispose) and does not include separation of waste at source and formal measures to achieve a circular economy, and implementation of waste minimisation, re-use and recycling measures are limited.

The participants highlighted that implementing the waste management hierarchy and achieving the objects of the NEMWA, as well as rendering specific waste management services may require the establishment of public-private partnerships. It was revealed that PLM require more PPP to render waste management services, since the municipality is currently not in a position to service both urban and rural areas. At the time of this research, the PLM had four PPP - three responsible for fleet management and one responsible for operating the landfill site. Further PPPs may be considered to render other waste-related services, including the separation of waste at source.

The interviews also revealed that although command and control instruments (such as waste by-laws) exist within the PLM, enforcement remains an issue. Compliance and enforcement aligns with Goal 8 of NWM, which seeks to establish effective compliance with and enforcement of the NEMWA (DEA, 2011b) and forms the backbone of implementing a successful waste management system. The interviews also revealed a perceived gap in implementing fiscal/economic instruments in the PLM. The objective of the National Pricing Strategy for Waste Management is to implement economic instruments as part of a mixture (basket) of policy instruments, which will reduce the generation of waste (DEA, 2009, DEA, 2011b). Although the PLM provides for gate fees to be collected at the landfill site, it has not been implemented to date.

According to Oelofse & Godfrey (2008), South African municipalities are faced with four comprehensive challenges namely: financial management, equipment management, labour management and institutional behaviour. PLM is no exception. The interviewees reported that several challenges exist with financial-, equipment-, and labour management within PLM and that institutional behaviour remains a problem.

Strategies proposed for the improvement of waste management within PLM included: focused strategies on waste avoidance and separation at source, as well as a focus on public education and awareness.

5.3 Recommendations for improvement

The following section presents recommendations to ultimately improve the PLM waste management system and its performance.

5.3.1 Recommendations to improve storage of waste and separation at source

To address the issues related to the inadequate storage of waste, as well as illegal dumping, it is recommended that PLM needs to acquire and use containers that can accommodate larger volumes of waste, especially in commercial and industrial areas.

Provision should also be made to provide households with receptacles, especially indigent households who cannot afford to pay for such receptacles (CSIR, 2011). Again absence of receptacles may result in littering and illegal dumping. Section 8.4 of National Policy for the Provision of Basic Refuse Removal Services to Indigent Households (DEA, 2011d), state that municipality must provide appropriate free receptacles for refuse storage. Lastly, waste storage systems must allow for and encourage separation at source.

The municipality may consider a 3-bag system (general waste, recyclables and garden waste). The waste collection system needs to make provision for the three separated waste streams. The system should be user-friendly and incorporate education and awareness regarding recyclable wastes.

5.3.2 Recommendations to improve collection and transportation of waste

Waste collection systems must provide for the collection of separated waste as required by the National Domestic Waste Collection Standards (and mentioned in Section 5.3.1 above). Existing municipal vehicles can, for instance, be modified to two-cabin trucks or a truck and trailer system to keep the two waste streams separate in one collection round (CSIR, 2011).

PLM needs to enforce their waste management by-laws which requires the adequate transportation of waste in line with the requirements of the NEMWA.

5.3.3 Recommendations to improve community awareness and education

Municipalities should ensure that people are aware of the impact of waste on their health, well-being and the environment through awareness and education (DEA, 2011b). It is important to raise awareness and to alter people's perception and attitudes towards waste and its concomitant impacts, particularly emerging wastes (UNEP, 2018). The CSIR (2011) also acknowledges that awareness and education campaigns play a significant role in the success of any waste minimisation and recycling initiative (CSIR, 2011).

Improving community awareness and education was mentioned by waste management officers and general workers of PLM. This aspect should be prioritised by PLM. The PLM could consider engaging communities in *Good Green Deeds* Programmes, which focus on mobilising South Africans to become more environmentally aware (DEFF, 2020).

5.3.4 Recommendations to improve the landfill site

The use of weighbridges should be standard practice to enable regular reporting of reliable waste data (UNEP, 2018). This may improve the accuracy of data reported to SAWIS.

It is argued that the implementation of gate fees for disposal of waste is a good practice that is likely to encourage recycling and waste minimisation (Soos, 2017). The PLM has provided for gate fees, and needs to implement the collection of gate fees as soon as possible.

The PLM needs to focus on addressing issues of legal non-compliance, such as the disposal of prohibited wastes, landfill fires, daily coverage, and other operational issues. Many of these would not be difficult to implement, with the allocation of the necessary human resources.

5.3.5 Recommendations to address the illegal dumping of waste

The PLM should provide households with receptacles, especially indigent households to combat littering and illegal dumping (as mentioned in Section 5.3.1 above). As mentioned earlier, raising awareness and improving education on waste management may contribute positively to address illegal dumping (SAWIS, 2018).

Lastly, the PLM must enforce their updated by-laws, which provides for issuing spot fines for illegal dumping when caught in the act.

5.3.6 Recommendations to improve law enforcement

The availability of human resources plays a key role in active compliance and enforcement. As proposed earlier, the PLM should make provision for enforcement officers on the proposed structure (organogram) for waste management by-law enforcement and also fill all vacant waste-related posts to enhance capacity. Appropriate training is also necessary to build the capacity of enforcement officials (UNEP, 2014).

5.4 Recommendations for future research

This study has highlighted certain relevant issues that still require research attention in order to extend insights on the current state of knowledge on municipal solid waste management systems, which may include further research on:

- Current approaches of municipal solid waste management – focusing on command-and-control, fiscal/economic, voluntary- and civil-based approaches;
- Critically evaluating the organisational structures of local government with an aim of improving waste management system performance;
- Critically evaluating the link between the NWMS, IWMPs, IDPs and SDBIPs of a sample of South African municipalities – also with a focus towards achieving the 2020 NWMS.

BIBLIOGRAPHY

- Abrahams, G. 2017. Polokwane Municipality, *A second city with 2030 vision*, March 2017.
- Adeleke, O., Akinlabi, S., Jena, T & Dunmadec, I. 2021. Towards sustainability in municipal solid waste management in South Africa: a survey of challenges and prospects." Transactions of the Royal Society of South Africa 76.1 (2021): 53-66.
- Afrika, M., Oelofse, S., Strydom, W., Mvuma, G., & John, J. 2016. Reduce, reuse and recycle. CSIR newsletter.
- Agamuthu, P & Masaru, T. 2014. Municipal Solid Waste Management in Asia and the Pacific Islands: Challenges and Strategic Solutions, Springer-Verlag, Singapore.
- Agamuthu, P & Fauziah SH. 2011a. Challenges and issues in moving towards sustainable landfilling in a transitory country - Malaysia. Waste Manage Res 29(1).
- Agamuthu, P & Fauziah, S.H. 2011b. 3R practice in Asia and the Pacific Islands. In: Proceedings of the ISWA world congress, Daegu, South Korea.
- Bhangwandin, G. 2013. A study of the current status of waste management and minimisation initiatives in two district municipal areas of the Gauteng Province (West Rand and Sedibeng). University of Johannesburg, South Africa.
- Centre for Environmental Rights (CER). 2013. Minimum requirements for the regulation of environmental impacts of hydraulic fracturing in South Africa, 2 December 2013. South Africa.
- City of Cape Town. 2017. 3rd Generation Integrated Waste Management Plan, Cape Town South Africa.
- City of Polokwane. 2016. Integrated Waste Management Plan, 2016 March, Polokwane, South Africa.
- City of Polokwane. 2019a. Service Delivery and Budget Implementation Plan, 2019/2020, Polokwane, South Africa.
- City of Polokwane. 2019b. Polokwane Local Municipality Waste Management By-laws, May 2019, Polokwane, South Africa.
- City of Polokwane. 2020a. Integrated Development Plan, 2020/2021. Polokwane, South Africa.
- City of Polokwane. 2020b. Approved Tariffs 2020/2021, Polokwane, South Africa.
- Council for Scientific and Industrial Research (CSIR). 2011. *Municipal waste management - good practices*. 1st edn. CSIR, Pretoria.
- Council for Scientific and Industrial Research (CSIR). 2015. Co-operative good practice guide in the waste sector: *A guideline for co-operatives by co-operatives*. Pretoria.

- Creswell, J.W. 1994. *Research Design: Qualitative and Quantitative Approaches*. Sage Publications: Thousand Oaks, CA.
- Creswell, J.W. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*, 3rd edition, .SAGE Publications, India.
- C40 Cities Climate Leadership Group. 2016. *Good Practice Guide, Sustainable Solid Waste Systems*, February 2016, London.
- Davidson, G, .2011. *Waste Management Practices: Literature Review*, Dalhousie University Office of Sustainability, Nova Scotia.
- Da Zhu., Asnani, P.U., Chris, Z., Sebastian, A & Shyamala, M. 2008. *Improving Municipal Solid Waste Management in India: A Sourcebook for Policy Makers and Practitioners*, The World Bank, Washington DC.
- Department of Environmental Affairs (DEA). 1998. National Environment Management (Act, 107 of 1998). (Notice 1540) *Government Gazette*, 19519, 27 November 1998.
- Department of Environmental Affairs (DEA). 2005. National Environment Management: Air Quality Act 2004, (Act no 39 of 2004). (Notice 167) *Government Gazette*, 27318, 24 February 2005.
- Department of Environmental Affairs (DEA). 2009. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). (Notice 278) *Government Gazette*, 32000, 10 March 2009.
- Department of Environmental Affairs (DEA). 2010. National Environmental Management Act, 1998 (Act N0.107 Of 1998), As Amended) Publication of Implementation Guidelines for Comment (Notice 654) *Government Gazette*, 33333. 29 June 2010
- Department of Environmental Affairs (DEA). 2011a. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). National Domestic Waste Collection Standards. (Notice 21) *Government Gazette*, 33935. 21 January 2011.
- Department of Environment Affairs (DEA). 2011b. *National Waste Management Strategy 2011*, South Africa
- Department of Environmental Affairs (DEA). 2011c. *Municipal Waste Sector Plan*. Department of Environmental Affairs, Pretoria.
- Department of Environmental Affairs (DEA). 2011d. National Policy for the Provision of Basic Refuse Removal Services to Indigent Households, (Notice 413) *Government Gazette*, 34385. 22 June 2011.
- Department of Environmental Affairs (DEA). 2012a. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). Draft National Norms and Standards for the Remediation of Contaminated Land and Soil Quality. (Notice 233) *Government Gazette*, 35160. 19 March 2012.

Department of Environmental Affairs (DEA). 2012b. South Africa Environment Outlook. Waste Management Draft 2 version 3, April 2012.

Department of Environmental Affairs (DEA). 2012c. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). National Waste Information Regulations. (Notice 625) *Government Gazette*, 35583, 13 August 2012.

Department of Environmental Affairs (DEA). 2012d. National Environment Management Act, 1998 (Act no 107 of 1998). Publication of Public Participation Guide. (Notice 807) *Government Gazette*, 35769, 10 October 2012.

Department of Environmental Affairs (DEA). 2013a. National Environment Management: Waste Act, 58 of 2008. National Norms and Standards for the Assessment of Waste for Landfill Disposal. (Notice 635) *Government Gazette* 36784, 23 August 2013.

Department of Environmental Affairs (DEA). 2013b. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). National Norms and Standards for Disposal of Waste to Landfill. (Notice 636) *Government Gazette*, 36784, 23 August 2013.

Department of Environmental Affairs (DEA). 2013c. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). National Norms and Standards for the Storage of Waste. (Notice 926) *Government Gazette*, 37088, 29 November 2013.

Department of Environmental Affairs (DEA). 2016a. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). National Pricing Strategy for Waste Management, (Notice 904) *Government Gazette*, 40200, 16 August 2016.

Department of Environmental Affairs (DEA). 2016b. Report on the determination of the extent and role of waste picking in South Africa. Pretoria.

Department of Environmental Affairs (DEA). 2017a. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). Norms and Standards for Sorting, Shredding, Grinding, Crushing, Screening or Baling of General Waste, (Notice 1093) *Government Gazette*, 41175, 11 October 2017.

Department of Environmental Affairs (DEA). 2017b. Strives to improve plastic bag recycling in South Africa.

Department of Environmental Affairs (DEA). 2018a. 3rd South Africa Environment Outlook Report, 11 September 2018, Pretoria.

Department of Environmental Affairs (DEA). 2018b. National Environmental Compliance and Enforcement Report 2017-18, South Africa.

Department of Environmental Affairs and Development Planning (DEA&DP). 2011. Guideline on Public Participation, EIA Guideline and Information Document Series, October 2011, Cape Town.

- Department of Environmental Affairs and Development Planning (DEA&DP). 2019. A Guide to Separation of Waste at Source, September 2019. Cape Town.
- Department of Environmental Affairs and Tourism (DEAT). 2000. White Paper on Integrated Pollution Waste Management for South Africa. (Notice 227) *Government Gazette*, 20978, 17 March 2000.
- Department of Environment, Forestry and Fisheries (DEFF). 2020. National Waste Management Strategy 2020, South Africa.
- Department of Environment, Forestry and Fisheries (DEFF). 2020. National Environment Management: Waste Act, 2008 (Act no 58 of 2008). Regulations Regarding Extended Producer Responsibility, (Notice 1184) *Government Gazette*, 43879, 05 November 2020.
- Department of Environment, Forestry and Fisheries (DEFF) and Department of Science and Innovation (DSI). 2020. Waste picker integration guideline for South Africa: Building the Recycling Economy and Improving Livelihoods through Integration of the Informal Sector. Pretoria.
- Department of Justice (DoJ). 1996. Constitution of Republic of South Africa, 1996 (Act no 107 of 1996). (Notice 2083) *Government Gazette*. 17678, 10 December 1996.
- Department of Local Government (DLG). 1998. Local Government: Municipal Structures Act, 1998 (Act no 117 of 1998). (Notice 1650) *Government Gazette* 19614, 18 December 1998.
- Department of Local Government (DLG). 2000. Local Government: Municipal Systems Act, 2000 (Act no 32 of 2000). (Notice 1189) *Government Gazette*, 21776, 20 November 2000.
- Department of Local Government (DLG). 2004. Local Government: Municipal Finance Management Act 2004 (Act no 56 of 2003). (Notice 176) *Government Gazette*, 26019, 13 February 2004
- Department of Science and Technology (DST). 2014. A National Waste R&D and Innovation Roadmap for South Africa: Phase 2 Waste RDI Roadmap. The economic benefits of moving up the waste management hierarchy in South Africa: The value of resources lost through landfilling. Department of Science and Technology: Pretoria
- Department of Water Affairs & Forestry (DWAF). 1998. Waste Management Series 2nd Edition. *Minimum Requirements for Waste Disposal by Landfill*, South Africa.
- Dlamini, B.R, Rampedi, I.T & Ifegbesan, P.A. 2017. Community resident's opinions and perceptions on the effectiveness of waste management and recycling potential in the Umkhanyakude and Zululand District Municipalities in the KwaZulu-Natal Province of South Africa." *Sustainability* 9.10 (2017): 1835.
- Eberhard, R. 2018. Waste management in South Africa's cities, March 2018, Pretoria.
- Environmental Protection Agency. 1997. Landfill manuals, landfill operational practices, Wexford, Ireland.

- Environmental Protection Agency. 2014. Guidance Note on Daily and Intermediate Cover at Landfills, Ireland.
- Esmann, E. 2017. Public-Private Partnerships in South Africa, *A very brief introduction*. 6 September 2017.
- Ginindza, B & Muzenda, E. no date. Waste Management Challenges to Opportunities in the West Rand District Municipality, Gauteng, South Africa: Initiatives, South Africa.
- Godfrey, L. 2008. Facilitating the improved management of waste in South Africa through a national waste information system. *Waste Management*, 28:1660–1671.
- Godfrey, L & Nahman, A. 2007. Are developing countries ready for first world waste policy instruments?, CISA, Italy.
- Godfrey, L., Muswema, A., Strydom, W., Mamafa, T & Mapako, M., 2015. Evaluation of co-operatives as a developmental vehicle to support job creation and SME development in the waste sector. Green Fund, Development Bank of Southern Africa, Midrand.
- Godfrey, L & Oelofse, S. 2017. Historical review of waste management and recycling in South Africa. *Resources* 6.4 (2017): 57.
- Goodship, V. 2010. Management, Recycling and Reuse of Waste Composites 1st Edition, Woodhead Publishing, University of Warwick, UK.
- Haghi, K.A. 2010. Waste Management: Research Advances to Convert Waste to Wealth, Nova Science Publishers, Inc. New York.
- Hoornweg, D & Bhada-Tata, P. 2012. What a Waste: *A Global Review of Solid Waste Management*. Urban development series; knowledge papers no. 15. World Bank, Washington, DC.
- Kubanza, N.S & Simatele, D.M. 2019. Sustainable solid waste management in developing countries: a study of institutional strengthening for solid waste management in Johannesburg, South Africa, *Journal of Environmental Planning and Management*, DOI: 10.1080/09640568.2019.1576510.
- Leso, L.K., Elansary, H.O., Mearns, K & Yessoufou, K. 2017. Ethnobotany at a local scale: diversity of knowledge of medicinal plants and assessment of plant cultural importance in the Polokwane local municipality, South Africa, *Botany Letters*, 164:1, 93-102, DOI: 10.1080/23818107.2016.1268064
- Limpopo Department of Economic Development, Environment and Tourism (LEDET). 2016. Limpopo Waste Management Report 2016: WASTE KHORO. Accessed via SAWIC (South African Waste Information Centre) <http://sawic.environment.gov.za/documents/5494.pdf>. Date of access: 10 March 2020.
- Liyanage, K & Perera, T. 1998. Design and development of a rapid data collection methodology, Sheffield Hallam Univ, UK.

- Lohri, CR., Camenzind, E.J & Zurbrügg, C. 2014. Financial sustainability in municipal solid waste management – Costs and revenues in Bahir Dar, Ethiopia. Elsevier Publishers.
- Luong, N.D., Giang, H.M., Thanh, B.X. & Hung, N.T. 2013. Challenges for municipal solid waste management practices in Vietnam. *Waste Technology* 1(1):6-9. Doi: <http://dx.doi.org/10.12777/wastech.1.1.2013.17-21>
- Maluleke, P.H. 2014. *A Review of Solid Waste Management Practices in Polokwane City, March 2014*, South Africa. University of South Africa. (Thesis – MSc) <http://hdl.handle.net/10500/13385>
- Mariwah, S. 2012. Institutional Arrangements for Managing Solid Waste in the Shama-Ahanta East Metropolis Ghana, *Journal of Sustainable Development in Africa* 14(6): 292- 312.
- Merrington, A. 2017. Applied Plastics Engineering Handbook: *Processing, Materials, and Applications*. Elsevier Science Publishers, Netherland.
- Miezah, K., Obiri-Danso, K., Kádár, K., Fei-Baff & Mensah, M.Y. 2015. Municipal solid waste characterization and quantification as a measure towards effective waste management in Ghana, *Waste Management* 46: 15–27.
- Miller, G.T & Spoolman, S.E. 2009. Living in the Environment Concepts, Connections, and Solutions, 16th edn, Brooks/Cole, Cengage Learning. USA.
- Mohana, G., Kumar S.U & Lalc, M. 2016. Managing of Solid Waste through Public Private Partnership Model, *Procedia Environmental Sciences* 35: 158 – 168, Elsevier B.V Publishers.
- Mudau, N.V. 2015. *A Process Mapping Appraisal of Municipal Waste Management System Compliance in Limpopo Province, South Africa*. North-West University (Thesis – PhD) <https://repository.nwu.ac.za/handle/10394/17235?show=full>
- Muswema. A.P., Okem, A., Blottnitz, H.V & Oelofse, S. 2018. Cooperatives in Waste and Recycling: A Recipe for Failed Waste Hierarchy Implementation? South Africa.
- Nahman, A & Godfrey, L. 2010 Economic instruments for solid waste management in South Africa: Opportunities and constraints. *Resources, Conservation and Recycling*, 54(8): 521-531.
- National Treasury. 2018a. Draft carbon tax bill 2017, National committee on climate change. South Africa.
- National Treasury. 2018b. 2017 Budget Review. Accessed via Treasury Information Centre <http://www.treasury.gov.za/documents/national%20budget/2017/review/Annexure%20E.pd>. Date of access: 15 June 2020.
- Nefale, A. 2018. An evaluation of strategic management of landfill sites: *A case study of Thohoyandou Block J. landfill site, Vhembe District Municipality, Limpopo Province*. South Africa. University of Venda. (Thesis- MSc) <http://hdl.handle.net/11602/1080>

- Nel, J., & Alberts, R. 2018. An introduction to environmental management and law. In: Strydom, H, King, N, and Retief, F. eds. Environmental Management in South Africa, Juta Publishing, Cape Town.
- Nkosi, L.F. 2014. An Evaluation of the Municipal solid waste management systems within city of Tshwane Metropolitan Municipality in Mamelodi East Township, Gauteng Province South Africa, November 2014, University of Pretoria, South Africa. (Thesis - MPH) <http://hdl.handle.net/2263/46145>
- NWU (North West University). 2018. Research ethics policy. http://www.nwu.ac.za/sites/www.nwu.ac.za/files/files/i-governance-management/policy/9P-9_Research%20Ethics%20Policy_e.pdf. Date of access: 2 February 2020.
- Oelofse, S. 2018. Getting South Africans to Separate Waste at Source. CSIR. Retrieved from <https://www.csir.co.za/getting-south-africans-separate-waste-source>
- Oelofse, S.H.H & Godfrey, L. 2008. Towards improved waste management services by local government – A waste governance perspective. *Proceedings of the CSIR: Science Real and Relevant Conference*. 17-18 November 2008, Pretoria.
- Ogola, J.S., Chimuka, L., & Tshivhase, S. 2011. Management of Solid Wastes: A case Study in Limpopo Province, Volume I, Mr. Sunil Kumar (Ed.), South Africa.
- Overstrand Municipality. 2015. Integrated Waste Management Plan, 4th Edn, 2015.
- Parker, M., Andrew Gilder, A & Rumble, O. 2015. South Africa: Carbon Tax – Meaning and Context, 09 December 2015, South Africa.
- Pikitup. 2015. Separation@Source programme. Accessed via Pikitup Information Centre <http://www.pikitup.co.za/seperationsource/>. Date of access: 17 March 2020.
- Polokwane Municipality. 2014. Polokwane Economic Growth and Development Plan 2030 Research Report.
- Rasmeni, Z.Z & Madyira, D.M .2019. A Review of the Current Municipal Solid Waste Management Practices in Johannesburg City Townships, January 2019. South Africa.
- Regassa, N., Sundaraa R.D & Seboka, B.B. 2011. Challenges and Opportunities in Municipal Solid Waste Management: The Case of Addis Ababa City, Central Ethiopia. Ethiopia.
- Rodseth, C, Notten P & Von-Blottnitz H. 2020. A revised approach for estimating informally disposed domestic waste in rural versus urban South Africa and implications for waste management. South Africa. 2020.
- SAWIS (South African Waste Information System). 2018. Accessed via SAWIC (South African Waste Information Centre) <http://sawic.environment.gov.za/>. Date of access 5 November 2019.

- Schenck, R & Blaauw, P.F .2011. The Work and Lives of Street Waste Pickers in Pretoria— A Case Study of Recycling in South Africa's Urban Informal Economy. *Urban Forum* 22(4):411-430.
- Simatele, D.M., Dlamini, S & Kubanza, N.S. 2017. From informality to formality: Perspectives on the challenges of integrating solid waste management into the urban development and planning policy in Johannesburg, South Africa." *Habitat International* 63 (2017): 122-130
- South African Local Government Association (SALGA). 2015. The role of a municipality as a service authority for waste management, Waste Summit 09 March 2015. South Africa.
- Soos, R. 2017. Financial Aspects of Solid Waste Management, Dar es Salaam.
- StatsSA (Statistics South Africa). 2016. Accessed via StatsSA Information Centre <http://www.statssa.gov.za/?p=11527>. Date of access: 10 March 2020
- Taiwo, C., Otieno, F & Christa Venter, C. 2018. Towards attaining the Polokwane waste reduction goals – *where are we?* SSB/TRP/MDM 2008(52), South Africa.
- The Auditor-General of South Africa. 2018. PFMA 2017/2018, Consolidated General Report on National and Provincial Audit Outcomes South Africa. Available at <https://www.agsa.co.za/Reporting/PFMAReports/PFMA2017-2018.aspx>
- Tshimbana, T.P. 2014. *An evaluation of electronic waste management in Ba-Phalaborwa local municipality, Limpopo Province, South Africa*. University of South Africa. (Thesis – MSc) <http://hdl.handle.net/10500/13809>
- United Nations Environment Programme (UNEP). 2014. Enforcement of Environmental Law: Good Practices from Africa, Central Asia, ASEAN Countries and China, Nairobi, Kenya.
- United Nations Environment Programme (UNEP). 2018. Africa Waste Management Outlook. United Nations Environment Programme, Nairobi, Kenya.
- United Nations Environment Programme (UNEP). 2020. South African Municipal Waste Management Systems: Challenges and Solutions. United Nations Environment Programme, South Africa
- Usui, T & Chikasada, M. 2012. Does garbage pricing increase illegal dumping of household waste? Soka University, 15 January 2012, Japan.
- Vaughn, J. 2009. Waste Management: A Reference Handbook, ABC Clio, USA.
- Wolsink, M & De Jong, P. 2000. Waste Sector Structure: *Institutional Capacity for Planning Waste Reduction*, Blackwell Publishers, Oxford

ANNEXURE 1
ACKNOWLEDGMENT LETTER FROM MUNICIPALITY



WASTE MANAGEMENT
WASTE MANAGEMENT
P.O. Box 111, Polokwane, 0100
Fax: 015 290 2468/ 081 473 2250
Email: thabisok@polokwane.gov.za
Tel: 015 290 2468
Fax: 015 290 2250

10 March 2020

Enquiries: Mr. Thabiso Kobe

Tel: (015) 290 2468/ 081 473 2250

Email: thabisok@polokwane.gov.za

To whom it may concern

LETTER OF ACKNOWLEDGEMENT: MASTERS RESEARCH PROJECT.

Dear Sir/ Madam,

It is my honour and pleasure to provide this letter of acknowledgement of request to conduct a Master's research by Mr Thembani Maluleke a student at North West University registered under Science in Geography and Environmental management.

I am coordinating waste management, education and awareness in all the clusters within the Polokwane Municipality, namely: City cluster, Mankweng-Sebayeng cluster, Seshego-Moletji cluster and Aganang cluster.

This is to ensure that Mr Thembani Maluleke will be assisted with his Masters research.

I hope you'll find above in good order.

Sincerely,

Thabiso Kobe

Waste Education Officer (Coordinator)

Polokwane Municipality, Waste Management SBU

thabisok@polokwane.gov.za

(015) 290 – 2468/ (081) 473 22 50

ANNEXURE 2

ETHICAL CLEARANCE CERTIFICATE



Private Bag X1290, Potchefstroom
South Africa 2520
106015
Tel: 018 299-1111/2222
Fax: 018 299-4910
Web: <http://www.nwu.ac.za>
106015
Senate Committee for Research Ethics
Tel: 018 299-4849
Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC)**, the Faculty of Natural and Agricultural Sciences Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: A review of municipal solid waste management systems in Polokwane City Limpopo Province				
Study Leader/Supervisor: Dr C Roos				
Student: TC Maluleke				
Ethics number:	N	W	U	- 0 1 4 5 8 - 2 0 - A 9
	Institution			Study Number Year Status
Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation				
Application type: Single	Risk Category:		Minimal	
Commencement date: 01/02/2020				
Expiry date: 01/04/2021				
Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.				

Special in process conditions of the research for approval (if applicable):

- The following documentation are archived by FNASREC and should be complete and kept up to date:
 - Research proposal
 - Signed approval from the scientific committee indicating the proposed risk category
- All researchers involved in the study should submit signed NWU code of conduct statements annually.
- All researchers of low risk studies should submit proof of relevant ethics training every two years.
- All researchers that take part in activities that pose a safety and security threat to the researchers or the environment should submit a risk assessment form annually.
- All research involving human interaction should follow best ethical practise and keep documents as proof. This includes informed consent, questionnaires, incorporation of risk-benefit, and responsible data management.
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the FNASREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:

- *The study leader/supervisor (principle investigator)/researcher must report in the prescribed format to the FNASREC:*
 - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
 - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.*
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the FNASREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-SCRE and FNASREC reserves the right to:*
 - *request access to any information or data at any time during the course or after completion of the study;*
 - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
 - *withdraw or postpone approval if:*
 - * *any unethical principles or practices of the study are revealed or suspected;*
 - * *it becomes apparent that any relevant information was withheld from the FNASREC or that information has been false or misrepresented;*
 - * *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
 - * *new institutional rules, national legislation or international conventions deem it necessary.*
- *FNAS-REC can be contacted for further information or any report templates via Roelof.Burger@nwu.ac.za 018 299 4269*

The FNASREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the FNASREC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely,



Prof Roelof Burger
Chairperson Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC)

ANNEXURE 3

CONSENT FORM

Title: A Review of Municipal Solid Waste Management Systems in Polokwane City Limpopo Province

My name is Maluleke Themba. I am post-graduate student at the North-West University, Potchefstroom Campus. I am under the supervision of Dr. Claudine Roos, who is a staff member and a senior lecturer at the North-West University. This research forms part of my Masters studies and it is on reviewing of Municipal Solid Waste Management Systems in Polokwane City Limpopo Province. It will concentrate on promote waste minimisation and the options that are available for the diversion of recyclables waste from being disposed at the landfill site.

Introduction

The primary aim of this research is to review and evaluate the elements of the municipal solid waste management system, which includes waste collection, transportation, separation, recycling and disposal in Polokwane City (Polokwane Local Municipality) and to suggest significant recommendations aiming at improving solid waste management systems and within the City.

Invitation to participate

This is an invitation for you, an official responsible for waste management, to participate in the study.

What is involved in the study?

Your involvement in the study would be that of a participant in semi-structured interview. The process will not be a long one and should take a maximum time of 30 minutes or less.

Risks

The interview only focuses on municipal solid waste management practices. The results presented will be anonymous. No risks have been identified with regards to your participation in this research.

Benefits

You could find participation beneficial in that it may clarify some of the issues pertaining to solid waste management. As a participant, the results of the study will be made available to you, should you be interested.

Participation is voluntary

The refusal to participate will have no penalty or loss of benefits to which the participant is otherwise entitled. The participant may discontinue participation at any time without penalty loss of benefits to which they are otherwise entitled.

Reimbursements

There are no reimbursements.

Confidentiality

All personal information will be kept confidential and responses are captured anonymously. Results will be captured in a manner that will ensure confidentiality.

Contact details of researcher

Please contact me directly on: 078 330 6486/ 073 050 0298 or tomaluleke@gmail.com

For further information you can contact my supervisor, Dr. Claudine Roos on: 018 299 1477 or Claudine.roos@nwu.ac.za

Consent Document

A Review of Municipal Solid Waste Management Systems in Polokwane City Limpopo Province

I confirm that I have been informed about the above study by Maluleke Thembani.

I have also received, read and understood the study as explained in the participant information section.

I understand that all my details (identifying data) will be kept strictly confidential.

I understand that I may, at any stage, withdraw consent and participation in the study.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

The research protocol above has been explained to me (name).....

Signature: Date:

ANNEXURE 4

INTERVIEW QUESTIONNAIRE FOR WASTE MANAGERS

A REVIEW OF MUNICIPAL SOLID WASTE MANAGEMENT SYSTEMS IN POLOKWANE CITY LIMPOPO PROVINCE

INTERVIEW QUESTIONS FOR MANAGERS

This questionnaire is designed to enable critically evaluate factors that influence municipality waste management system performance. Your responses will be preserved with discretion. Kindly answer each question honestly.

PUT AN X OR WRITE YOUR ANSWER WHERE APPLICABLE

A. GENERAL INFORMATION

1. Designation:
2. What is your highest Level of Education
3. Years of Experience on Waste Management

Less than 1 year	
1-3 years	
4-8 years	
9 years and above	

B. MUNICIPAL SOLID WASTE QUESTIONS

4. What is the flow of municipal solid waste in your municipality?
5. Is the municipality waste collection service adequate?

Very satisfied	
Slightly satisfied	
Not satisfied	

6. Is there public-private partnerships helping in rendering specific waste management services in your municipality

Yes	
No	

7. If yes, how many and their roles?
8. How is the municipality implementing and enforcing waste minimization and recycling?
9. What is the level of awareness and education with regards to pollution illegal dumping?
10. What are the command and control instruments in use to regulate waste generation?
11. What are the Fiscal/Economic instruments in use to reduce the generation of waste?
12. What are the challenges that the municipality is encountering in managing municipal solid waste?

Challenges	Very serious	Serious	Not Serious	Not at all
Financial management				
Equipment management				
Labour management				
Institutional behaviour				
Other				
.....				
.....				

13. What are the existing/strategies to improve solid waste management systems and save airspace in landfill?

Thank you for your participation!

ANNEXURE 5

QUESTIONNAIRE FOR GENERAL WORKERS

QUESTIONNAIRE FOR GENERAL WORKERS

This questionnaire is designed to facilitate the evaluation of factors that influence municipality waste management system performance. Your responses will be preserved with confidentiality. Kindly answer each question honestly.

PUT AN X OR WRITE YOUR ANSWER WHERE APPLICABLE

A. GENERAL INFORMATION

1. Your gender?

Male	Female
------	--------

2. Your age?

18 to 35 years	
36 to 49 Years	
50 and Above	

3. Your work type?

Kerbside waste collector	
Street sweeper	

4. Years of Experience in Waste Management

B. MUNICIPAL SOLID WASTE QUESTIONS

5 Which training related to waste management have you attended?

Waste handling	
Waste characterisation	
Other (specify)	
None	

6. Is there sufficient resource to render solid waste collection services in your municipality?

.....

.....

7. Do you separate municipal solid waste when collecting?

.....

.....

8. How do you collect municipal solid waste?

Inside bins		Near Bins		Scattered		All of above	
-------------	--	-----------	--	-----------	--	--------------	--

9. How often does the municipality collect municipal solid waste?

Every day		Once a week		Twice a week		Other (specify):
-----------	--	-------------	--	--------------	--	---------------------------

10. Is the collection of municipal solid waste satisfactory?

Strongly agree		Agree		Fair		Disagree		Strongly Disagree	
----------------	--	-------	--	------	--	----------	--	-------------------	--

9. What is the most common problem that you encounter during litter picking?

Sharp objects	
Community negative attitude	
Other (specify):	

10 How serious is illegal dumping of waste in your municipality?

.....

.....

.....

11. What is the most common problem that you encounter when disposing of waste in a disposal facility?

Lack of proper place to dispose	
Exposure to health hazard	
No spotter	

Thank you for your participation!

ANNEXURE 6

LANDFILL OBSERVATION CHECKLIST

Landfill Observation Checklist

OBSERVATION (disposal facilities)	Options		
	1	2	3
1. Classification	1 = GMB	2 = SGB-	3 = SGB+
2. Waste permit	1 = In possession of permit	2 = Applied for permit	3 = No permit
3. Waster site ownership	1 = Local municipality	2 = Private company	
4. Site operator	1 = Local municipality	2 = Contracted company	
5. Operation no. of days	1 = Monday to Sunday	2 = Monday to Saturday	3 = Monday to Friday
6. Operation time	1 = 7H00- 17H00	2 = 07H00 – 18H00	3 = 24H00
7. Site notice board information	1 = Sufficient	2 = To some extent	3 = Not sufficient
8. Distance from residential area	1 = Less than 1km	2= 1km to 3km	3 = 4km and above
9. Distance from source of water	1 = Less than 1km	2 = 1km to 3km	3 = 4km and above
10. Status	1 = Controlled dump	2 = Partially controlled dump	3 = Not controlled dump
11. Fencing	1 = Well fenced	2 = Fenced but damaged	3 = No fence
12. Signposting	1 = Enough and directive	2 = Not enough	3 = No sign
13. Water and sanitation	1 = Available	2 = Not available	
14. Waste acceptance	1 = Weighbridge	2 = Use of security guards	3 = No weighbridge
15. Control of vehicle access	1 = Well controlled	2 = To some extent	3 = Not controlled
16. Spotter	1 = Available everyday	2 = Sometimes visit	3 = None
17. Equipment at site	1 = Enough, in good condition	2 = Not enough and not in a good condition	3 = None
18. Immediate covering of putrescible	1 = Yes	2 = Sometimes	3 = No
19. Protective clothes for workers	1 = Well dressed	2 = At least one is not dressed	3 = Not at all
20. Final cover	1 = Done rehabilitation	2 = Partially done	3 = Not done
21. Prohibition of uncontrolled waste salvaging	1 = Prohibited	2= To some prohibited	Not prohibited
22. Drainage of water away from the waste	1 = Well done	2 = Partially done	3 = Not done at all
23. General site maintenance	1 = Definitely	2 = To some extent	3 = Not at all
24. Burning of waste	1 = Do burn	2 = Do not burn	
25. Animals	1 = Present	2 = Not present	