

Investigating waste source separation models in Gauteng: Private sector versus co-operatives

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PREFACE AND ACKNOWLEDGMENTS

“I can do all things through Christ who strengthens me”

Considering the limited research on waste source separation models in South Africa, this research aimed to investigate the effectiveness of waste source separation models in the northern parts of the City of Johannesburg, Gauteng by focusing on co-operative and private sector waste source separation models.

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ABSTRACT

Globally, the rapid rate of urbanisation, growth in populations and changing consumption patterns have significantly contributed towards increased municipal solid waste (MSW) generation. The rising costs of managing existing landfill sites and their related pollution, combined with the imminent depletion of landfill airspace capacity, have directed policies and strategies (internationally and in South Africa) towards waste diversion from landfill sites. The waste management hierarchy promotes re-use, recycling, recovery and treatment of waste as preferred alternatives to landfilling. Source separation of waste plays a crucial role towards implementing the waste management hierarchy. This research aims to investigate the effectiveness of waste source separation models in South Africa, focusing on the northern parts of the City of Johannesburg, Gauteng as a case study. The research specifically focuses on (source separation) private companies and co-operatives located in the three regions of the City of Johannesburg. To evaluate the effectiveness of these source separation models, five key performance areas (KPAs) and related key performance indicators (KPIs) were developed, based on a review of academic literature and legislative requirements related to waste source separation. A survey questionnaire was employed to gather information related to the KPIs from three co-operatives and three private companies. Performance evaluation scores (A–C) were assigned to indicate each waste separation model's performance against the evaluated KPIs. Overall, the private and co-operative waste source separation models effectively made provision for a working environment that promoted equality, personal growth and development (KPA 4). The co-operative waste separation model was more effective in making provisions for a lawful and safe working environment (KPA 3), whereas the private model was more effective in ensuring the separation of sufficient quantities and quality of recyclable waste (output) at an acceptable level of resources (input) (KPA 1). Both models were, however, ineffective in making provisions for a working environment with sufficient capacity, infrastructure and machinery (KPA 2), and promoting public involvement through communication, education, and awareness (KPA 5). Reflecting on the recommendations for improvement, it is clear that having access to adequate infrastructure, machinery, and weighbridges is critical in undertaking effective source separation activities. Furthermore, additional provisions need to be made to ensure sufficient human capacity, compliance with legal requirements, and improved communication with waste generators through customised awareness and educational programmes. Based on the lessons learned from private and co-operative waste source separation models, it is recommended that this research be duplicated in other South African municipalities with other types of waste source separation models, in addition, to expanding the geographic area to provide further insights.

Keywords: *waste; separation at source; models; private sector; co-operatives*

ABBREVIATIONS AND ACRONYMS

3Rs	Reduce, Re-use, Recycle
ASMARE	Association of informal waste workers (catadores) in Belo Horizonte, Brazil
CBO	Community-Based Organisation
CFL	Compact Fluorescent Light
Co-op	Co-operative
CoJ	City of Johannesburg Metropolitan Municipality
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs and Tourism
DEFF	Department of Environment, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries and Environment
DSI	Department of Science and Innovation
ECA	Environmental Conservation Act (Act No 73 of 1989)
EPR	Extended Producer Responsibility
FNAS REC	Faculty of Natural and Agricultural Science Research Ethics Committee
GDARD	Gauteng Department of Agriculture and Rural Development
GWMO	Global Waste Management Outlook
HSRC	Human Sciences Research Council
IndWMP	Industry Waste Management Plan
IP&WM	White Paper on Integrated Pollution and Waste Management
ISWM	Integrated Sustainable Waste Management

IWMP	Integrated Waste Management Plan
KPA	Key performance areas
KPI	Key performance indicators
MSW	Municipal Solid Waste
MWMO	Municipal Waste Management Organisation
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NEMWA	National Environmental Management: Waste Act (Act No. 59 of 2008)
NGO	Non-Government Organisation
NWMS	National Waste Management Strategy
NWU	North-West University
OECD	Organization for Economic Cooperation and Development
P	Private companies
PET	Polyethylene terephthalate
Pikitup	Pikitup Johannesburg (SOC) Ltd
PPE	Personal Protection Equipment
PPP	Public Private Partnership
RO	Research objective
SDG	Sustainable Development Goals
UN	United Nations
UNEP	United Nations Environment Programme
UNICEF	United Nations International Children's Emergency Fund
VAGO	Victorian Auditor-General's Office
WIS	Waste Information System

KEY DEFINITIONS

Co-operative:

“co-operative” means an autonomous association of persons united voluntarily to meet their common economic and social or cultural needs, and aspirations through a jointly owned and democratically controlled enterprise organised and operated on co-operative principles (Co-operatives Amendment Act, 06 of 2013)

Effectiveness:

“effectiveness” means the degree to which something is successful in producing a desired result/outcome; success (Oxford Learner’s Dictionaries, 2022)

Environment:

“environment” means the surroundings within which humans exist and that are made up of (i) the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among or between them; and (iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being (National Environmental Management Act, 107 of 1998)

Extended Producer Responsibility (or EPR):

“Extended producer responsibility” refers to an environmental policy approach in which a producer’s responsibility for a product is extended to the post-consumer stage of a product’s life (DEFF: National Waste Management Strategy, 2020)

Private Sector:

Private (or non-governmental) service providers within the waste sector are responsible for the management of waste produced during a products life cycle (DEA: National Waste Management Strategy, 2011)

Separation at Source:

“Separation at source” is the separation of different types of post-consumer waste materials for separate collection (DEFF and DSI: Waste Picker integration guideline for South Africa, 2020)

Municipal Solid Waste (MSW):

“Municipal solid waste” refers to general waste, which is waste that does not pose an immediate hazard or threat to health or to the environment, and includes— (a) domestic waste; (b) building and demolition waste; (c) business waste; (d) inert waste; or (e) any waste classified as non-hazardous waste in terms of the regulations made under section 69. A large portion of this waste is composed of domestic waste (National Environmental Management Laws Amendment Act, 02 of 2022)

Waste:

“waste” means— (a) any substance, material or object— (i) that the generator of that substance, material or object has no further use for within its own processes, whether or not it has any commercial value for the generator, but which can be re-used, recycled, recovered or traded in by any person; or (ii) that is rejected, abandoned, discarded or disposed of, either temporary or permanently, or is intended to be discarded or disposed of by the generator of that substance, material or object, regardless of whether or not that substance, material or object has any commercial value for the generator or can be re-used, recycled, recovered or traded in by any person; or (b) any other substance, material or object that may be defined as a waste by the Minister by notice in the Gazette; but any waste or portion of waste, referred to in paragraphs (a) and (b), ceases to be a waste— (aa) once it is re-used, recycled or recovered or traded in by the holder of that waste or portion of waste in accordance with a condition stipulated in a valid waste management licence, where applicable, or in accordance with an applicable norm or standard made in terms of this Act; or (bb) where the Minister has, in the prescribed manner, excluded the holder of any waste stream or a portion of a waste stream from the definition of waste, enabling the holder thereof to trade in the excluded waste stream or portion of the excluded waste stream, provided that the holder has satisfied the requirements of proving the environmentally safe use of the waste stream or portion of waste stream by it or any other person and committed to provide the Minister with annual reports of the use thereof. (National Environmental Management Laws Amendment Act, 02 of 2022)

Waste Management Hierarchy:

The waste management hierarchy is a structured, hierarchical approach to integrated waste management, arranged in descending order of priority; waste prevention, source reduction, re-use, recycling, recovery, treatment and safe disposal (DEA: National Waste Management Strategy, 2011)

Waste Minimisation:

“Waste minimisation” is a waste management approach that focuses on reducing the amount and toxicity of hazardous waste generated (in addition to other wastes regulated) Waste minimisation techniques focus on preventing waste from ever being created, otherwise known as source reduction, and recycling. These techniques can be practised at several stages in most waste-generating processes, but require careful planning, creative problem solving, changes in attitude, sometimes capital investment, and genuine commitment” (DEFF: National Waste Management Strategy, 2020)

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CHAPTER 1 INTRODUCTION

1.1 Background

The rapid increase in municipal solid waste generation has posed numerous challenges towards the implementation of sustainable waste management systems in countries around the world (De Souza Melaré *et al.*, 2017). The rate of municipal solid waste generation continues to increase as the world population keeps growing and the impact of this increase greatly affects every individual (Karak *et al.*, 2012). The increase in municipal solid waste generation is attributed to urbanisation and industrialisation as a result of exponential economic development (Sharma and Jain, 2020). It is estimated that by 2050 the global solid waste generation will reach 3.40 billion tonnes per annum (Kaza *et al.*, 2018).

Africa's average municipal solid waste generation rate in 2012 was approximately 0.78 kilograms per capita per day, significantly lower than the global municipal solid waste generation rate average of 1.2 kilograms per capita per day. Even though African cities have some of the lowest per capita solid waste generation rates, the supply of effective waste management services is insufficient (Wilson *et al.*, 2015). The inadequate supply of waste-related service delivery is due to the limited funds directed towards waste management practices and resources, despite the fact that waste collection and disposal accounts for large portions of municipalities' annual waste management budgets (Guerrero *et al.*, 2013).

Municipalities in South Africa face numerous challenges when it comes to the coordination of waste management and the implementation of sustainable waste management practices. According to Nahman and Godfrey (2010), the main issues include inefficient waste collection and disposal services for low to middle-income households, undocumented waste management activities (including unlicensed recycling and storage facilities), illegal dumping of unsegregated waste, outdated landfill site technology, limited landfill airspace capacity, inaccurate or incomplete waste data, inadequate waste management infrastructure, and ineffective waste minimisation practices (Adeleke *et al.*, 2021; Nahman and Godfrey, 2010).

Similar to many other developing countries around the world, landfilling remains the most preferred waste management practice for the disposal of solid waste in South Africa. This "traditional" practice is implemented by numerous municipalities reason being it is considered to be less expensive than implementing alternatives and requires minimum participation from households (Nanada and Berruti, 2021). However, the availability of open land to develop new landfill sites in large metropolitan cities is limited. The increasing costs of maintaining existing landfill sites and the rapid depletion of landfill airspace capacity is presenting an opportunity for

the implementation of waste minimisation and waste diversion policies and strategies (Kumar and Samadder, 2017).

Concepts such as the waste management hierarchy have become fundamental decision-making tools that outline the steps governments must follow to develop and implement sustainable waste management systems (Price and Joseph, 2000). The waste management hierarchy forms an integral part of the National Environmental Management Waste Act (Act 59 of 2008) and it provides a framework for the development of country-specific policies such as the National Waste Management Strategy (NWMS). The (then) Department of Environmental Affairs developed a NWMS in 2011 with the vision to address waste minimisation and diversion from landfilling, while taking into consideration the socio-economic issues in the country. The strategy was revised in 2020, with Pillar 1 of the NWMS (DFFE, 2021) focusing on waste prevention and the management of waste as a resource, to guide municipalities on how to achieve the long-term outcome of “zero waste to landfills”. The NWMS (2020) highlighted the importance of working towards a circular economy, providing for extended producer responsibility schemes (EPR), waste sector entrepreneurship, and public-private partnerships (PPPs) and the importance of collaborating with civil society groups (DFFE, 2021). Waste separation at source is emphasised as an important step towards implementing the waste management hierarchy and a circular economy (Moh, 2017; Oelofse and Godfrey, 2008).

1.2 Problem statement and rationale for the study

South Africa generated approximately 55 million tonnes of general waste in 2017, of which 34.5% was recycled/recovered and 65.2% was disposed of at landfill sites (State of Waste Report, 2018). The low diversion rate indicates that South Africa is still very dependent on landfilling as the primary waste disposal method, despite the low airspace availability at the landfill sites and growing environmental concerns (Kadyamadare, 2017; Simatele and Kubandza, 2019).

Over the years, the operational costs of maintaining and monitoring landfill sites (in operation or decommissioned) are increasingly becoming expensive and limiting (Nahman, 2011). The existing landfill sites in the country are rapidly approaching the end of their lifespan and the need to change the country’s waste management practices towards more environmentally sustainable methods is prompting municipalities to find alternative, cost-effective waste management strategies that can divert waste away from landfilling (Dlamini *et al.*, 2019; Muzenda, 2014).

Pillar 1 of the 2020 NWMS prioritises waste minimisation by highlighting various focus areas such as increasing waste reduction, re-use, recycling, and recovery methods to reach the expected outcome of “zero waste to landfills” (DFFE, 2021). The Strategy promotes the separation of waste

at source while creating employment opportunities through public and private sector involvement in alignment with its strategic vision (DFFE, 2021). The role that the private sector and civil society organisations can play towards achieving the outcomes set out in Pillar 1 of the NWMS is pivotal (Matete and Trois, 2008).

Research conducted by Godfrey *et al.* (2017), “*Co-operatives as a development mechanism to support job creation and sustainable waste management in South Africa*”, assessed the formalisation of waste pickers through the establishment of co-operatives as a mechanism for job creation and economic development. The study also highlighted the requirements needed for the creation of viable co-operatives in South Africa (Ezeah *et al.*, 2013; Godfrey *et al.*, 2017). The study conducted by Godfrey *et al.* (2017), highlighted the focus area of “*waste collection including separation at source*” in Pillar 2 of the NWMS. This focus area encompassed the development and implementation of innovative models using various approaches such as EPR and tools to incorporate the informal sector in separation at source service delivery (DEFF, 2020). This study seeks to expand on the research conducted by Godfrey *et al.* (2017) by focusing on private and co-operative waste separation models.

This research specifically aims to evaluate the effectiveness of waste source separation models in South Africa, with the aim of providing opportunities for learning and future improvement. For this purpose, a case study approach is followed, focusing on the City of Johannesburg (CoJ) located in the Gauteng Province. Gauteng has the fastest-growing population in the country, with an immigration and urbanisation rate of approximately 3% annually (Pikitup, 2020a). The rapid increase in population and economic growth directly translates to the rapid increase in waste generation, consequently, straining waste management resources and diversion projects of municipalities in economic hubs such as the CoJ (Schoeman and Rampedi, 2021). The CoJ had approximately 63 waste-related PPPs in 2018, which assisted with waste activities such as illegal dumping and clean-up campaigns. The CoJ seeks to actively promote the number of PPPs that will assist with waste diversion projects (Pikitup, 2018; Pikitup, 2020a).

The research aims to learn from both private and co-operative waste source separation models, within the CoJ, to make recommendations towards increasing the effectiveness of future waste source separation models.

1.3 Research aim and objectives

This research aims to investigate the effectiveness of private and co-operative waste source separation models in South Africa, by focusing on the northern parts of the City of Johannesburg, Gauteng, as a case study area.

This aim will be achieved by accomplishing the following objectives:

1. Developing key performance areas (KPAs) and related key performance indicators (KPIs) to evaluate the effectiveness of waste source separation models;
2. Evaluating the effectiveness of co-operative and private sector waste separation models against developed KPIs
3. Comparing the effectiveness of co-operative and private sector waste separation models with the aim of making recommendations for future waste source separation models.

1.4 Scope of the research

The research study focused on investigating the effectiveness of the co-operative and private sector source separation models in the northern parts of Johannesburg. The northern parts of Johannesburg include urban areas such as Sandton, Rosebank, and Randburg. Additionally, large townships such as Alexandra are also located in the northern parts of Johannesburg. The research focused on the northern parts of Johannesburg because both source separation models are implemented in this region.

Although “source separation” would typically refer to the separation of waste by source products (i.e. glass, plastic, paper, metal, etc.) generally prior to collection from generators (i.e. households), this research refers to “source separation models” as groups/organisations who/which collect (source separated or mixed recyclable waste) from households or receive recyclable waste from drop-off points and then do further separation, and in some instances also sorting, shredding, baling and/or crushing. In this sense, the “source separation models” are seen as “middlemen” between generators of waste (i.e. households) and buy-back centres, which the latter utilises the recyclable waste for re-use, recycling or recovery purposes.

In the context of this research, the term “model” refers to a practice or process that can be used as an example to be imitated. The study explored the practices of co-operatives and private companies to assess whether they were effective in separation at source practices. “Co-operatives” refer to formalised waste reclaimers and/or waste pickers who collect and/or receive and sort recyclable waste to sell to buyback centres. While “private companies” mean registered entrepreneurs and small business owners who collect, and/or receive and sort recyclable waste to sell to buyback centres.

The research was undertaken in 2022, and the data collection process was conducted over a period of two months.

1.5 Assumptions and limitations

The research was conducted in the northern part of Johannesburg because this is one of the few areas in South Africa, accessible to the researcher, which has both private and co-operative source separation models existing/operating in one area.

The research findings are limited to three co-operative and three private waste management companies located in the northern parts of the CoJ. This is a relatively small sample size and does not allow for a “like-for-like” comparison between co-operative and private source separation models. The comparison attempted in this research is towards identifying opportunities for future improvements from the strengths and weaknesses of both models, rather than a direct comparison.

Although the research findings are limited to the CoJ, learning may be generalisable to the larger South African context.

1.6 Potential contribution of the research

The research contributes to the ongoing research conducted on sustainable waste management practices such as separation at source and diverting waste from landfilling through the implementation of alternatives. The research findings provide opportunities for future improvement of source separation models.

1.7 Structure and outline of the dissertation

The dissertation contains five chapters. A summary of each of the chapters is provided below:

➤ Chapter 1 Introduction

This chapter was comprised of the background, problem statement and rationale for the study, the research aims and objectives, the scope of the research, assumptions and limitations, structure and outline of the dissertation, and the conclusion. This chapter gives a clear understanding of the need to explore source separation models.

➤ Chapter 2 Literature review

This chapter explored and discussed relevant literature on co-operative and private sector source separation models nationally and internationally.

➤ Chapter 3 Methodology

This chapter is comprised of the research design, data collection and analysis methods, ethical considerations, methodological assumptions and limitations. This chapter indicates how the data was collected, analysed and represented.

➤ Chapter 4 Results and Discussion

In this chapter, all the research findings were presented and discussed.

➤ Chapter 5 Conclusions and Recommendations

In this chapter, the conclusions were drawn from the results and discussions made throughout the study and recommendations for future research studies were made.

1.8 Conclusion

Chapter 1 provided an overview of the background, research aims and objectives, problem statement, and the research scope of the study. It also outlined the assumptions and limitations encountered throughout the study.

The next chapter (Chapter 2) provides a literature review, which aims to contextualise separation at source with regard to co-operatives and the private sector.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This chapter aims to contextualise the research by reviewing existing literature on the subject matter. The focus will be on the research topic, where the co-operative and private sector source separation models in Gauteng are investigated. The literature review explored the following themes: Municipal solid waste management around the world and in South Africa; the waste management hierarchy and its applications in environmental management policies; the importance of source separation; integration of the informal sector into the recycling industry through the establishment of co-operatives; waste picker integration in South Africa; significance of co-operative and private sector source separation; and the lesson learned from Europe and America on separation of waste at source. These themes aim to provide a broader understanding of the research topic and highlight the importance of source separation in achieving sustainable solid waste management.

The literature review was conducted by exploring relevant internet sources such as peer-reviewed journals and books, obtained from Google Scholar, Science Direct, etc. Institutional publications such as dissertations and theses were obtained from the North-West University (NWU) Library website (NWU Institutional Repository: Boloka). Documents from international, national and local spheres of government were also taken into consideration. Relevant literature was found using various combinations of keywords/phrases such as “*landfilling*”, “*separation at source*”, “*source separation co-operatives*”, “*source separation private sector*”, and “*solid waste management*”.

2.2 Municipal solid waste (MSW) management around the world and in South Africa

Waste collection, transportation, recycling, recovery, treatment and disposal are all functions encompassed in municipal solid waste (MSW) management. In South Africa, however, the waste flow generally moves from generation, collection to disposal in a linear manner (Mihai *et al.*, 2021; Nyika *et al.*, 2019). These functions/activities need to be managed in such a way that they do not negatively impact public health, safety or environmental quality. Additionally, they should contribute to the circular economy (Kubanza and Simatele, 2019; Henry *et al.*, 2006). Various municipalities in developing countries are grappling with the provision of efficient solid waste management services to all their citizens due to budget constraints (mainly urban areas are prioritised) and the rapid increase in solid waste generation rates (Cheng and Hu, 2010; Omotayo *et al.*, 2020). The rapid increase in solid waste generation is attributed to accelerated population growth and an influx of people moving toward large cities to explore better economic activities (Samah *et al.*, 2013).

Metin *et al.* (2003) indicated that the general composition of waste varies from metropolitan cities to small towns and villages. Organic solid waste contributes over 40% in metropolitan cities and increases to as much as 60% in smaller towns and villages. Recyclable solid waste contributes over 15% in smaller towns and villages and increases to as much as 30% in metropolitan cities (Metin *et al.*, 2003:427). Recyclable waste is generally packaging material that is made of plastic, paper, metal or glass. A study conducted by Edjabou *et al.* (2021), indicated that waste diversion measures that were based on specific household waste types were far more effective than diversion measures based on generalised information. The study found that the citizens had positive waste behaviour when the waste diversion methods were customised to the specific type of waste they generated (Edjabou *et al.*, 2021).

Over the last two decades, numerous countries around the world have adopted frameworks such as the waste management hierarchy and the circular economy to address waste-related issues. These frameworks have enabled countries to develop integrated sustainable waste management policies that can deal with the increase in solid waste generation, although the implementation of these policies proves to be challenging in developing countries (Kurniawan *et al.*, 2022).

2.3 Integrated Sustainable Waste Management (ISWM)

Small communities in prehistoric societies disposed of their waste in a variety of ways, their dry waste would be buried and their wet waste would be discharged into surface water. As communities continued to expand in size, an organised waste management approach was required to prevent odours and diseases emanating from the waste (Seadon, 2006). It was vital to define what the constituents of waste were so that legislators could effectively address waste-related issues (Pongracz and Pohjola, 2004).

Conventional waste management plans did not produce desirable results reason being: (1) the recommendations were not appropriate to the socio-economic circumstances; (2) civil society and community-based organisations (CBOs) did not assist with policy implementation because they were not included in the planning process; and (3) decision-makers were not fully committed to the planning process (Anschutz *et al.*, 2004).

Around the mid-1990s, research institutions along with non-government organisations (NGOs) and international agencies established a collaborative programme to develop a framework that could identify, analyse and resolve prevalent issues with waste management plans in low to middle-income countries. This conceptual framework was officially titled *Integrated Sustainable Waste Management* (ISWM) (Wilson *et al.*, 2013). Figure 2-1's illustration of the ISWM concept, highlights three fundamental dimensions of waste management that should be considered when

evaluating and planning a waste management system, namely: (1) The interested and affected parties involved in waste management (Stakeholders); (2) the technical and practical components of the waste system (Waste system elements); and (3) the sustainability characteristics of the local context (Aspects) (Topic and Biedermann, 2015; Wilson *et al.*, 2012). The second dimension of the ISWM concept, as illustrated in Figure 2-1, refers to the handling and disposal of solid waste.

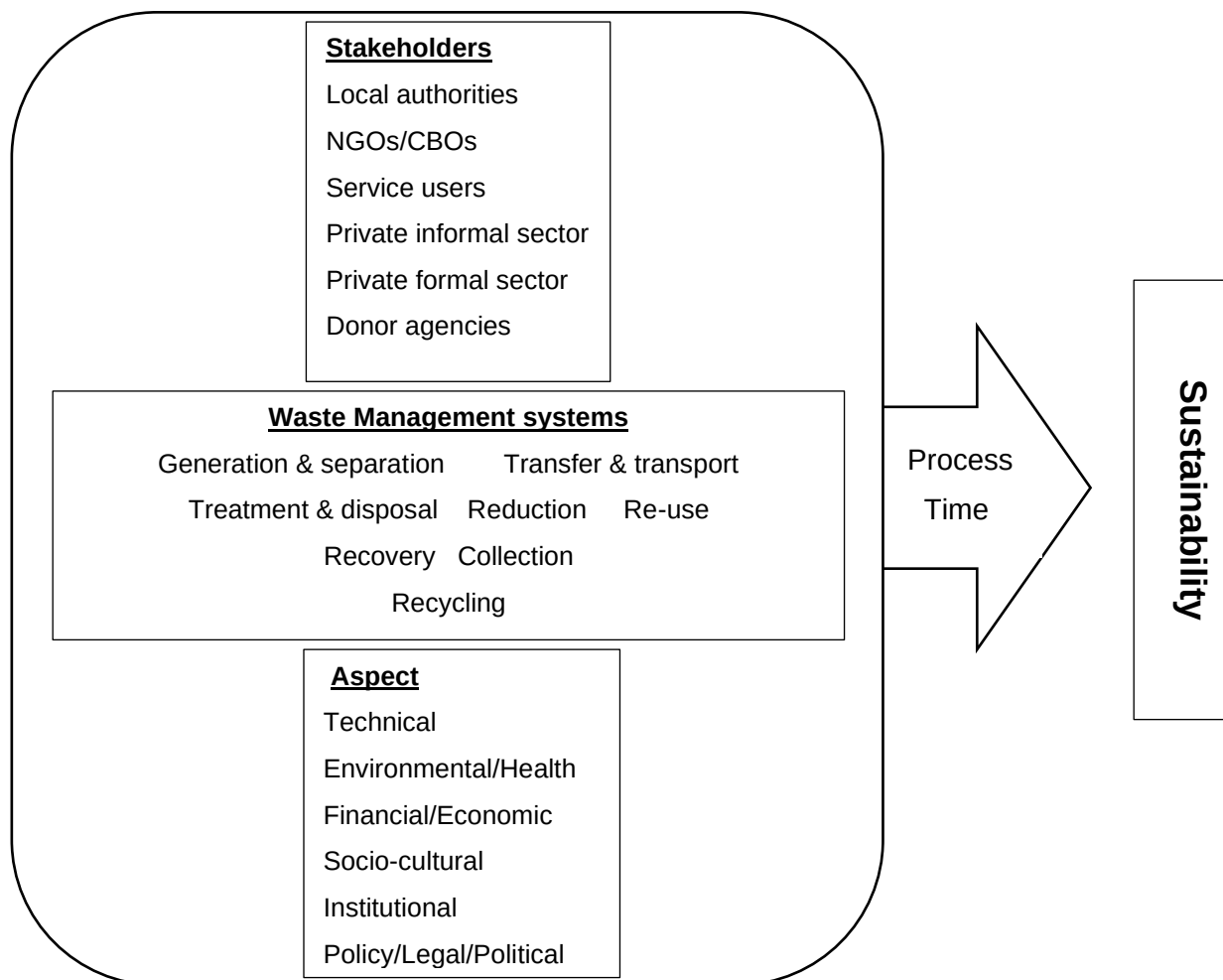


Figure 2-1: Integrated Sustainable Waste Management concept (adapted from Wilson *et al.*, 2013).

The environmental implications of these waste system elements have promoted the adoption of other conceptual frameworks such as the waste management hierarchy (Wilson, 2007).

2.3.1 The waste management hierarchy

The 2015 Global Waste Management Outlook (GWMO) by the United Nations Environment Programme (UNEP) emphasised the need for integrated and sustainable solid waste management systems that addressed technical and governance issues. The GWMO sought to find an assessment tool that would consider a product's life cycle to minimise the impacts caused by the product when it reaches its end of life. The waste management hierarchy presented a generalised ranking system (or sequencing of waste management options in order of priority) that provided technical methods and sustainable waste management practices (UNEP, 2015).

The waste management hierarchy seeks to prioritise the minimisation of environmental impacts caused by waste generation while preserving natural resources. The hierarchy outlines the most preferred waste management practices (top of the hierarchy) to the least preferred waste management practices (bottom of the hierarchy), as depicted in Figure 2-2 (Bai and Sutanto, 2002).

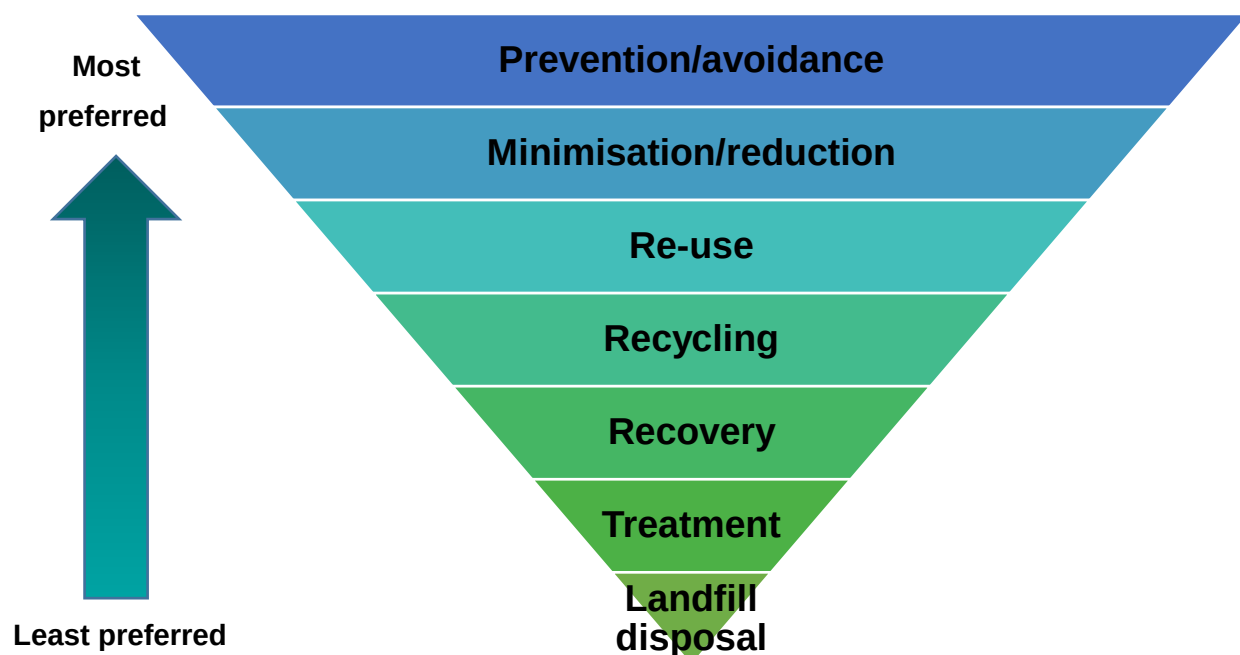


Figure 2-2: The Waste Management Hierarchy [adapted from UNEP, 2015:31, National Waste Management Strategy (DEA, 2012a; DEFF, 2021)]

Waste prevention (or avoidance) and waste minimisation (or reduction) are commonly used terms that refer to the most preferred practices of the waste management hierarchy. Waste prevention practices are said to be preventive measures that include “source reduction”, “prevention” and

“product re-use”, while waste minimisation practices include measures to reduce the amount or toxicity of waste generated in addition to waste prevention (EEA, 2002; Salhofer *et al.*, 2008).

Waste minimisation is generally described as the reduction of waste volumes at the source (source reduction) and the diversion of waste materials from entering the waste stream (waste diversion) (Ali and Siong, 2016). In the South African context, “*waste minimisation*” is defined as “*a waste management approach that focuses on reducing the amount and toxicity of hazardous waste generated, in addition to other wastes regulated*” under the Resource, conservation and Recovery Act. *Waste minimisation techniques focus on preventing waste from ever being created, otherwise known as source reduction, and recycling. These techniques can be practised at several stages in most waste-generating processes, but require careful planning, creative problem solving, changes in attitude, sometimes capital investment, and genuine commitment*” (DFFE, 2020). The phrase “*Reduce, Reuse, and Recycle*” was adopted from the concept of waste minimisation. In various policy documents, this phrase is referred to as the 3Rs (Mallak *et al.*, 2018:2).

The term ‘source reduction’ describes the degree to which people change their waste behaviour by merely not producing waste at all, subsequently saving money by avoiding the utilisation of other solid waste management practices such as waste diversion (recycling), recovery (incineration) or disposal (landfilling) (Goddard, 1995). Additionally, source reduction can reduce the accelerated depletion of natural resources caused by the increased demand for new products (Murphy and Pincetl, 2013). Source reduction promotes the utopian concept of “zero waste” by encouraging the reduction of waste created at the source. This means that when products reach their end of life, they will not be disposed of rather they will be remanufactured and resold within the system at an equivalent or slightly lower value (Song *et al.*, 2015).

Re-use and recycling are the next most preferred practices in the waste management hierarchy, although re-use is preferable to recycling because it requires minimal resources and energy (Al-Salem *et al.*, 2009). Recycling is a significant method of waste diversion. It entails the separation and collection of different types of waste materials (such as paper, plastic, glass, and green waste), as well as the remanufacturing or assembling of waste materials into products that have profitable market resale value (Taylor, 2000). A study conducted by Hamzaoui-Essoussi and Linton (2014), investigated customers’ willingness to pay for products that are made from recycled material. Remanufactured products are commonly referred to as green products. These products are seen as environmentally friendly because they recover the value of the material that was originally built for usage. The study indicated that customers who had adequate environmental knowledge were willing to buy recycled products or products that had remanufactured material in them depending on the product’s perceived risk (Hamzaoui-Essoussi and Linton, 2014).

The South African NWMS (2020), seeks to increase the recycling rates in the country by changing consumer behaviour through the promotion of source separation programs throughout various sectors and communities. The NWMS (2020), further emphasises that the promotion of EPR schemes will significantly increase the recycling rates in the country by promoting the commercial viability and beneficiation of recycled products (DEFF, 2021).

Recovery and treatment are the next most preferred waste management options, while disposal is the least preferred practice of the waste management hierarchy. Despite landfilling being the least favoured method of waste management, the most commonly used disposal method in the developing country context is landfilling (DEFF, 2021). Landfilling can be broadly categorised as sanitary landfilling, controlled landfilling (controlled disposal) and open dumping (uncontrolled disposal) (Bundhoo, 2018). The term landfill is loosely used given the fact that there is no definitive definition of the word, therefore the operational features of this word are not delineated. Open dumps are disposal sites that do not have engineered measures such as leachate control or landfill gas management systems. They are generally low-lying areas of open land where waste is disposed of uncontrollably (Joseph, 2002; Remigios and Wiseman, 2012). Sanitary landfill sites are engineered facilities that are designed to contain specific types of waste streams depending on the authorisation obtained by the waste management facility. This type of landfill site is designed to manage leachate discharge by using a series of ponds for treatment upon inception while managing and monitoring gas emissions from waste decomposition. Semi-controlled or operated landfills are designated sites where unsegregated waste is disposed of, compacted then covered with topsoil daily. These landfill sites have limited design measures to mitigate environmental issues that result from increased leachate generation and uncontrolled landfill gas emissions (Karani, 2007; Remigios, 2010).

Globally, there is growing recognition of the need to create sustainable waste management policies and strategies that prioritise waste prevention. The waste management hierarchy should be utilised as a flexible universal framework from which policymakers can draw inspiration to develop effective waste management strategies that address local waste-related matters (Ferrari *et al.*, 2016).

2.3.2 Application of the waste management hierarchy in environmental management policies in Africa

Municipal solid waste (MSW) management crosscuts several sustainable development goals (SDGs) and its impact on these SDGs highlights its importance (UN, 2022). A study conducted by Rodic and Wilson (2017), highlighted how SDGs 6 and 11 seek to minimise adverse impacts on the environment and human health by addressing specific solid waste management targets.

These goals emphasised the need to reduce waste generation by promoting the 3Rs (waste diversion) and waste prevention strategies (source reduction) while creating employment (Rodic and Wilson, 2017). The study further emphasised that it is crucial to define waste as a resource and adopt waste separation at source as a guiding principle to overcome solid waste management issues and achieve the SDGs (Gamaralalage *et al.*, 2022).

The African Union adopted “*Agenda 2063*” in 2013, as a framework document for equitable growth and sustainable development in Africa. Agenda 2063 takes into consideration the SDGs while emphasising the need to build on and accelerate the implementation of nation-specific policies and related initiatives. One of Agenda 2063’s targets is to recycle 100% of MSW by 2063 through the development and implementation of nation-specific policies that encourage the movement of waste management up the hierarchy (AUC, 2015).

2.3.2.1 The waste management hierarchy and its implementation in South Africa

The amendment of the Environmental Conservation Act (Act 73 of 1989) (ECA), is where the story of environmental management in South Africa begins. This legislative document offered the first legal definition of waste and outlined the requirements of waste management. However, it mainly focused on the authorization, management, and supervision of waste disposal facilities (Godfrey and Oelofse, 2017). This act sought to make provisions for the environment’s effective protection, controlled use and related issues by minimising the effects of poorly managed landfill sites. Additionally, it acknowledged that the Minister (of Environmental Affairs and Tourism at the time) could issue regulations concerning waste reduction, re-use and recovery (DEAT, 1989).

At the time, land, air, and water matters were treated separately when it came to the regulation and management of environmental impacts caused by industrial emissions. The diffusion of institutional and legal structures resulted in the fragmentation of environmental policies in South Africa. This fragmentation enabled the movement of pollution to environmental mediums that offered the least regulatory resistance (Kotze, 2007; Kotze, 2014). In response, the publications of the White Paper on Environmental Management Policy and Chapter 2: Section 24 of the Constitution of the Republic of South Africa (Act 108 of 1996) set the stage for the National Environmental Management Act (Act No.107 of 1998) (NEMA) (Blackmore, 2018). The NEMA became an overarching legislative framework, repealing and replacing various parts of the ECA while offering a medium for integrated and coordinated environmental management through the promulgation of other laws such as the NEMWA (Act 59 of 2008) (NEMWA), National Environmental Management Waste Amendment Act (Act 26 of 2014) (NEMWAA) and the NWMS, particularly for waste related matters (Sohan, 2021; Strydom *et al.*, 2009).

The publication of the White Paper on Integrated Pollution and Waste Management (IP&WM) in 2000, triggered a paradigm shift in South African waste management (Makgae, 2011). The IP&WM established the legal foundation for integrated pollution control and waste management, this introduced the concept of the waste management hierarchy for the first time in South Africa (DEAT, 2000).

The NEMWA, which came into effect in 2009, is the main piece of legislation that governs the management of waste in South Africa (Prinsloo, 2019). This Act provides for environmental protection by establishing requirements for the management of waste, which also aims to reduce impacts on human health and well-being. The Act further encourages the prevention of ecological degradation and pollution through the implementation of the waste management hierarchy in Sections 16 and 17 of the NEMWA by providing for: “(i) *minimising the consumption of natural resources*; (ii) *avoiding and minimising the generation of waste*; (iii) *reducing, re-using, recycling and recovering waste*; (iv) *treating and safely disposing of waste as a last resort*,” (DEA, 2012a:18).

To accomplish the objectives of the NEMWA, the 2011 National Waste Management Strategy (NWMS) was promulgated. This strategy provided specific details on processes that were required to accomplish the NEMWA’s objectives and give effect to the waste management hierarchy (Nel and du Plessis, 2001). A variety of instruments were utilised by the 2011 NWMS to implement its eight strategic goals and achieve the respective targets. These instruments include; EPR schemes, Integrated Waste Management Plans (IWMPs), and other economic instruments (Muzenda, 2014). In an effort to divert waste away from landfill sites and increase recycling rates in the country, the 2011 NWMS outlined the need to shift waste management up the hierarchy (Muzenda *et al.*, 2012). The first goal of the 2011 NWMS was to “*Promote waste minimisation, re-use, recycling and recovery*”. The focus of this goal was to implement the waste management hierarchy and realise the goal of diverting waste away from the landfill (Mazhandu, *et al.*, 2021).

Two objectives were used as a basis to structure Goal 1 of the 2011 NWMS, in addition to representing the preferred methods of the waste management hierarchy (Mazhandu *et al.*, 2020). The first objective emphasised the need to promote waste minimisation in product design, composition and manufacturing. The second objective emphasised the promotion of product re-use, in addition to the recycling, or recovery of waste materials. The respective target for objective one indicated that waste reduction and recycling targets set in Industry Waste Management Plans (IndWMP), which address paper and packaging, pesticides, lighting (CFLs), and tyres need to be achieved. The respective targets for objective two indicated that; 25% of recyclable material diverted away from landfills should be re-used, recycled or recovered; and that separation at

source initiatives should be initiated in all major cities, large towns and metropolitan municipalities (DEA, 2012a).

To build on the successes of this strategy, the South African government amended the 2011 NWMS in 2020 to place an emphasis on the waste management hierarchy, encourage stakeholder collaboration, and promulgate the circular economy (DEFF, 2021).

The 2020 NWMS has three “pillars” (or focus areas), with waste minimisation and waste prevention enshrined in Pillar 1 of the strategy. Pillar 1 (Waste Minimisation) highlights the need to divert waste away from the landfill site by increasing reduction, re-use, and recycling initiatives while promoting the role of the waste sector in the circular economy (DEFF, 2021; Thobejane, 2022; Sohan, 2021). Pillar 1’s strategic thrust includes; *“minimising the impact of waste, particularly plastic packaging, on our coasts, rivers, wetlands, and human settlement environments; increasing re-use, recycling, recovery, and alternative waste treatment; and maximising the role of the waste sector in the circular economy”*. The thrust further emphasised the need to develop long-term partnerships and collaborations between the public and private sectors, to achieve the ultimate aim of “zero waste to landfill” (DEFF, 2021:33).

2.4 The importance of source separation

Pillar 1 of the 2020 NWMS mentions the expected, ultimate (long-term) outcome of “zero waste to landfill” through the accomplishment of short, medium, and long-term goals. This pillar highlights the importance of MSW separation at source in diverting waste away from landfill sites. This pillar emphasises the need to prioritise the recycling of waste materials such as glass, paper, plastic, tyre and metal to increase the recycling rates in the country (DEFF, 2021; Olatayo *et al.*, 2022).

The practice of MSW separation at source is comprised of separating waste according to distinct categories, namely; paper, plastics, metal, and glass. Source-separated waste materials can be remanufactured and resold rather than going to the waste stream (Pham Phu *et al.*, 2019). Waste materials that are source-separated directly from households have a far better quality than waste materials that are separated after collection. This is due to the fact that source-separated waste at a household level has minimal contamination (Asase, 2011). Civil society plays a crucial role in source separation activities reason being residents can source separate their waste material at a household level, thus reducing the costs of collecting, transporting, and sorting unsegregated MSW (Sukholthaman and Sharp, 2016).

A study conducted by Tai *et al.* (2011), highlighted that effective waste diversion can be greatly impacted by the type of source separation collection method. The pilot study was conducted in

China where eight cities were identified to investigate the source separation collection rates. The source separation collection rates ranged from 8.9% to 40.1%, of which the “household collection” rates (8.1% to 35.2%) were higher than the “municipal collection” rates (0.8% to 4.9%) (Tai *et al.*, 2011:1677). The study found that household collection significantly contributed toward general source separation rates. The results indicated that the collection method greatly affected the effectiveness of separation at source (Tai *et al.*, 2011).

2.4.1 The role of the informal sector in waste separation at source

Liu *et al.* (2020), indicated that separation at source plays a crucial role in diverting waste away from entering the waste stream, although the informal sector has been the most significant role player in this practice (Liu *et al.*, 2020). In significant parts of society, the informal sector provides an essential “front-line” service that frequently influences the economy (Ezeah *et al.*, 2013). In developing countries, waste pickers have significantly contributed to the increase in recycling rates by collecting and separating waste at source (Chi *et al.*, 2011).

2.4.1.1 Integrating the informal sector in waste separation at source

The existence and operations of the informal sector are not managed or regulated by governmental bodies rather, they are driven by socioeconomic conditions and market-related forces. Waste pickers are the largest participants in this sector. Waste pickers and informal waste collectors are described as people who separate waste at source and sell their material to earn an income. The difference between waste pickers and informal waste collectors is that informal waste collectors exchange or pay for specific waste materials, stockpile the waste to generate more income, and then sell it off when the market prices are favourable (Ahmed and Ali, 2004). Informal waste recyclers, in one commercial area in Nigeria, supply approximately 48% of raw materials to small businesses and artisans in that area. A large amount of material recovered include ferrous (e.g. Steel) and non-ferrous (e.g. Aluminium) metals, paper, rubber, and plastic material (Oguntoyinbo, 2012).

The accurate amount of recyclable waste diverted by waste pickers and informal waste collectors is unknown or approximated, although economic evaluation studies indicated that the inclusion and informal waste recyclers in an integrated recycling plan could significantly reduce solid waste diversion costs by approximately 78% (Oguntoyinbo, 2012). These projections have prompted governments to strategise around the incorporation and formalisation of informal waste recyclers in sustainable solid waste minimisation initiatives. As a result, the establishment of co-operatives came about (Velis, 2017) (Refer to Section 2.5 below).

2.4.1.2 Waste picker integration in South Africa

Informal waste recyclers (particularly waste pickers) are the main drivers of recycling in various countries around the world, although their operations are conducted in unsafe working environments (Godfrey *et al.*, 2016; Navarrete-Hernandez and Navarrete-Hernandez, 2018). Waste pickers are constantly subjected to unsafe working conditions, from handling various waste materials without Personal Protective Equipment (PPE) to enduring various conditions while retrieving these materials, particularly those that are situated at landfill sites (Bala *et al.*, 2021; Schenck *et al.*, 2019). Makaluza and Burger (2018), indicated that waste pickers are often included in the survivalist tier of the larger informal sector because they entered the informal sector as a recourse to generate an income. They are generally not fairly remunerated for their efforts and they have limited opportunities to move up within the informal sector or enter the formal waste sector (Yu *et al.*, 2020).

The South African government sought to remediate these issues by developing a “*Waste Picker Integration Guideline*”. This guideline aimed; to formalise and incorporate waste pickers into solid waste management strategies such as source separation programmes, ensure that municipal waste and recycling policies acknowledge and show appreciation for the work done by waste pickers, build on the successes of existing systems, enhance the livelihood of waste pickers and increase recycling rates in the country (DEFF, 2021).

A study conducted by Godfrey and Oelofse (2017), indicated that South Africa’s recycling rate is speedily catching up with many European countries and that the main contributors were waste pickers. Godfrey *et al.* (2016), indicated that waste pickers have integrated themselves into existing waste management systems in such a way that the waste value chain benefits significantly from their contribution (Godfrey *et al.*, 2016). The study conducted by Mamphitha (2011) on “*The role played by subsistence waste pickers in recycling*”, indicated that buy-back centres received approximately 80% of their waste from waste pickers. These waste pickers collected their recyclable materials from households every week and sold them to various buy-back centres. Some residents mentioned that they appreciated the waste pickers’ involvement in collecting their recyclable material when the municipality failed to do so consistently (Mamphitha, 2011).

Section F of the “*Waste Picker Integration Guideline for South Africa*”, seeks to incorporate waste pickers through integrated source separation programs. The South African government emphasised the need to prioritise the establishment of co-operatives to increase waste diversion while ensuring that the waste pickers have adequate working conditions and resources (DEFF, 2020).

2.5 Co-operatives in waste separation at source

A co-operative is seen as an instrument of economic development. It is typically a group of people who jointly own an organisation that can be governed and monitored while achieving the required economic, social, and environmental demands (Dwivedi, 1996). Co-operatives within the waste sector provide members with the opportunity to: conduct their activities in a safe environment; be recognised by spheres of government and financial institutions; acquire training, and significantly increase their separation at source activities (Bhuwmik, 2007).

2.5.1 Significance of co-operative source separation

Co-operatives can increase source separation efficiency through the various networks (community members, buy-back centres, and municipal entities) they create within the waste value chain (Tirado-Soto and Zamberlan, 2013). According to a study conducted in three Mexican communities, approximately 3000 informal waste recyclers collected 353,000 tonnes of recyclable waste annually. Whereas, one of Brazil's most successful co-operatives (ASMARE) recycled 500 tonnes of waste material in a month (Oteng-Ababio, 2012).

Co-operatives can achieve goals that would be difficult for individuals to achieve because they are self-reliant, actively involved, empowered and equitable despite their socio-economic conditions. These principles allow them to alleviate various challenges to achieve maximum productivity. Co-operative members are generally marginalised due to their low levels of education and minimal business expertise (Medina, 2000). This makes them susceptible to unscrupulous individuals who seek to exploit their labour. Additionally, it is difficult for them to acquire adequate operational resources because they are not fully supported by public policies and industries (Do Carmo and de Oliveira, 2010).

The South African government actively supports co-operatives as a way to formalize informal waste recyclers by fostering business development and job creation through the adoption of several Brazilian models (Khumalo, 2014). Despite this, co-operatives have a failure rate of 91.8% within a few months of operation. A study conducted by Bala *et al.* (2021:6), indicated that the high failure rate could be attributed to challenges such as lack of operational infrastructure (e.g. sorting and storing facilities, collection trucks, etc.) and inaccessibility to the market (e.g. business is conducted through a middle-man and often co-operatives are not given sufficient income for their recyclables) (Bala *et al.*, 2021).

2.5.2 Potential benefits of co-operative source separation

According to Gutberlet (2013a), Rutkowski and Rutkowski (2015) as well as Silva de Souza Lima and Mancini (2017), co-operative source separation can provide governments with the following benefits:

- Provision of employment opportunities with minimal investment: Co-operatives can provide people with various employment opportunities, such as truck drivers, waste collectors, waste sorters, etc.;
- Reduction of waste diversion costs;
- Promotion of source separation at a household level by increasing public involvement through education and awareness;
- Conservation of natural resources by creating a closed loop chain (circular economy): Co-operatives understand the market dynamics of waste. They know the value of each waste type, and the quantities required by the buy-back centres; and
- Increase landfill airspace capacity through effective source separation activities (Gutberlet, 2013a; Silva de Souza Lima and Mancini, 2017).

South Africa's promotion of co-operative source separation initiatives has enabled waste pickers to move up the value chain and become sustainable entrepreneurs who can transition into the private sector within the waste and recycling industry (Muswema and Oelofse, 2016).

2.5.3 Challenges of co-operative source separation

Co-operatives are seen as a powerful tool that encourages "*grassroots development of the informal sector*", however, they are still susceptible to various internal and external challenges (Ezeah *et al.*, 2013). Various co-operative members that were interviewed in a study conducted by Godfrey *et al.* (2017), indicated that the challenges they faced ranged from:

- Finances, which includes issues with handling cash payments, SARS matters, start-up and operational capital;
- Infrastructure limitations, especially a lack of adequate equipment, transportation, and sorting facilities;
- Inadequate skills, knowledge and/or training, with limited record-keeping experience or mentorship;
- Lack of adequate document management, group dynamics, or basic co-operative training;
- Administrative challenges, with member selection issues, registration problems, etc.;
- Operational and/or technical challenges, such as market fluctuations, theft, inadequate PPE, and tension with undocumented foreign nationals; and

- Governance challenges, with a lack of stakeholder engagement and local government assistance.

Studies conducted by Alves *et al.* (2019), Campos (2014) and Strydom and Godfrey (2015), highlighted similar challenges.

2.5.4 Lessons learned from co-operative source separation in South America

Colombia hosts one of the most vibrant co-operative movements in the world. In 1986, The Social Foundation, a non-governmental organisation, launched a “*National Recycling Program*”, which established over 100 co-operatives throughout the country (Medina, 2000). The foundation provided co-operatives with grants and loans for certain projects while offering free business consulting services. Co-operatives operated in various working conditions depending on their capabilities: (1) some co-operatives utilised pushcarts, horse carts, or pick-up trucks to collect the material; while (2) others used well-travelled paths across the city, collecting material from wheelie bins at designated pick-up sites on the curb. Furthermore, some (3) participated in source separation initiatives, where they collected the material directly from households, businesses, and various industries (Medina, 1997).

Through the efforts of UNICEF, the “*National Waste and Citizenship Forum*” in Brazil, engaged several social groups and various government entities at all levels to come together and solve informal recyclers' inclusion (Rutkowski and Rutkowski, 2015). The Brazilian government created an inclusion program for informal recyclers, where a budget was allocated towards the promotion of co-operatives. The municipalities benefited from the economic and operational advantages of waste diversion provided by the co-operatives, in addition to taking credit for the outcomes achieved and the increased diversion rates (Rutkowski and Rutkowski, 2015). There are 14 cooperatives with 2500 members in Rio alone. In Porto Alegre, cooperatives were incorporated into a curb-side recycling program. These cooperatives served 79% of the city's residents while cutting expenditures overall (Medina, 2000). An industry organisation developed an educational package for co-operatives and engaged with NGOs to assist in the development and cultivation of co-operatives (Medina, 1998).

2.6 Private sector source separation

The private sector can be categorised into two parts namely; the formal and informal private sector. The informal private sector consists of registered entrepreneurs, micro-enterprises, and small business owners that generally participate in the collection, source separation, storage and recycling of waste materials (Donald, 1999; Olukanni *et al.*, 2014). The formal private sector consists of large commercial companies and corporations that generally handle the recycling

and/or remanufacturing of waste materials and are significant role players in the waste value chain (Bartone *et al.*, 1991). The formal private sector still dominates large parts of the waste and recycling industry in South Africa, although there is limited research conducted on the private sector's direct involvement in separation at source activities. A study conducted by Thorleifsson (2020), indicated that the private sector was a significant role player in waste diversion activities such as waste-to-energy initiatives, separation at source infrastructure, and education and awareness programmes (Thorleifsson, 2020).

2.6.1 Significance of private sector source separation

The private sector can assist in the development of source separation educational programs that inform community members on how to categorise and reduce MSW. Companies and corporations within this sector can facilitate the environmental awareness training of community members through educational campaigns at schools, universities and workplaces (Dhokkhikah *et al.*, 2015).

For each waste type, source separation receptacles are required. The cost of these receptacles makes it challenging for municipalities to provisions for each household. The lack of adequate source separation receptacles contributes to the low household recycling rates. (Oduro-Kwarteng *et al.*, 2016). The private sector can make provisions for the establishment of regional recycling infrastructures such as material recovery facilities, buy-back centres etc. through EPR schemes and other separation at source programmes (Mativenga *et al.*, 2017). Substantial investments from the private sector can significantly increase the demand for recyclable material, subsequently increasing source separation activities and overall recycling rates (Godfrey, 2021). Additionally, the private sector can develop and provide cost-effective receptacles that are durable and can be easily acquired by the residents (Afrika *et al.*, 2010).

2.6.2 Benefits of private sector waste separation at source

The involvement of the private sector companies in separation at source activities has numerous benefits for the local government and the communities involved (Mnaro, 2014). Private sector companies contracted by local government provide consistent door-to-door collection of separated waste material, and provide additional infrastructure and equipment (recycling plastics or receptacles) for recycling while promoting education and awareness. Additionally, when local government contracts end and are not renewed these companies ensure active participation from communities by charging residents to continue providing the service (Otitoju and Seng, 2014; Rathi, 2006; Sarbassov *et al.*, 2019).

2.6.3 Challenges of private sector waste separation at source

Regardless of the efficient service provided by private sector companies, there were challenges private sector companies faced, namely:

- The inefficiencies of local government's procurement process for a service provider have encouraged monopoly, where one company with multiple divisions is awarded various contracts. This company can inflate service costs for minimal work done, consequently reducing investments for separation at source infrastructure (Massoud *et al.*, 2003; Samson *et al.*, 2022; Walls *et al.*, 2005).
- Community members in some areas refuse to allow private sector companies to collect their separated waste reason being they had the perception that they were "enriching" them. To an extent, they demanded incentives to separate their household waste (Ramavandi *et al.*, 2014).
- Private sector companies need to provide additional recycling equipment for separated materials to remediate the lack of adequate receptacles (Babazadeh *et al.*, 2018).

2.6.4 Lessons learnt from private sector waste separation at source in Europe and North America

Private companies in Europe and North America have taken the role of developing and coordinating effective source separation programmes. These companies form agreements with residents and local spheres of government to maximise profits and increase waste diversion (Xu *et al.*, 2015). For example, the "*Municipal Waste Management Organisation*" and "*Rural Governance Organisation*" were given authority by Iranian municipalities to manage their MSW (Babazadeh *et al.*, 2020). These organisations were responsible for; the collection, transportation and disposal of waste from rural and urban areas; the recycling and source separation initiatives; and the development of compost facilities. The MWMO developed educational programmes to train educators on how to educate residents about MSW separation at source. Source separation receptacles were placed in designated areas in the city and residents were informed to dispose of their separated materials in those areas. The MWMO contracted an additional service provider to collect the source-separated material and transfer it to sorting facilities and recycling stations (Babazadeh *et al.*, 2018; Babazadeh *et al.*, 2020). Despite the implementation of numerous source separation plans and educational programmes, large volumes of recyclable material were still being disposed of at landfill sites (Hasanvand *et al.*, 2008).

2.7 Waste source separation models in the case study area: City of Johannesburg (CoJ), Gauteng

The following sections provide some background on the source separation models employed in the case study area, the City of Johannesburg (CoJ) in Gauteng, South Africa.

The CoJ appointed Pikitup as an independent entity mandated with the responsibility to provide waste management services to residents and businesses within the city. Pikitup offers two services, namely - council and commercial waste management services (Pikitup, 2015). A council waste management service is a service that is provided by municipalities. This includes activities such as street sweeping, public litter collection, and kerb-side collection of all types of MSW. Whereas, a commercial service is a waste management service that can be provided by various service providers within the waste sector (VAGO, 2021). This includes; bulk services, builders' rubble collection, restaurants waste collection, business waste collection, etc. Private companies within the waste sector have been utilised by the CoJ to provide residents with recycling initiatives, mainly through tenders (OECD, 2013; Pikitup, 2010).

In October 2009, a separation at source programme was implemented and piloted by Pikitup at the Waterval Depot in an effort to boost recycling rates (Schoeman and Schmidt, 2016). The target of this programme was to roll out separation at source and education to 50% of the households in the CoJ by 2016 (CoJ, 2011:220). This target was not reached, however, the programme was expanded to include six additional depots and approximately 400 000 households were covered (Schoeman and Schmidt, 2016).

From 2013, it was decided that separation at source activities would be included in Pikitup's operations. To cater for this inclusion, depot operations had to be adjusted. In the following depots, Avalon, Central Camp, Marlboro, Selby, Southdale, Waterval, and Zondi, a co-operative model was implemented to conduct separation at source activities on MSW (Pikitup, 2022).

Despite a progressive increase in the source separation participation rate (61, 73%), the overall waste diversion rate reported was still relatively low at approximately 15% (Pikitup, 2022:10). This low number makes it abundantly evident that recycling is not being done throughout the city (Pikitup, 2020b). There were various factors that hindered separation at source activities, which subsequently reduced the diversion rate (Schoeman and Schmidt, 2016), which are elaborated on in the next section.

2.7.1 Waste separation at source challenges in the CoJ

The CoJ indicated that a variety of obstacles were impeding the implementation of the household separation at source programmes, subsequently reducing waste diversion rates. These obstacles include:

- A lack of adequate resources to extend separation at source activities to areas that were not covered before;

- Insufficient investment in separation at source initiatives;
- A lack of waste pickers' integration in source separation programmes;
- A lack of education and awareness regarding separation at source; and
- Unwillingness from the households to participate in separation at source initiatives (Pikitup, 2020b).

These barriers are similar to those found by Roos *et al.* (2021), who investigated waste separation at source behaviour among South African households in Abaqulusi Local Municipality in KwaZulu-Natal.

2.7.2 Waste separation at source opportunities in the CoJ

Waste separation at source provides waste pickers, co-operatives, and private sector contractors with ample business opportunities. In the CoJ, Pikitup seeks to:

- Strengthen engagements and partnerships with communities, NGOs and the private sector;
- Create a support network for waste pickers and co-operatives to help them become sustainable;
- Increase infrastructure development, education and awareness; and
- Adopt an effective waste separation at source model that can be implemented throughout the City of Johannesburg (Pikitup, 2022).

2.8 Chapter summary

The rapid increase in MSW generation has prompted local spheres of government to explore alternative strategies to reduce waste generation while considering environmental and socio-economic conditions. This chapter discussed the shift in MSW management from disposal to minimisation in South Africa and countries around the world. With the aid of existing literature, a discussion was conducted on the paradigm shift in South African environmental management policies that address waste management, the waste management hierarchy, the waste pickers' integration, the significance of co-operative and private sector source separation and the lesson learnt from Europe and America. The concept of ISWM emphasised the need to manage waste sustainably. This concept promotes the waste management hierarchy as a conceptual framework for policymakers to utilise in developing effective nation-specific policies. The need to divert waste away from landfilling prompted the development of various strategies that promote the movement of waste management up the hierarchy. Separation at source was found to be a significant waste diversion practice, although there was limited research conducted on the way source separation activities are conducted by the private sector and co-operatives in South Africa.

The methods used to achieve the research objectives are outlined in Chapter 3.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter outlines the research design, data collection and -analysis approaches utilised during this study. Additionally, the methodological assumptions and limitations, as well as the sampling techniques, description of the study area, and ethical considerations are presented.

3.2 Research approach

Qualitative and quantitative research approaches are the two most widely used research methods. Qualitative research is distinguished from quantitative research by “the use of words rather than numbers” or the use of open-ended questions (interviews and open-ended questionnaires) rather than closed-ended ones (surveys) (John, 2016). Research that incorporates both qualitative and quantitative research approaches is referred to as mixed-methods research (Chih and Yan-Yi, 2017). For a thorough investigation of the waste source separation models in northern parts of the City of Johannesburg, Gauteng, this study employed a mixed-methods research approach.

3.2.1 Mixed methods research

Mixed methods research is increasingly becoming a dominant paradigm in the fields of health and social science. Over the last couple of years, there has been an increasing number of social science and healthcare researchers employing this research approach (Doyle *et al.*, 2009). This increase is attributed to the fact that this approach has a broader focus than a single-method approach. Mixed method research allows the researcher to collect more data about a phenomenon in several ways. This research approach generates results that shed light on complex matters and provide additional insight into these matters (Giddings, 2005; Giddings and Grant, 2014).

It was anticipated that there are several dimensions for this study, which sought to investigate the effectiveness of waste source separation models in Gauteng by comparing co-operative and private sector waste source separation models in the northern parts of Johannesburg, and that these dimensions could not be grasped by using a mono-method approach. As a result, it was essential to incorporate elements of both research designs (qualitative and quantitative) to achieve the research aim and objectives.

Mixed methods research enables a researcher to build knowledge about actual problems based on pragmatism, which emphasises the discovery of answers to research questions rather than

the methods utilised (Ivankova, 2014). Priority and the implementation of data collection are the two primary elements that aid researchers in choosing the most appropriate type of mixed methods design for their study. A researcher may prioritise a sequential or combination of both research designs depending on the practical limitations of data collection, and the comprehension of the data collected (Molina-Azorin, 2016).

Four mixed-methods research designs are commonly employed by researchers, namely; explanatory, exploratory, triangulation and embedded (Creswell and Clark, 2017). The explanatory and exploratory designs utilise a sequential method of data collection and analysis, whereas triangulation and embedded designs utilise a combination method of data collection and analysis. The explanatory design clarifies the quantitative findings using qualitative findings. The exploratory design enables the researcher to examine a research topic using qualitative data before measuring it, to test it quantitatively (Ivankova *et al.*, 2006). The triangulation design utilises a combination of both qualitative and quantitative research designs concurrently. This design is utilised when researchers seek to comprehend a complex phenomenon. The embedded design enables a researcher to incorporate one form of data into the methods used for the other type of data (Bastable *et al.*, 2019; Wolf *et al.*, 2015).

An embedded mixed methods (case study) design was utilised to collect the data, where a quantitative design was embedded into a qualitative design to achieve the research aim and objectives (Mozo-Reyes *et al.*, 2016).

A study conducted by Mozo-Reyes (2012), illustrated an embedded mixed methods approach. The study titled *“Will they recycle? Design and implementation of eco-feedback technology to promote on-the-go recycling in a university environment”*, counted and weighed (quantitative) cans and bottles thrown in recycling bins and the users’ immediate reactions were noted (qualitative) within the same study period (Meeren *et al.*, 2005; Mozo-Reyes, 2012; Mozo-Reyes *et al.*, 2016).

The research design is outlined in Section 3.3 below.

3.3 Research design

According to Bloomfield and Fisher (2019:27), *“research design is the blueprint or plan that will be used by researchers to answer a specific research question”*. Table 3-1 provides an overview of the research design in relation to the three research objectives.

Table 3-1: Research design

Research objective	Methodology	Justification
1. Develop key performance areas (KPAs) and key performance indicators (KPIs) to evaluate the effectiveness of waste source separation models	Key performance areas (KPAs) were established to develop key performance indicators (KPIs) that would be used to evaluate the effectiveness of waste source separation models, based on a literature review of existing publications that highlight the effectiveness of waste source separation. Publications by Agunwamba (2003), Al-Khatib <i>et al.</i> (2015), Fredick <i>et al.</i> (2018), Koushki <i>et al.</i> (2004), Pauliuk <i>et al.</i> (2012), Periathamby <i>et al.</i> (2009), Okonta and Mohlalifi (2020), Sanjeevi and Shahabudeen (2015), Tsiboe and Marbell (2004), and Zaman (2014b), were included.	According to Deus <i>et al.</i> (2019), a literature review is a suitable method that can be utilised to develop performance indicators. Such indicators are useful when making comparisons, such as comparing the effectiveness of municipalities and private industries (Zaman, 2014a).
2. Evaluate the effectiveness of co-operative and private sector waste separation models against developed KPIs	Survey questionnaires were used to gather information linked to the KPIs from co-operatives and private industries. The effectiveness of the source separation models was evaluated against the KPIs . Performance	Survey questionnaires are a useful way of gathering data on sensitive matters. Additionally, they can be administered to widespread participants (Patten, 2017). Performance evaluation scores are frequently used in effectiveness evaluation research to enhance a researcher's knowledge of

Research objective	Methodology	Justification
	evaluation scores were assigned to each of the KPIs evaluated.	various aspects of effectiveness amongst selected cases (Alberts <i>et al.</i> , 2020; Alberts <i>et al.</i> , 2021; Zaman, 2014a).
3. Compare the effectiveness of co-operative and private sector waste separation models with the aim of making recommendations for future waste source separation models	The outcomes of RO2 were compared in terms of the performance evaluation scores and recommendations for future waste separation models are proposed in Chapter 5.	Comparative analysis is a set of research tools that combine structured cross-case comparisons with in-depth within-case analysis (Legewie, 2013). Comparative analysis was considered a suitable method because it is an effective analytical technique for cross-case analysis that focuses on the complexity that distinguishes the cases under consideration (Adegbite, 2016; Cooper and Glaesser, 2012).

3.4 Description of the case study area

When a researcher seeks to conduct an in-depth and comprehensive investigation of the aspects they want to know about a targeted population in their study, a case study design can be utilised (Ranjit, 2013). This is a method where a specific instance or a small number of carefully chosen situations are investigated intensely (Gilbert, 2008).

The research was conducted in a specific case study context, focusing on the northern parts of the City of Johannesburg, Gauteng, South Africa.

3.4.1 Case study selection criteria

One of the targets set in Goal 1 of the 2011 NWMS, stated that by 2016 “*all metropolitan municipalities, secondary cities and large towns should have initiated separation at source programmes*” (DEA, 2011; DEFF, 2021:6).

The criteria used to select the case study included:

- The municipality should have formally initiated a source separation programme;
- The municipality should have both co-operative and private source separation programmes/models in order to provide for comparison between these two models;
- The municipality should agree to participate in the research;
- There should be a sufficient number of participants (both from co-operatives and private companies) willing to participate in the research.

South Africa has eight metropolitan municipalities, of which the City of Johannesburg (CoJ) is the only metropolitan municipality that initiated a voluntary separation at source programme in selected suburban areas (DEA, 2018). The implementation of the City of Johannesburg voluntary separation at source programme promotes the development of two distinctive source separation models (i.e. co-operative and private) (CoJ, 2011).

Due to limited time and resources, the entire City of Johannesburg could not be included as part of the research scope. The northern parts of the City of Johannesburg were ultimately selected as the geographical area to represent the study area. The northern parts of the City of Johannesburg, which include urban areas such as Sandton, Rosebank and Randburg, were selected purposively, based on the following reasons:

- ***Existence/implementation of two or more waste source separation models within the same region:*** The City of Johannesburg has implemented and piloted a voluntary separation at source programme at the Waterval depot (which provides services to the northern Johannesburg suburban areas such as Northcliff, Rosebank, etc.) in 2009. Pikitup established partnerships with co-operatives and private sector companies that were engaged in waste source separation activities. Pikitup implemented a separation at source programme to divert recyclable waste away from the landfill sites. This programme targeted the diversion of dry waste to increase the landfill air space capacity, although Pikitup has always failed to achieve the dry waste diversion targets (Pikitup, 2021). In 2020, the diversion target for dry waste was 75% and Pikitup failed to achieve this target due to limited resources, insufficient education and awareness officers, lack of monitoring, and evaluation, and delays in the procurement of a service provider that could expand the separation at source programme (CoJ, 2020).
- ***Active participation from residents in source separation activities:*** A study by Okonta and Mohlalifi (2020), assessed the “*factors affecting source recycling among metropolitan Johannesburg residents*”, in the Dainfern and Lone Hill suburbs located in region A. The study

indicated that approximately 60% of the respondents separated their waste (Okonta and Mohlalifi, 2020:448).

- **Access to (verified) information of registered co-operatives and private sector companies.**
- **Willingness** to take part and provide consent to carry out the research.

3.4.2 Description of the study area: Northern parts of the City of Johannesburg, Gauteng, South Africa

The case study area selected for this research is the northern parts of the City of Johannesburg, Gauteng, South Africa (see Figure 3-1).

The Gauteng province is home to one of the largest metropolitan municipalities in South Africa. Johannesburg is made up of a population of 5.4 million people, and there are approximately 1.85 million households (Schoeman and Rampedi, 2021:818). This dynamic city has a fairly young population as compared to the rest of the country, where 34.3% of the population is between the ages of 14 – 35 (CoJ, 2019; CoJ, 2012). This is due to the large influx of young people migrating to Johannesburg in pursuit of employment opportunities (Schoeman and Rampedi, 2022a).

Considered the “economic hub” of South Africa, the CoJ has a monthly migration rate of approximately 3000 people (CoJ, 2019; Schoeman and Rampedi, 2022a:4). The population has increased at a rate of 2.91% each year on average between 2008 and 2018, which was significantly higher than the 1.56% annual national average (CoJ, 2012; CoJ, 2020; Schoeman and Rampedi, 2022a:4). The rapid population growth has resulted in an infrastructure backlog, which has put an enormous strain on available infrastructure, especially waste management services and recycling (Pikitup, 2022; Rasmeni and Madyira, 2019).

There are seven administrative regions, from Orange Farm to Midrand (Figure 3-2), that makeup 1645 km² of Johannesburg’s land area. Each of the seven administrative regions (Figure 3-2) is responsible for the provision of basic services, such as waste management services, electricity, etc. (Pikitup, 2022). Within these regions, 12 waste management depots and 41 garden sites are strategically positioned throughout the city to provide waste management services to residents (Pikitup, 2022).

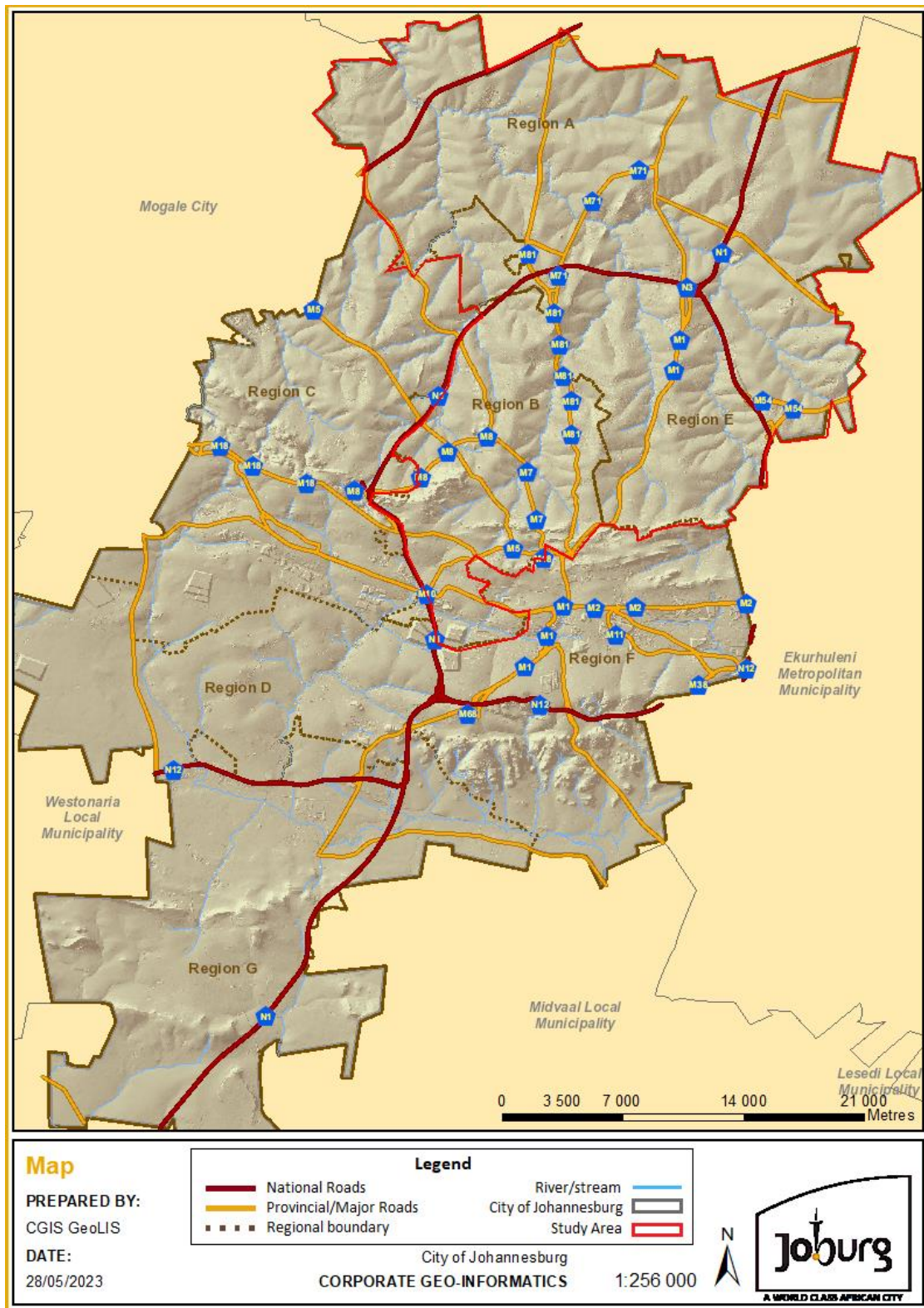


Figure 3-1: Map of the CoJ Regions (A, B and E) (Source: Joburg GeoLIS)

Out of the seven administrative regions (Figure 3-2), this research focused on three regions (A, B and E) that are located in the northern parts of the city of Johannesburg. There are notable

locations in each of the three regions where waste source separation activities are carried out. For instance, Region A includes Midrand and Diepsloot, Region B includes Randburg and Rosebank, and Region E includes Sandton and Alexandra. These areas were selected based on the criteria provided in Section 3.4.1 above.

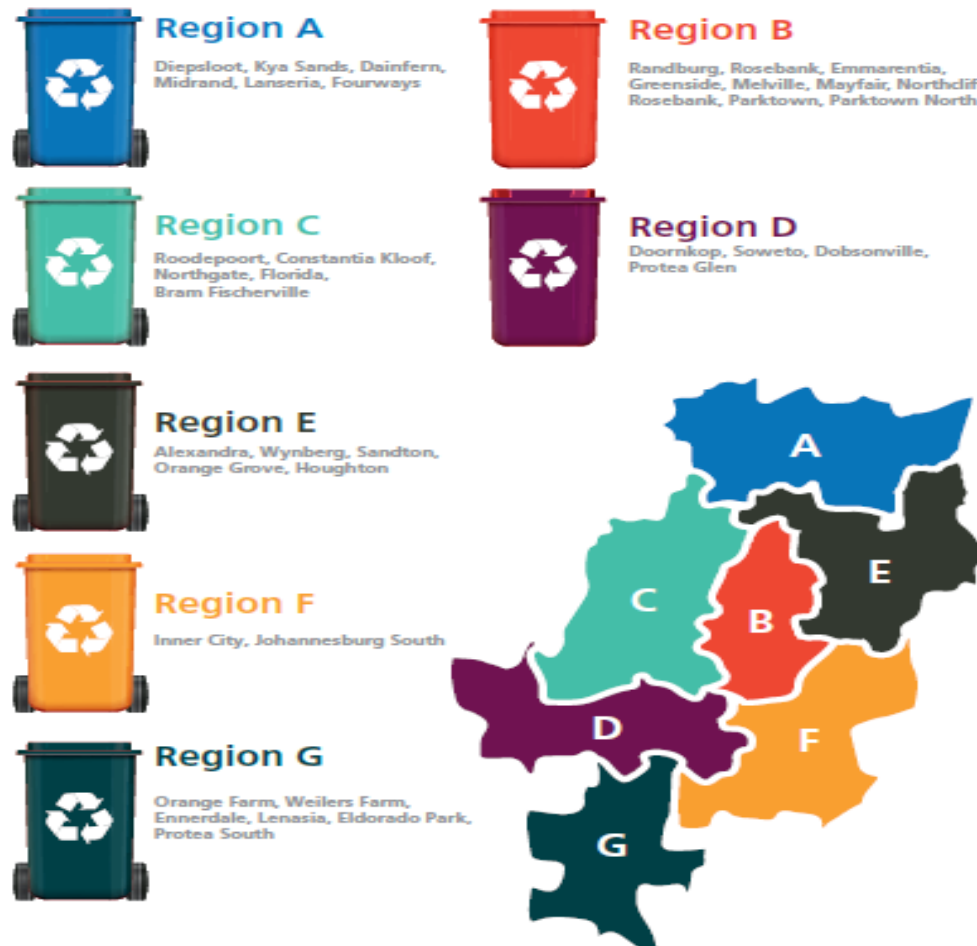


Figure 3-2: Seven administrative regions of the CoJ (Pikitup, 2022).

3.5 Data collection

To achieve the research aim, the following steps were followed:

- **Step 1:** Define the term “effectiveness” in the context of waste source separation models (Section 3.5.1);
- **Step 2:** Define and develop key performance areas (KPAs) based on the definition of effectiveness (Section 3.5.2);
- **Step 3:** Develop key performance indicators (KPIs) for each of the KPAs (Section 3.5.3);

- **Step 4:** Gather information related to the KPIs (using surveys) from a sample of respondents representing private and co-operative waste separation models (Section 3.5.4);
- **Step 5:** Evaluate the effectiveness of private and co-operative waste source separation models based on performance against KPIs (Section 3.5.5); and
- **Step 6:** Lastly, compare the effectiveness of private and co-operative waste source separation models, to propose recommendations that can improve waste separation at source in the future.

The sections below outline the approaches followed to collect data.

3.5.1 Defining “effectiveness” of waste source separation models (step 1)

The term effectiveness is defined as “*the ability to be successful and produce the intended results*” (Cambridge, 2022). In the case of this research, “intended results” i.e. effective source separation of waste were considered to be (Box 1):

Box 1. Defining *effective* source separation of waste:

The separation of sufficient **quantity** and **quality** of recyclable waste using an acceptable amount of **resources** (human, financial) within a **working environment** that has **sufficient capacity** (human, infrastructure, facilities, technology), that is **lawful** and **safe**, and that promotes **equality, personal growth** and **development**, whilst also ensuring **community participation** through **communication, education** and **awareness** (Kashyap and Visvanathan, 2014; Mastellone *et al.*, 2017; Medina, 2000; Saipul *et al.*, 2018).

3.5.2 Defining and developing key performance areas (KPAs) (step 2)

Key performance areas (KPAs) are precise, quantifiable objectives that a business or individual establishes to monitor development and performance (Otley, 1999). Performance measurements are crucial because they show where performance gaps exist between actual and desired performance and indicate how far those performance gaps have been closed (Eshtaiwi *et al.*, 2018; Lindberg *et al.*, 2015; Weber and Thomas, 2005).

The key performance areas (KPAs) for this research were established based on the review of existing literature on source separation models and their effectiveness (based on the definition supplied in Box 1). Publications by Al-Khatib *et al.* (2015); Ayvaz-Cavdaroglu *et al.* (2019); Ceballos *et al.* (2015); Cimpan *et al.* (2015); Fredick *et al.* (2018); Husaini *et al.* (2007); Okonta and Mohlalifi (2020); Pauliuk *et al.* (2012); Periathamby *et al.* (2009); Sodoke *et al.* (2022); Tsiboe and Marbell (2004); Vyas and Vines (2019); Zhang, *et al.* (2012), focusing on socio-cultural, organisational, and economic themes, were used to develop suitable KPAs (Zaman, 2014a).

Based on the definition of “*effective*” source separation of waste, and the literature findings, five key performance areas (KPAs) were identified (Box 2):

Box 2. *Key performance areas* to evaluate the effectiveness of waste source separation models.

- **KPA 1:** Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input) (Ayvaz-Cavdaroglu *et al.*, 2019; Cimpan *et al.*, 2015; Fredick *et al.*, 2018; Husaini *et al.*, 2007; Okonta and Mohlalifi, 2020; Zhang *et al.*, 2012).
- **KPA 2:** Provision for a working environment with sufficient capacity, infrastructure and machinery (Pauliuk *et al.*, 2012; Periathamby *et al.*, 2009).
- **KPA 3:** Provision for a working environment that is lawful* and safe (Mastellone *et al.*, 2017).
- **KPA 4:** Provision for a working environment that promotes equality, personal growth and development (Ceballos *et al.*, 2015; Sodoke *et al.*, 2022; Vyas and Vines, 2019).
- **KPA 5:** Provision for community participation through communication, education and awareness (Al-Khatib *et al.*, 2015; Fredick *et al.*, 2018; Okonta and Mohlalifi, 2020; Tsiboe and Marbell, 2004).

** The intent of the research was not to provide for a full legal compliance verification/audit. As far as lawfulness is concerned, the research focused on compliance to national norms and standards/regulations applicable to waste management activities expected from waste source separation facilities. No international/local (by-laws) obligations were included as part of KPA 3.*

3.5.3 Developing key performance indicators (KPIs) (step 3)

Key performance indicators (KPIs) are quantifiable measures that companies use to assess the success or failure of a specific objective (Sanjeevi and Shahabudeen, 2015). KPIs are not meant to provide a complete account of all the factors/considerations, which may influence performance (in this case “effective separation of waste”), but rather to focus on the key quantifiable measures to achieve performance over time (Bauer, 2004).

Based on learning from the literature, KPIs were developed for each of the five KPAs (Box 2). The KPIs developed to evaluate the waste source separation models in this research are outlined in Table 3-2 below.

Literature references and examples are provided in Table 3-2 for clarity. It should be noted that the examples provided (column 3) are not exhaustive and are meant to be illustrative to provide the reader with context/background related to each KPI.

Table 3-2: Key performance areas (KPAs) and key performance indicators (KPIs)

Key performance indicator (KPI)		Source/reference	Example
KPA 1: Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input)			
KPI 1.1	To what extent does the source separation make provision for the separation of sufficient/adequate quantities/volumes of recyclable waste?	Mouw, 2020; Rutkowski and Rutkowski, 2015	The waste source separation model should collect at least 400 tonnes of mixed recyclable waste (recyclable and non-recyclable) per annum (at least 33 tonnes per month). The total volumes of mixed recyclable waste collected.
KPI 1.2	To what extent does the source separation model make provision for the separation of sufficient/adequate waste quantities /volumes sorted?	Carroll, 2003; Sorme <i>et al.</i> , 2019; Van Haaren <i>et al.</i> , 2010	The waste source separation model should collect at least 400 tonnes of sorted recyclable material per annum (at least 33 tonnes per month). Sorted recyclable material. Collection of 100% recyclable waste (not mixed with non-recyclable wastes) would produce the highest quality of recyclable material that can be sorted and sold.
KPI 1.3	To what extent does the source separation make provision for the separation of sufficient/adequate quality recyclable waste?	Cimpan <i>et al.</i> , 2015	The waste source separation model should provide residents with waste receptacles that can safely store (minimise contamination as best as possible) recyclable waste in the resident's households. The collected recycling receptacles must be full of recyclable waste. Must have minimal to no residual waste (non-recyclable waste). Residual waste (tonnages) = The total volumes of mixed recyclable waste collected (tonnages) – sorted recyclable material (tonnages).
KPI 1.4	To what extent does the source separation programme make provision for business/economic viability/feasibility?	Ayeleru <i>et al.</i> , 2021	The waste source separation model's output income should exceed the working capital (i.e. salaries, wages, and other

Key performance indicator (KPI)		Source/reference	Example
			operational costs) in such a way that the model is not solely dependent on grants and loans.
KPI 1.5	To what extent does the source separation model ensure access to sufficient markets (demands) for separated waste?	Wilson <i>et al.</i> , 2009	The waste source separation model should generate revenue from selling the separated waste material.
KPI 1.6	To what extent does the source separation model ensure access to acceptable financial incentives for separated waste?	Hole and Hole, 2020; Li <i>et al.</i> , 2021; Wang <i>et al.</i> , 2020	The waste source separation model should have access to financial incentives from various sources. E.g. Awards (prize money, machinery, etc.), Financial support (grants, loans, etc.)
KPI 1.7	To what extent does the source separation model generate an acceptable income from selling sorted material?	Zhuang <i>et al.</i> , 2008	The waste source separation model should generate an income (from selling the sorted material).
KPI 1.8	To what extent does the source separation model ensure that resource/input costs are kept at an acceptable level?	Ayeleru <i>et al.</i> , 2021	The waste source separation model's working capital should not exceed the output income.
KPI 1.9	To what extent does the source separation model ensure that labour costs are kept at an acceptable level?	DEADP, 2021; Leu and Lin, 1998; Metin <i>et al.</i> , 2003	The waste source separation model should collect the largest amount of recyclable waste within an acceptable level of labour cost incurred. e.g. Salaries
KPI 1.10	To what extent does the source separation model ensure that operational costs are kept at an acceptable level?	DEADP, 2021; Leu and Lin, 1998; Metin <i>et al.</i> , 2003	The waste source separation model should collect the largest amount of recyclable waste within an acceptable level of the operational cost incurred. e.g. fuel/maintenance of trucks, utilities (water and electricity), and site/building rental.
KPA 2: Provision for a working environment with sufficient capacity, infrastructure and machinery			
KPI 2.1	To what extent does the source separation model provide for sufficient human capacity?	Khajuria <i>et al.</i> , 2010	The waste source separation model should employ adequate staff to separate waste and the workforce should be used effectively.

Key performance indicator (KPI)		Source/reference	Example
KPI 2.2	To what extent does the source separation model provide access to infrastructure and machinery, which will reduce further contamination/prevent pollution?	Bafail and Dematel, 2022; Richard, 1992	Waste receptacles should prevent further contamination of recyclable waste. The recyclable waste should not be contaminated further during collection, transportation and sorting.
KPI 2.3	To what extent does the source separation model provide access to infrastructure and machinery for the collection and transportation of waste?	Ferronato <i>et al.</i> , 2021; Kofoworola, 2007	The waste source separation model should have vehicles that consistently/frequently collect and transport recyclable waste from households/other pick-up points.
KPI 2.4	To what extent does the source separation model provide access to infrastructure and machinery for the separation/sorting of waste into different categories/types?	Kofoworola, 2007; Tai <i>et al.</i> , 2011	The waste source separation model should have access to a sorting facility that is preferably secure and covered to allow for the separation of recyclable waste by source.
KPI 2.5	To what extent does the source separation model provide access to infrastructure and machinery for the shredding, and crushing of waste?	Leverenz <i>et al.</i> , 2002	The waste source separation model should have access to a shredding and crushing machine, to reduce the empty spaces between materials such as glass.
KPI 2.6	To what extent does the source separation model provide access to infrastructure and machinery for the baling/compaction of waste?	Leverenz <i>et al.</i> , 2002	The waste source separation model should have access to a baling machine that compacts waste streams such as paper and cardboard, to increase the material selling value.
KPA 3: Provision for a working environment that is lawful and safe			
KPI 3.1	To what extent does the source separation model provide for a safe work environment?	Engkvist, 2010a; Engkvist, 2010b; Gutberlet and Baeder, 2008; Gutberlet <i>et al.</i> , 2013b	The waste source separation model should provide mechanisms and processes to promote a safe working environment and reduce injuries on duty. This may include having engineering controls (i.e. automated shutdowns of machinery), administrative controls such as (standard operating procedures (SOPs) or work instructions, demarcation areas, signage, etc.), information, communication and training; and providing employees with adequate personal protective equipment (PPE) (i.e. hearing protection, safety boots, face masks, overalls, etc.).

Key performance indicator (KPI)		Source/reference	Example
KPI 3.2	To what extent does the source separation model provide access to basic facilities and sanitation within the work environment?	Gutberlet and Baeder, 2008b ; Schenck <i>et al.</i> , 2019	The waste source separation model should provide employees with access to basic sanitation amenities such as taps with clean drinking water, (ablution facilities) flushing toilets, covered shelters, and wash basins.
KPI 3.3	To what extent does the source separation model provide for the identification and implementation of applicable legal requirements?	Mak <i>et al.</i> , 2019	The waste source separation model should have processes in place that address regulatory compliance. These processes need to be amended subject to the change/amendments to applicable laws.
KPI 3.4	To what extent does the source separation model comply with the National Norms and Standards for the Storage of Waste?	DEA, 2017	The waste sorting facilities need to comply with the National Norms and Standards for the Storage of Waste (GNR. 926 of November 2013) if the storage capacity exceeds 80 m ³ for the storage of hazardous waste or 100 m ³ for the storage of general waste. The facility should be registered (if applicable). The location of the sorting facility should take into consideration public health and environmental protection while ensuring optimum transportation and handling of recyclable waste. The sorting facility should also allow easy access to emergency personnel.
KPI 3.5	To what extent does the source separation model comply with the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste?	DEA, 2017	The waste sorting facilities should be registered in terms of the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste (GNR. 1093 of October 2017), regardless of the facility's capacity. Should the operational area of the facility exceed 1000 m ² , the facility must comply with these norms and standards. Facilities smaller than 1000m ² should implement the duty of care.

Key performance indicator (KPI)		Source/reference	Example
KPI 3.6	To what extent does the source separation model comply with the Waste Information Regulations?	DEA, 2012	The waste source separation model should be registered on the SAWIS and report on the information gathered such as waste quantities/volumes received, waste quantities/volumes sorted and sold to the market, etc.
KPI 3.7	To what extent does the source separation model monitor and report on legal compliance?	DEA, 2017; DEA, 2012; Ramachandra and Bachamanda, 2007	Should the waste source separation model include any of the activities listed in Annex 1 of the National Waste Information Regulations (GNR. 625 of August 2012), the Waste Information Regulations must be implemented. This includes: • Having a monitoring system in place to keep track of all activities and record accurate information. • Conducting audits to ensure that the information reported is factual and that the model complies with all relevant laws. • Ensuring that all the incidents are reported to a competent authority. • Inspecting machinery and equipment for any signs of deterioration.
KPI 3.8	To what extent does the source separation model implement corrective actions to address any non-compliances?	Hedstrom <i>et al.</i> , 2013	The waste source separation model should have measures in place to prevent or address non-compliance.
KPA 4: Provision for a working environment that promotes equality, personal growth and development			
KPI 4.1	To what extent does the source separation model provide opportunities for gender equality?	Coelho <i>et al.</i> , 2018	The waste source separation model should provide males and females with equal conditions and opportunities.
KPI 4.2	To what extent does the source separation model provide opportunities for youth and/or disabled individuals?	DEFF, 2020a	The waste source separation model should provide opportunities for youth and disabled individuals to participate in waste source separation activities.

Key performance indicator (KPI)		Source/reference	Example
KPI 4.3	To what extent does the source separation model provide opportunities for <i>previously disadvantaged individuals?</i>	DEFF, 2020a	The waste source separation model should provide employment opportunities to previously disadvantaged individuals. This includes informal reclaimers.
KPI 4.4	To what extent does the source separation model provide opportunities for <i>local employment and local procurement?</i>	DEFF, 2020b	The waste source separation model should provide local informal reclaimers with the opportunity to be a part of a formal organisation. Preference should be given to South African citizens.
KPI 4.5	To what extent does the source separation model provide opportunities for <i>personal growth and skills development?</i>	Engkvist <i>et al.</i> , 2016	The waste source separation model should provide employees with opportunities (such as educational support, training, etc.) to develop their skills and growth.
KPA 5: Provision for active community participation through communication, education and awareness			
KPI 5.1	To what extent does the source separation model provide sufficient communication, education and awareness of the <i>different categories/streams of waste?</i>	Shaw <i>et al.</i> , 2006	The waste source separation model should educate residents regarding the various waste streams using various visuals in newspapers, notice boards, pamphlets, etc.
KPI 5.2	To what extent does the source separation model provide sufficient communication, education and awareness that <i>inculcates a culture of source separation?</i>	Chen <i>et al.</i> , 2017; Oduro-Kwarteng <i>et al.</i> , 2016	The waste source separation model should motivate residents to increase their participation in source separation activities. The model should have an interactive source separation education and awareness programme.
KPI 5.3	To what extent does the source separation model provide sufficient communication, education and awareness on the <i>correct separation and sorting of waste?</i>	Chen <i>et al.</i> , 2017	The waste source separation model should educate residents on how to separate their waste correctly from source to reduce further contamination using various visuals in newspapers, notice boards, pamphlets, etc.
KPI 5.4	To what extent does the source separation model provide sufficient communication, education and awareness on the <i>impact of source separation towards diverting recyclable waste away from the landfill?</i>	Godfrey and Oelofse, 2017; Moodley <i>et al.</i> , 2021	The waste-source separation model should educate residents on the importance of diverting waste away from the landfill through source separation activities. Subsequently, increasing participation rates.

3.5.4 Gathering information related to the KPIs from a sample of respondents representing private and co-operative waste separation models (step 4)

A structured survey questionnaire with open- and closed-ended questions was used to investigate the effectiveness of the co-operative and private sector waste separation at source models in the northern parts of Johannesburg (Roopa and Rani, 2012).

3.5.4.1 Developing the survey questionnaire

Survey questionnaires have been one of the most popular data collection methods, commonly utilised by novice researchers in the fields of social science (Rowley, 2014). Questionnaires can be distributed to potential participants by e-mail, post, online platforms or hand delivery (Neville *et al.*, 2015). This makes them advantageous in the sense that they enable researchers to collect responses from a relatively large number of people that are scattered or located in remote areas (Ahern, 2005).

Performance indicators illustrated in Table 3-2, were used to develop the questions included in the questionnaire. Research findings of Agunwamba (2003); Al-Khatib *et al.* (2015); Ayvaz-Cavdaroglu *et al.* (2019); Fredick *et al.* (2018); Husaini *et al.* (2007); Okonta and Mohlalifi (2020); Pauliuk *et al.* (2012); Periathamby *et al.* (2009); and Tsiboe and Marbell (2004) guided the development of individual questions (as they relate to the KPIs). Google Forms was used to develop the survey questionnaire. The questions included in the questionnaire are outlined in **Annexure A**.

3.5.4.2 Piloting the survey questionnaire

The questionnaire was piloted by two Pikitup employees within the waste minimisation department, who have knowledge of the source separation programme and active participants. The pilot study responses were not included in this research study but were rather used to improve the survey questionnaire. Their responses influenced the following:

- Provided an option for 'no tonnages' because accessibility to weighbridges may be limited;
- Provided an option for residual waste to get an overview of the waste tonnages and identify potential gaps;
- Proposed differentiation between 'full with mixed recyclable waste' and 'full with recyclable waste only';
- Proposed cost ranges for the sale of recyclables;

- Proposed regulatory compliance measures, processes and policies applicable to the source separation activities in the City of Johannesburg.

3.5.4.3 Distributing the survey questionnaire

The Google Forms link to the survey questionnaire was distributed to participants electronically via email. For those participants that had connectivity issues due to Eskom's load shedding, manual distribution of a printed survey questionnaire was preferred.

3.5.4.4 Observations (site visits)

The primary goal of this research was to compare the effectiveness of the private and co-operative waste source separation models, with the site visits serving as a supplement. Site visits are systematic investigations of actual data acquired from real-world settings (Bao *et al.*, 2020).

This research did not make provisions for in-depth scrutiny during site visits, but simply included site visit observations as a tool to supplement and/or verify the information provided.

Unfortunately, site visits could not be conducted with the private companies, due to the unavailability of the various owners. The three co-operatives availed themselves for site visits.

Observations during site visits included:

- Nature of buildings, facilities, machinery and equipment (also sanitation facilities);
- The number of individuals/staff working on site;
- Waste storage practices;
- The pollution control, separation and segregation measures implemented;
- Working practices/procedures, including safety aspects (PPE, site notices, access control); etc.

The site visits also provided an opportunity to retrieve documented evidence, such as waste tonnage information, training-related documents, and certificates of registration/licences (where applicable).

No formal observation checklists were used, and observation information was captured intuitively.

3.5.5 Selection of research participants

Purposive sampling was used to select potential research participants. Purposive sampling is one of the most commonly used non-probability sampling methods and is typically utilised when the

research study seeks to yield cases that are considered rich in information (Patton, 2002; Suri, 2011).

As outlined in Chapter 1, co-operatives and private sector companies located in the northern parts of Johannesburg were selected to participate in this research. A dataset with over 100 private waste management companies was used to identify the private participants located in the northern side of Johannesburg. Of these, approximately 30 private waste management companies that are directly involved in waste source separation activities were contacted. Of these 30 companies, only eight companies expressed interest to participate in the research. When approached for their participation in the research, only three companies (Table 3-3) participated in the study. The private sector participants were located in Regions A, B and E, respectively.

Out of the nine co-operatives operating in the northern parts of Johannesburg, only three of the nine co-operatives, which work closely with Pikitup, expressed their interest and willingness to participate in the study (Table 3-3). The three co-operatives were located in Region E because they are generally clustered in close proximity to the Pikitup depot that services them (in this case the Marlboro Depot).

Table 3-3 provides a description of the three private waste management companies (P1 to P3) and the three co-operatives (Co-op 1 to Co-op 3) which participated in this research (six participants). The names of the private waste management companies and co-operatives that participated in the study were kept anonymous (confidential), and abbreviations were given (i.e., P or Co-op) as identifiers for the research participants.

Table 3-3: Description of private (P) and co-operative (Co-op) participants

Case study	Region	Description
P1	B	This private waste management company is located near the north riding area. Main activities include collection, transportation and sorting of recyclable waste (to sell to buy-back centres). They (strictly) service residents and do not purchase waste from reclaimers, waste pickers, etc.
P2	E	This private waste management company is located near the Bramley View area. Main activities include collection, transportation and sorting of recyclable waste (to sell to buy-back centres). They (strictly) service residents and do not purchase waste from reclaimers, waste pickers, etc.

Case study	Region	Description
P3	A	This private waste management company is located near the Midrand area. Main activities include collection, transportation and sorting of recyclable waste (to sell to buy-back centres). Secondary activities include: assisting residents who drop off their recyclable waste at the site and purchasing recyclable waste from communities (occasionally).
Co-op 1	E	This co-operative is located near the Linbro Park area. Main activities include: sorting recyclable waste to sell to buy-back centres.
Co-op 2	E	This co-operative is located in the Marlboro area. Main activities include: sorting recyclable waste to sell to buy-back centres.
Co-op 3	E	This co-operative is located in the Marlboro area. Main activities include: sorting recyclable waste to sell to buy-back centres.

In qualitative research, a small sample allows a researcher to collect comprehensive sets of data that lead to thorough knowledge of a 'social phenomenon', particularly from minority, disadvantaged or 'hard to reach' groups (Haq, 2014; Tongco, 2007).

3.5.6 Evaluating the effectiveness of the private and co-operative waste source separation models based on performance against KPIs (step 5)

Performance evaluation scores are typically used to evaluate/score the effectiveness of different environmental management instruments (Alberts *et al.*, 2020; Alberts *et al.*, 2021; Zaman, 2014a). Symbols (A to C), rather than numbers, are used as grading scales, because they allow the user to determine their grade assignment, whereas numbers may convey the sense of absolute judgement (Bangor *et al.*, 2009).

The performance evaluation scores were based on a shortened version of the Lee and Colley review package (generally uses six rating symbols from A through to F), which is generally used to review the quality of EIA reports (Lee *et al.*, 1999). According to Lee *et al.* (1999:10), the letter grading scale was used to deter reviewers from using "crude aggregations" to derive scores at higher levels of the assessment pyramid.

Based on the responses from the survey questionnaires, the evaluation scores in Table 3.4 were used to evaluate the performance of each KPI listed in Table 3.2.

Table 3-4: Performance evaluation scores used to evaluate each of the KPIs listed in Table 3-2.

Symbol	Description	Colour code
A	Adequately addressed the KPI	A: Green
B	Partially addressed the KPI	B: Yellow
C	Inadequately/did not address the KPI	C: Red

This A to C performance evaluation scoring system has been applied commonly in South African environmental performance evaluation/effectiveness research (Alberts *et al.*, 2021; Alberts *et al.*, 2021; Cilliers *et al.*, 2022; Claassens *et al.* 2022).

3.5.7 Comparing the effectiveness of private and co-operative waste source separation models (step 6)

The final step (step 6) involved the comparisons between the effectiveness of the private and co-operative waste source separation models. The performance evaluation scores (A to C) of the three private companies and the three co-operatives against each of the KPIs were outlined in a matrix/table (see Table 4-1) for comparison.

3.6 Data analysis

Data analysis is the process of organising and classifying data collected during the study to make sense of a vast amount of unstructured data (Mason, 2002).

To compare the effectiveness of the co-operative and private sector source separation models, cross-case analysis was utilised. Cross-case analysis enables a researcher “to compare cases from one or more settings, communities, or groups” (Khan and VanWynsberghe, 2008). For this purpose, a matrix (Table 4-1, p.51) was used. Further data analysis included graphs of performance per KPA, for both privates and co-operatives, which are individually discussed (Figure 4-1 to 4-10, p.55-77).

3.7 Ethical considerations

In any research project, it is crucial to protect human participants by using the proper ethical norms and standards (Arifin, 2018). Review boards in research review the ethical considerations of each research study to determine whether the researcher is competent and has considered the participants’ confidentiality throughout the study (Connelly, 2014).

For this research, ethical clearance was provided by the Faculty of Natural and Agricultural Science Research Ethics Committee (FNAS REC) (ethics number: NWU–01210–22-A9). The study was carried out per the North-West University FNAS REC’s ethical guidelines, to ensure that the participants’ confidentiality will be protected and that they experienced minimal to no risk.

All participants had to provide informed consent, before participating in the research, and were provided with an opportunity to withdraw from the research at any time.

3.8 Methodological assumptions and limitations

Methodological assumptions are beliefs or preconceived notions the researcher has even though, these assumptions may not be proven, they are required to conduct research (Tracy, 2013).

A few limitations were discovered throughout the research. Firstly, the number of total respondents (three private companies and three co-operatives) limited the comparisons (correlations/associations) which could be made between the performance and the type of source separation model. As a result, the research provides narrative comparisons, rather than statistical comparisons to compare the two source separation models. With a larger sample size, representing a sizeable portion of the “source separation” industries in Gauteng, more comparisons (supported by statistical analysis) would have been possible.

The research findings are limited to a specific geographical area, the northern parts of Johannesburg, Gauteng. The inclusion of a broader geographical area may provide findings that were not represented in this research.

Research findings are based on the information supplied by research participants. Where possible, supplementary evidence (i.e. tonnage reports) was sought. Only co-operatives availed themselves for a site visit (where additional information could be collected on aspects related to buildings, equipment, etc.). It was assumed in this study that every participant would truthfully and factually answer the questionnaire questions. They were further assured that their identity would be kept concealed and that their private information would be handled with confidentiality.

Documents such as tonnages records, SOPs, business plans, etc. could not be disclosed in this study reason being the private waste management companies did not consent to have their private documents published to the public. Therefore, the information collected from each case was based on self-reported information, which was deemed to be an accurate representation of performance.

The potential limitation of using field notes from site visits as *ad hoc* observations (without the use of an observation guide) is that there is minimal guidance on the specifics of the notes (i.e. description, depth, etc.) (Phillippi and Julia, 2018).

3.9 Chapter summary

Chapter 3 outlined the methodological design of the research. This included the research approach and -design, description of case study area, data collection and -analysis, ethical considerations, methodological assumptions and limitations. The next chapter, Chapter 4, provides the results and discussions of the research.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the research, which aimed to investigate the effectiveness of waste source separation models in the northern parts of the City of Johannesburg, Gauteng, South Africa by comparing the co-operative and private sector waste source separation models, according to the three research objectives (RO):

- **RO1:** Developing key performance areas (KPAs) and key performance indicators (KPIs) to evaluate the effectiveness of waste source separation models;
- **RO2:** Evaluating the effectiveness of co-operative and private sector waste separation models against developed KPIs
- **RO3:** Comparing the effectiveness of co-operative and private sector waste separation models with the aim of making recommendations for future waste source separation models.

4.2 Results related to RO1: Develop key performance areas (KPAs) and key performance indicators (KPIs) to evaluate the effectiveness of waste source separation models

To evaluate the *effectiveness* of waste source separation models (Box 1), key performance areas (KPAs) with associated key performance indicators (KPIs) were developed. Since these KPAs and KPIs were already presented in Chapter 3 (Table 3-2, p.36), they will not be repeated in this chapter in detail. In summary, the KPAs included: (1) Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input); (2) Provision for a working environment with sufficient capacity, infrastructure and machinery; (3) Provision for a working environment that is lawful and safe; (4) Provision for a working environment that promotes equality, personal growth and development; and (5) Provision for community participation through communication, education and awareness with their associated KPIs (as illustrated in Table 3-2 and Table 4-1).

These KPAs and KPIs were developed by means of a comprehensive literature review, which identified applicable policies, legislation and academic publications (as indicated in Table 3-2).

4.3 Results related to RO 2: Evaluate the effectiveness of co-operative and private sector waste separation models against developed KPIs

To evaluate the effectiveness of the private and co-operative waste source separation models, a structured survey questionnaire, where the questions are based on the developed KPIs, was

electronically and telephonically administered (Section 3.5.4). Additionally, site visits were conducted where the observations supported the self-administered survey questionnaires.

4.3.1 Survey questionnaire results

A total of six respondents (three private companies and three co-operatives) participated in the research (see Table 3-3, p.44) and completed the questionnaires. The responses to the questionnaires related directly to the KPIs are provided in Table 4-1. The survey questionnaire responses are, therefore, not presented as a set of separate results. Based on the questionnaire responses, performance evaluation scores (A to C, as shown in Table 3-4) were allocated. The specific responses to each KPI are discussed in the sub-sections of Section 4.3.2.

4.3.2 Effectiveness of co-operative and private sector waste separation models

The performance of each of the six cases (P1 to P3; Co-op 1 to Co-op 3), representing the two waste source separation models (i.e. private vs co-operatives), were evaluated against the five KPAs and their corresponding KPIs. Their performance (A–C) against each KPI is indicated in Table 4-1.

Table 4-1: Performance evaluation scores (A to C) for private- (P1 to P3) and co-operative (Co-op1 to Co-op3) waste source separation models evaluated against the five KPAs with their associated KPIs

Effectiveness evaluation criteria		Private separation at source models			Co-operatives separation at source models		
		P1	P2	P3	Co-op1	Co-op2	Co-op3
KPA 1: Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input)							
KPI 1.1	To what extent does the source separation make provision for the separation of sufficient/adequate quantities/volumes of recyclable waste?	C	A	C	C	C	C
KPI 1.2	To what extent does the source separation model make provision for the separation of sufficient/adequate waste quantities /volumes sorted ?	C	B	C	C	C	C
KPI 1.3	To what extent does the source separation make provision for the separation of sufficient/adequate quality recyclable waste ?	B	B	A	B	B	B
KPI 1.4	To what extent does the source separation programme make provision for business/economic viability/feasibility ?	C	A	A	C	C	C
KPI 1.5	To what extent does the source separation model ensure access to sufficient markets (demands) for separated waste?	A	B	A	A	A	A
KPI 1.6	To what extent does the source separation model ensure access to acceptable financial incentives for separated waste?	C	C	B	C	C	C
KPI 1.7	To what extent does the source separation model generate an acceptable income from selling sorted material ?	C	C	B	A	B	B
KPI 1.8	To what extent does the source separation model ensure that resource/input costs are kept at an acceptable level?	A	C	C	C	C	C

Effectiveness evaluation criteria		Private separation at source models			Co-operatives separation at source models		
		P1	P2	P3	Co-op1	Co-op2	Co-op3
KPI 1.9	To what extent does the source separation model ensure that labour costs are kept at an acceptable level?	A	A	A	B	B	B
KPI 1.10	To what extent does the source separation model ensure that operational costs are kept at an acceptable level?	C	A	A	B	B	B
KPA 2: Provision for a working environment with sufficient capacity, infrastructure and machinery							
KPI 2.1	To what extent does the source separation model provide for sufficient human capacity ?	C	C	B	A	A	A
KPI 2.2	To what extent does the source separation model provide access to infrastructure and machinery, which will reduce further contamination/prevent pollution ?	C	C	B	C	C	C
KPI 2.3	To what extent does the source separation model provide access to infrastructure and machinery for the collection and transportation of waste ?	A	A	A	B	B	B
KPI 2.4	To what extent does the source separation model provide access to infrastructure and machinery for the separation/sorting of waste into different categories/types ?	B	B	A	C	C	C
KPI 2.5	To what extent does the source separation model provide access to infrastructure and machinery for the shredding, and crushing of waste ?	C	C	C	C	C	C
KPI 2.6	To what extent does the source separation model provide access to infrastructure and machinery for the baling/compaction of waste ?	C	C	A	C	C	C
KPA 3: Provision for a working environment that is lawful and safe							
KPI 3.1	To what extent does the source separation model provide for a safe work environment ?	B	B	B	A	A	A

Effectiveness evaluation criteria		Private separation at source models			Co-operatives separation at source models		
		P1	P2	P3	Co-op1	Co-op2	Co-op3
KPI 3.2	To what extent does the source separation model provide access to basic facilities and sanitation within the work environment?	A	A	A	B	C	C
KPI 3.3	To what extent does the source separation model provide for the identification and implementation of applicable legal requirements?	A	C	A	A	A	A
KPI 3.4	To what extent does the source separation model comply with the National Norms and Standards for the Storage of Waste?	C	C	A	A	A	A
KPI 3.5	To what extent does the source separation model comply with the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste?	C	C	A	A	A	A
KPI 3.6	To what extent does the source separation model comply with the Waste Information Regulations?	C	C	A	A	A	A
KPI 3.7	To what extent does the source separation model monitor and report on legal compliance?	B	B	A	A	A	A
KPI 3.8	To what extent does the source separation model implement corrective actions to address any non-compliances?	B	C	C	C	C	C
KPA 4: Provision for a working environment that promotes equality, personal growth and development							
KPI 4.1	To what extent does the source separation model provide opportunities for gender equality?	C	C	A	A	A	A
KPI 4.2	To what extent does the source separation model provide opportunities for youth and/or disabled individuals?	C	A	A	C	C	C
KPI 4.3	To what extent does the source separation model provide opportunities for previously disadvantaged individuals?	A	A	A	A	A	A

Effectiveness evaluation criteria		Private separation at source models			Co-operatives separation at source models		
		P1	P2	P3	Co-op1	Co-op2	Co-op3
KPI 4.4	To what extent does the source separation model provide opportunities for local employment and local procurement ?	A	A	A	A	A	A
KPI 4.5	To what extent does the source separation model provide opportunities for personal growth and skills development ?	C	B	A	C	C	C
KPA 5: Provision for active community participation through communication, education and awareness							
KPI 5.1	To what extent does the source separation model provide sufficient communication, education and awareness of the different categories/streams of waste ?	C	C	C	C	C	C
KPI 5.2	To what extent does the source separation model provide sufficient communication, education and awareness that inculcates a culture of source separation ?	C	B	A	C	C	C
KPI 5.3	To what extent does the source separation model provide sufficient communication, education and awareness on the correct separation and sorting of waste ?	C	C	A	C	C	C
KPI 5.4	To what extent does the source separation model provide sufficient communication, education and awareness on the impact of source separation towards diverting recyclable waste away from the landfill ?	C	C	A	C	C	C

4.3.2.1 Performance of the three private waste management companies

The performance of the private waste management companies against KPAs 1 to 5 is discussed in the following sub-sections.

4.3.2.1.1 KPA 1: Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input)

KPA 1 focuses on the provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input). As illustrated in Table 4-1, this KPA is comprised of 10 KPIs. The following overall scores were achieved by the three private case studies for KPA 1: A = 12, B = 6 and C = 12 (Figure 4-1). KPI 1.9 (ensure that *labour costs* are kept at an acceptable level), was the only KPI which scored well for all three private companies. KPI 1.5 (ensure access to sufficient *markets (demands)* for separated waste) and KPI 1.3 (provision of sufficient/adequate *quality* recyclable waste) also performed fair, with A = 2, B = 1, C = 0 and A = 1, B = 2, C = 0 (Table 4-2).



Figure 4-1: Overall performance evaluation scores for KPA 1 of the three private waste management companies evaluated

KPI 1.1 addressed the extent to which the waste source separation model made provisions for the separation of sufficient/adequate **quantities/volumes** of recyclable waste. P1 and P3 did not adequately address this KPI (scoring C). They indicated that the tonnage records for the recyclable waste received before sorting were unavailable. According to a study conducted by

Godfrey and Scott (2010), it is difficult to determine the precise tonnages for recyclable waste received by private waste management companies without access to facilities such as weighbridges. To alleviate this issue, some waste companies estimate tonnages using the load capacity of the collection trucks and the frequency of collection per week, as seen in P2 (scoring A). Weighbridges and other waste weight assessment facilities are generally found at landfill sites and buy-back centres. Because they occupy a substantial amount of space and are relatively expensive, many private companies choose to operate without them (Mazhandu, 2021). As stipulated in the Second-Hand Goods Act (6 of 2009), buyback centres are legally required to have waste weight assessment facilities such as weighbridges to accurately quantify the sorted waste received from private waste management companies, pay them accordingly (prices are subject to market-related changes), provide sellers with accurate tonnages, and report on all activities pertaining to sorted recycling material upon reception (DEA, 2016).

None of the private companies scored well against KPI 1.2, which addressed the extent to which the waste source separation model made provision for the **separation of sufficient/adequate waste quantities/volumes**. P2 (scoring B) and P3 (scoring C) indicated that they sorted less than 400 tonnes of waste in 2022, with just 100 tonnes of high-value waste types such as cans, plastics, and paper. P3 did not have any tonnage records for tyre, polystyrene, residual and e-waste. Interestingly, P1 (scoring C) indicated that they did not have the tonnage records for the total recyclable waste sorted in 2022, despite providing the total tonnage records for each waste type collected.

P1 and P2 partially addressed KPI 1.3 (scoring B), which addressed the extent to which the waste source separation model made provisions for the separation of sufficient/adequate **quality recyclable waste**. Sufficient quality of recyclable waste refers to preserving the essential characteristics of the material to produce high-quality secondary products (Oliveira *et al.*, 2018). This means that recyclable waste should not be mixed (or contaminated with) non-recyclable waste. According to both private companies, residents placed their recyclable waste in separate “recycling” plastic bags (clear bags provided by Pikitup). The participants reported that upon collection, these bags are often half empty (with recyclable waste) or filled with mixed recyclable waste (with potentially high amounts of non-recyclable waste). When mixed with non-recyclable items (undesired products) or wet waste, recyclable waste becomes contaminated and may lose its value. A study conducted by Brooks *et al.* (2018), revealed that even when recyclable materials were placed in the correct recycling bins/bags, the contamination rate did not decrease because some people still threw food waste into these bins (as shown in P2). Lyas *et al.* (2005) argued that recycling bags (which are generally used as a cost-effective alternative to recycling bins) can greatly alleviate contamination when filled with recyclable material only (as shown in P3 scoring

A). Atkinson *et al.* (2022) revealed that highly contaminated recyclable materials cannot be used due to the high cost of cleaning to retain some quality. The cost of cleaning these items affects recycling markets, resulting in significant pricing disparities (Coelho *et al.*, 2011).

KPI 1.4 (economic feasibility/viability) and KPI 1.5 (markets/demands) aim to reflect on the extent to which the source separation models have the potential to generate sufficient income. All three private companies collect waste and sell it to buy-back centres and/or recycling companies. All the private companies (P1 to P3) indicated that they had access to sufficient markets in the CoJ area (**KPI 1.5**) and that the demand for recyclable goods met or exceeded their supply. Table 4-2 provides an outline of the selling prices of recyclable materials of P1, P2 and P3 in 2022. While P1 and P2 focused on a wider range of recyclable waste materials, compared to P3 (which only sold cans, plastic and paper), P2 sold recyclables at much lower prices. This was because the market demand for recyclables in the area, where P2 operates, was lower than in the other two areas (P1 and P3). According to Viljoen (2019), buyback centres establish their pricing based on market demands for recycling material. Hence, market demand is one of the factors that significantly impacts pricing disparities. For example, China's manufacturing industry has been the largest importer of plastic waste over the last two and a half decades. However, the influx of contaminated plastic waste had a negative impact on its environment, and thus leading to an import ban on this type of waste. Consequently, global PET markets have been significantly affected by this ban (Huang *et al.*, 2020; Wang *et al.*, 2020). Other factors which may contribute to pricing disparities include baling potential, value/quality of the material, the weight of products, etc. (Hemmelmayer *et al.*, 2015; Langenhoven and Dyssel, 2007; Mueller, 2005; Viljoen, 2019).

Table 4-2: Mean prices for recyclable materials in 2022 (private companies)¹

Type of recyclable	Private 1 (R/kg)	Private 2 (R/kg)	Private 3 (R/kg)
Can	Above R9.50	Less than R2.50	Above R9.50
Plastic (PET)	R2.51 – R5	Less than R2.50	R7.51 - R9.50
Glass	Less than R2.50	Less than R2.50	-
Paper (White)	R2.51 - R5	Less than R2.50	R2.51 - R5
Tyre	Less than R2.50	R2.51 - R5	-
E-waste	R5 – R7.50	R2.51 - R5	-
Polystyrene	R5 – R7.50	Less than R2.50	-

P2 and P3 indicated that they believed that they were **economically viable/feasible** (KPI 1.4 = C). P3 specifically stated that changes in legislation such as the introduction of the extended

¹ The Rand/kg value each company sold their waste for in 2022.

producer responsibility (EPR) regulations supported the viability of their business model. Even though, P1 sold the most diverse range of recyclable materials, at reasonable prices (Table 4-2), they were the only company that indicated that they did not believe that their business model was economically viable/feasible (KPI 1.4, P1 = C). This could be attributed to the fact that – although they had access to sufficient market prices, they did not collect sufficient recyclable waste. Further supported by P1 indicating that they did not collect or separate sufficient quantities of recyclable waste (KPI 1.1 and KPI 1.2 = C). Additionally, mentioning that the recyclable materials were often mixed with non-recyclable waste and that the recycling bags/bins were often half-empty upon collection. Other attributes would be their operational expenses.

Interestingly, only P3 indicated that they had access to **acceptable financial incentives** such as sponsorships (scoring A for KPI 1.6). Whereas, P1 and P2 indicated that they did not have access to any form of public or private financial incentives, other than generating income from selling recyclables (scoring C). The lack of recycling resources, infrastructure and capacity from spheres of government necessitates the need for private companies to bear the costs of collecting, transporting, sorting and selling their recyclable material. Additionally, the lack of knowledge of available funding for recycling or sustainable waste management initiatives restricts companies' access to financial investments (Rajagopaul *et al.*, 2020).

KPI 1.7 evaluated whether the private companies **generated acceptable income** from selling recyclable materials. P1 and P2 indicated that they generated an estimated income of less than R500 000 per annum from selling sorted material (scoring C), while P3 generated revenue between R500 001 – R1 000 000 per annum (scoring B for KPI 1.7). The higher income of P3 may be attributed to the fact that P3 had access to higher market prices for recyclable materials (Table 4-2), albeit they focused on a less diverse range of recyclable materials. Even if the revenue generated may be acceptable, it may not be sufficient to cover the costs associated with running the business every month (i.e. input, labour and operational costs) (Viljoen *et al.*, 2019).

Finally, KPIs 1.8, 1.9 and 1.10 evaluated the extent to which the source separation model ensured that **resource/input costs, labour costs and operational costs**, respectively, were kept at an acceptable level. Although they believed that their business model was not economically viable (KPI 1.4), P1 indicated that their resource/input costs were kept at an acceptable level (KPI 1.8 = A) and that it did not exceed their income generated from selling recyclable waste. P1 also reported that their labour costs were kept at an acceptable level (KPI 1.9), however, the company expressed concerns about their operational costs (KPI 1.10). P1 indicated that fuel and maintenance costs, as well as utility- and site rental costs, were not maintained at an acceptable level (scoring C for KPI 1.10). Faraca *et al.* (2019) revealed that transportation and utility costs

(i.e. electricity, water, and sewage) are unavoidable for registered sorting, shredding, baling and crushing facilities.

Interestingly, P2 and P3 indicated that both labour costs (KPI 1.9 = A) and operational costs (KPI 1.10 = A) were at an acceptable level (i.e. not exceeding their income of R500 000 per annum). These two private companies, however, indicated that their resource/input costs (KPI 1.8 = C) exceeded their income. It was still interesting to note that both P2 and P3 believed that they had an economically viable/feasible business model (KPI 1.4).

4.3.2.1.2 KPA 2: Provision for a working environment with sufficient capacity, infrastructure and machinery

KPA 2 focuses on the provision of a working environment with sufficient capacity, infrastructure and machinery. As illustrated in Table 4-1, this KPA is comprised of six KPIs. The following overall scores were achieved by the three private company case studies for KPA 2: A = 5, B = 4 and C = 9 (Figure 4-2). The KPIs associated with KPA 2 generally scored poorly, with the exception of KPI 2.3 (provision of infrastructure and machinery for collection and transportation of waste) and KPI 2.4 (provision of infrastructure and machinery for separation/sorting of waste into different categories/types).

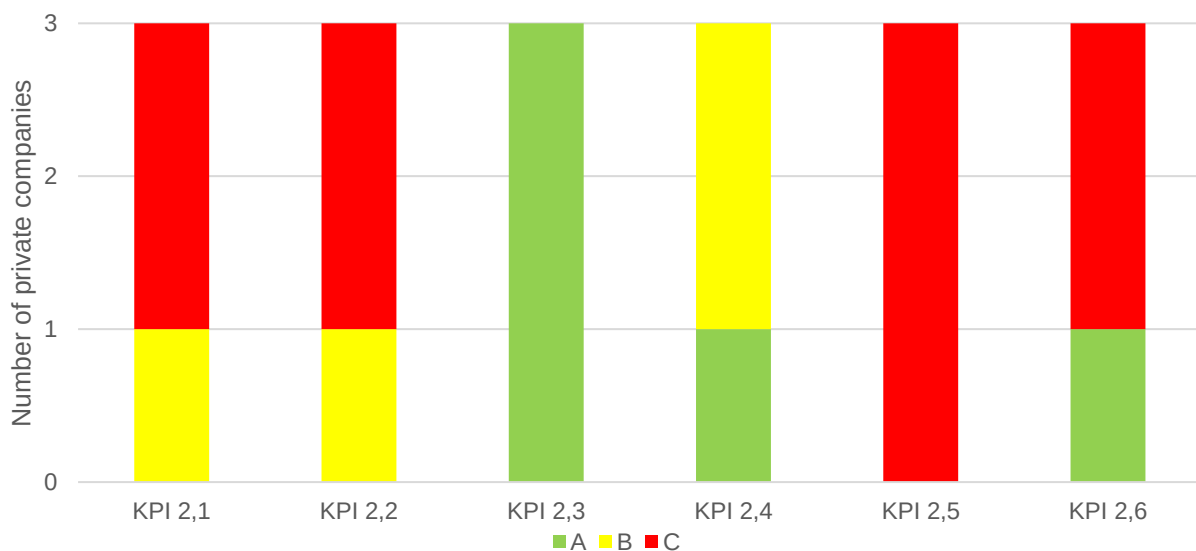


Figure 4-2: Overall performance evaluation scores for KPA 2 of the three private waste management companies evaluated

Manual sorting of waste is one of the most cost-effective sorting methods although it requires a substantially large workforce (Ruj *et al.*, 2015). The rate at which an individual sorts recyclable materials is dependent upon a variety of factors, nevertheless, a substantial amount of people is required to collect, transport, and sort the recyclable material, especially in developing countries which are not dependent on mechanised processes (Hayami *et al.*, 2007:50). KPI 2.1 addressed the extent to which the waste source separation model made provisions for **sufficient human capacity**. P1 and P2 indicated that they did not have sufficient human capacity, both mentioning capacity shortages for the sorting of recyclable materials (scoring C). P1 had a staff complement of four individuals responsible for the sorting of waste, and P2 had a staff complement of eight. P3 indicated that they also do not have a large staff complement (four individuals responsible for waste sorting), but they implemented measures to be less dependent on large staff numbers (scoring B). One of these measures includes drop-off sites for recyclables, which only accept separated waste, thus reducing the number of staff needed to collect and separate waste after collection.

Additionally, P3 stated that they had continuous engagements with residents to ensure effective source separation of waste to reduce **contamination** (KPI 2.2 = B) of recyclable materials. P1 and P2 indicated that they did not implement any measures to reduce further contamination of recyclable material during collection, transportation and sorting (KPI 2.2 = C). P2 even indicated that because of the way in which waste was transported and separated, it often ended up being mixed during loading and transportation.

Transportation is a crucial factor that influences the frequency of waste collection (Santos *et al.*, 2022). All three private companies indicated that they had access to sufficient **vehicles to collect and transport** recyclable waste from collection points to their facilities (scoring A on KPI 2.3). After collection, waste is offloaded at a facility where the waste is sorted into different categories. Although source separation of waste (by the generator of waste) is ideal, this is not always achievable, and further waste sorting is required at the waste management facility (Ruj *et al.*, 2015).

P3 indicated that they had access to sufficient **infrastructure and machinery for the separation/sorting of waste into different categories** (KPI 2.4 = A). Their waste material was kept at a secure, covered sorting facility and was further sorted manually into respective waste types (scoring A for KPI 2.4). A secure facility ensures that the material is kept safe from theft and is protected from weather conditions such as rain (Tai *et al.*, 2011). P2 indicated that they collected mixed recyclable waste once a week from residents and sorted their material manually. They had limited, yet available space and infrastructure for the sorting of waste (KPI 2.4 = B). P1 indicated that they collected mixed recyclable waste from residents throughout the week and

sorting was manually done. The infrastructure for the sorting of waste into different categories was insufficient (KPI 2.4 = B).

None of the private companies had access to shredding or crushing machinery (KPI 2.5 = C). P3 was the only company that had access to a bailing machine (KPI 2.6 = A). This means that P3 has the potential to increase the weight (volume ratio of recyclable wastes), making the storage and transportation of recyclable wastes more effective.

4.3.2.1.3 KPA 3: Provision for a working environment that is lawful and safe

KPA 3 focuses on the provision of a working environment that is lawful and safe. As illustrated in Table 4-1, this KPA is comprised of eight KPIs. The following overall scores were achieved by the three private case studies for KPA 3: A = 9, B = 6 and C = 9 (Figure 4-3). KPI 3.2 (access to basic facilities and sanitation), was the only KPI which scored well for all three private companies. KPI 3.7 (measures for monitoring and reporting on legal compliance) also performed fair, with one A and two Bs. Overall, P3 scored well, meeting most of the KPIs (6 As,1 B and 1 C) (Table 4-2).

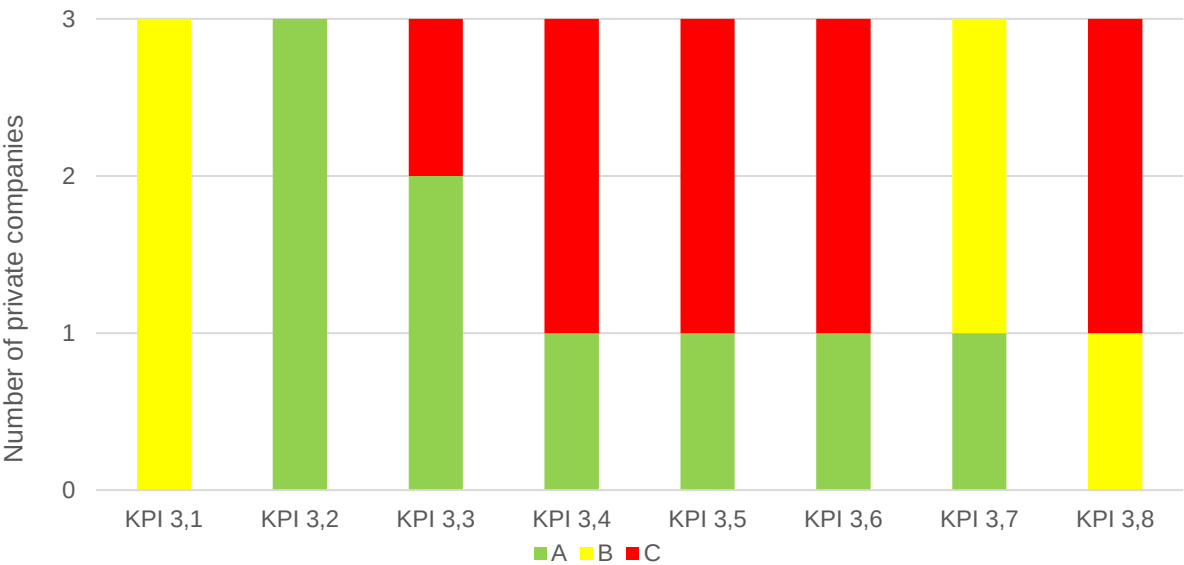


Figure 4-3: Overall performance evaluation scores for KPA 3 of the three private waste management companies evaluated

KPI 3.1 and 3.2 evaluated the extent to which the private companies provided a safe working environment. KPI 3.1 addressed the extent to which the waste source separation model provides for a **safe working environment**. This would typically include measures such as supplying employees with personal protective equipment (PPE), developing work instructions for safe

operation, providing the necessary training and communication, and ensuring the safe operation of machinery and equipment (Engkvist, 2010a; Engkvist, 2010b; Gutberlet and Baeder, 2008b; Gutberlet *et al.*, 2013b). Rajapaksha *et al.* (2017) highlighted that gloves, overalls and boots are essential items to ensure worker safety. Additionally, safe practice training programmes tailor-made to the employees' working conditions, duties and responsibilities are also important (Pineiro *et al.*, 2020).

All three private companies had some measures in place towards providing a safe working environment – a few of which could be improved upon. P3 indicated that they provided their employees with PPE twice a year, and provided occupational health and safety training once a year. However, they indicated that the machinery was not marked/labelled to contain safety warnings (scoring B). P1 and P2 indicated that they provided their employees with PPE once a year, provided occupational health and safety training once a year, and their machinery was remarked/re-labelled for safety warnings once a year (scoring B). All three companies indicated that they did not have any specific engineering measures in place to reduce injuries. P1, however, stated that they had various administrative measures in place. They had toolbox talks with their workers before a shift started and they provided them with a safe operating procedure (SOP). P2 stated that they had on-site training with their workers, and they also provided them with an SOP. While P3 stated that they gave their workers instructions, provided them with an SOP and made provision for medical care (on-site clinic). P1 and P2 did not provide extensive medical care for their workers (but had a first aid box available), mentioning that their employees barely get injured on duty.

According to Schenck and Blaauw (2011: 428), access to basic facilities and sanitation is a part of basic human needs, and the absence of basic facilities and sanitation for workers “*creates another environmental problem*”. KPI 3.2 addressed the extent to which the waste source separation model provided access to **basic facilities and sanitation** within the work environment. All three private companies provided their employees access to the following amenities: taps with clean drinking water, ablution facilities, and covered shelter (KPI 3.2 = A). Additionally, P1 provided access to wash basins, where employees could thoroughly wash their hands. Singh *et al.* (2022), highlighted that the COVID-19 pandemic exposed various occupational health and safety risks, further emphasising the importance of employees' health and sanitation needs.

KPIs 3.3 to 3.8 evaluated the provision that the private companies made for legal compliance of their operations – from identifying the applicable legislation to implementing the legislation, and lastly providing for monitoring, reporting and corrective action. Mak *et al.* (2019) indicated that the enforcement of regulations is an important factor towards enabling source separation models

to be more effective. P1 and P3 indicated that they had processes in place to **identify applicable legislation and to ensure regulatory compliance**, and indicated that these processes were occasionally amended (KPI 3.3 = A). P2 indicated that they did not have any processes in place to identify or implement specific legal requirements (KPI 3.3 = C).

While the purpose of this research was not to perform a full legal compliance verification/audit, KPIs 3.4, 3.5 and 3.6 reflected on the provision of three pieces of legislation which would be applicable to facilities which sort, shred, bale, and/or crush waste materials for supply to the recycling market:

- KPI 3.4 evaluated the extent to which the private companies made provisions to comply with GNR 926 of November 2013, the **National Norms and Standards for the Storage of Waste** (DEA, 2013). These norms and standards are applicable to facilities, which store more than 80 m3 of hazardous waste or more than 100 m3 of general waste;
- KPI 3.5 evaluated the extent to which private companies made provisions to comply with GNR 1093 of October 2017, the **National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste** (DEA, 2017). These norms and standards are applicable to facilities with an operational area of more than 1000 m2;
- Lastly, KPI 3.6 evaluated the extent to which private companies made provisions to comply with GNR 625 of August 2012, **the National Waste Information Regulations** (DEA, 2012b). These regulations could be applicable to the generation, transportation and treatment of waste by the private companies.

P1 and P2 did not comply with the National Norms and Standards for the Storage of Waste (KPI 3.4 = C), they indicated that they did not register their facility with the competent authority, nor did they comply with the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste (KPI 3.5 = C). Furthermore, these private companies (P1 and P2) did not comply with the Waste Information Regulations (KPI 3.6 = C). Both companies stated that they were not registered with any competent authority nor were they registered to the South African Waste Information System (SAWIS), implying that their waste generation, transportation and treatment tonnage records were unaccounted for. This data omission suggests that the City of Johannesburg's dry waste diversion rate may not be accurate.

P3, on the other hand, indicated that they complied with the National Norms and Standards for the Storage of Waste (KPI 3.4 = A), indicating that they registered their facility with the competent authority, Gauteng Department of Agriculture and Rural Development (GDARD). Additionally, they complied with the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste (KPI 3.5 = A), and the Waste Information Regulations (KPI 3.6 = A).

KPI 3.7 evaluated the extent to which the companies provided for ***monitoring and reporting of legal compliance***, while KPI 3.8 evaluated the provision of ***corrective actions to address non-compliance***. P3 indicated that they monitored and tracked compliance-related information, conducted audits, reported on non-compliances, and also conducted inspections of machinery and equipment (KPI 3.7 = A). However, they did not have a formal corrective action procedure/process to address legal non-compliance (KPI 3.8 = C). P2 also monitored and tracked compliance-related information, in addition to inspecting machinery and equipment. However, they did not conduct audits or report any non-compliances (KPI 3.7 = B), nor did they implement corrective actions to address any non-compliances (KPI 3.8 = C). Similarly, P1 indicated that they monitored and tracked compliance-related information, and conducted audits, in addition to inspecting machinery and equipment (KPI 3.7 = B). P1 did not have a formal procedure/process to implement corrective actions to address any non-compliances, however, the company sought advice from a private consultant to implement corrective actions for non-compliances (KPI 3.8 = B).

4.3.2.1.4 KPA 4: Provision for a working environment that promotes equality, personal growth and development

KPA 4 focuses on the provision of a working environment that promotes equality, personal growth and development. As illustrated in Table 4-1, this KPA is comprised of five KPIs. The following overall scores were achieved by the three private company case studies for KPA 4: A=10, B=1 and C=4 (Figure 4-4). KPI 4.3 (providing opportunities for previously disadvantaged individuals) and KPI 4.4 (providing opportunities for local employment and procurement) scored well, with all three private companies performing well (A) in these two areas.

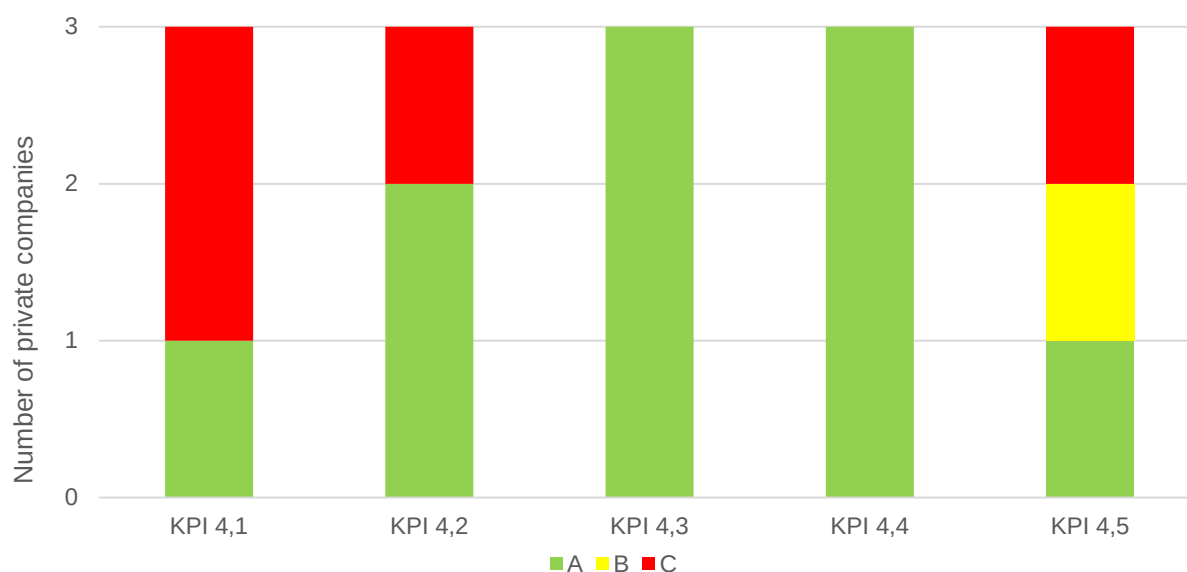


Figure 4-4: Overall performance evaluation scores for KPA 4 of the three private waste management companies evaluated

The 2020 National Waste Management Strategy (DEFF, 2020: 8) specifically aims to “...address the role of vulnerable groups, waste pickers and the informal sector and supporting women, youth and people living with disabilities in the circular economy”. Furthermore, the South African Extended Producer Responsibility (EPR) Regulations (DFE, 2021), and the Guideline for Waste Picker Integration (DEFF, 2020) make explicit mention of empowering women, youth and previously disadvantaged individuals. KPI 4.1 to KPI 4.3 reflect on the extent to which the private companies made provision for gender equality, youth and/or disabled individuals, as well as previously disadvantaged individuals, as part of their waste separation model.

Gender equality means that the “rights, responsibilities and opportunities of individuals will not depend on whether they are born male or female” (Bayeh, 2016:38). Given the entrepreneurial nature of the waste management industry, the South African government has implemented initiatives (such as women empowerment campaigns, training, etc.) to address gender inequality and provide women in this industry with more opportunities (Lukamba, 2016). KPI 4.1 addressed the extent to which the private companies made provisions for **gender equality**. P2 indicated that they only employed one female, while P1 only employed males (with no female employees) (KPI 4.1 = C). P3 had a proportionate staff complement, where 50% (two individuals) of the employees were male and 50% (two individuals) were female.

According to Viljoen *et al.* (2016), the majority of young people who work in the informal waste industry do so because of their socio-economic conditions, and many of them are school leavers who struggle to compete for jobs in other industries. Similarly, the nature of waste separation activities also makes this sector accessible to persons with minor disabilities (Viljoen *et al.*, 2016). P2 made provisions to include opportunities for **youth and/or disabled individuals** (KPI 4.2 = A) who were **previously disadvantaged** (KPI 4.3 = A). They indicated that all eight of their employees came from disadvantaged backgrounds and seven of their male employees were young (18 – 21), two suffered from minor disabilities (hearing and sight). Similarly, P3 also made provisions for youth and/or disabled individuals who were previously disadvantaged, stating that two of their four employees (50%) were young and/or disabled (scoring A for KPI 4.2) and that all four staff members came from disadvantaged backgrounds (KPI 4.3 = A). P1 did not employ any young or disabled people (KPI 4.2 = C), but all of their employees came from disadvantaged backgrounds (KPI 4.3 = A).

All three private companies provided opportunities for **local employment and local procurement** by indicating that they only hired South African citizens (KPI 4.4 = A).

KPI 4.5 evaluated the extent to which the waste source separation model provided opportunities for **personal growth and skills development**. Within the waste separation context, personal growth and skills development opportunities could include training/internships/experience in financial management, community engagement, and administration (Godfrey *et al.*, 2017). Workers that are trained in the core functions of the business are empowered to be innovative, enabled to develop their skills further and perform their duties more efficiently (Xu and Chen, 2018). P3 indicated that they financed their employees' skills development training (KPI 4.5 = A), which included training in leadership and decision-making, communication, financial management, administration and group dynamics. Similarly, P2 also financed their employees' skills development training (scoring B for KPI 4.5), indicating that their employees received training in conflict management, communication and administration, which is less aligned with the core skills outlined by Godfrey *et al.*, (2017). P1, on the other hand, indicated that they did not finance their employees' skills development training, nor did they provide them with educational support (scoring C for KPI 4.5). Their employees were either already trained in the necessary aspects of waste management before employment, or they receive training which is organised and funded by organisations outside of their place of employment.

4.3.2.1.5 KPA 5: Provision for active community participation through communication, education and awareness.

Gamaralalage *et al.* (2022) highlight the importance of raising public awareness of various waste streams and the significant role active public involvement can play in improving the effectiveness of waste source separation models. KPA 5 focuses on the provision of active community participation through communication, education and awareness. As illustrated in Table 4-1, this KPA is comprised of four KPIs. The following overall scores were achieved by the three private companies for KPA 5: A = 3, B = 1 and C = 8. This KPA generally scored poorly, with most of the KPIs not being addressed/achieved by P1 and P2 (scoring mostly Cs). Overall, P3 scored well, meeting most of the KPIs (3 As and 1 C) (Figure 4-5).

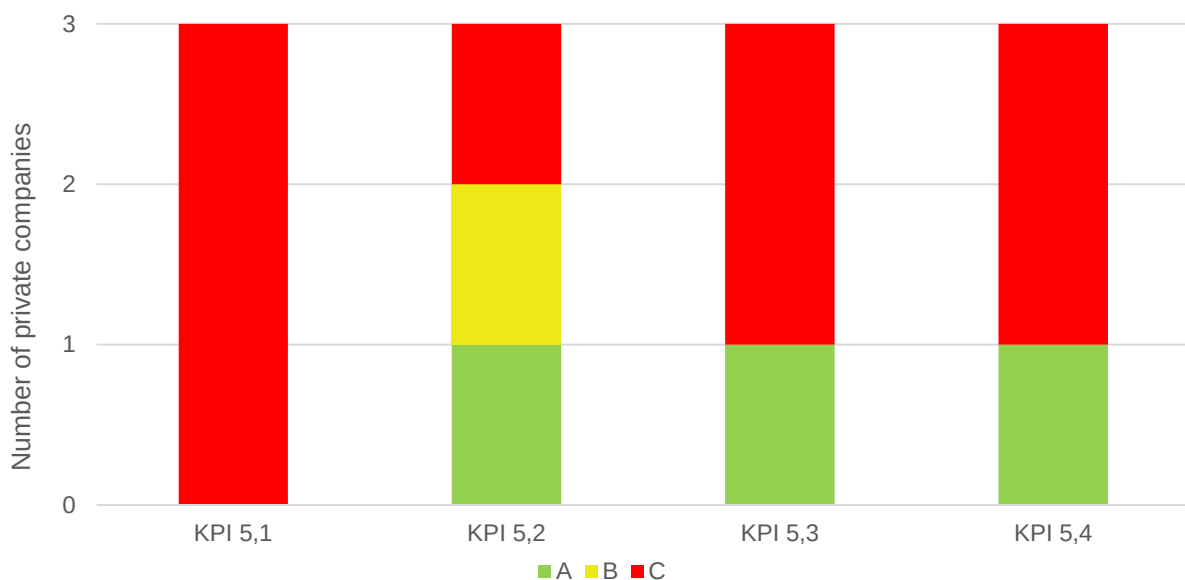


Figure 4-5: Overall performance evaluation scores for KPA 5 of the three private waste management companies evaluated

A study conducted by Sukholthaman and Sharp (2016), highlighted the importance of active public involvement in simplifying source separation processes such as treatment (preserve optimum product quality after use, reduce contamination and eliminate non-recyclable waste), collection (kerb-side collection efficacy), and disposal (diverting large volumes of recyclable waste away from the landfill) (Knickmeyer, 2020). According to Knickmeyer (2020); Sukholthaman and Sharp (2016), educating residents regarding proper source separation methods will significantly improve the efficacy of source separation activities.

KPI 5.1 addressed the extent to which the waste separation model provided sufficient communication, education and awareness of the ***different categories/streams of waste***. All three waste management companies indicated that they did not have a source separation educational programme that educated residents regarding various waste streams (scoring C).

P1 indicated that they did not have any measures for communication, education or awareness on waste separation towards changing households' behaviour (KPI 5.2 = C and KPI 5.3 = C). P2 indicated that they distributed awareness material on the importance of waste separation at source to households (KPI 5.2 = B), although they further stated that the participation rate did not increase when new residents were educated regarding separation at source (KPI 5.3 = C). This suggests that the waste management company attempted to ***inculcate a culture of source separation among the residents***, although they failed to effectively incorporate the resident's active participation towards diverting recyclable waste away from the landfill.

P3 informed residents of waste streams and the importance of waste source separation and diversion away from landfilling (KPI 5.3 and 5.4 = A) and also provided for continuous engagements with residents to inculcate a culture of source separation among the residents (scoring A for KPI 5.2).

4.3.2.2 Performance of the three co-operatives

The performance of the co-operatives against KPAs 1 to 5 is discussed in the following sub-sections. For the sake of brevity, background information on the KPAs, which was already discussed in the sub-sections of Section 4.3.2.1, will not be repeated below.

4.3.2.2.1 KPA 1: Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input)

The following overall scores were achieved by the three co-operative case studies for KPA 1: A = 7, B = 8 and C = 15. KPI 1.5 was the only KPI which scored well (A = 3) for all three co-operatives (Figure 4-6). KPIs 1.3, 1.7, 1.9 and 1.10 performed fairly, with all three co-operatives partially addressing these KPIs (scoring Bs) (Figure 4-6). Finally, KPI 1.1, 1.2, 1.4 and 1.6 scored poorly (Cs only) for all three of the co-operatives.

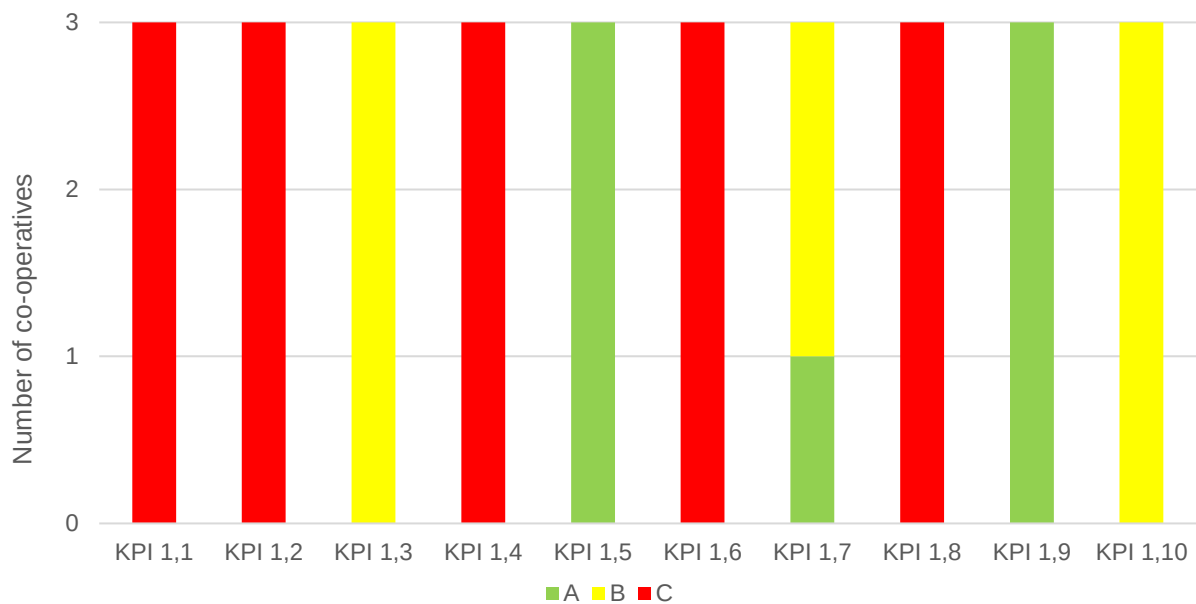


Figure 4-6: Overall performance evaluation scores for KPA 1 of the three co-operatives evaluated

KPI 1.1 addressed the extent to which the waste source separation model made provisions for the separation of sufficient/adequate **quantities/volumes** of recyclable waste, while KPI 1.2 addressed the extent to which the waste separation model made provision for the **sorting** of sufficient quantities/volumes of waste. The three co-operatives did not address these KPIs (scoring C) because they did not have the tonnage records for the mixed recyclable waste they collected/received, and they only kept tonnage records of sorted/separated recyclable materials. The co-operatives did not have weighbridge facilities to quantify the volumes of recyclable waste received before sorting. This made it challenging for them to quantify the volumes of sorted recyclable material required to make the co-operative sustainable. Co-operatives mostly had to rely on estimated tonnages of separated waste. Furthermore, the estimated tonnage records for sorted recyclable material for all three co-operatives were less than 400 tonnes per annum (KPI 1.2 = C). Waste streams that had the largest tonnages include paper (ranging from 251 – 500 tonnes per annum), plastic (ranging from 101 – 250 tonnes per annum) and glass (ranging from 101 – 205 tonnes per annum). The co-operatives also all indicated that the **quality of recyclable waste** (KPI 1.3) was average. Residents received recycling bags from Pikitup and the bags were filled with mixed recyclable waste upon reception, sometimes mixed with non-recyclable waste streams (scoring B for KPI 1.3).

KPI 1.4, which addressed the extent to which the waste source separation model made provision for **business/economic viability/feasibility** scored poorly (C). All three co-operatives indicated that they did not believe that their business model was viable because they did not receive sufficient (KPI 1.1) good quality (KPI 1.3) material and the inconsistency of trucks affected their supply of recyclable waste material (scoring C). All three of the co-operatives also expressed concerns about receiving sufficient funding and support to sustain their businesses. Godfrey *et al.* (2017), emphasised that municipalities needed to develop a strategy that reduces co-operatives' dependence on government funding and other handouts so that they can sustain themselves (also refer to KPI 1.6).

Table 4-3 illustrates the mean prices for recycling material in 2022 provided by each co-operative. These prices were in the same range as what private companies received for their recyclable materials (Table 4-2). This indicates that each co-operative had access to sufficient **markets (demands)** (KPI 1.5 = A). Aluminium cans, generally, had the highest selling price (value), followed by plastics, glass and paper. White paper had the highest value for the paper stream, Polyethylene terephthalate (PET) had the highest value for the plastic stream and returnable glass bottles (which do not need to be crushed) had the highest value for the glass stream. Co-ops 2 and 3 mentioned that they prefer not to collect glass that needs to be crushed because crushing posed a safety hazard and crushed glass is heavy to transport, while the Rand per kilogram income is low (as confirmed by Venter *et al.*, 2010). Different from the private companies, the co-operatives did not include tyres, e-waste and polystyrene as part of their business models.

Table 4-3: Mean prices for recyclable materials in 2022 (co-operatives)²

Type of recyclable	Co-op 1 (R/kg)	Co-op 2 (R/kg)	Co-op 3 (R/kg)
Cans	Above R9.50	Above R9.50	Above R9.50
Plastic (PET)	R7.51 - R9.50	R7.51 - R9.50	R7.51 - R9.50
Glass	R2.51 - R5	R2.51 - R5	R2.51 - R5
Paper	R2.51 - R5	R2.51 - R5	R2.51 - R5
Tyres	-	-	-
E-waste	-	-	-
Polystyrene	-	-	-

All three co-operatives indicated that they did not receive any **financial incentives** (scoring C for KPI 1.6) other than the income generated from selling their recyclable waste streams. Although co-operatives receive assistance from Pikitup, in the form of providing clear bags for the

² The Rand/kg value each co-operative sold their waste for in 2022.

separation of waste by households, training of workers (skills development), and educating residents on separation at source initiatives. They indicated that financial support and incentives were generally lacking.

Co-op 1 indicated that they generated an estimated **income** between R500 000 and R 1 000 000 per annum (KPI 1.7 = A). Even though the estimated income was substantial, Co-op 1 believed that their income did not exceed their **resource/input costs** (KPI 1.8 = C). They reported that **labour costs** (KPI 1.9 = B) were increasing, but still acceptable, and that the **operational cost** incurred was limited to truck hire for the transportation of waste materials to buy-back centres (KPI 1.10 = B). Co-ops 2 and 3 indicated that they generated an estimated income of less than R500 000 per annum (KPI 1.7 = B). They indicated that they did not incur excessive operational costs aside from hiring a truck to transport their sorted material to a buyback centre (scoring B for KPI 1.10). Similar to Co-op 1, they indicated that they did not believe that their income exceeded their expense, mainly due to resource/input costs and labour costs (scoring C for KPI 1.8 and B for KPI 1.9). All three co-operatives operate on Pikitup-owned facilities, therefore they do not incur rental and utility costs. They further mentioned that they did not have costs related to water or electricity.

4.3.2.2.2 KPA 2: Provision for a working environment with sufficient capacity, infrastructure and machinery

The following overall scores were achieved by the three co-operative case studies for KPA 2: A = 3, B = 3 and C = 12. The KPIs associated with KPA 2 generally scored poorly, with the exception of KPI 2.1. KPI 2.3 performed fairly, being partially addressed by all three co-operatives (scoring B) (Figure 4-7).

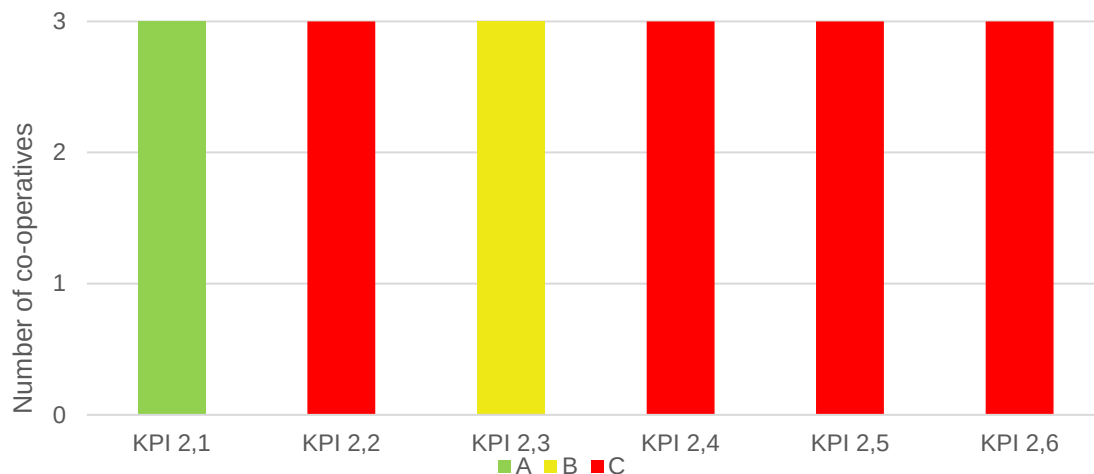


Figure 4-7: Overall performance evaluation scores for KPA 2 of the three co-operatives evaluated

KPI 2.1 addressed the extent to which the waste source separation model made provisions for **sufficient human capacity**. All three co-operatives had sufficient human capacity, where they had staff complements of 25, 15 and 17, respectively (scoring A). Yet, the labour force did not complement the (relatively low) tonnages of sorted recyclable materials (refer to KPI 1.2 above). According to Medina (2000:61), co-operatives with substantial staff complements (exceeding 10 staff members) should be able to sort large volumes of recyclable material at a relatively fast pace. The reasons for the weak relationship between staff numbers and sorting times/volumes were not investigated further.

Access to (reliable) transport allows co-operatives to service larger areas and collect higher volumes of recyclable materials, as compared to those that have unreliable transport or do not have transportation at all. In the CoJ, co-operatives that have a “*special arrangement*” with Pikitup are provided with recyclable material (Pikitup collects and transports recyclable material to the co-operatives) (Strydom and Godfrey, 2015:15). The three co-operatives did not have access to their own vehicles, but their special arrangement with Pikitup meant that recyclable waste was collected, transported and delivered to them. As mentioned in the discussion of KPI 1.10 above, the co-operatives make use of truck hire to take the waste from their facilities to buy-back centres (which may cause challenges due to vehicle availability) (KPI 2.3 =B). They received mixed recyclable waste three times a week (two loads each), depending on the availability of transportation from Pikitup. Given the nature of this arrangement (i.e. collection and transportation being “outsourced”), the co-operatives could not implement measures to reduce the **further contamination** of recyclable waste during transportation (scoring C for KPI 2.2).

All of the co-operatives indicated that sorting was done manually and that they did not have access to a secure, access-controlled facility (scoring C for KPI 2.4). Co-op 1 had a covered structure (sorting material in an open area exposes the materials to weather conditions and increases the risks of contamination), which, however, did not provide any security for their sorted material. They also indicated that people stole their material and when they could not find anything to steal, they burned the material. Co-op 2 and Co-op 3 sorted their recyclable material in an open area with barely any security (there was a makeshift gate but it provided minimal security). None of the co-operatives had access to **shredding and crushing** infrastructure and machinery, nor did they have access to a bailing machine (scoring C for KPI 2.5 and 2.6). The lack of access to these types of machinery/equipment limits the ability to reduce the volume-to-weight ratio of recyclable wastes, which is a disadvantage when transporting waste.

4.3.2.2.3 KPA 3: Provision for a working environment that is lawful and safe

Compared to the other KPAs, KPA 3 performed relatively well with KPIs 3.1 and 3.3 to 3.7 all scoring satisfactorily (As). KPAs 3.2 and 3.8, however, performed poorly (mostly scoring Cs) (Figure 4-8).

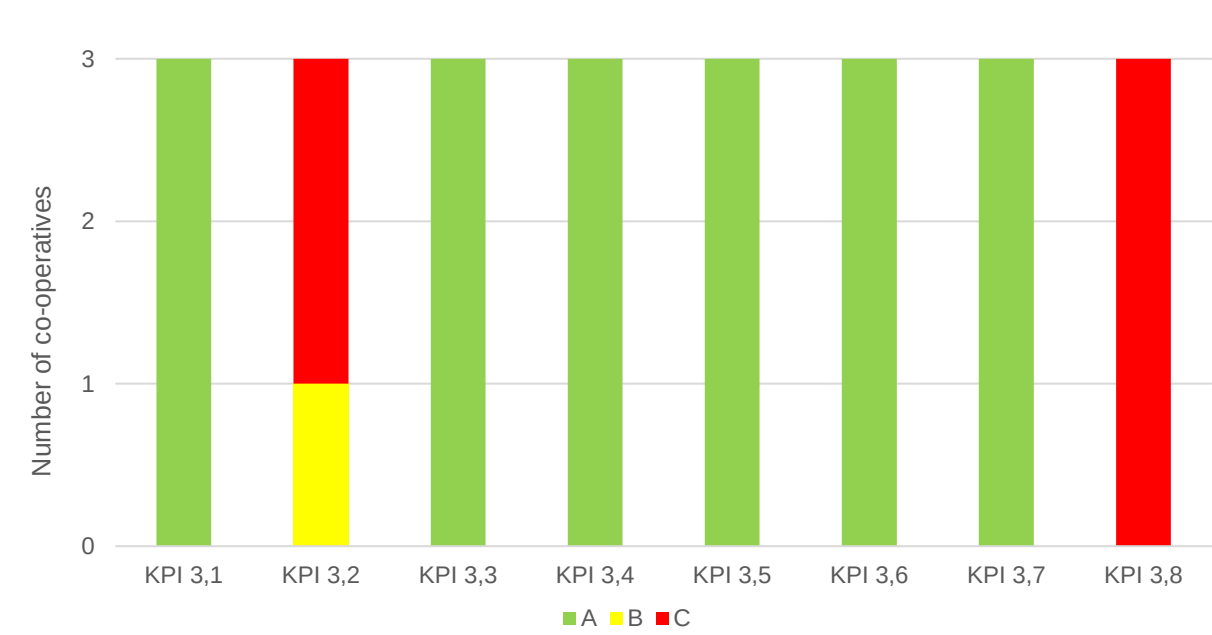


Figure 4-8: Overall performance evaluation scores for KPA 3 of the three co-operatives evaluated

KPI 3.1 addressed the extent to which the waste source separation model made provisions for a **safe work environment**. The sorting of waste is a physical task and demands workers to have

endurance, stamina, and some strength. Because of the potentially hazardous nature of sorting activities (injuries due to sharp objects, exposure to harmful materials, etc.), good health and safety practices in the workplace are vital (Stowell and Warren, 2018). The three co-operatives indicated that they provided their employees with PPE once a year; they had a standard operating procedure (SOP) for the sorting of waste and maintaining a safe working environment; and they were registered with the compensation fund for medical care. Although they did not provide specific occupational health and safety training. All of the co-operatives indicated that they had regular “team or toolbox talks” with their employees. They also mentioned that their workers were cautious and aware of safety measures and that there were little to no injuries reported (scoring A).

Co-ops 2 and 3 did not adequately address KPI 3.2, indicating that they did not provide **basic facilities and sanitation** for their workers (scoring C). On the other hand, Co-op 1 indicated that although they did not provide access to ablution facilities, their workers had covered shelter and taps with clean running water (scoring B).

KPIs 3.3 to 3.8 evaluated the extent to which waste separation models provided for the identification, implementation and monitoring/reporting of legal compliance. As stated in sub-section 4.3.2.1.3, the purpose of this research was not to perform a full legal compliance verification/audit but rather to focus on some “key” legal compliance indicators related to waste sorting.

The co-operatives indicated that Pikitup **identified and communicated legislative requirements** to them, and requirements to change processes/procedures were communicated depending on the amendments to legislation (scoring A for KPI 3.3). All three co-operatives also adequately addressed KPIs 3.4 to 3.6. Each co-operative indicated that they **complied with the National Norms and Standards for the Storage of Waste** (scoring A for KPI 3.4), and they indicated that their facility was registered with the competent authority (supporting evidence was provided during the site visits conducted). They also complied **with the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste** (scoring A for KPI 3.5). Lastly, the three co-operatives indicated that they were registered with **SAWIS** through Pikitup (scoring A for KPI 3.6). This implies that all the tonnage records are accounted for by the CoJ. All three co-operatives indicated that they **monitored and tracked** their information, reported duty-related injuries, and conducted inspections – of which the results are reported to Pikitup (scoring A for KPI 3.7). They did, however, mention that they did not have processes in place to implement **corrective actions** to prevent or address any non-compliance (scoring C for KPI 3.8).

4.3.2.2.4 KPA 4: Provision for a working environment that promotes equality, personal growth and development

The following overall scores were achieved by the three co-operative case studies for KPA 4: A = 9, B = 0 and C = 6. KPI 4.1 (opportunities for gender equality), KPI 4.3 (opportunities for PDIs) and KPI 4.4 (local employment) performed well (scored As). While KPI 4.2 (opportunities for youth and/or disabled individuals) and KPI 4.5 (personal growth and skills development) performed poorly (scoring Cs) (Figure 4-9).

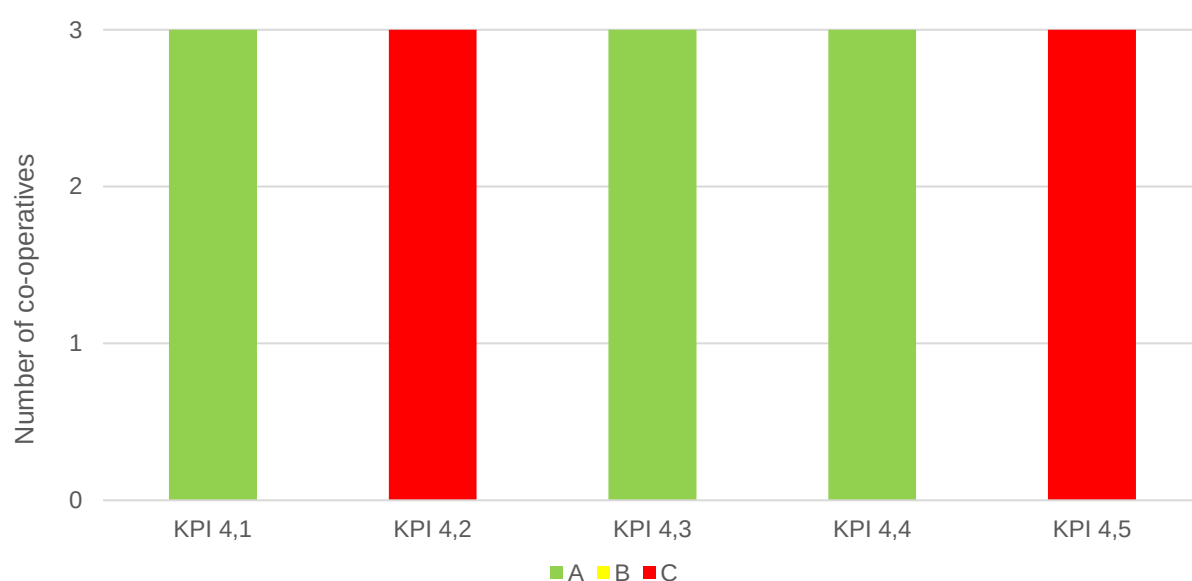


Figure 4-9: Overall performance evaluation scores for KPA 4 of the three co-operatives evaluated

All three co-operatives have made provisions to provide opportunities for **gender equality** (scoring A for KPI 4.1). Co-ops 2 and 3 had staff complements that were nearly evenly distributed, with six males/nine females and ten males/seven females, respectively. Co-op 1 had a staff complement that was comprised of six males/nineteen females. When we reflect on gender equality, the expectation should not be that the same number of males and females be employed, but rather that access to opportunities for both males and females is provided. The co-operatives demonstrated that they provided opportunities for and employed, both males and females. The economic situation in the country has driven many women, who happen to be single mothers, to choose waste separation/informal waste harvesting as a means of income (Nyathi *et al.*, 2018).

Waste separation has been recognised by the government as a possible vehicle to drive employment and provide young people with a livelihood, although disabled people still experience the most inequalities in this industry. The reasons vary from the lack of knowledge about disabilities to discrimination (Etambakonga and Roloff, 2019; Sheik *et al.*, 2022). KPI 4.2 addressed the extent to which the waste source separation model made provision for **youth and/or disabled individuals**. While all three of the co-operatives indicated that they employed a limited number of young people (aged 18 – 21), Co-op1 and Co-op 3 indicated that they did not provide for disabled employees (scoring C). They indicated that the nature of their manual sorting operations, which require physical fitness/strength, limited their ability to accommodate disabled persons. Co-op 2 indicated that they employed one person with a minor disability.

Furthermore, the three co-operatives provided opportunities to **previously disadvantaged individuals** through **local employment and procurement**. They indicated that all their employees were from disadvantaged backgrounds and that most of them were South African citizens, with a few staff members being from neighbouring countries (Lesotho and Zimbabwe) (scoring A for KPI 4.3 and 4.4).

KPI 4.5 addressed the extent to which the waste source separation model provided opportunities for **personal growth and skills development**. The three co-operatives indicated that they did not finance their employees' skills development training, nor did they provide them with educational support (scoring C). However, their employees did attend skills development workshops hosted by Pikitup, where the following training was provided: leadership and decision-making, conflict management, communication, financial management, administration and group dynamics.

4.3.2.2.5 KPA 5: Provision for active community participation through communication, education and awareness

The KPIs associated with KPA 5 performed poorly, with all of the co-operatives scoring C for the associated KPIs (Figure 4-10).

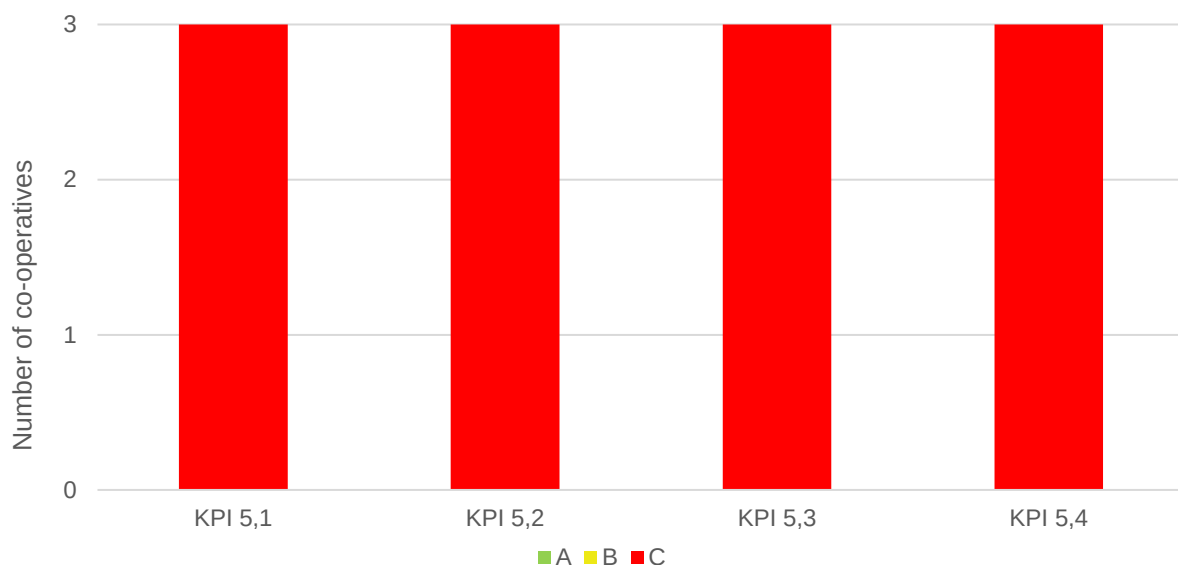


Figure 4-10: Overall performance evaluation scores for KPA 5 of the three co-operatives evaluated

According to Schoeman and Rampedi (2022b), low waste separation participation rates are attributed to the “generic” separation programmes implemented in South Africa, which do not cater to the country’s existing socio-economic disparities. It is crucial to understand the factors that influence residents’ waste separation at source behaviour so that effective education and awareness programmes can be developed (Okanta and Mohlalifi, 2020).

KPI 5.1 addressed the extent to which the waste source separation model provided sufficient communication, education and awareness of the **different categories/streams of waste**. The three co-operatives indicated that they did not have any educational or awareness programmes that educated residents regarding separation, waste streams, and/or the importance of diverting waste from landfill sites (scoring C), therefore, also scoring poorly (C) for KPIs 5.2, 5.3 and 5.4.

Although none of the co-operatives implemented any awareness and/or communication programmes, it should be noted that Pikitup uses education and awareness pamphlets to educate residents regarding separation at source (Maema, 2017). Furthermore, they engaged in educational campaigns at schools, universities, community centres, etc. to inculcate a culture of source separation among the residents and ensure that they engage in proper source separation practices (Okanta and Mohlalifi, 2020).

4.4 Results related to RO 3: Compare the effectiveness of co-operative and private sector waste separation models with the aim of making recommendations for future waste source separation models

This section aims to compare the effectiveness of private and co-operative waste separation models. As mentioned earlier, the purpose of the comparison is not to do a “like for like” comparison to determine which of the two programmes is the “best” or “most effective”, but rather to learn from the successes (A scores) and challenges (C scores) of each programme, with a view of making recommendations for the improvement of future waste source separation models.

4.4.1 Key findings: Comparing the effectiveness of the co-operative and private sector waste separation models

Percentages of the performance evaluation scores achieved in each KPA by the private companies and co-operatives were calculated to provide for clear comparisons on the effectiveness of co-operative and private sector waste source separation models.

The performance percentages for each case per KPA were calculated as follows³.

$$\text{Performance percentage (\%)} = \frac{\text{The total number of a specific score (A, B, or C) achieved}}{\text{The number of KPIs in that KPA}} * 100$$

The performance percentages of all six cases were provided to make comparisons on the effectiveness of each model (co-operative and private sector waste source separation). To make recommendations for future improvements, the reflections below are limited to key successes (A scores) and key challenges/problem areas (C scores).

4.4.1.1 Comparing performance against KPA 1

The KPIs associated with KPA 1 were fairly addressed by the private model when compared to the co-operative model, which fared poorly.

Reflecting on the percentage of As (KPIs adequately addressed) scored by the three private companies (P1 = 30%, P2 = 40% and P3 = 50%), it is clear that the private model had slightly more ‘pockets of success’ than the co-operative model (Co-ops 2 and 3 scored A = 10% and Co-op 1 scored A = 20%), as shown in Figure 4-11. These pockets of success were evident in KPIs, such as economic viability/feasibility (KPI 1.4), access to adequate market (demands) (KPI 1.5),

³ Example: KPA 4 % = total number of A scores achieved by P1 / 5 * 100

and acceptability of labour (KPI 1.9) and operational costs (KPI 1.10) (Table 4-1). Whereas, the co-operatives effectively had access to the market (demands).

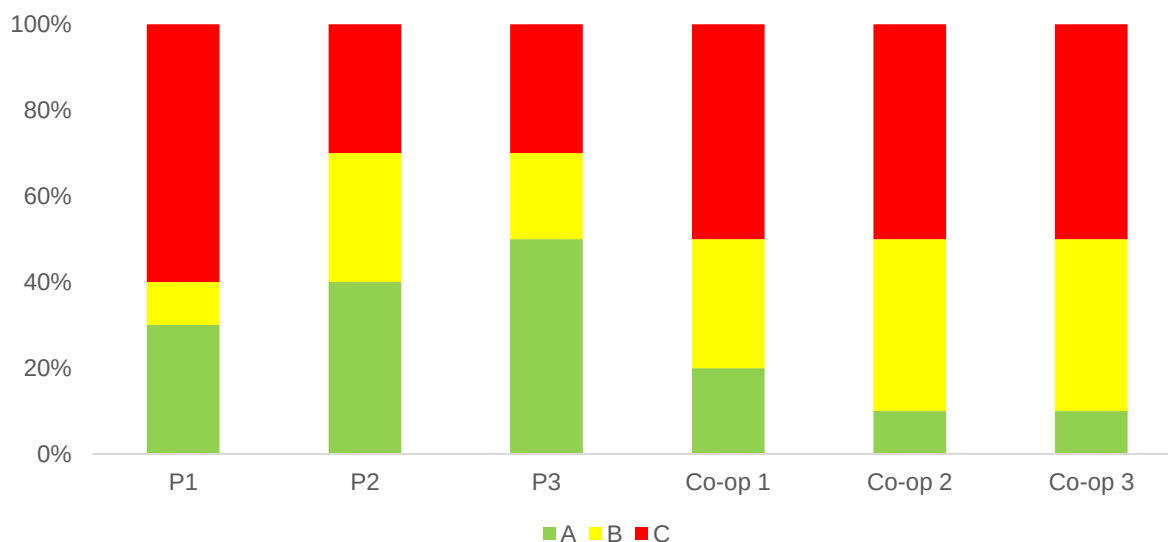


Figure 4-11: Overall performance evaluation percentage (A, B and C) for each case in KPA 1

When reflecting on pitfalls/challenges, the co-operatives scored poorly (Cs) in half of the KPIs. The co-operatives failed to make provisions for sufficient quantities of recyclable waste (KPI 1.1), sufficient quantities of material sorted (KPI 1.2), did not provide for sufficient business/economic viability (KPI 1.4), and access to acceptable financial incentives (KPI 1.6). They also did not ensure that input costs are kept at an acceptable level (KPI 1.8), with expenses generally exceeding income. The private companies (P1 and P2) faced similar challenges to the co-operative with KPIs 1.6 and 1.7 performing poorly.

The main lessons from these reflections include:

- Waste separation models should provide for weight assessment infrastructure (such as weighbridges) to quantify the volumes of recyclable waste received/collected, separated and sold;
- Adequate waste volumes should be collected and sorted to increase the revenue generated from selling sorted material; and
- Access to sufficient markets for recyclable material, acceptable labour and operational costs may improve economic/business viability.

4.4.1.2 Comparing performance against KPA 2

The KPIs associated with KPA 2 were poorly addressed by both models (co-operative and private), with the exception of P3, which scored fairly well (50% As). Both models were largely ineffective in providing a working environment that had sufficient infrastructure and machinery (KPIs 2.2, 2.4, 2.5 and 2.6) (Figure 4-12).

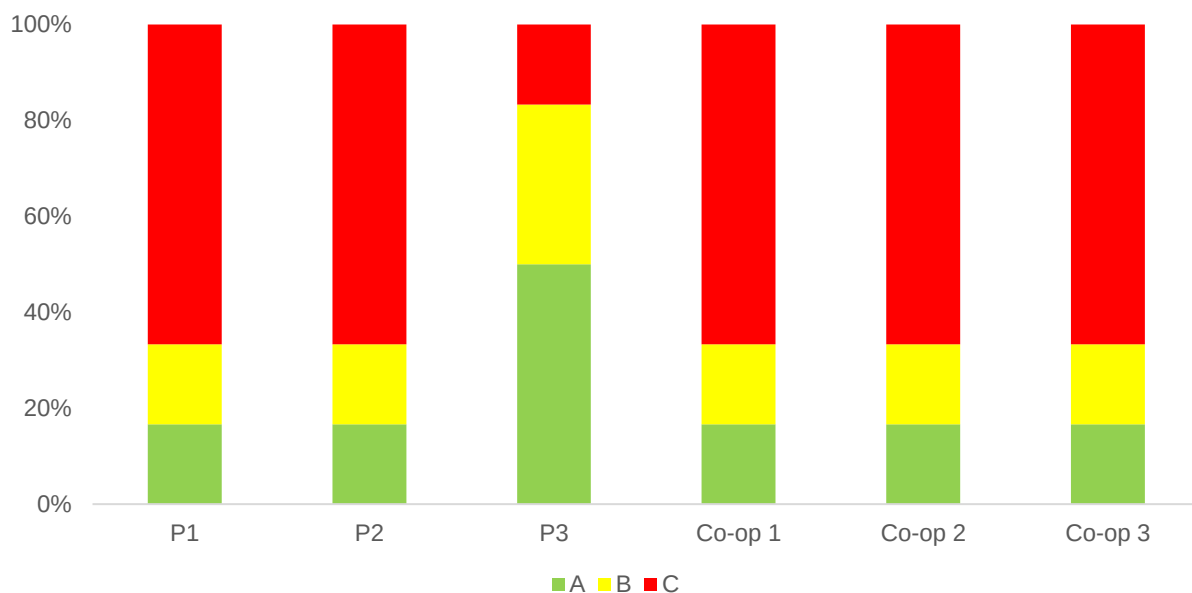


Figure 4-12: Overall performance evaluation percentage (A, B and C) for each case in KPA 2

The co-operatives scored a high percentage of Cs (C = 67%) because they did not have access to any baling (KPI 2.6), shredding and crushing infrastructure or machinery (KPI 2.5). Additionally, they failed to reduce further contamination (KPI 2.2) of recyclable material because they did not have access to infrastructure that enabled effective source separation. Similarly, P1 and P2 also scored a high percentage of Cs (C = 67%) because they did not have access to any baling (KPI 2.6), shredding and crushing infrastructure or machinery (KPI 2.5), they did not reduce further contamination (KPI 2.2) of recyclable material nor did they have sufficient human capacity (KPI 2.1). However, they had access to machinery that collected and transported waste (A = 17%).

P3 performed better than the other case studies (A = 50%) because they had access to infrastructure and machinery that collected, transported (KPI 2.3) and sorted recyclable waste into various categories (KPI 2.4), in addition to having access to a baling machine (KPI 2.6). However, they did not have access to shredding and crushing machinery (KPI 2.5). Co-operatives

generally scored better in KPI 2.1, because they had sufficient human capacity with a much larger staff number compared to the private companies.

The main lessons from these reflections include:

- Sufficient human capacity increases the capacity to manually separate waste;
- Consistent/frequent access to (reliable) vehicles and equipment contributes towards collecting larger volumes of recyclable waste;
- Infrastructure and machinery are required to prevent further contamination of waste, and for effective source separation of all recyclable waste; and
- Machinery such as compactors and balers increase the amount of recyclable waste that can be stored and transported.

4.4.1.3 Comparing performance against KPA 3

The KPIs associated with KPA 3 were generally well-addressed by both models. Looking at the percentage of As scored by the co-operatives (75%), it is apparent that the co-operative model was slightly more effective in making provisions for a working environment that was lawful and safe, as shown in Figure 4-13.

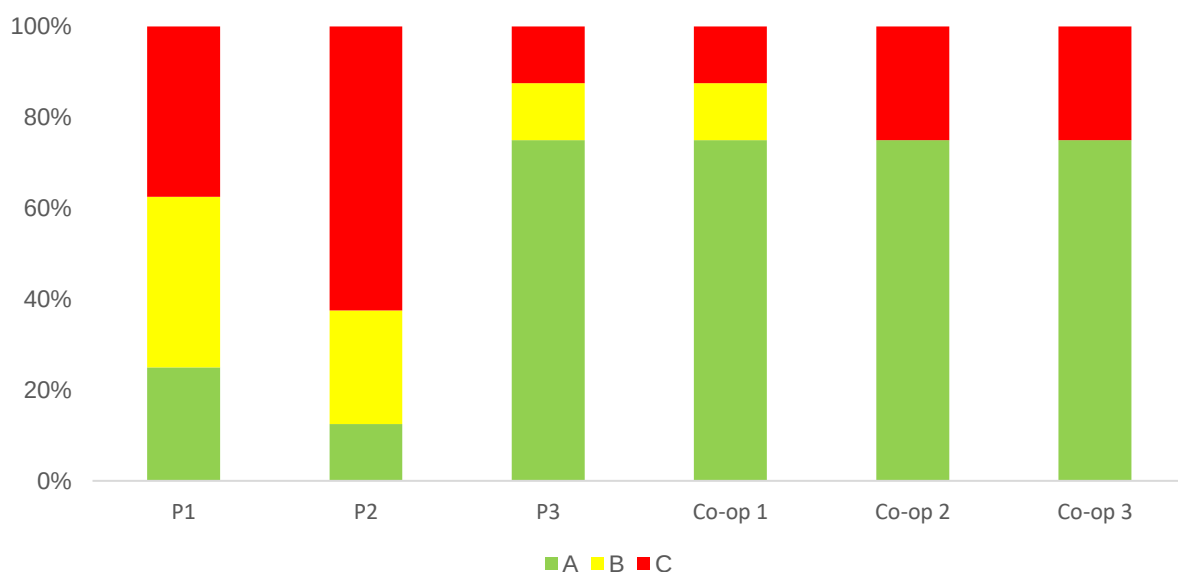


Figure 4-13: Overall performance evaluation percentage (A, B and C) for each case in KPA 3

The co-operatives:

- Provided a safe work environment (KPI 3.1),

- Identified and implemented applicable legal requirements (KPI 3.3) – mainly through their engagement with Pikitup,
- Monitored and reported on legal compliance (KPI 3.7), and
- Complied with relevant regulations and norms and standards (KPI 3.4 to 3.6).

Except for P3, the private companies generally performed poorer in these areas. All three private companies provided access to basic facilities and sanitation (KPI 3.2), but they generally did not have measures in place to identify, implement, monitor and report on legal compliance.

The main lessons from these reflections include:

- Access to basic facilities and sanitation is a basic human right and also enables a sanitary work environment;
- Training, awareness, toolbox talks and the provision of PPE provides for a safe working environment;
- Efforts must be made to identify applicable legislative requirements;
- Legal requirements must be implemented, monitored and reported on; and
- Corrective actions must be implemented for legal non-compliances.

4.4.1.4 Comparing performance against KPA 4

The KPIs associated with KPA 4 were generally well-addressed by both models (co-operative and private), with equality, personal growth and development being relatively well-addressed (Figure 4-14).

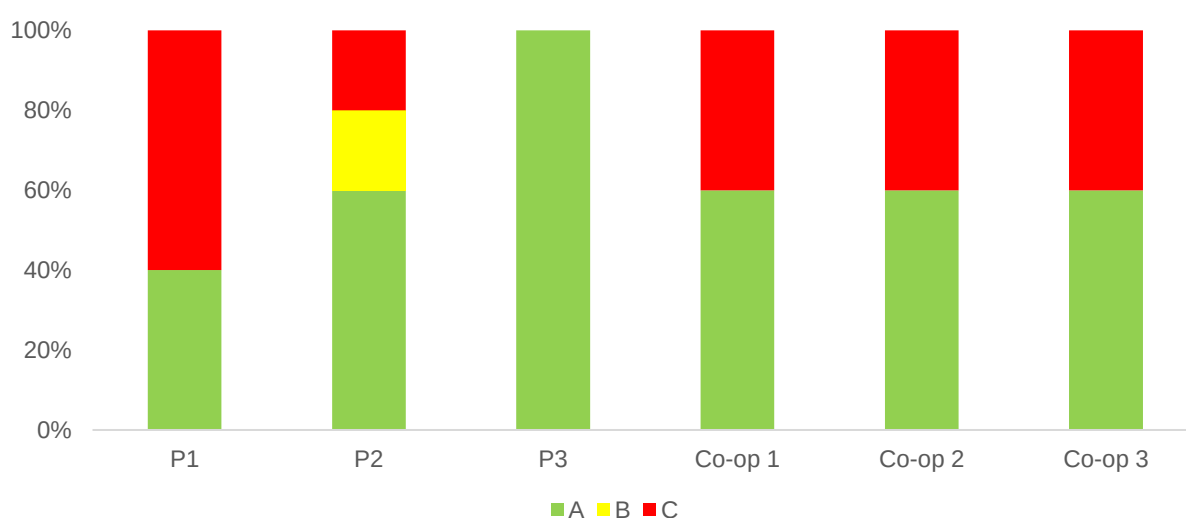


Figure 4-14: Overall performance evaluation percentage (A, B and C) for each case in KPA 4

It is apparent that both models were effective in making provisions for a working environment that promoted equality, personal growth and development, as shown in Figure 4-14.

An area for improvement by co-operative includes making provision for youth and disabled individuals (KPI 4.2) and providing opportunities for personal growth and skills development (KPI 4.5), whereas private models need to provide more opportunities for gender equality.

The main lessons from these reflections include:

- Waste separation models should provide for gender equality, persons with disabilities and the youth;
- It may be difficult to provide opportunities for disabled persons, due to the physical nature of waste source separation activities;
- Waste separation models should make a concerted effort to equip employees with the necessary skills and knowledge to cultivate their personal growth and development; and
- Due to the relatively low skills level required for source separation, it is possible to appoint local workforces, with limited schooling; and
- Providing employment opportunities to the local community can alleviate unemployment and encourage residents to engage in source separation activities.

4.4.1.5 Comparing performance against KPA 5

Apart from P3, which performed well, the KPIs associated with KPA 5 were poorly addressed by both models (co-operative and private). Again both models were ineffective in making provisions for active community participation through communication, education and awareness (with the exception of P3) (as shown in Figure 4-15).

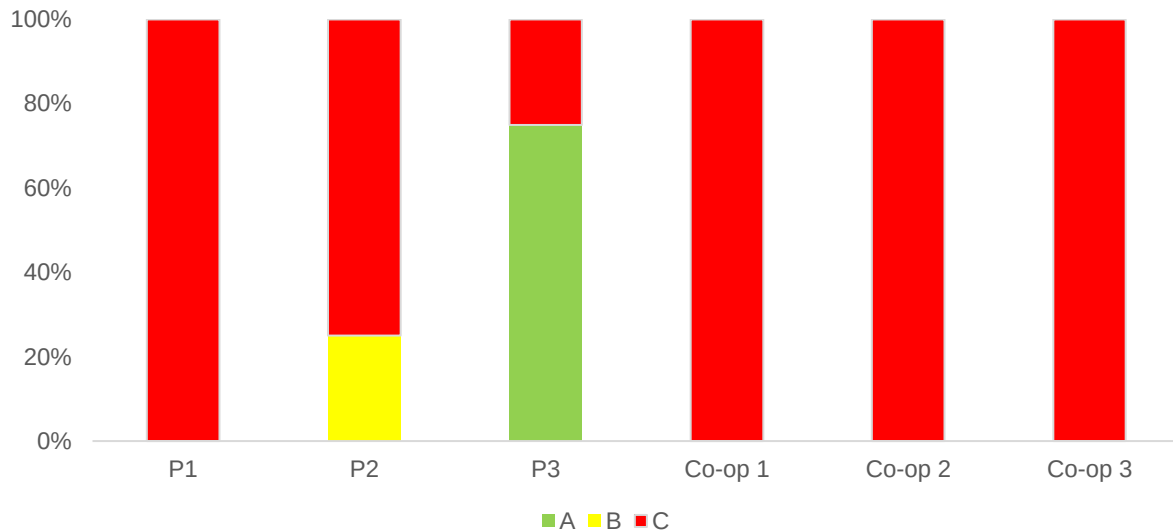


Figure 4-15: Overall performance evaluation percentage (A, B and C) for each case in KPA 5

A study conducted by Debrah *et al.* (2022), revealed that the lack of education and awareness programmes hinders the community's active participation in waste separation at source activities and reduces their contribution towards promoting sustainable waste management practices. Both source separation models (with the exception of P3) poorly addressed communication, education and awareness of communities towards the separation of waste at source.

The main lessons from these reflections include:

- Residents' contributions towards diverting recyclable waste away from landfill are extremely important towards achieving effective source separation of waste;
- The lack of effective education and awareness programmes has hindered residents' active participation in source separation activities;
- Existing awareness levels among the residents should be investigated and measures to increase these levels should be proposed;
- Programmes must be implemented to increase education and awareness of households regarding waste source separation. These programmes need to communicate the importance of households' roles in waste separation and diversion of waste from landfills.

4.5 Chapter summary

This research aimed to determine the effectiveness of private and co-operative waste source separation models. For this purpose, the performance of waste source separation models were determined by evaluating their practices against five KPAs. These included (1) Provision for the

separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input); (2) Provision for a working environment with sufficient capacity, infrastructure and machinery; (3) Provision for a working environment that is lawful and safe; (4) Provision for a working environment that promotes equality, personal growth and development and (5) Provision for active community participation through communication, education and awareness (RO1).

The effectiveness of each of the three private companies (P) and co-operatives (Co-op) were evaluated against the KPAs and associated KPIs. Performance evaluation scores (A to C) were assigned to indicate performance/effectiveness (RO2).

The effectiveness of both models (co-operative and private waste source separation) was compared using the overall performance scores achieved in each KPA (RO3).

- The private model effectively addressed KPIs related to KPA 1
- Both models ineffectively addressed KPIs related to KPA 2
- The co-operative model effectively addressed KPIs related to KPA 3
- Both models effectively addressed KPIs related to KPA 4
- Both models ineffectively addressed KPIs related to KPA 5

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This research aimed to investigate the effectiveness of private and co-operative waste source separation models in South Africa, by focusing on the northern parts of the City of Johannesburg, Gauteng, as a case study area. This section draws conclusions related to the three research objectives, provides recommendations for future waste source separation models, areas of future research and an overall conclusion.

5.2 Conclusions

Taking into consideration the extensive scope of what “effectiveness” could mean for waste separation at source, KPAs and KPIs were developed to evaluate each (waste source separation) model’s effectiveness (RO1). Survey questionnaires were utilised to collect the information (related to the KPIs) from three co-operatives and three private companies. The results (performance evaluation scores) from RO2 were used to compare the effectiveness of each model (RO3).

5.2.1 Conclusions related to RO1: Develop key performance areas (KPAs) and key performance indicators (KPIs) to evaluate the effectiveness of waste source separation models

The definition of effectiveness in the context of waste source separation was developed (section 3.5.1), and used as a guide to develop the key performance areas (KPAs). To establish the key performance indicators (KPIs) that evaluated the effectiveness of waste source separation models, a literature review consisting of existing publications was required. These publications included Agunwamba (2003), Al-Khatib *et al.* (2015), Fredick *et al.* (2018), Koushki *et al.* (2004), etc. Additionally, applicable policies and relevant legislative documents were also incorporated. This included the National Norms and Standards for the Storage of Waste, the National Norms and Standards for the Sorting, Shredding, Grinding, Crushing, Screening or Baling of Waste, and the National Waste Information Regulations. The following KPAs (with associated KPIs) were developed:

1. Provision for the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input), with ten associated KPIs.
2. Provision for a working environment with sufficient capacity, infrastructure and machinery, with six associated KPIs.

3. Provision for a working environment that is lawful and safe, with eight associated KPIs.
4. Provision for a working environment that promotes equality, personal growth and development, with five associated KPIs.
5. Provision for community participation through communication, education and awareness, with four associated KPIs.

Table 4-1 (p.51) provided an outline of all of the KPAs and their associated KPIs and will not be repeated here.

5.2.2 Conclusions related to RO2: Evaluate the effectiveness of co-operative and private sector waste separation models against developed KPIs

The following overall performance scores were achieved by private source separation models for KPA 1: 12 As, 6 Bs and 12 Cs. Two of the three private companies considered their businesses to be economically viable. All three of them kept their labour and operational costs low, separated recyclable material of a sufficient quality, and had access to sufficient markets (demands) for separated material. However, they did not generate an acceptable income from selling sorted material because they did not have sufficient quantities of recyclable waste or separated waste. This finding was supported by studies conducted by Godfrey and Scott (2020) and Mazhandu (2021), who highlighted that most companies choose to operate without weighbridges because they are expensive and they take up substantial space, therefore they do not have the precise tonnage records for the recycling material they handle. This further leads to these companies failing to keep their input costs at an acceptable level because they cannot accurately quantify the volumes of recyclable waste required to generate an acceptable income.

The following overall performance scores were achieved by private source separation models for KPA 2: 5 As, 4 Bs and 9 Cs. All three private companies had access to machinery that collected and transported recyclable waste, although the lack of adequate infrastructure or machinery that can shred, crush and bale recyclable material continues to negatively impact source separation process and hinder the implementation of sustainable waste management practices. Only one private company had access to infrastructure that could separate waste into various categories and had access to a baling machine. The other two private companies did not reduce further contamination of recyclable material. Asuse (2011) highlighted that waste materials that are source-separated at a household have better quality because they have minimal contamination.

The following overall performance scores were achieved by private source separation models for KPA 3: 9 As, 6 Bs and 9 Cs. Schenck and Blaauw (2011), emphasised the importance of

addressing employees' basic human needs to prevent the development of other environmental issues. All three private companies provided their employees with facilities and sanitation within the work environment and they fairly made provisions for a safe work environment. As for regulatory compliance and applicable legal requirements, only one private company performed well, with two of the private companies not identifying, implementing, monitoring or reporting legal requirements/compliance. This finding was supported by a study conducted by Nahman and Godfrey (2010), which indicated that unlicensed recycling and waste storage facilities contributed to the numerous challenges municipalities in South Africa faced.

The following overall performance scores were achieved by private source separation models for KPA 4: 9 As, 2 Bs and 4 Cs. Godfrey *et al.* (2017) emphasised the inclusion of all groups (i.e. PDIs, young people, disabled individuals, South African citizens, etc.) in the waste circular economy. The three private companies provided opportunities for previously disadvantaged individuals and local employment. Additionally, two of the three private companies provided opportunities for youth and/or disabled individuals (aligning with the Waste Picker Integration Guideline for South Africa), however, gender quality was not adequately addressed.

The following overall performance scores were achieved by private source separation models for KPA 5: 3 As, 1 B and 8 Cs. Private companies are significant role players in source separation activities because they can develop source separation education and awareness programmes that are tailor-made for their business and increase overall recycling rates. Only one private company inculcated a culture of source separation among the residents. They had continuous engagements with the residents and highlighted the importance of waste separation and diversion away from landfilling. Additionally, the impact of educating residents regarding proper source separation practices was evident because this company received sufficient quality of recyclable waste. On the other hand, it seems source separation education and awareness were not adequately prioritised by the other two private companies.

The following overall performance scores were achieved by co-operative source separation models for KPA 1: 3 As, 12 Bs and 15 Cs. The three co-operatives had sufficient access to market (demands) for separated waste, but they failed to adequately address half of the KPIs. They specifically indicated the lack of financial incentives from external sources. Godfrey *et al.* (2017) emphasise the need for municipalities to develop strategies that reduce co-operatives' dependence on government funding and other handouts so that the benefits highlighted by Gutberlet (2013) and Silva de Souza Lima and Mancini (2017) can be realised.

The following overall performance scores were achieved by co-operative source separation models for KPA 2: 3 As, 3 Bs and 12 Cs. All the co-operatives had sufficient human capacity but

they were unable to use it effectively because they did not receive consistent volumes of recyclable waste. Co-operatives generally did not have access to sufficient infrastructure, machinery and equipment, such as covered, secured buildings, balers and compactors. A study conducted by Bala *et al.* (2021) supported this finding by stating that challenges such as lack of operational structure contribute towards co-operatives' high failure rate.

The following overall performance scores were achieved by co-operative source separation models for KPA 3: 18 As, 1 B and 5 Cs. The co-operatives provided access to safe and sanitary working environments and had mechanisms in place (through Pikitup) to identify and implement legal requirements. Taking into consideration the special arrangement these co-operatives have with Pikitup, they would be obligated to comply with regulations and applicable legal requirements.

The following overall performance scores were achieved by co-operative source separation models for KPA 4: 6 As, 6 Bs and 3 Cs for KPA 4. The co-operatives made adequate provisions for the promotion of equality (gender, youth, disabled individuals and local employment). According to Godfrey *et al.* (2017), the South African government perceive co-operatives as a development vehicle to support job creation and sustainable waste management. When looking at the KPIs adequately addressed in KPA 4, it is clear that the co-operative model successfully fosters this idea. The opportunities to improve employees' personal growth and skills development were, however, limited and remain an area for improvement.

The following overall performance scores were achieved by co-operative source separation models for KPA 5: 0 As, 0 Bs and 12 Cs. All three co-operatives poorly addressed the KPIs linked to KPA 5, with insufficient provision for community participation in waste separation through communication, education and awareness. Schoeman and Rampedi (2022b) stated that a generic source separation programme does not cater to the country's socio-economic disparities. Further stating that the factors that influence residents' waste source separation behaviour should be understood to develop effective education and awareness programmes.

5.2.3 Conclusions related to RO3: Comparing the effectiveness of co-operative and private sector waste separation models with the aim of making recommendations for future waste source separation models

The private model was more effective in addressing KPIs linked to KPA 1, even though both models were fairly effective in ensuring the separation of sufficient quantity and quality of recyclable waste (output) at an acceptable level of resources (input). Both models were ineffective in providing a working environment with sufficient capacity, infrastructure and machinery (KPA 2). While the three private companies did not have sufficient human capacity, the co-operatives

indicated that they lacked the necessary machinery to effectively sort material and reduce further contamination of recyclable material upon collection and transportation.

The co-operative model was, generally, more effective in making provisions for a lawful and safe working environment (KPA 3) than the private waste separation model. This was mainly due to their relationship with Pikitup, which provides for the identification, implementation, monitoring and reporting of legal requirements related to waste storage, separation and reporting information.

Both models were effective in making provisions for a working environment that fostered equality, personal growth and development (KPI 4), with P3 adequately addressing all KPIs. There were a few KPIs P1 and P2, as well as the co-operatives, did not adequately address but overall both models performed well with regards to KPA 4.

Both models were generally ineffective in making provisions for active public involvement through communication, education and awareness (KPA 5), with the exception of P3.

Based on these findings, the following recommendations (Section 5.3) for the improvement of future source separation models are made.

5.3 Recommendations for improvement of future source separation models

Adeleke *et al.* (2021) as well as Nahman and Godfrey (2010), highlighted that ineffective waste minimisation practices contribute towards municipalities' waste management challenges. Therefore, implementing effective waste source separation systems, whether they are based on private or co-operative models, is crucial.

To improve the effectiveness of future waste separation models or systems, the following recommendations are made:

- **Improve the accuracy of tonnage records of collected and separated/sorted waste materials:** It is advised that future waste separation models make provision for the capturing of volume/weight data of the waste that they receive and the waste that they separate and eventually sell to buy-back centres for re-use, recycling and/or recovery. Acquiring accurate tonnage records for the recyclable waste received will provide source separation models with the information required to plan, coordinate, and manage their activities, workforce and resources accordingly. This information should, ultimately feed into the provincial or national waste information system, as required by the National Waste Information Regulations (GNR. 625 of 2012). The potential implication would be that co-operatives and private waste management companies would be able to generate substantial profit while keeping costs at an acceptable level by planning based on accurate tonnages records.
- **Provide for adequate infrastructure and machinery:** As emphasized by Godfrey *et al.* (2017), access to adequate infrastructure and machinery is vital towards the success of any

waste separation model. Both private and co-operative waste separation models should make provisions for access to infrastructure and machinery that can bale, shred or crush recyclable material. This increases the weight: volume ratio of waste for more effective storage and transportation of waste. Co-operative models, which may not have access to sufficient capital funds to acquire buildings, infrastructure and machinery, may need to seek external funding, such as municipal infrastructure grant (MIG) or DSI Waste Roadmap funding (Godfrey *et al.*, 2017). Other options may include borrowing or hiring machinery or providing communal facilities for those involved in the waste separation industry. The potential limitation would be the accessibility to adequate resources (various factors can affect resource allocation).

- ***Provide for safe and sanitary working conditions:*** Although the current waste separation models investigated generally provided for safe working conditions (i.e. training, PPE, work instructions/SOPs etc.), access to sufficient sanitation facilities (toilets and washrooms) were not consistently provided. Source separation models should make provision for the necessary sanitation of their workers. Schenck and Blaauw (2011) highlight the importance of providing access to basic infrastructure and sanitation services to ensure the dignity, health and safety of waste source separation workers. The potential implication would be that the worker's health and safety is ensured and that workers are efficient.
- ***Increase human capacity:*** The efficiency and effectiveness of the manual sorting and source separation of waste is highly dependent on sufficient manpower and human capacity. However, labour costs may be a limiting factor towards achieving a business model which is financially viable. Source separation models should make provision for sufficient human capacity, especially where waste is sorted manually. When employing people, it is important to provide opportunities for the youth, disabled persons, and previously disadvantaged individuals, as proposed by the *Guideline for Waste Picker Integration* (DEFF & DSI, 2020). Furthermore, employment opportunities should make provision for gender equality and local employment. It is also important to improve the capacity of the workforce through continuous education, awareness and skills development. The potential limitation would be that increased labour does not directly translate to increased profitability.
- ***Ensure compliance with legal requirements:*** Source separation models should provide mechanisms to identify, implement and monitor/report compliance to applicable legal requirements. These include national, provincial and local strategies, policies, laws and regulations. The reasons for non-compliances should be identified, and measures should be implemented to address these non-compliances. The potential limitation would be the lack of awareness of applicable laws and policies.
- ***Improving communication, awareness and educational programmes with waste generators:*** The behaviour of waste generators (i.e. households, businesses, etc.) plays an important role in waste separation at source. For source separation models focusing on collecting waste from households, residents' existing awareness levels need to be investigated so that educational programmes can be tailor-made (for each area) based on those findings. Furthermore, these programmes need to emphasise the importance of source separation at a household level, while highlighting the importance of residents' active involvement in diverting waste away from landfill sites. The potential implication would be residents' increased awareness levels and active involvement in waste source separation activities and initiatives.

5.4 Areas of future research

The study's limitations and conclusions suggest the following areas for future research:

- Because there is limited research done on the effectiveness of waste source separation models, it is recommended that this research be replicated in other municipalities in South Africa, also focusing on other types of waste source separation models.
- This research had six cases (three co-operatives and three private companies), therefore limiting comparisons (correlations/associations). For future research, it is recommended that the sample size of “source separation” models be increased to provide for more in-depth statistical analysis.
- The research findings were limited to the northern parts of Johannesburg, Gauteng. It is recommended that the geographic area be broadened to provide for additional learning in other parts of South Africa.
- Future research on the legal compliance of source separation models is recommended. The identification, implementation and monitoring/reporting of legal compliance was identified as a weakness during this research.
- This research found that residents’ active participation in source separation activities was low. This could be attributed to insufficient communication, education, and awareness programmes for the source separation models investigated. Research to investigate households’ waste separation behaviour and existing awareness levels may be beneficial towards understanding the factors influencing waste separation at source.

5.5 Overall conclusion

An effective waste source separation model makes provision for the separation of sufficient quantity and quality of recyclable waste using an acceptable amount of resources (human, financial) within a working environment that has sufficient capacity (human, infrastructure, facilities, technology), that is lawful and safe, and that promotes equality, personal growth and development, whilst also ensuring community participation through communication, education and awareness. Overall, both waste source separation models were ineffective. However, each model made adequate provisions in some key performance areas i.e. the private sector model made adequate provisions in KPAs 1 and 4, while the co-operative model made adequate provisions in KPAs 3 and 4.

Looking at the findings, each model made sufficient provisions in certain KPAs, although challenges in effectively making provisions for KPAs 2 and 5 necessitates a need for collaborative deliberation.

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ANNEXURE A

Google forms survey used to collect responses related to each key performance indicator (KPI)

5/28/23, 7:44 PM

Invitation of participate in a research study on waste source separation models in Gauteng

Invitation of participate in a research study on waste source separation models in Gauteng

Introduction

You are invited to participate in a research study conducted by Mmathabo Thibela under the supervision of Prof Claudine Roos. The study is entitled "Investigating waste source separation models in Gauteng: Private sector versus co-operatives" and aims to compare the effectiveness of private sector and co-operative source separation models in the northern parts of Johannesburg, South Africa.

Your company/co-operative was

purposely selected as a participant in this research study reason being this study will focus on waste separation at source and recycling activities in which your company is directly involved. The questionnaire completion time is approximately 15-35 minutes.

This research study will form part of a Master's dissertation which will be submitted in fulfilment of the requirements for the MSc. Degree in Geography and Environmental Management at the North-West University: Potchefstroom Campus.

Definitions

Waste separation at source- the process of separating waste material by its source products, e.g. glass, plastic, paper or metal.

Residual waste- materials considered non-recyclable after sorting has been done (e.g. food waste, green waste, etc.)

Potential benefits

The study will

contribute to the limited research done in South Africa regarding the effectiveness of implemented source separation models. It will further provide insight into why these source separation models have yet to be fully rolled throughout Johannesburg.

Confidentiality

The records from this study will be kept as confidential as possible, including your identity. The information obtained will be used exclusively for research and no other purpose. The following information will be required amongst other things: (1) Employee Information; (2) Education and Awareness programme ; (3) Infrastructure and Machinery; (4) Profitability; and (5) Waste Information.

The necessary approval to conduct the research study has been obtained from the North-West University, Faculty of Natural and Agricultural Science Ethics Committee (NWU-

https://docs.google.com/forms/d/1d_eOv5c-uAGUpGAHHmJMIq8ChzI9csLPGHVCHKJQQ/edit

1/17

Your participation in this research study is voluntary. Your responses will be collected anonymously and will only be used for the purposes of this research. E-mail addresses will not be disclosed, but are collected solely for the purposes of potential follow-up.

Please complete the entire questionnaire and then click "submit" when you have completed the survey.

** Indicates required question*

1. Please provide your email address. *

2. I hereby give consent and are willing to participate in the survey? *

Mark only one oval.

☐ Yes *Skip to question 3*

☐ No

1. Provision for a model that makes provision for the separation of sufficient quantity and quality of recyclable waste (output), at an acceptable level of resources (input)

3. 1.1 Please select the (total) tonnages of mixed recyclable waste collected in 2022. *

Mark only one oval.

☐ Less than 400t

☐ 401 - 500t

☐ 501 - 600t

☐ 601t - 700t

☐ Above 701t

☐ I do not have the tonnages

4. 1.2 Please select the (total) tonnages of recyclable waste sorted in 2022. *

Mark only one oval.

- ☐ Less than 400t
- ☐ 401 - 500t
- ☐ 501 - 600t
- ☐ 601t - 700t
- ☐ Above 701t
- ☐ I do not have the tonnages

5. 1.2.1 Please select the (total) tonnages of recyclable waste (per category) sorted in 2022. *

Mark only one oval per row.

	0 - 100t	101 - 250t	251 - 500t	501 - 750t	above 750t	N/A
Can	☐	☐	☐	☐	☐	☐
Plastic	☐	☐	☐	☐	☐	☐
Glass	☐	☐	☐	☐	☐	☐
Paper	☐	☐	☐	☐	☐	☐
Tyre	☐	☐	☐	☐	☐	☐
E-waste	☐	☐	☐	☐	☐	☐
Polystyrene	☐	☐	☐	☐	☐	☐
Residual	☐	☐	☐	☐	☐	☐

6. 1.3 Which of the following waste receptacles do you provide or collect from residents? *

Mark only one oval.

- ☐ Recycling bins
- ☐ Recycling plastics
- ☐ All the above
- ☐ None of the above

7. 1.3.1 Are your waste receptacles full of recyclable waste upon collection? *

Mark only one oval.

- ☐ Yes, They full of mixed recyclable waste
- ☐ Yes, They are full of recyclable waste only
- ☐ No, They are half-empty upon collection
- ☐ No, They are full of non-recyclable waste

8. 1.3.2 Please select the (total) tonnages of residual waste in 2022 (per annum). *

Mark only one oval.

- ☐ Less than 50t
- ☐ 51 - 100t
- ☐ 151 - 200t
- ☐ 201t - 300t
- ☐ Above 301t
- ☐ I do not have the tonnages

9. 1.4 Is your business model economically viable? *

Mark only one oval.

- ☐ Yes, I believe it is viable
- ☐ No, I do not believe it is viable
- ☐ I am uncertain

10. 1.5 Please select the price per tonne (R/kg) for the sorted waste in 2022 (per category). *

Mark only one oval per row.

	Less than R2.50/kg	R2.51/kg - R5/kg	R5.01/kg - R7.50/kg	R7.51/kg - R9.50/kg	Above R9.50/kg	N/A
Can	☐	☐	☐	☐	☐	☐
Plastic	☐	☐	☐	☐	☐	☐
Glass	☐	☐	☐	☐	☐	☐
Paper	☐	☐	☐	☐	☐	☐
Tyre	☐	☐	☐	☐	☐	☐
E-waste	☐	☐	☐	☐	☐	☐
Polystyrene	☐	☐	☐	☐	☐	☐

11. 1.6 Do you receive any of the following financial incentives? choose any *

Check all that apply.

- ☐ Tender contracts
- ☐ Sponsorships
- ☐ Awards (Prize money, machinery, etc.)
- ☐ Grants
- ☐ Loans
- ☐ None of the above

12. 1.7 Please select an estimate of the income generated (from selling sorted material) in 2022. *

Mark only one oval.

- ☐ 0 - R500 000
- ☐ R500 001 - R1 000 000
- ☐ R1 000 001 - R5 000 000
- ☐ Above R 5 000 000

13. 1.8 Does your output income exceed your working capital? *

Mark only one oval.

- ☐ Yes, I believe it does
- ☐ No, I do not believe it does
- ☐ I am uncertain

14. 1.9 Please select an estimate of the (total) labour costs (staff salaries) incurred in 2022. *

Mark only one oval.

- ☐ 0 - R500 000
- ☐ R500 001 - R1 000 000
- ☐ R1 000 001 - R5 000 000
- ☐ Above R 5 000 000

15. 1.10 Please select an estimate of the following operational costs incurred in 2022. *

Mark only one oval per row.

	0 - R500 000	R500 001 - R1 000 000	R1 000 001 - R5 000 000	Above R 5 000 000	N/A
Fuel/maintenance of trucks	☐	☐	☐	☐	☐
Utilities (Water & Power)	☐	☐	☐	☐	☐
Site Rental	☐	☐	☐	☐	☐

2. Provision for a working environment with sufficient capacity, infrastructure and machinery

16. 2.1 Please provide an estimate (number) of your staff complement. *

17. 2.2 What measures have you developed to ensure that the recyclable material is not contaminated further (during collection, transportation, and sorting)? *

18. 2.3 Do you have access to trucks for the collection and transportation of recyclable waste? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

19. 2.3.1 How often do you collect recyclable waste from residents? *

Mark only one oval.

- ☐ Once a week
- ☐ Twice a week
- ☐ Three times a week
- ☐ Week days only
- ☐ Weekends only
- ☐ Every day of the week

20. 2.4 Do you have access to a secure sorting facility? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

21. 2.4.1 Do you have access to waste sorting equipment or is sorting done by hand? *

Mark only one oval.

- ☐ Access to waste sorting machine
- ☐ Sorting is done by hand
- ☐ All the above
- ☐ None of the above

22. 2.5 Do you have access to a shredder and/or crusher? *

Mark only one oval.

- ☐ Yes, I only have access to a shredder
- ☐ Yes, I only have access to a crusher
- ☐ Yes, I have access to both
- ☐ No, I do not have access to both

23. 2.6 Do you have access to a bailing machine? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

3. Provision for a working environment that is lawful and safe

24. 3.1 How often do you provide the following? *

Mark only one oval per row.

	Twice a year	Once a year	Never
Personal Protective Equipment	☐	☐	☐
Occupational Safety and Health training	☐	☐	☐
Remarking of heavy machinery	☐	☐	☐

25. 3.1.1 What measures are in place to reduce injuries on duty? *

26. 3.1.2 Do you provide your employees with the following? *

Mark only one oval per row.

	Yes	No	N/A
Medical care (when injured on duty)	☐	☐	☐
Standard operating procedures	☐	☐	☐

27. 3.2 Which of the following amenities do your employees have access to? *

Check all that apply.

- ☐ Taps with clean drinking water
- ☐ Ablution facilities (flushing toilets)
- ☐ Covered shelter
- ☐ Wash basins
- ☐ None of the above

28. 3.3 Do you have processes in place to ensure regulatory compliance? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

29. 3.3.1 Are these processes amended subject to the change in applicable laws? *

Mark only one oval.

- ☐ Yes, they are always amended
- ☐ Yes, they are occasionally amended
- ☐ No, they are never amended
- ☐ I am uncertain

30. 3.4 Have you registered your facility with the competent authority according to the national norms and standards for the storage of waste? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

31. 3.5 Do you comply with the national norms and standards for the sorting, shredding, grinding, crushing, screening or baling of waste? *

Mark only one oval.

- ☐ Yes
☐ No
☐ I am uncertain

32. 3.6 Are you registered on the SAWIS (South African Waste Information System)? *

Mark only one oval.

- ☐ Yes
☐ No
☐ I am uncertain

33. 3.6.1 Which competent authority do you report your waste information to? *

Check all that apply.

- ☐ PIKITUP SOC LTD
☐ EISD (City of Johannesburg)
☐ GDARD
☐ None of the above

34. 3.7 Do you perform the following activities? *

Mark only one oval per row.

	Yes	No	N/A
Monitor and track information	☐	☐	☐
Conduct audits	☐	☐	☐
Report (duty related) incidents	☐	☐	☐
Inspect machinery and equipment	☐	☐	☐

35. 3.8 What measures do you have in place to prevent or address non-compliance? *

4. Provision for a working environment that promotes equality, personal growth and development

36. 4.1 How many (number) female employees do you have? *

37. 4.1.1 How many (number) male employees do you have? *

38. 4.2 How many (number) young and/or disabled employees do you have? *

39. 4.3 How many (number) previously disadvantaged individuals have you provided with employment opportunities? *

40. 4.4 How many (number) individuals from the local community (South Africa citizens) have you provided with employment opportunities *

41. 4.5 Have you provided your employees with the following opportunities? choose any *

Check all that apply.

- ☐ Educational support (bursary, books, etc.)
- ☐ Financing of skills development training
- ☐ Learnership
- ☐ None of the above

42. 4.5.1 Have your employees received any of the following skills development training before? choose any *

Check all that apply.

- ☐ Leadership and decision-making
- ☐ Conflict management
- ☐ Communication
- ☐ Financial management
- ☐ Administration
- ☐ Group dynamics
- ☐ None of the above

5. Provision for active community participation through communication, education and awareness

43. 5.1 Does your separation at source educational programme educate residents regarding various waste streams? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

44. 5.2. Is your separation at source educational programme interactive? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

45. 5.3 Does your educational programme educate residents regarding proper source separation practices (at a household level)? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

46. 5.4 Does the participation rate increase when new residents are educated regarding separation at source? *

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ I am uncertain

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