

Investigating solid waste management in unserviced rural areas: A case study of Matobole Village, Limpopo Province

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PREFACE AND ACKNOWLEDGMENTS

The lack of waste management services in developing countries often leads to undesirable waste management practices, which may cause detrimental impacts to the environment. The aim of this research was to investigate solid waste management in unserved rural areas using Matobole Village in the Limpopo Province as a case study. The research objectives were to determine solid waste management practices and explore challenges and opportunities for solid waste management in Matobole Village, with the view of making recommendations for improvement.

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ABSTRACT

Municipalities are mandated by the Constitution of the Republic of South Africa (RSA) to provide waste management services; however, most South African municipalities are struggling to provide these services due to a lack of funding, inadequate infrastructure, unsuitable equipment, and shortage of skilled personnel. The *National Domestic Waste Collection Standards* (GN 21 of January 2011) requires that equitable waste collection be provided to all South Africans. However, the gap between waste collection services rendered in urban and rural areas remains significant. South African rural areas are generally receiving inadequate, failed or no waste collection services. Residents in these unserved areas are many times left to their own devices to find a means of managing their waste. The consequence, more often than not, being that waste either ends up being illegally dumped in open spaces, being buried, or being burned in an uncontrolled manner.

This research aimed at investigating solid waste management in unserved rural areas focusing on Matobole Village in Limpopo Province. For this purpose, structured survey questionnaires were administered to a sample of 238 households in Matobole village, with the view of: (1) determining solid waste management practices and (2) exploring waste management challenges and opportunities in the village. A total of 205 households responded to the survey (86% response rate).

According to the results of the survey, the respondents generate food waste more than any other type of waste. The absence of waste storage infrastructure encouraged the use of old buckets, and plastic carrier bags for waste storage, and wastes were, generally, not separated at source. Limited waste streams, such as food and beverage containers or packaging, plastic and glass are informally reclaimed for potential recycling. Other waste streams, such as food waste, are used for purposes such as animal feeding. Although waste collection services were partially being rendered to households in Matobole village since May 2022, the majority of the village (approximately 89% of households) are still largely unserved with regards to waste collection. The lack of waste collection mostly led to undesirable methods of waste disposal. The most frequently used methods of waste disposal in the rural households surveyed included backyard burning or burying of waste. Respondents argued that these methods of disposal were inexpensive and convenient for rural households. Waste management challenges mentioned by the respondents included, amongst others, infrequent waste collection services, a lack of storage infrastructure, no funds to buy own refuse bags or bins, inappropriate waste disposal methods, lack of communication, awareness and education, and unavailability of space for waste disposal. Waste-related opportunities suggested by respondents included: income generation through recycling and job creation, creating a cleaner and safer environment, and improving knowledge and awareness on waste management.

Keywords: Solid waste, solid waste management, rural areas, unserved areas, waste collection services.

ABBREVIATIONS AND ACRONYMS

CBO	Community-based organisation
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism
DEFF	Department of Environment, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries and Environment
ECA	Environmental Conservation Act
EPA	Environmental Protection Agency
EPWP	Expanded Public Works Programme
EU	European Union
IDP	Integrated Development Plan
IWMP	Integrated Waste Management Plan
MTSF	Medium Term Strategic Framework
MDGs	Millennium Development Goals
MSW	Municipal Solid Waste
NDP	National Development Plan
NGOs	Non-Governmental Organisations
NPO	Non-profit Organisation
NEMA	National Environmental Management Act
NEMWA	National Environmental Management Waste Act
NEMWAA	National Environmental Management Waste Amendment Act

NWA	National Water Act
NWMS	South African National Waste Management Strategy
PLM	Polokwane Local Municipality
RSA	Republic of South Africa
SDGs	Sustainable Development Goals
SWM	Solid Waste Management
UNEP	United Nations Environment Programme

KEY DEFINITIONS

Collection: The gathering of identified products at the end of their lives, at the place of its generation or storage by a waste picker, collector or reclaimer or service provider (DEFF, 2021).

Disposal: Means the burial, deposit, discharge, abandoning, dumping, placing or release of any waste into, or onto, any land (DEA, 2009).

Household: A collection of individuals staying on a distinctive property and/or premises regardless of their relationship to one another (DEA, 2010).

Indigent household: Any household that is at or below the poverty threshold as determined by the concerned municipality (DEA, 2011c).

Recycling: A process where waste is reclaimed for further use, which process involves the separation of waste from a waste stream for further use and the processing of that separated material as a product or raw material (DEA, 2008).

Reuse: To utilise the whole, a portion of or a specific part of any substance, material or object from the waste stream for a similar or different purpose without changing the form or properties of such substance, material or object (DEA, 2014).

Rural areas: Sparsely populated areas in which people farm or depend on natural resources, including villages and small towns that are dispersed through these areas (Rural Development Framework, 2000)

Solid waste: The unwanted and discarded material resulting from day to day activities in the community (Mishra *et al.*, 2014)

Solid waste management: The discipline associated with the control of generation, storage, collection, transfer, processing and disposal of solid waste (Mishra *et al.*, 2014)

Storage: The accumulation of waste in a manner that does not constitute treatment or disposal of that waste (DEA, 2008).

Unserviced areas: Areas which have either inadequate collection services, failed collection services, or have never had any form of waste collection. High-density unserviced areas may include informal settlements and formal high-density housing developments. Both areas can be regarded as low-income areas with high rates of unemployment (DEAT, 2001).

Waste: According to the amended definition of “waste” in the National Laws Amendment Act (2 of 2022), 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 reused, 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 reused, 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 paragraph (a) and (b) ceases to be a waste-*

(aa) once it is reused, recycled or recovered or traded in by the holder of the waste or portion of waste in accordance with a condition stipulated in a valid waste management license, 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 the waste stream by it or any other person and committed to provide the Minister with annual reports of the use thereof (South Africa, 2022).

Waste management services: Means waste collection, treatment, recycling and disposal services (DEA, 2008)

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CHAPTER 1 INTRODUCTION

1.1 Background

Waste management remains a challenge in Africa due to corruption, low public awareness, political conflicts and instability, poor service delivery, weak legislation, and lack of enforcement (Godfrey *et al.*, 2019). The demand for sustainable waste management services (according to the waste management hierarchy, which prioritises waste prevention followed by reduction, reuse, recycling, recovery, and treatment/disposal) outstrips the supply because most of the services focus on waste collection and disposal only [United Nations Environment Programme (UNEP), 2018]. Despite this, only a fraction of the generated waste is collected in urban areas and even less in rural areas (Rodseth *et al.*, 2020). Mihai (2017) states that an estimated 1.9 billion people lack waste collection services.

The responsibility of providing waste services in most African countries including South Africa lies with the local government. However, most of them are struggling to provide for such services effectively as they do not have the technical or financial capacity to do so. As a result, the private sector has taken the role of providing these services and infrastructures, but at a higher price and only to those who can afford to pay. Some municipalities have partnered with the private sector and community-based organisations (CBOs) to provide cost-effective and efficient waste services leading to improvements in the provision of solid waste collection. Despite these improvements, millions of tons of waste are still being dumped and less is recycled (UNEP, 2018). To address these challenges, a number of continental and regional policies, strategies, international conventions and country-specific legislation have been developed. One of the continental policies developed is the 'Agenda 2063: The Africa we want', which aims for a high standard of living, quality of life and wellbeing for all citizens by providing basic quality services including waste management (UNEP, 2018).

Waste disposal, via land, ocean and river dumping, of the collected waste prevails in Africa. Controlled and uncontrolled dumping is common since it is considered the most convenient waste management practice. It occurs as a result of, amongst others, a lack of funds, a lack of waste management planning, a small market for recyclables, irregular waste collection services, poor environmental awareness, poor waste management infrastructure, resistance to change and social behaviour (Mihai & Taherzadeh, 2017). These challenges together with challenges associated with separation at source, waste collection and diversion of waste away from landfills lead to the emergence of social and technical innovations in the African continent as tools to address them (UNEP, 2018).

1.2 Problem statement and rationale for the study

Despite improvements in waste management since implementing the South African National Waste Management Strategy (NWMS) in South Africa in 2011, waste management remains a challenge, particularly in rural areas [Department of Environment, Forestry and Fisheries (DEFF), 2020]. Waste generation results from human-induced activities, such as consumption patterns, economic development, population growth and urbanisation (Nyika *et al.*, 2019). In 2017, 121 million tons of waste was generated compared to 108 million tons in 2011 [Department of Environmental Affairs (DEA), 2011a and 2018]. Poor waste collection services and disposal practices are prevalent, and the gap in service provision and disposal practices between rural and urban areas is enormous (Rodseth *et al.*, 2020).

The 2011 National Waste Management Strategy was structured around a framework of eight goals to address waste management challenges in South Africa. Goal 2 of NWMS 2011 targeted to provide *adequate waste collection services to at least 95% of urban households and 75% of rural households* (DEA, 2011a). However, the revised NWMS of 2020 indicated that municipalities are still implementing least cost methods for collection and disposal of waste while municipalities are still not providing waste collection in rural areas (DEFF, 2020). Separation at source programmes have been introduced in some metropolitan areas but there is still backlog in the delivery of waste services in most municipalities due to inconsistent waste collection, lack of recycling infrastructure and culture, and lack of education and awareness (DEFF, 2020). Pillar 2 of the 2020 NWMS focuses on “*effective and sustainable waste services*”. One of the focus areas of Pillar 2 highlights the importance of “*Waste Collection including separation at source*”.

The responsibility of providing waste management services (here, waste collection and disposal) is placed on municipalities by the Constitution of the Republic of South Africa Act 108 of 1996 (Constitution). *The National Domestic Waste Collection Standards* (GN 21 of January 2011) aims to bring equality in the provision of waste collection services and to ensure that the services provided to all South Africans are acceptable, affordable and sustainable (DEA, 2011b). Waste collection services are important as they improve the quality of life in communities and ensures a clean and acceptable living and working environment. Furthermore, the *Guideline on Waste Collection in high density and unserviced areas* was developed to assist municipalities to implement the NWMS as it became clear during its development that attention needs to be paid to densely settled and unserviced areas. These are areas with more households that receive inadequate, failed or no waste collection services at all. The main aim of these guidelines is to introduce appropriate general waste collection systems in these areas [Department of Environmental Affairs and Tourism (DEAT), 2001].

Municipalities struggle to provide these services in rural areas due to numerous challenges, including budget constraints; a lack of infrastructure, proper equipment, treatment centres, and road access; and collection distances (Rodseth *et al.*, 2020; Viljoen *et al.*, 2021). As a result of these challenges, households resort to waste management practices contradicting the waste management hierarchy, such as burning and illegal dumping (Nyika *et al.*, 2019). These practices harm the environment and human health (Shah *et al.*, 2012). The opportunity thus exists for the investigation of solid waste management, i.e. practices, challenges and opportunities, in unserviced rural areas.

For this purpose, an unserviced village in the Limpopo Province, Matobole Village, was selected as a case study. Prior to May 2022, the village was not receiving any form of waste management services, including collection by the municipality. For this reason, households were and are still managing their own waste and disposing it in a manner suitable to them but contradicting the requirements of the waste management hierarchy.

1.3 Research aim and objectives

The research aimed to investigate solid waste management practices in unserviced rural areas using Matobole Village in the Limpopo Province as a case study, with the view of making recommendations for improvement.

The research objectives were to:

1. **Research objective 1:** Determine solid *waste management practices* in Matobole Village
2. **Research objective 2:** Explore *challenges and opportunities* for solid waste management in Matobole Village

1.4 Scope of the research

This study focused on Matobole Village, with 623 households, located in Polokwane (Polokwane Local Municipality) in Limpopo, South Africa. This village was selected based on its geographical proximity, which made it convenient for the researcher to reach the study site, and the non-existence of waste collection services. Two hundred and thirty-eight (238) households were targeted for inclusion in the study to provide a representative sample of respondents based on the number of households in the area. Only solid waste management practices were included in the scope of the study, and the research did not focus on liquid wastes or sewage. The research largely focused on municipal solid waste (MSW) and did not include industrial, business or hazardous waste streams. Data collection involved conducting structured survey questionnaires.

Two visits were made to each of the sampled households between 16 June and 30 July 2022. Electronic and paper-based structured survey questionnaires were administered on the first visit, whilst the second visit was dedicated to collecting paper-based questionnaires, where applicable.

1.5 Assumptions and limitations

Apart from the limitations related to the scope of the research (limited to Matobole Village in the Limpopo Province), the following additional assumptions and limitations must be noted:

- The research only focused on solid waste. No other types of waste, e.g. liquid, were included in the scope of the study.
- The findings of this study relate to solid waste data gathered in one year (from January 2022 to October 2022). It is assumed that the data represents what is reasonably expected in a 'normal year'. It must be noted that exceptional circumstances, such as the COVID-19 restrictions, may influence solid waste data gathering. These exceptional circumstances are not provided for in this research.
- The results of this research aim to contribute to an expanded understanding of how solid waste is currently managed in unserved rural areas such as Matobole Village in the Limpopo Province and does not necessarily represent what may be expected in other unserved rural areas in South Africa.
- It is assumed that the responses of respondents participating in the structured survey questionnaire administered to a sample of households were truthful and representative of the practices, challenges and opportunities related to solid waste management in Matobole Village in the Limpopo Province in general.
- The research only focused on households headed by able-bodied adults. No households headed by minors or incapacitated adults were included in the scope of the study.

Methodological limitations are provided in Chapter 3 (Methodology) of this study.

1.6 Potential contribution of the research

Several studies on solid waste management in unserved rural areas have been done (Anyasi & Atagana, 2021; Haywood *et al.*, 2021; Pan, 2020; Rodseth *et al.*, 2020). However, no studies on solid waste management in Matobole Village in the Limpopo Province have been undertaken. This study will add to the body of academic knowledge on solid waste management practices, challenges and opportunities in unserved rural areas.

1.7 Structure and outline of the dissertation

This section briefly describes the structure and outline of each of the five chapters of the dissertation and the topics covered in each chapter. **Chapter 1** (Introduction) provides the background to the study, the problem statement and rationale for the study, research aim and objectives, scope of the research, assumptions and limitations and potential contribution of the research. **Chapter 2** (Literature review) reviews the literature on solid waste management in unserved rural areas. The reviewed literature includes books, theses and dissertations, journal articles, electronic information sources and legislation. **Chapter 3** (Methodology) presents the methodology to realise the aim and objectives of the study. **Chapter 4** (Results and discussion) provides and discusses the study results gathered through the methodology described in Chapter 3. **Chapter 5** (Conclusions and recommendations) presents the conclusions and recommendations concerning the research aim and objectives based on the results provided in Chapter 4.

1.8 Chapter summary

This chapter provided the background to the study, the problem statement and rationale for the study, research aim and objectives, scope of the research, assumptions and limitations and potential contribution of the research. The next chapter (**Chapter 2**: Literature review) reviews the literature on solid waste management in unserved rural areas. The reviewed literature includes books, theses and dissertations, journal articles, electronic information sources and legislation.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

The literature review focused on investigating solid waste management practices, challenges and opportunities in rural areas in developing countries. The review aimed to provide context to achieve the research aim and objectives. The review focused on the research objectives, methodologies and results from similar waste management studies conducted in Nepal, China and India. South Africa, as a developing country, faces similar waste management challenges as these developing countries. The reviewed literature provided teachings from the mentioned countries that could be applied to manage South Africa's waste sustainably.

The literature review was conducted using Google Scholar, Science Direct, and Scopus, accessed through the North-West University library's online database. The University's online Boloka: Institutional Repository was used to access dissertations and theses completed by postgraduate students. South African waste management legislation was accessed from Lexis Nexis through the University library's online database. A combination of search terms such as "solid waste", "waste management", "unserved", "rural areas", and "South Africa" was used.

2.2 Solid waste management in developing countries

According to the Population Reference Bureau (2016), 86% of the world's population lives in developing countries (Han *et al.*, 2019). Household waste management in these countries is a major challenge and is associated with or characterised by partial or ineffective waste service provision, as well as the occurrence of informal waste management practices. The lack of service provision, together with a lack of knowledge and awareness on waste management, has given rise to improper waste practices such as illegal dumping, littering and uncontrolled waste burning, which pose a threat to the environment and human health. Unfortunately, these practices are hard to be addressed, especially in rural areas, due to many factors, such as a lack of funding, inappropriate waste management infrastructure, insufficient waste collection vehicles and equipment, and the unavailability of data (Rodseth *et al.*, 2020).

Waste management is one of the most important components of working towards achieving sustainable development. Seven of the seventeen United Nations Sustainable Development Goals (SDGs) relate either directly or indirectly to waste management. It has been a public health objective since the mid-19th century to provide regular and reliable waste collection services to 100% of the urban population, but this objective is still not yet met in low and lower-middle income

countries. Furthermore, rural communities are mostly excluded from these objectives, which mainly focuses on “urban” households or populations (Rathnamala *et al.*, 2021).

It is estimated that at least two billion people in the world still lack access to waste collection services (Van Niekerk & Wegmann, 2019). In 2015, the average waste collection coverage in low-income countries was approximately 36%, and 64% in lower-middle income countries (UNEP, 2015). There is also a significant gap in collection coverage between urban and rural areas in developing countries such as South Africa, India and China, where rural areas still have low rates of collection services (Han *et al.*, 2015; Rathnamala *et al.*, 2021; Rodseth *et al.*, 2020).

Provision of waste management services in most developing countries is the responsibility of local authorities, who according to Viljoen *et al.* (2021) are struggling to provide for such services due to financial factors, including high costs associated with service provision, lack of financial support, and users unwilling to pay for services; and the lack of proper equipment and infrastructure such as waste bins and treatment centres. In some large cities of developing countries waste collection services are rendered by private service providers for a fee, whereas in small cities these providers are unable to render the services due to affordability by households which then results in waste not being collected (Rai *et al.*, 2019b). These challenges, together with the distance households have to travel to access communal containers, often leads to illegal dumping in open spaces and roadsides, waste being buried, or waste being burned in an uncontrolled manner.

2.3 Defining important concept relating to the research topic

This section provides definitions of the terms waste, waste management services, collection services and unserviced areas which have been used in the study.

2.3.1 Waste

The legal definition of waste is often unclear and as such contributes to many interpretations of the term. In the European Union (EU) each Member State interpret the definition of waste differently and this results in trade barriers (Pongrácz & Pohjola, 2003). In simple terms waste can be defined as “stuff people throw away” (UNEP, 2015).

There is currently more than one legal definition of waste in South Africa. These differing definitions complicates the characterisation and categorisation of waste, hampers the successful implementation of the waste management hierarchy, and causes confusion amongst government and industries dealing with waste management issues (Oelofse & Godfrey, 2008). Waste is defined in numerous pieces of South African legislation, including the Environmental

Conservation Act No. 73 of 1989 (which has mostly been repealed), National Water Act No. 36 of 1998, National Environmental Management Waste Act No. 59 of 2008, and National Environmental Management Waste Amendment Act No. 26 of 2014. The most recent definition of waste is in the National Environmental Management Laws Amendment Act No. 2 of 2022. The legal definition of waste is provided in the introductory section of this dissertation. For the purposes of this dissertation, and in simple terms, waste is regarded as “municipal solid waste” and includes articles or substances, that are intended for disposal (by the generators of waste), which may or may not have commercial value.

2.3.2 Waste management services

According to DEA (2008) “waste management services” means waste collection, treatment, recycling and disposal services. The rendering of these services is the responsibility of local municipalities as mandated by the Constitution of the Republic of South Africa (South Africa, 1996) and are to be provided in a sustainable manner that promotes an environment that is not harmful to the health and wellbeing of people.

2.3.3 Waste collection services

According to the National Domestic Waste Collection standards, “waste collection” means the act of collecting domestic waste at the place of waste generation or storage by an approved service provider or the municipality (DEA, 2011b). In South Africa, the main approach to waste collection is door-to-door collection or curb-side collection, where waste bins or bags are placed on the road-side kerb next to houses, where they are collected by a service provider in accordance with a waste collection schedule (Gläser, 2022).

2.3.4 Unserviced areas

For the purposes of this research, “unserviced areas” are defined as areas which have either inadequate collection services, failed collection services, or have never had any form of waste collection. High-density unserviced areas may include informal settlements and formal high-density housing developments. Both areas can be regarded as low-income areas with high rates of unemployment (DEAT, 2001).

2.4 Lack of waste collection services as an issue of concern

Developing countries around the world are experiencing challenges with waste collection services. Besides challenges experienced in unserviced areas, waste collection itself is faced with a variety of safety, economic and environmental challenges (Gläser, 2022). This section will

provide an international, African and South African perspective on the lack of waste collection services and its implications.

2.4.1 International developing country context

Internationally, developing countries are faced with the challenge of waste management due to growing population, rural-to-urban migration, increasing economic activities, urbanisation, and increased living standards (Rai *et al.*, 2019a). These factors have given rise to a number of health and environmental issues, which requires municipalities to develop strategies to reduce the level of waste and improve waste management and waste collection services. Unfortunately, the rendering of waste collection services in some countries can cost as much as 50% of the total budget allocated to waste management, which forces municipalities to charge a fee or make use of private service providers for household waste collection (Rai *et al.*, 2019a). Although private service providers are used in many developing countries, such providers are non-existent in some countries, due to non-subscription to their services by households. The absence of private service providers results in municipalities (especially those with insufficient resources and capacity) being unable to reach all households to collect waste (Rai *et al.*, 2019a).

Rural areas are often neglected and avoided by municipalities and waste operators due to its inaccessibility and remoteness, or geographical constraints such as mountains, wetlands, hills and high plateaus. These constraints make it difficult to implement proper waste collection facilities and services in rural areas.

According to Mihai (2017), approximately 2 billion people in rural areas still lack waste collection services. Many developing countries, such as India, Turkey, Mexico and others have poor waste management and collection services due to a lack of funds, insufficient training on MSW, unavailability of qualified waste management professionals, and lack of accountability in current SWM systems (Kumar *et al.*, 2017). Another contributing factor is that rural areas are often overcrowded and many of the settlements in these areas are established illegally. Low-income households can many times not afford, or are unwilling to pay for, waste collection services. Generated waste is then often illegally dumped around the households or open areas - making it difficult for collection vehicles to access the areas (Sharholy *et al.*, 2008).

The 2030 Agenda for Sustainable Development was launched and adopted by 198 countries in 2015 as a framework that will guide global development and to, amongst others, address challenges related to sanitation, service delivery and infrastructure (Mabhaudhi *et al.*, 2021). Seventeen SDGs were proposed at the UN General Assembly in 2014 (Statistics South Africa, 2019) to promote prosperity while protecting the planet. Mawonde & Togo (2019) describe SDGs

as “universal goals aiming to promote more inclusive societies, fighting inequalities and recognising the importance of cooperation and partnerships in pursuit of sustainable development along with human development”. The SDGs build on the previous Millennium Development Goals (MDGs) in order to achieve what the MDGs failed to achieve by recognising the interlinkages between human wellbeing, healthy environment and economic prosperity (Mabhaudhi *et al.*, 2021).

SDG 11 (*Make cities and human settlements inclusive, safe, resilient and sustainable*) focuses on ensuring that people have access to adequate, safe and affordable basic services including waste collection, as well as paying close attention to the issues of waste management to reduce adverse environmental impacts by year 2030 (Cibrario, 2018).

2.4.2 African context

The African continent is faced with major developmental challenges including waste management. One of the major challenges faced by African countries is the lack of waste collection services in both urban and rural areas, but worse in rural areas (Simelane & Mohee, 2012). Rural areas are receiving limited or no waste collection services, due to the lack of infrastructure, poor roads which makes it difficult to access the communities, and long distances which makes it difficult to implement modern waste collection systems (DEAT, 2001). The lack of waste collection in these areas results in the accumulation of waste in open areas, streets and markets, drainage channels and watercourses, while it encourages poor practices such as illegal dumping, open burning or burying of waste (Van Niekerk & Wegmann, 2019). These practices pose a threat to both the environment and human health.

According to the *Global Waste Management Outlook* (UNEP, 2015) the overall waste collection coverage in Africa is poor, because of insufficient financial resources and collection infrastructure, and because many of the households in Africa are located in rural areas. In 2012, it was estimated that only about 55% of the total generated waste (68 million tonnes) was collected in Africa (UNEP, 2018). Most of this waste was collected in city centres (90% waste collection coverage), while collection in rural areas was mostly neglected (<10% in rural areas) (UNEP, 2018). Formerly, municipalities and private waste service providers used to be the sole providers of waste collection services, however, currently, the informal sector, CBOs, NGOs and resident associations have become increasingly involved in waste management in African countries (Van Niekerk & Wegmann, 2019).

The African Union’s *Africa Agenda 2063: The Africa We Want* with its aspirations and goals aims to hasten the implementation of past and current continental initiatives for growth and sustainable

development. Goal 1 of the agenda aims to provide high standard of living, quality of life and wellbeing for all citizens by ensuring access to safe drinking water and sanitation, supplying electricity and internet connection, and ensuring that at least 50% of the waste generated is recycled (African Union Commission, 2015). With regard to waste collection, Africa Agenda 2063 aims to address waste collection services and provide environmentally sound waste management to all citizens by 2030 (UNEP, 2018).

2.4.3 South African context

Waste collection in South Africa is the responsibility of local government as mandated by the Constitution of the Republic of South Africa (South Africa, 1996), but the municipality can decide to provide the services itself or make use of a private service provider. The service is to be provided to communities under the municipality's jurisdiction and does not include industry/commercial waste generators. However, industries can ask the municipality to collect their waste or contract a private waste collector at a fee (GreenCape, 2020). The *National Domestic Waste Collection Standards* (2011) outline the minimum requirements for domestic waste collection, and its main objective is to ensure that municipalities provide equitable waste collection services to all households within its jurisdiction. Waste collection services provided by municipalities and private service providers consists of kerbside collection from households, commercial collection, as well as communal waste collection, where kerbside collection is impractical (Nahman & Godfrey, 2010).

The country is still faced with the challenge of inequality in the provision of waste collection services, especially between urban and rural areas (Rodseth *et al.*, 2020). Only 59% of households had their waste collected in 2016 either by a local municipality, service provider or a community member, while waste from only 2% of households was collected from communal containers or central collection points (DEA, 2018). Although there has been an improvement in weekly waste collection at 60.3% in 2021, most households still rely on communal or household refuse dumps (Statistics South Africa, 2021). Rural households are still receiving less or no waste collection services, and are left to rely on their own refuse dumps. Reasons for less or no provision of waste collection rural areas include factors such as distance and resulting costs. The lack of waste collection has resulted in massive backlogs in the provision of waste collection services specifically in peri-urban and rural areas (Treasury, 2011: DEA, 2011a). Rural areas with no waste collection services have resorted to waste management practices convenient and suitable to them but contradicting the waste management hierarchy and are detrimental to human health and the environment. In many cases, the gap in waste collection services in urban areas has been filled by the informal waste sector (waste pickers) who are playing an important role in the diversion of

waste from landfill (GreenCape, 2020). They do this to generate an income by recycling the collected material.

The second draft of the South Africa State of Waste Report by DEA (2018) and General Household Survey (Statistics South Africa, 2021) provided a breakdown of waste collection services per province in 2016 and 2021. Less than 50% of households in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga had their waste collected by local authority or a private company, while more than 50% disposed waste on their own or at a communal dump in 2016. Of the four provinces, only KwaZulu-Natal province showed an improvement in waste collection services from 45% in 2016 to 53.1% in 2021. Rural areas were the least serviced in these provinces. Only 1.9% of rural households in Eastern Cape, 8.9% in KwaZulu-Natal, 7.4% in Limpopo and 11.5% in Mpumalanga received waste collection services from municipalities in 2021. Of all the provinces, Limpopo Province (research province) was the least serviced province, with 68.1% of households using own refuse dumps for waste disposal (Statistics South Africa, 2021).

2.5 Legal framework applicable to waste collection services

The sections below provide an overview of the South African legal framework for waste management, specifically focusing on the provision of waste collection services.

2.5.1 Constitution of the Republic of South Africa

The Constitution of the Republic of South Africa Act 108 of 1996 remains the supreme law and is binding to all organs of state. It provides the legislative and other measures for providing an environment that is not harmful to the health and well-being of all South Africans in Section 24 which states that: *“Everyone has a right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that -i. Prevent pollution and ecological degradation; ii. Promote conservation; and iii. Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development”* (South Africa, 1996).

The Constitution further assigns the mandate for the provision of waste collection services to local municipalities in Schedule 5, Part B of the Constitution (South Africa, 1996).

2.5.2 National Environmental Management Waste Act

The National Environmental Management Waste Act (59 of 2008) (NEMWA) was promulgated in 2009 and provides for the management of waste to ensure environmental protection, provides a holistic approach to waste management and strengthens the country's (previously) fragmented waste-related legislation (Zhakata *et al.*, 2016). Section 9 of the NEMWA elaborates on waste service standards, while Section 23 of the Act provides for waste collection services. This section addresses requirements such as:

- Equitable allocation of collection services;
- Payment of applicable waste collection charges;
- The municipality may limit provision of general waste collection services if there is failure to comply with conditions for the provision of such services, however, such limitations should not pose a risk to health or the environment;
- The municipality may differentiate between categories of users and geographical areas when setting collection standards; and
- Provision of containers or receptacles for the collection of waste (DEA, 2008).

Section 24 restricts waste collection services to the mandate of municipalities, unless otherwise approved.

Municipalities must, therefore, ensure that all communities under its jurisdiction have access to basic waste collection services and that those services are at an affordable price in line with its tariff policy as mentioned in Chapter 8 of the Municipal Systems Act No. 32 of 2000 (DEA, 2008). According to section 74(2)(a) of Municipals System Act No. 32 of 2000, waste collection tariffs for poor households should only cover operating and maintenance costs or be subsidised (South Africa, 2000).

Organs of state are required by Section 11 of NEMWA to prepare integrated waste management plans (IWMPs) in order to properly plan for waste management. Section 12 of the NEMWA outlines the requirements, which should be outlined in IWMPs – including information of waste collection services. Section 2.5.7 of this dissertation elaborates on integrated waste management planning.

2.5.3 National Domestic Waste Collection Standards

Section 7(1)(a) and (b) of NEMWA requires that the Minister develop norms and standards for planning and provision of waste management services (including collection). In 2011, the Minister of the (then) Department of Environmental Affairs *developed the National Domestic Waste Collection Standard* (GN 21 of January 2011) (DEA, 2011b) to redress the past imbalances in the provision of waste collection services.

Although developed under NEMWA, its development was also informed by the Constitution of the Republic of South Africa, *General Waste Collection Standards of Gauteng*, current waste collection practices in South African municipalities, stakeholder consultations, and international waste management standards and good practices in both developed and developing countries (DEA, 2011b).

The standard aims to provide acceptable, affordable, and sustainable waste collection services to all South Africans in order to improve their quality of life and to ensure a clean and more acceptable place to live and work in. In cases where waste collection services cannot be rendered by municipalities, the municipality must allow for more feasible alternatives to address the lack of services provided by the municipality (DEA, 2011b).

Section 4 of the standard provides the requirements for waste separation at source by households, collection of recyclable waste, provision of receptacles and bulk containers, demarcation of communal collection points, and collection frequency. Municipalities are required to implement waste separation at source and encourage household participation while providing an enabling environment for waste recycling by households (DEA, 2011b).

The standard further addresses the aspects of waste collection vehicles, health and safety, as well as communication, awareness creation and complaints in Section 6 to 8 of the Standards (DEA, 2011b).

2.5.4 National Policy for the Provision of Basic Refuse Removal for Indigent Households

Some households in South Africa are unable to afford waste services (including refuse removal) as a result of their poor economic status. For this reason, the Minister of the Department of Environmental Affairs developed and implemented the *National Policy for the Provision of Basic Refuse Removal for Indigent Households* (GN 413 of 22 June 2011) in 2011. The aim of this policy was to provide mechanisms for South African municipalities to provide basic refuse services to communities under their jurisdiction and to ensure that poor households have access

to refuse removal services and are not discriminated against due to their poor economic status (DEA, 2011c).

The criteria for determining who the recipients of the refuse removal services should be are outlined in Section 7 of the policy. The main criterion is that the recipient must be registered on the municipality's indigent register. Other criteria include:

- The net income of members of less than or equal to two old age pensioners;
- People staying in the municipality whose indigent status have been verified;
- Households headed by minors, pensioners and people with disabilities;
- Property value; and
- Other criteria determined by the municipality (DEA, 2011c).

Section 8.3 of the policy outlines the collection frequency of biodegradable and recyclable materials in medium and high-density settlements. Although on-site composting is encouraged, biodegradable waste is collected at least once a week while recyclable materials are collected once a month in rural area and fortnightly in urban areas.

2.5.5 Guidelines on Waste Collection in high density and unserved areas

The *Guidelines on Waste Collection in high density and unserved areas* (2001) was developed to assist municipalities to implement waste collection services in densely settled and unserved areas (DEAT, 2001). These are areas with more households, and areas that receive inadequate, failed or no waste collection services at all. The main aim of the guidelines is to introduce appropriate general waste collection systems in high-density and unserved areas by bringing attention to waste avoidance as the first priority. In cases where waste avoidance is not practical, it should be reduced, reused and recycled before it is collected and reused (DEAT, 2001).

Some communities are faced with the challenge of waste scavenging by animals and people which results in littering and negatively impact on human health. To avoid this challenge, Section 5.3 of the guidelines requires that municipalities make people aware of collection days and time, and provide education on how households can participate effectively in the collection system (DEAT, 2001).

The guideline also provides a range of service options for waste collection to communities. Waste can be dumped into communal skips by households and be transported to a landfill site, can be collected from households by a local contractor to a local collection point, or through kerbside collection by waste collection vehicles (DEAT, 2001).

2.5.6 National Waste Management Strategy

Section 6 of NEMWA requires the Minister to establish the NWMS in order to achieve its objectives. In order to achieve these objectives, the strategy must *include “objectives, plans, guidelines, systems and procedures relating to the protection of the environment and the generation, reuse, recycling, recovery, treatment, disposal, use, control and management of waste”*.

2.5.6.1 National Waste Management Strategy (2011)

The NWMS 2011 is based on the hierarchical approach to waste management in South Africa (Kubanza & Simatele, 2019) and is binding to all state organs (DEA, 2008). The strategy aims at addressing waste management gaps or challenges, and its success depends on the proper implementation of regulatory and economic instruments.

One of the challenges mentioned in the 2011 NWMS was the *historical “backlog of waste services in rural formal areas, urban informal areas and tribal areas”*. These services, formerly, only favoured the more affluent and urban communities.

Goal 2 of the 2011 NWMS aims to ensure that waste services (herein waste collection) are effectively and efficiently delivered to at least 95% of urban households and 75% of rural households. The effective and efficient delivery of this service is supported by various regulatory, planning and fiscal instrument and that include the *National Domestic Waste Collection Standard, the National Policy for the Provision of Basic Refuse Removal for Indigent Households*, municipal and provincial IWMPs, Municipal by-laws, fiscal mechanisms, and coordinated action by all spheres of government.

2.5.6.2 National Waste Management Strategy (2020)

The NWMS 2020 is a revision of the 2011 strategy and aims on providing a framework for government policy and strategic interventions for the waste sector. It is aligned and responsive to Sustainable Development Goals and the National Development Plan (NDP) (DEFF, 2020), and considers priorities outlined in the Medium-Term Strategic Framework (MTSF). The 2020 strategy promotes the circular economy concept and is premised on the three pillars (*waste minimisation, effective and sustainable waste services, and compliance, enforcement and awareness*) that will promote a culture that is intolerable of illegal dumping, littering and pollution, clean communities, financially sound and properly managed waste services, and zero waste to landfills.

The implementation of the NWMS 2020 brought about improvements in waste collection and disposal services. Some examples include the introduction of waste separation at source programmes in some metropolitan municipalities, such as the City of Johannesburg and the City of Cape Town, which reduces the amount of waste for collection for landfill disposal. However, overall delivery of waste services is still a challenge, particularly in informal settlements and rural or peri-urban communities (DEFF, 2020).

Pillar 2 (effective and sustainable waste services) of the NWMS 2020 aims to address these challenges by providing waste services that are effective and contribute to sustainable development. Its outcome is to ensure that all South Africans live in clean communities and that the services provided are financially sustainable. This can be achieved through the reviewing of municipal budgets towards sustainable and effective waste services, and implementing initiatives that supports separation at source such as providing separate bin or kerb-side collection and the delivery of specific waste to drop-off facilities (DEFF, 2020).

2.5.7 Guidelines for integrated waste management planning

As mentioned in Section 2.2.2, organs of state are required to prepare IWMPs as outlined in Section 11 of NEMWA. Section 12 of NEMWA requires that the plans include:

- The number of people not receiving waste collection services;
- How the national, provincial and local department will address waste management service delivery to residential areas in the case of a municipal integrated waste management plan; and
- Establish targets for waste collection, minimisation, reuse and recycling (DEA, 2008)

According to Sango *et al.* (2014) IWMP is a tool developed to outline and guide waste management practices that have a potential to negatively impact the environment and human health. One of the municipalities' strategic goals in the IWMP should be how it will roll out waste collection services to indigent households and previously unserved areas.

The Department of Environmental Affairs (DEA, 2009) developed the *National Framework Guidelines for the Development of Integrated Waste Management Planning* to assist municipalities on how they can provide waste collection services to communities under its jurisdiction. Indigent households should be registered in the indigent register and the register be kept up to date. In order to provide for waste collection services to indigent households, municipalities will need to develop an inventory of these resources to highlight plans on how they will provide waste collection services now and in cases where new establishments are

constructed. A plan on how waste collection services will be rolled out to different settlement types also needs to be developed (DEA, 2009).

2.6 Addressing waste collection challenges: Lessons learned from other countries

Developing countries are faced with waste management challenges and most are unable to provide waste management services including services for waste collection. This section provides solutions, opportunities and measures put in place to address waste collection challenges in developing countries such as Nepal, China and India. The purpose of these sub-sections is not to provide a comprehensive literature review of lessons learned from other countries, but to provide illustrative examples relating to the research context focusing on waste collection in other developing countries.

2.6.1 Lessons learned from Nepal

The cost associated with waste management in Nepal is high and these forced municipalities to charge a fee for waste collection. Apart from costs, the overall waste collection is ineffective due to poor route planning, lack of information on collection schedules, improper bin collection systems and low budgets (Rai *et al.*, 2019a). To address the issue of funds, municipalities are providing door-to-door waste collection at a fee (Asian Development Bank, 2013). A study by Rai *et al.* (2019a) also indicated that households expressed willingness to pay extra for waste collection services provided their preferences are met and included in policy. Their willingness to pay was based on the municipality increasing the frequency of collection per month, the two-way distance from collection spot and their house, and subsidise their waste collection bins (Rai *et al.*, 2019a).

Collection rate in small municipalities is less than 50%, which has led to citizens practicing unacceptable practices such as open burning, incorrect composting and disposal in open spaces. Some households instead of practicing the unacceptable methods, participate in waste separation at source as mentioned by Rai *et al.* (2019b). The separated waste is used to make compost and other recycled items such as bottles and plastic items are sold in the market. In areas where waste collection is provided, the types of services provided are collection through community bins, door-to-door, roadside pickup from open piles and self-delivery. Another study by Rai *et al.* (2019b) suggested that municipalities can place the 20 litre bins at regular intervals on the streets to improve the cleanliness of the cities and the efficiency of waste collection services. The involvement of the private sector including NGOs and CBOs is also common in Nepal and has helped in improving operational efficiency and cost effectiveness in waste collection (Asian Development Bank, 2013).

2.6.2 Lessons learned from China

Solid waste generation has increased rapidly in China while the country, in many areas, lack advanced waste management facilities. A study by Wang *et al.* (2017) pointed out inconsistencies in waste collection facilities in villages in Jiangsu Province, Hebei, Sichuan, Jilin and Shaanxi where some villages had more equipment than others. Waste is collected by waste collection workers employed by the villages to make sure that the waste ends up in local or centralised waste collection facilities. In this study, the two waste collection methods that were successful in most villages were door-to-door waste collection and collection from local waste facilities. The Chinese government also issued a series of laws and regulations to address waste management problems and to increase investments into rural solid waste management. In instances where the tax income became too low to provide waste collection services, the national government began subsidising some waste collection services and transportation (Wang *et al.*, 2017).

Some cities tried the “*village collection, township transfer, and county treatment*” model to address waste management challenges (Guan *et al.*, 2015) while in the Jiangxi Province the model used was the “*household classification, village collection, township transfer and county treatment*” (Pan *et al.*, 2017). These models suggest that waste be collected from individual villages by cleaning staff responsible for waste collection. The waste is collected from the trash containers at the residents’ houses using hand carts to the local deposit stations (open dump tank or small room). The waste will then be transferred to the county designated site by the respective township before being disposed at the solid waste treatment facilities designated by the government (Guan *et al.*, 2015). However, the model failed in many villages due to insufficient facilities, the absence of rural solid workers, lack of supervision from authorities, and villagers being unable to afford transportation costs (Guan *et al.*, 2015).

2.6.3 Lessons learned from India

Door-to-door collection of solid waste in some Indian cities is performed by people working in the informal sector. This sector plays an important role in waste management, has the potential to streamline the segregation and collection process, and ensures that less waste is disposed in landfills. Waste is collected at a fee and an extra income is generated from the sale of recyclables (Lahiry, 2017). A study by Shah and Sattler (2020) provided a number of improvements that can be considered to increase the efficiency of waste collection in India. These improvements can be useful not only to India, but other developing countries struggling with the provision of waste collection services. Main areas for improvement mentioned by Shah and Sattler (2020) include:

- Collection of waste on a daily basis instead of alternating days;

- More regular services by sweepers;
- Vehicles used for waste collection be mechanised;
- Increased access to waste collection vehicles;
- Coordination between the timing of waste generation and collection be improved; and
- Conduct public awareness campaigns to encourage communities to participate in waste separation and to practice proper waste disposal methods such as throwing waste in bins instead of open burning.

Waste collection and street sweeping services in Gurugram town are provided by private agencies contracted by the authorities through tenders (Naveen *et al.*, 2018). Waste collection in this town is predominantly manual where mechanical sweeping is performed at night in some main roads and markets, and waste is collected and taken to transit sites by manually-pulled rickshaws. The transit sites include community bins, skips and refuse containers. Waste is then collected from these transit sites to waste treatment plants and landfill sites by large dumpers (Naveen *et al.*, 2018).

Furthermore, in a study by Agarwal *et al.* (2015), waste collection was done on a contract basis by municipalities, rag pickers and small-time contractors. Daily street sweeping and primary collection are done by sweepers. The sweepers collect the waste thrown directly on the streets or in plastic bags which is then transported by hand-cart trolleys or tractor trolleys to nearby open dumps, bins or to the out-skirt of the cities. Municipal workers are also responsible for waste collection and collect the waste from collection points by tractors and bull carts to disposal sites.

2.6.4 Applicability of lessons learned to South Africa

The following lessons can be learned from these research findings, which could also be applicable to the South African context:

- Collection coverage in smaller towns and rural areas of Nepal is less than 50%. These areas are practicing separation of waste at source in their households for own use such as animal feeding, and composting. The NWMS 2020 encourages waste separation at source in South Africa. Should separation at source, with reclamation for personal use be achieved, this will decrease pressure on waste collection systems in the country.
- Involvement of public-private partnerships is common in Nepal and has proved to be beneficial as it has improved operational efficiency and cost effectiveness of waste collection;
- Employment of waste collection workers working within the community is essential in ensuring that waste is collected and ends up in the right places. Rural areas without door-

to-door waste collection in South Africa can consider this method to ensure that waste is collected and stored in local waste collection facilities while waiting to be collected by the municipality.

- South African national government can consider subsidising local government to enable them to collect waste in rural areas, as with China where the national government subsidised some waste collection services and transportation where income from waste service fees were too low.
- While building waste storage and collection facilities (such as transfer stations) in villages, it is important for government to consider the distance to be travelled to such facilities from households where waste is generated. A study by Han *et al.* (2015) noted the willingness of residents to dump waste in collection facilities provided the distance is not long.
- One of the suggested improvements for effective waste collection in India was the use of mechanised vehicles. Lack of waste collection equipment is one of the factors that contribute to the lack of waste collection in rural areas in South Africa. Municipalities therefore need to provide regular maintenance and servicing of collection vehicles to address this issue. Where it is not viable, municipalities may consider the use of non-mechanised vehicles and equipment, such as donkey-carts or hand-pulled trolleys to move waste to areas where it can then be collected by mechanised vehicle once a sufficient amount of waste has been accumulated (to make it more economically viable).

2.7 Waste management practices implemented in unserviced areas

Studies by Fauziah and Agamuthu (2012), Wang *et al.* (2018), Rodseth *et al.* (2020), Viljoen *et al.* (2021), and the South African NWMS highlighted that waste management in rural areas in developing countries, specifically Malaysia, China, India and South Africa is still a significant challenge. These countries struggle to provide waste collection services to rural households, and where rural areas are serviced, these areas rely largely on landfill disposal (Moh & Manaf, 2017). As a result of the lack of waste collection services, most rural households in these countries have resorted to burial, burning, littering and open dumping of waste, which are undesirable waste management options.

2.7.1 Waste management practices in unserviced rural areas in Malaysia

Malaysia's solid waste management poses an environmental problem due to its dependency on landfilling for waste disposal (Moh & Manaf, 2017). The utilised landfills are not properly engineered, meaning they are without proper gas collection, liners, and leachate collection and treatment. These landfills expose the environment to air, soil, and water pollution, providing a breeding ground for biological vectors that cause diseases like cholera, diarrhoea, food poisoning,

and respiratory problems (Fadhullah *et al.*, 2022). Waste is also disposed in open dumps due to lower financial, maintenance and operational costs (Fadhullah *et al.*, 2022). Other potential methods of maximising and managing solid waste include waste incineration and separation for recycling. However, it is unclear what the future holds for solid waste management in the country because existing incinerators are not functioning to their maximum capacity, are not producing the desired results, and waste separation is not practised (Moh & Manaf, 2017).

In areas where waste collection services are not provided, households managed and handled waste disposal by burying or burning waste in their compounds (Fauziah & Agamuthu, 2012).

Waste separation is highly encouraged in Malaysia due to high generation of organic waste. Unfortunately, the majority of households are not participating in this initiative and mainly informal waste pickers are taking part to improve their livelihood and generate an income. The government and private organisations are also attempting to establish a more comprehensive solid waste management system, coupled with awareness campaigns, source separation, recycling strategies, and other projects. The country is also in the process of transforming its waste management policy and strategies which led to the closure of open dumpsites, development of sanitary landfills with proper treatment systems and pollution control, and the upgrading of existing landfills. Waste separation at source also became mandatory for households under clause 74 of Act 672 to help recover higher number of recyclables (Moh & Manaf, 2017).

2.7.2 Waste management practices in unserved rural areas in China

A study by Han *et al.* (2015) on 22 villages in Southwest China revealed that the villages lack proper funds, legislation and infrastructure for environmental control. For these reasons, waste services are rarely provided, including collection, transfer and disposal. This leads to waste being dumped in open dumpsites and river banks and burned randomly, causing water and air pollution. It was estimated that between 30 - 60% of waste that are generated is burned and dumped in open areas (without treatment), resulting in environmental pollution and health impacts.

Villagers are encouraged to participate in sorting inert, organic and recyclable waste to improve the management of domestic waste in their areas. The Chinese government has started to subsidise recyclers and material recycling companies and offered them tax incentives (Han *et al.*, 2015). Waste that is separated by rural households, include bottles, glass, metal, and paper, which are often sold for income to family members or scavengers. Other waste is recycled through anaerobic fermentation to produce bio-fertilisers, biogas and other resources and treat bio-solids by composting (Wang *et al.*, 2018).

2.7.3 Waste management practices in unserviced rural areas in India

Historically, landfilling was India's most common method of solid waste disposal in un-engineered dumps and roadside open dumps. The lack of waste collection in low-income areas of India gave rise to improper disposal of waste in open areas, roadsides and open burning (Rathnamala *et al.*, 2021).

A study by Balu *et al.* (2020) in Indpur Village revealed that households dump waste on the streets and in a common dumping area designated by the local government as a landfill area. Waste dumped in the designated landfill is often burned, resulting in new waste being dumped on top of the burnt waste. Plastic waste is often dumped into open drainage canals causing blockage of the water flow.

2.7.4 Waste management practices in unserviced rural areas in South Africa

The lack of waste management services in rural areas has led to unacceptable practices of waste management such as littering, illegal dumping in open spaces and on the streets, and uncontrolled disposal methods such as burning, burying and the use of a pit inside the yard (Rodseth *et al.*, 2020). These practices pollute water, air and land and negatively impact human health and the environment (Muzenda *et al.*, 2012).

According to Viljoen *et al.* (2021) the probability of open dumping and littering in rural areas is increased by insufficient waste collection services and waste collection facilities, as well as the lack of information on the nearest landfills, awareness and education on waste management by rural households.

Examples of waste management options/practices available to households sourced from Serret and Ferrara (2008) are presented in **Figure 2-1** below.

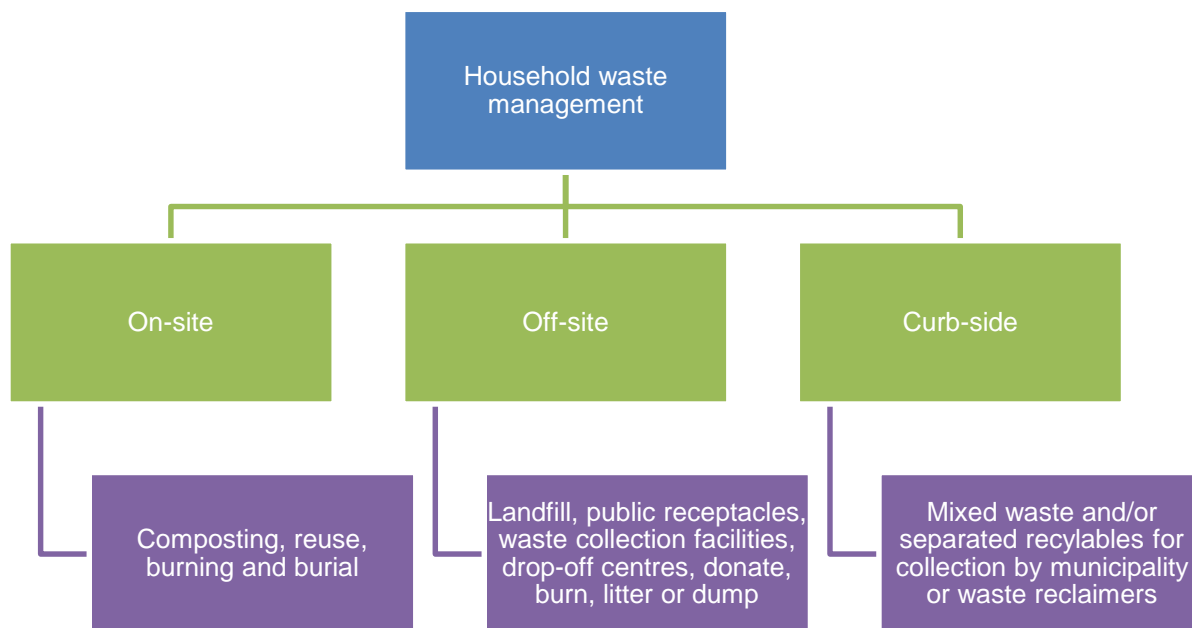


Figure 2-1: Waste management options/practices available to households (Adapted from Serret & Ferrara, 2008).

Both Puling (2004) and Hlahla *et al.* (2014) suggest that the growing volume of waste generated must not be seen as a challenge but as an opportunity to promote and implement sustainable household management practices. Environmental benefits, income-generating opportunities and networking platforms can be established through the waste sector in rural communities through the integration and investment in stakeholders such as municipalities, NGOs and waste pickers. Waste management practices such as composting and reuse are beneficial for rural households. Waste such as cardboard, crop, dung, paper, sawdust, residue and wood are used as heat and energy, while food waste such as bones and meat are fed to animals (Viljoen *et al.*, 2021).

Most rural areas generate organic waste which can be managed through composting. The three composting methods suitable for rural areas are mentioned by Moharana (2012) and they are pit method, heap method, and vermicomposting.

Rural households should also be encouraged to participate in separation and reclamation of waste. A study by the Council for Scientific and Industrial Research (CSIR) (2010) on identifying good waste management practices within municipalities identified opportunities for a food for waste programme in the Hibiscus Municipality. The programme involved the collection of waste by community members in their areas and drop it at designated collection points for food parcels

as a form of payment. This practice is good for the environment and the livelihood of community members as it keeps the neighbourhood clean and alleviate poverty.

For effective solid waste management in rural areas, and to address the challenges resulting from uncollected waste, waste management should improve on a household- and community-level. Practices such as reuse of non-biodegradable waste, separation at source, and composting of biodegradable waste should be practiced. The uncontrolled burying and burning of waste are not encouraged especially in dense settlements, but in cases where they are practiced they should be done under controlled conditions. If burial of waste is the only option, it should be done in a backyard pit or a communal trench, taking consideration of the location of ground- and surface water resources (DEAT, 2001).

2.8 Chapter summary

This chapter provided solid waste management in developing countries focusing on the waste collection services as an issue of concern. Developing countries are struggling to provide waste management services due to a number of factors including high costs associated with service provision, lack of financial support, and users unwilling to pay for services; the lack of proper equipment and infrastructure such as waste bins and treatment centres and the structure of rural areas. Important concepts relating to waste collection such as waste and waste collection services were defined to provide a better understanding of the topic. The international, African and South African context on the lack of waste collection services showed that the gaps in waste collection coverage between rural and urban areas is still huge and needs to be addressed. This gap can be addressed through lessons learned from other developing countries such as Nepal, China and India as provided in this chapter.

The legal framework applicable to waste collection services discussed included the Constitution of the RSA, NEMWA, the National Domestic Waste Collection Standards, the National Policy for the Provision of Basic Refuse Removal for Indigent Households, Guideline on Waste Collection in high density and unserved areas, the NWMS and the Guidelines for integrated waste management planning toolkit. These legislations provided the requirements for waste collection services and provided guidance on who is responsible for the services and how the services should be carried out. The next chapter will provide the methodology employed to investigate SWM practices, challenges and opportunities in Matobole Village.

CHAPTER 3 METHODOLOGY

3.1 Introduction

Chapter 3 presents the methodology employed to investigate solid waste management practices in Matobole Village in the Limpopo Province. It includes the research design, case study selection, data collection and analysis to determine solid waste management practices and explore challenges and opportunities for SWM in Matobole Village. This chapter also provides an overview of the ethical considerations, and methodological assumptions and limitations.

3.2 Research design

According to Creswell and Creswell (2017), the research design (**Table 3-1**) should consider the intended factors and outcomes influencing data collection and integrity. The research followed a case study approach, where Matobole Village in the Limpopo Province was selected as the case study area. A mixed methods approach, where qualitative and quantitative data were gathered, was used to collect data. According to Watson (2015) quantitative research involves a range of methods that use statistical and numerical data to systematically investigate social problems, while qualitative research aims to help understand the social world and why things happen or are the way they are. It answers the ‘how’ and ‘why’ of people’s attitudes, behaviour, cultures, opinions, practices, and how they are affected by events around them (Hancock *et al.*, 2007). According to Lacey and Luff (2007), with qualitative research, the researcher may be required to form relations between behaviour or ideas and biographical characteristics of participants such as age and gender or to seek relationships between various identified themes.

Table 3-1: Research design

Research objective	Research method	Research method justification
Determine solid waste management practices in Matobole Village	A structured survey questionnaire administered to a representative sample of households	<p>According to Jones <i>et al.</i> (2013) and Matveev (2002), a structured survey questionnaire is appropriate for this research for the following reasons:</p> <ul style="list-style-type: none"> • It allows for a large population to be assessed with ease; • It is convenient in terms of time and is cost-effective;
Explore challenges and opportunities for solid waste management in Matobole Village		

Research objective	Research method	Research method justification
		<ul style="list-style-type: none"> • It provides ease of acquiring demographic data such as age, gender and income; • Reliable data is obtained due to the controlled nature of data gathering; • Specifying the dependent variables under investigation is clear and specific; and • Tabulating and analysing information using statistical programmes are relatively straightforward.

3.3 Case study selection

This section presents the case study selection criteria of the case study area, Matobole Village, and describes the study area.

3.3.1 Selection criteria

The following selection criteria were used to identify a potential case study area:

- The area had to be “unserved” as far as waste collection services are concerned. *“Unserved”* in this context means that *the village is not receiving or partially receiving any waste management services from the municipality, including waste collection.*
- The area had to have sufficient households living in the area to provide a sufficient number of responses on waste management practices; and
- The area had to have sufficient individuals willing to participate in the research.

Various areas in South Africa exist, which met the case study selection criteria. Based on convenience sampling, due to its geographical proximity to the researcher’s location, and the researcher’s historical connection to the site (being a former resident of the village), Matobole Village was selected as the case study area. The selected village is considered to be unserved as it does not receive (or as it receives partial) waste collection services from PLM (one of the gaps in the municipality’s IWMP is the lack of waste removal services in rural areas), and had sufficient households which were willing to participate in the research.

The following section details the study area for this research, namely Matobole Village.

3.3.2 Study area description

Matobole Village in the Limpopo Province covers an area of 2.82 km² and is located 51.8 km south of the City of Polokwane. The village is under the jurisdiction of the PLM and forms part of the Molepo/Chuene/Maja cluster ward 2 (**Figure 3-1**). It is under the leadership of King Maja and Induna Ralebofu. The total population of Matobole village is 2 566, with 623 households (Census, 2011). The population group is 99.96% Black African, and the first language is 95% Sepedi.

The village is not receiving waste collection services from the municipality. The municipality is only rendering waste services in the City and townships, and plans to extend such services to rural areas in future (PLM IWMP, 2016). Some level of informal weekly waste collection is being rendered in all wards but not in all villages under the Expanded Public Works Programme (EPWP) incentive grant. Challenges hindering the rendering of this service in other villages is the lack of equipment and personnel (PLM IDP, 2021-2026). Some parts of Matobole Village started receiving such services in May 2022 and this was discovered during data collection in July 2022 (refer to Chapter 4).

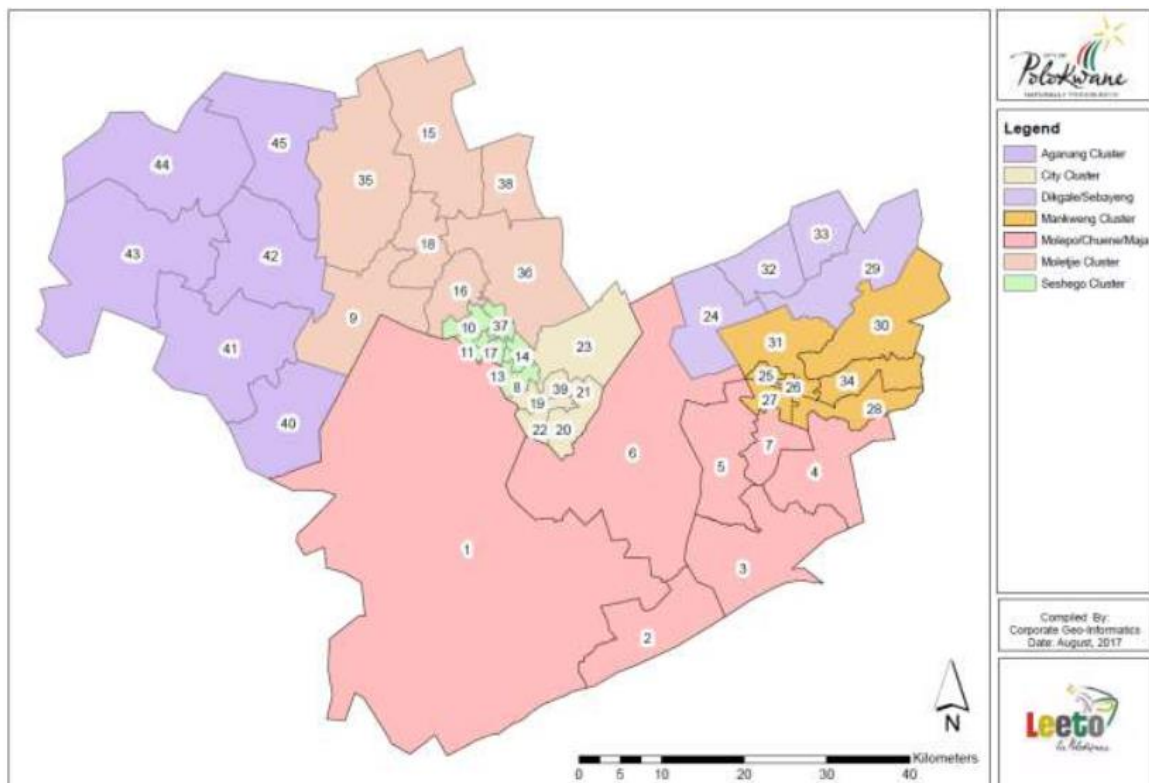


Figure 3-1: Polokwane Local Municipality Cluster Map (Polokwane Local Municipality IDP 2021-2026).

Table 3-2: Polokwane Local Municipality Clusters and Wards (Polokwane Local Municipality Draft IDP 2021-2026).

	Clusters	Ward numbers
1	Mankweng cluster	06, 07, 25, 26, 27, 28, 34
2	Moletjie Cluster	09,10,15,16,18,35,36,38
3	Molepo/ Chuene/ Maja Cluster	1,2,3,4,5
4	Sebayeng/ Dikgale Cluster	24,29,32,33,30,31
5	Aganang Cluster	40,41,42,43,44,45
6	City Cluster	08,19,20,21,22,23,39
7	Seshego Cluster	11,12,13,14,17,37

3.4 Data collection

Data was collected between 16 June and 30 July 2022 by administrating a structured survey questionnaire to a sample of households in Matobole Village to enable the researcher to determine solid waste management practices and explore challenges and opportunities for solid waste management in the Village. On weekdays, data was collected from 16:00 to 18:30, and on weekends between 10:00 and 13:00, and again in the afternoon from 16:00 to 17:00 to make provision for those coming back to the village (over weekends) from school and work (where they spend their time during the week).

3.4.1 Structured survey questionnaire

As explained earlier, a structured survey questionnaire was used to collect data for the purposes of this research. The use of survey questionnaires is popular in the social science (Young, 2016) and are useful for collecting non-experimental descriptive designs (Mathers *et al.*, 2007). They are frequently used for collecting information on attitudes and behaviour. The distribution of survey questionnaires is usually restricted to a representative sample of the potential group of interest i.e. families, individuals, students etc. Survey questionnaires are frequently used to collect waste-related data from households in South Africa. Examples of such studies include Issock *et al.* (2020), Roos *et al.* (2021), and Kubanza and Simatele (2019).

As with other research methods, the use of survey questionnaires poses both advantages and disadvantages. According to Mathers *et al.* (2007) they are a very convenient way of collecting useful data from a large sample, but this can only be achieved if the questions are clear, precise and are asked consistently as there will be no opportunity to clarify misunderstandings after the researcher has left. Less experienced researchers such as students doing dissertation projects

find them most appealing because they are easy to construct and can be used to gather large datasets easily (Young, 2016). They also increase reliability of responses when filled in the absence of the researcher, especially if the topic is sensitive (Phellas *et al.*, 2011). In this case, the participant will be free to give an honest answer. Questionnaires can be sent/returned by post or email, administered directly to participants, or completed on the Web (Phellas *et al.*, 2011). Questionnaires for this study were administered directly to the chosen participants by the researcher. With this approach the researcher is more likely to achieve a higher response rate than they would have had they used a postal survey.

A structured survey questionnaire contains a large number of close-ended questions with possible answers already pre-coded for participants to choose from (Mathers *et al.*, 2007). A drawback for this type of questions is that participants will not have an opportunity to clarify their choice of answer should they need to. Another disadvantage for survey questionnaires is the incurring of additional costs and time spend to access participants in cases where the research is conducted far from the researcher (Phellas *et al.*, 2011). This was the case for this study as the researcher is based in Gauteng Province and the research was conducted in a village in Limpopo Province.

3.4.1.1 Developing the structured survey questionnaire

A questionnaire consisting of three sections were developed (**Annexure B**). Section A contained questions to determine basic household demographics such as gender, age, education level, employment type and household size. Section B addressed household waste management practices. These two sections had closed-ended questions and provided participants with pre-determined structured options to choose from. These questions are quick and easy to answer and can easily be analysed (Hyman & Sierra, 2016). Section C contained two open-ended questions where participants could provide their own responses on potential challenges and opportunities experienced by households with regards to solid waste management in the village. Open-ended questions (Section C) were selected to allow the participants to elaborate on their answers and give more detailed information.

The research objectives and existing literature [Issock *et al.* (2020), Noufal *et al.* (2020), Roos *et al.* (2021), and Wegedie (2018)] guided the development of the questionnaire on waste management in rural areas. The questionnaire was developed in English and was not translated into Sepedi (the main language spoken in the Village). The reason for not translating the questionnaire was that in most households, one or more people understood English. Where necessary, the questions were verbally translated to Sepedi during distribution of the survey questionnaire.

3.4.1.2 Piloting the structured survey questionnaire

The questionnaire was piloted to determine whether the respondents would understand the questions and its intent. As part of the piloting process, the questionnaires were administered to 35 households including that of Induna Mr Daniel Ralebofu. The results showed that some questions were confusing to the respondents and needed to be revised to be clearer. Where further clarifications were necessary, the researcher explained concepts in English or Sepedi as she can speak the language fluently. The results of the pilot study were merely used to revise and modify questions that were not clear to participants before officially administering the questionnaire to the village. These responses were not included as results of this research.

3.4.1.3 Determining the sample size

Maree (2009) defines sampling as the process used to select a portion of a population for research purposes. The Andrew Fisher formula was used to calculate the representative samples size, based on the household size of 623, a confidence level of 95% and standard deviation of 0.5. The researcher used household size data (623 households) from Census 2011 because there was no updated data on the number of households in the Village at the time of the research (Statistics South Africa, 2011).

The targeted household sample size was calculated as 238 households. Households were randomly selected to ensure accuracy in representation. Only households headed by capacitated adults (male and female participants 18 years and older) were included in the research.

3.4.1.4 Administering the structured survey questionnaire

Permission to administer the survey questionnaire to the sampled households was granted by the Village's Induna, Mr Daniel Ralebofu. Survey participants were also required to provide informed consent (**Annexure A**). The research targeted a minimum of 238 households in Matobole Village. An 86% participation rate was obtained, with 205 households participating in the research (Table 3-3). Reasons for non-participation was largely due to not being able to access to houses (fencing and aggressive dogs), or targeted households not being available due to different commitments such as funerals, church and work.

The researcher made use of a combination of electronic and hard copy questionnaires. Responses to electronic questionnaires were captured immediately, while hard copy questionnaires were administered and collected at a later date, which was agreed upon between the researcher and respondent(s). The purpose of the research was explained to the household members during questionnaire administration. It was also explained that they could assist each

other with answering the questions since they are all members of the same household employing the same practices and experiencing the same challenges. However, only the main respondent's demographic information was captured.

3.5 Demographic information of survey respondents

A sample size of 238 households was selected for participation, however only 205 households were reached and were able to participate in the study averaging 86.1% participation rate. **Table 3-3** provides an overview of the participants' socio-demographic variables such as gender, age, education level, employment type, household size and net monthly income.

Table 3-3: Demographic information of respondents from Matobole Village (n = 205).

Demographic information	Number of households	Percentage
Gender		
Male	83	40.5%
Female	122	59.5%
Age		
18-25	75	36.6%
26-35	39	19.0%
36-45	49	23.9%
46-55	31	15.1%
56-65	11	5.4%
>65	0	0%
223		
Level of education		
Tertiary	88	42.9%
High school	93	45.4%
Primary school	12	5.9%
Never went to school	7	3.4%
Not stated	5	2.4%
Employment type		
Full-time	58	28.3%
Part-time	91	44.4%
Self-employed	24	11.7%
Unemployed	29	14.1%
Not stated	3	1.5%
Household size		
1 member	9	4.4%
2-3 members	70	34.1%
4-5 members	96	46.8%
>6 members	27	13.2%
Not stated	3	1.5%
Net household income/month		

Demographic information	Number of households	Percentage
R1-R12 816	106	51.7%
R12 817-R32 058	89	43.4%
R32 059-R51 299	8	3.9%
>R51 300	2	1.0%
Total	205	100%

3.5.1 Gender of respondents

Participation in the study was dominated by female participants averaging 59.5% response rate while the remaining 40.5% were male respondents.

3.5.2 Age of respondents

The majority of respondents (as shown in Table 4-1) were between the ages 18 to 25 at 36.6% and age 36 to 45 at 23.9%. No respondents over the age of 65 participated in the study.

3.5.3 Level of education

Cao *et al* (2018) indicated that villagers with higher level of education are more likely to participate in waste management and recognise the importance of environmental protection. They may also have more ideas on waste management and be able to encourage their families to support and participate in waste management. With regard to education level, 45.4% of participants had high school education, 42.9% had tertiary education and only 3.4% never went to school.

3.5.4 Employment type

The majority of the households at (91 households or 44.4%) were employed part-time, while 14.1% of participants were unemployed at the time of the survey being conducted. Only 28.3% of participants were employed on a full-time basis.

3.5.5 Household size

Different studies have shown that household size has an influence (both positive and negative) on waste management practices such as waste generation and waste separation (Fadhullah *et al.*, 2022; Noufal *et al.*, 2020; Trang *et al.*, 2017). The participants in this research were dominated by households with four to five members at 46.8% and households with two to three members at 34.1%. Households with more than 6 members were at 13.2% and with one member at 4.4%.

3.5.6 Net household income per month

As with household size, Noufal *et al.* (2020) indicated that some studies found that income level has an impact on waste generation. While some studies indicated that households with more income are likely to generate more waste (because they have more purchasing power than households earning less income), others such as the work by Trang *et al.* (2017) proved that households with higher income generate less waste as they prefer eating out than cooking at home.

The majority of the survey participants (51.7%) earned a monthly income of between R1 – R12 816, followed by households earning between R12 817 – R32 058 at 43.4%. Only two households (1%) that participated in the study earned more than R51 300.

3.6 Data analysis

Data analysis is defined by LeCompte and Schensul (1999) as the process used by a researcher to reduce data to a story and its interpretation. Qualitative data can be analysed through formal systems developed to assist the researcher in giving meaning to their data more easily. These systems involve coding techniques for locating and highlighting the data's underlying ideas, grouping the same information into categories, and forming relationships between different ideas and themes (O'Connor & Gibson, 2003). Kawulich (2004) pointed out that for a researcher to analyse qualitative data, they need to immerse themselves in the data to become familiar with it, look for patterns and themes, and then search for relationships between the data.

Data collected for this study through a structured survey questionnaire was analysed to determine waste management practices of rural household in Matobole Village, as well as challenges and opportunities related to waste management. Frequency tables and graphs were used to analyse the frequency of predetermined responses selected by participants in Section B of the questionnaire. Open-ended responses to the questions posed in Section C, focusing on opportunities and challenges were thematically analysed. The framework suggested by Mwangi and Thuo (2014) for "*conceptualising and identifying problems, challenges and mechanisms for waste management in developing countries*" informed the categorisation of responses. The framework provides for (1) technical, (2) financial/economic, (3) social and cultural, (4) environmental health, (5) institutional and political and (6) legal and policy categories. This framework has been applied by Roos *et al.* (2021) within the South African context, and was also considered to be suitable for this research.

Open-ended response data were analysed thematically through coding and deductive reasoning (Braun & Clarke 2006:79) to describe patterns and relationships between variables in data sets.

The process involved familiarisation with the data, initial codes generation and collating of codes into themes according to the categories proposed by Mwangi and Thuo (2014).

3.7 Ethical considerations

Protecting human subjects in any research study is essential. This is done by applying ethical principles. This research focused on households headed by adults and excluded households headed by minors. The research proposal was submitted for approval, and permission to conduct the research was granted by the Faculty of Natural and Agricultural Sciences of the North-West University, Potchefstroom Campus, with ethics number NWU-01224-22-A9. Permission was granted after a review and approval by the Faculty of Natural and Agricultural Sciences Ethics Committee (NFAS-REC). The proposal followed scientific methods, adhered to the University's required standards as set out in the Academic Rules for Master's and Doctoral students, and considered the methodology to have minimal risk. In addition, all participants were required to provide informed consent, and were informed of their right to withdraw from the research at any stage.

3.8 Methodological assumptions and limitations

The following methodological assumptions and limitations regarding data collection must be noted:

- Research findings are based on self-reported data which were gathered through survey questionnaires. Self-reported data was not verified through individual data collection, however, informal observations supplemented the reported data collected from households.
- A total of 205 of the 238 targeted households (86.1%) responded to the survey. This was considered to be an acceptable response rate and to be adequately representative of the population of Matobole Village.
- Reported challenges and opportunities for waste management in Matobole Village are based on the perceptions of respondents and may be referred to as "perceived challenges and opportunities".
- Only 74 of the 205 participants (36%) responded to the questions related to identifying challenges and opportunities for waste management in Matobole Village. Although the entire survey population did not respond to this question, responses by 74 participants were still regarded as being useful (considering the current knowledge gap). The 74 responses were thematically analysed and presented in a frequency table. No further correlations or associations were attempted due to the sample size.
- Socio-demographic information was only collected to illustrate the representative nature of the survey respondents. No further correlations or associations between socio-

demographic information and survey responses were attempted, since this was not part of the objectives or scope of the research.

- Most participants assumed that the research was from the municipality and that the municipality would finally address their waste management challenges. The researcher had to re-inform the respondents that the survey was related to independent research done by a university student.
- Participants were not readily available during the times (originally) selected for administering surveys. To address this limitation, data collection (surveys) was extended by two weeks, to gather sufficient responses. There was a limitation with accessing households where there were dogs. Five houses from the selected sample had dogs and could not be accessed.
- Data collection occurred a few weeks after the South African National Census of 2022. During this period, the nation was asked to be alert for robbers who pretended to be from Statistics South Africa. This caused mistrust amongst potential participants. The researcher had to properly introduce herself to households and she had to explain the purpose of her research very elaborately.

3.9 Chapter summary

This chapter discussed the methodology followed for the study. The study adopted qualitative research analysis, and the research objectives guided its design. Data was collected through a structured survey questionnaire with close-ended and open-ended questions. The research design, case study selection, data collection and data analysis were discussed in detail. Case study selection provided an overview of the study area and the criteria used to select the Village. Data collection provided details on how the structured survey questionnaire was developed, piloted and administered to participants, and how the sample size was determined using the Andrew Fisher Formula. Socio -demographics of the participants were presented here, and included gender, age, level of education, employment type, household size, and net household income per month. Data collection methods and ethical considerations were also explained. The next chapter will focus on data presentation and discussion.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the data collected through a structured survey questionnaire from 205 respondents in Matobole Village. The collected data was analysed to determine solid waste management practices and explore challenges and opportunities for solid waste management in Matobole Village. The first section (4.2) presented results and discussions on solid waste management practices (generation, separation, recycling, reuse, storage, and collection) **(RO1)**, while the second section (4.3) presented results and discussion on challenges and opportunities for solid waste management **(RO2)**. The results of this research were discussed in comparison with the results of similar studies done by other authors around.

4.2 Results related to RO1: Solid waste management practices in Matobole Village

This section presents and discusses solid waste management practices by households of Matobole Village. It investigates the types of waste generated by households; whether households are participating in waste separation, reclamation/harvesting, and reuse; the types of wastes they separate, reclaim/harvest and reuse; how waste is stored in their homes; methods of disposal; and waste collection.

4.2.1 Waste types generated

Participants were asked to choose the types of waste generated in their households and their responses are presented in **Figure 4-1**.

As indicated in Figure 4-1, all of the households which participated in the research indicated that they generate food waste, while 96% of respondents indicated that they generated food and beverage containers/packaging. Plastic waste (52%), glass waste (51%), paper waste (49%) and wood waste (42%) were also indicated as waste types being generated by approximately half of the respondents. It was surprising to note that only 7% of households indicated that they generated cardboard and paperboard waste, since cardboard is generally used as a packaging material. Finally, only 3% of respondents indicated that their households generated electronic waste (E-waste).

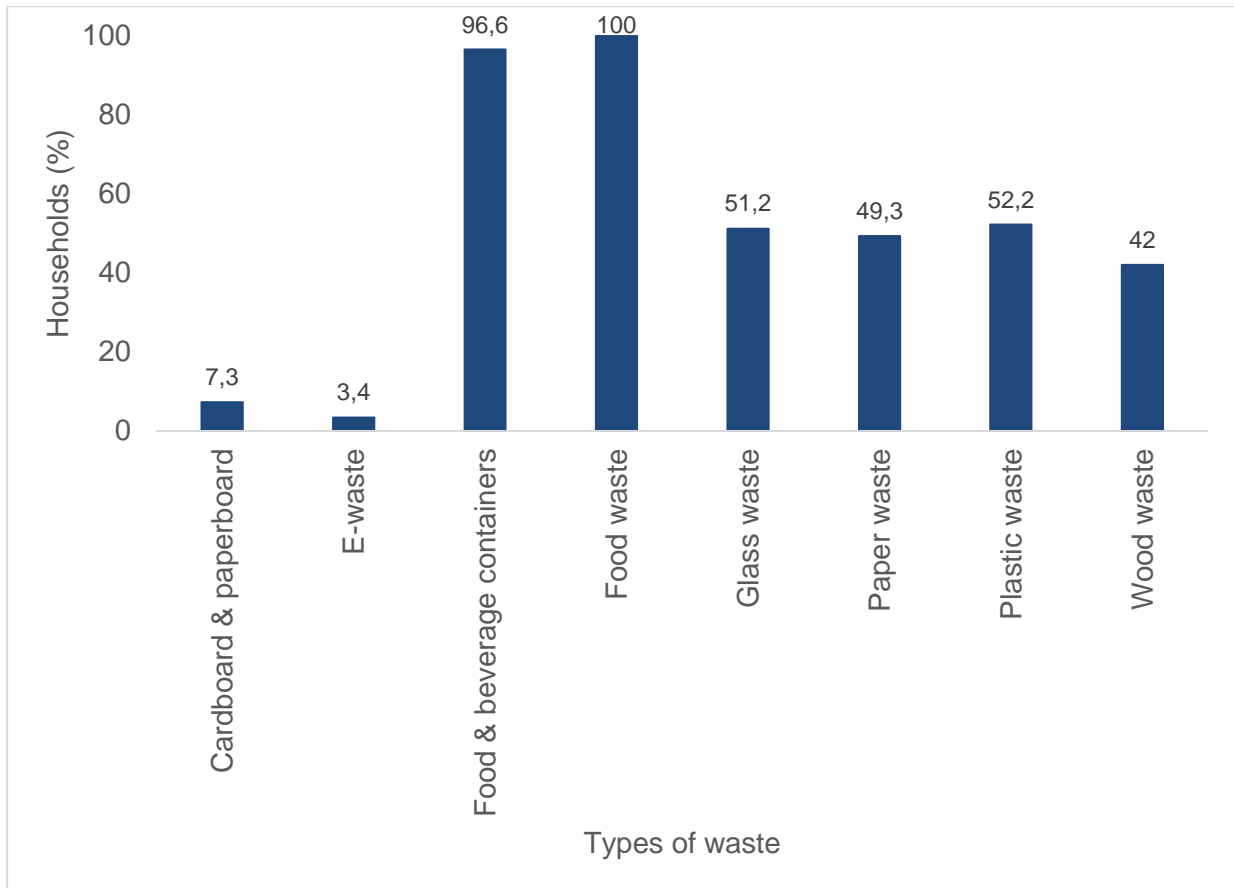


Figure 4-1: Types of waste generated by households in Matobole village (n = 205)

The types of waste generated by households in Matobole village correspond with waste generated in other sub-Saharan countries (UNEP, 2018). The results of this research are, furthermore, supported by Suthar and Singh (2015) who indicated that food waste is generated by almost all households in sub-Saharan Africa. They stated that most households in developing countries prepare their daily meals in the house/kitchen resulting in food waste which makes up approximately 57% of municipal solid waste in sub-Saharan African cities (UNEP, 2018). The European Commission also reported that 42% of the total amount of food waste is generated by households (Machate, 2020).

In rural areas, recyclable wastes such as glass, paper and plastic are mostly generated by higher income households as they generally have higher consumption habits. Households with lower income generate less of these wastes due to poor consumption power. These waste types are also many times reused by households, and they do not necessarily regard it as being “waste” (Nxumalo *et al.*, 2020).

Although this research indicates the E-waste is generated by an insignificant number of households (3.4%) in Matobole village, this waste stream is projected to increase in African

countries such as South Africa, Senegal and Uganda due to electrical and electronic equipment demand and supply. This increase will pose a challenge in South Africa because there has not been much research done on it, nor has it been given much attention in the legislation (Khangale *et al.*, 2020).

4.2.2 Factors perceived to influence waste generation

According to research by Sivakumar and Sugirtharan (2010), Suthar and Singh (2015), Trang *et al.* (2017), Machate (2020), Noufal *et al.* (2020) and Nell *et al.* (2022), household waste generation is as a result of a variety of factors such as socio-economic status of households, geographical locations, cultural conditions, season, and consumption habits, amongst others. Participants were asked which factors they think influence waste generation by their households. The participants’ responses are presented in **Figure 4-2**.

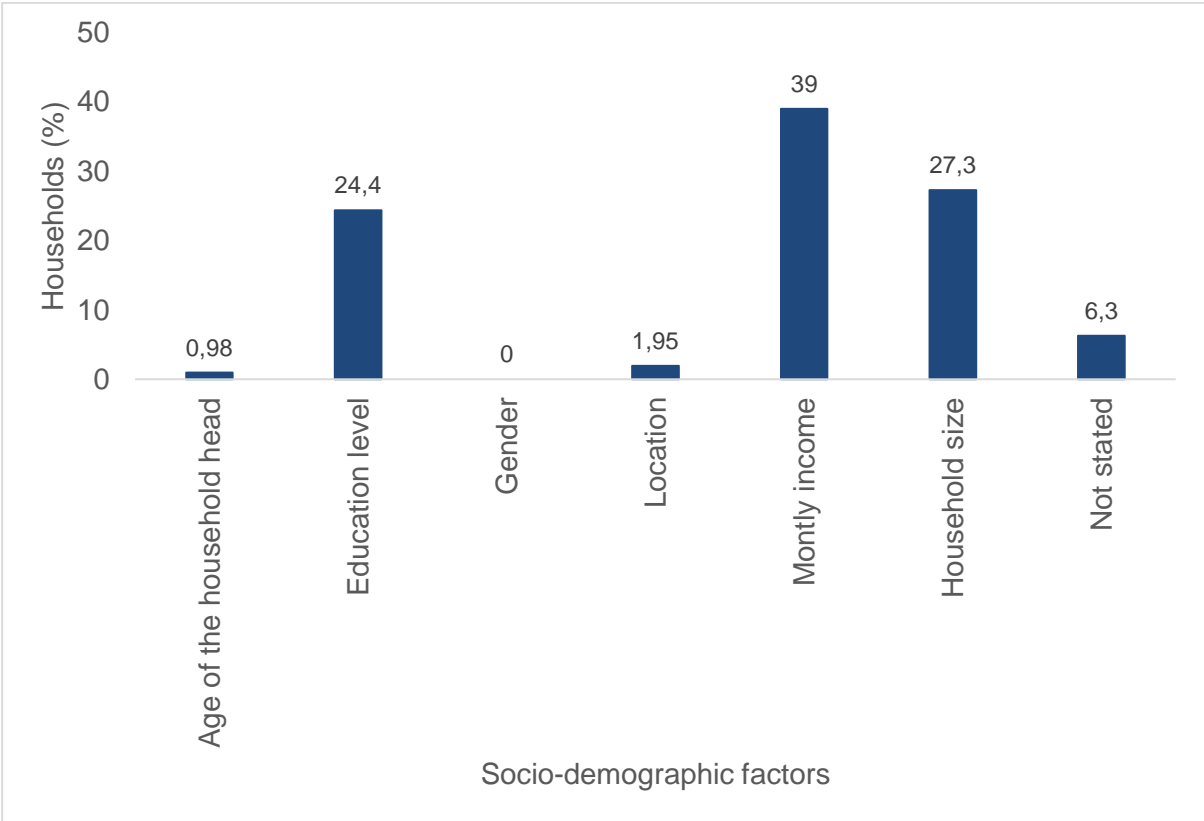


Figure 4-2: Socio-demographic factors believed to influence waste generation in Matobole Village households (n = 205)

The responses indicate that the top three factors perceived/believed to influence waste generation are net monthly income (mentioned by 39% of households), household size (mentioned by 27% of households) and education level (mentioned by 24% of households). Only 1.9% of respondents mentioned that location may play a role, and less than 1% of households

mentioned that the age of the head of the household may play a role. None of the participants perceived gender to play a role in waste generation. Six percent of households did not complete the question.

These responses correspond with the results of a study done by Machate (2020) which indicated that education level, family size, household income and employment status had the biggest influence on waste generation among households surveyed in the City of Tshwane, South Africa.

4.2.3 Waste separation, reclamation/harvesting and reuse by households

Participants were asked if their households were (at the time of the survey) participating in waste separation, reclamation/harvesting and/or reuse (**Figure 4-3**).

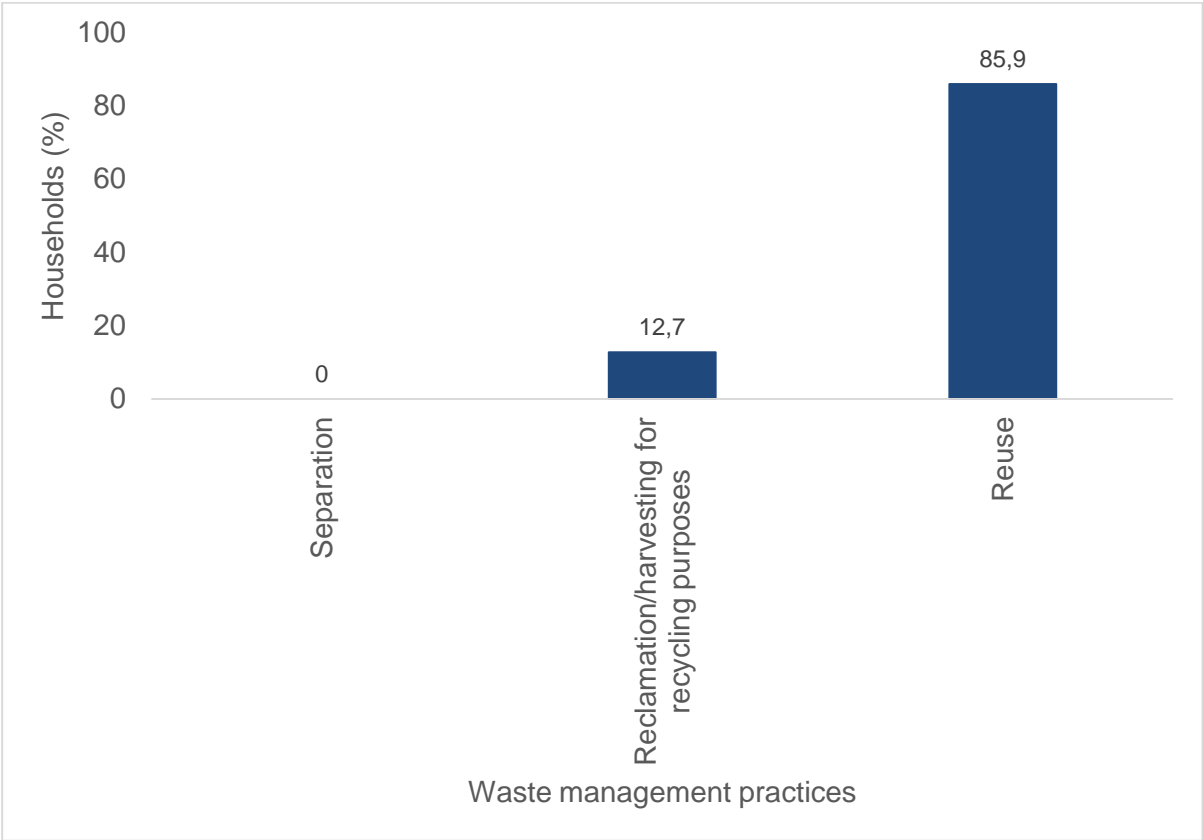


Figure 4-3: Households participation in separation, reclamation/harvesting and reuse in Matobole Village (n = 205)

One-hundred-and-seventy-six (176 or 85%) of households in Matobole Village indicated that they often reused waste (after being provided with examples of reuse), while twenty-six of the households (26 or 12.7%) indicated that they reclaimed or harvested waste for recycling purposes. According to Strydom (2018), waste reuse in developing countries is not uncommon, and is mostly a result of socio-economic issues such as unemployment and poverty.

Although the *National Domestic Waste Collection Standards* (DEA, 2011b) and the *National Waste Management Strategy* (DEA, 2011a; DEFF, 2020) strongly promote waste separation at source, the results of this study revealed little progress in this regard. None of the participants indicated that their households separated waste at source.

The results correspond with research by Viljoen *et al.* (2021) in a rural town in Hantam Municipality, South Africa. The results of their study revealed low levels of waste separation with only four households separating paper, old clothes and food waste. Other studies done by Godfrey and Oelofse (2017), Oyekale (2018), Strydom (2018), and Viljoen *et al.* (2021) also revealed a lack of waste separation in South African rural areas. Similarly, a study by Abduli *et al.* (2008), which included 21 villages in the province of Bushehr in Iran, revealed that none of the households separated waste and that separation was only done by waste pickers and collection workers.

Low levels of waste separation can be attributed to the lack of waste collection services in rural areas as this means that there are no collection programmes for the collection of recyclable waste. Households, therefore, see no reason to separate waste as they use disposal methods suitable to them. Knickmeyer (2020) also mentioned that factors such as demographic characteristics, psychological factors, economic factors, and political background may influence waste separation at source.

NEMWA structured its objectives around the waste management hierarchy to manage waste in South Africa. Together with other policies and legislation they prioritise the moving of waste away from landfill towards value recovery. Waste reuse and recycling are the most preferred waste management options, following waste avoidance and reduction. Recycling has been the main focus of the NWMS 2011 to divert waste from landfill and waste pickers have been playing an integral part in diverting recyclables from landfills. Although South Africa has achieved recycling rate that compares favourably with other developed countries, the rates are generally low in rural areas (Strydom & Godfrey, 2016; DEFF, 2020).

As mentioned earlier, only 12.7% of households in Matobole Village indicated that they reclaim waste for recycling purposes. These results compare well with the results of studies conducted in developing countries including South Africa. A study by Strydom and Godfrey (2016), which targeted a representative sample of 3 500 households in both urban and rural areas of South Africa, indicated that only approximately 14.5% of households reclaimed waste for recycling purposes. The reclamation of waste for recycling purposes presents opportunities to rural households and the informal sector (waste pickers) to generate an income (Schenck *et al.*, 2016), while the quantity of waste disposed to landfill is reduced (Oyekale, 2018). In 2020, Yu *et al.*

(2020) reported that the recycling sector has provided employment to over 2.5 million people and has made a significant contribution to the country's total employment and the promotion of entrepreneurship and self-employment. However, it is reported that households provide many reasons for not reclaiming waste for recycling purposes. According to Oyekale (2018) and Strydom (2018) households do not think that it is important to recycle waste, they perceive waste separation as too time consuming, separation and storage infrastructure and services for recyclables are lacking; and they do not perceive recycling to be their responsibility.

4.2.4 Waste types being reclaimed/harvested and reused by households

Examples of waste streams that are often reused and reclaimed for recycling purposes include paper and packaging, plastic, waste tyres, and E-waste (UNEP, 2018). Waste types reclaimed and reused in Matobole Village are illustrated in **Figure 4-4**. No households indicated that they separated waste at source.

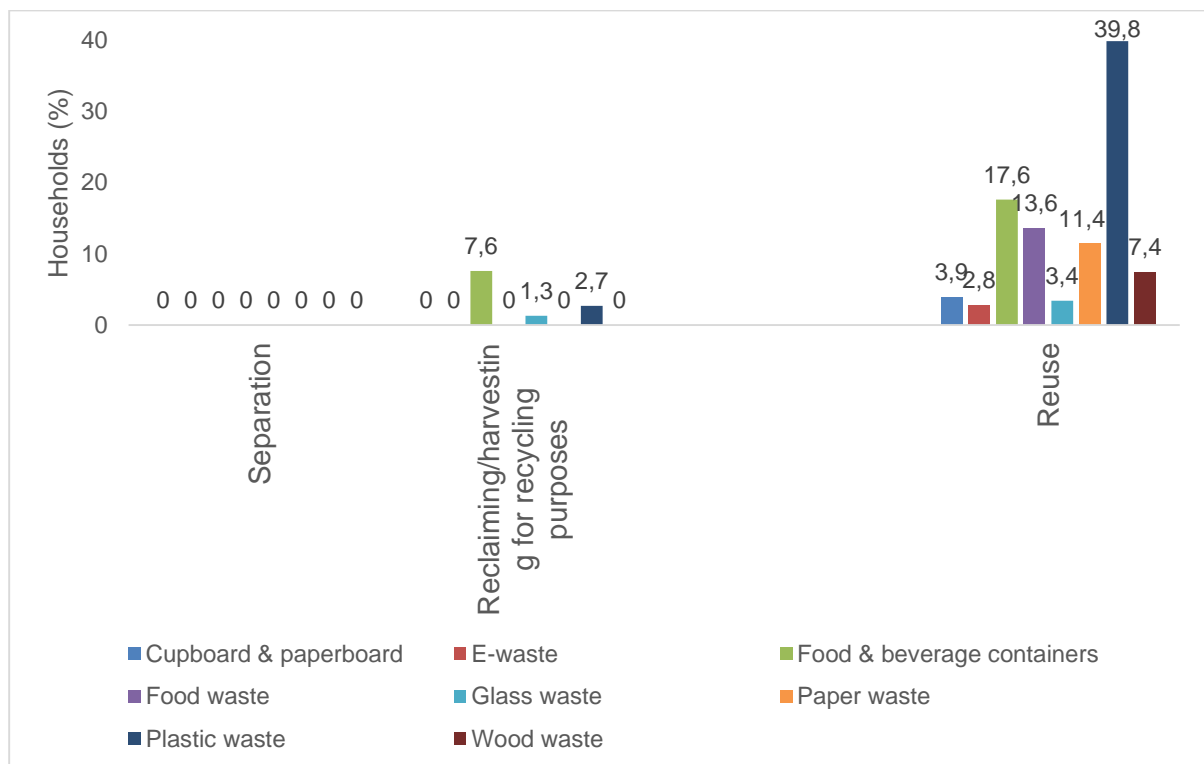


Figure 4-4: Types of waste separated, reclaimed/harvested, and reused by households in Matobole Village (n = 205)

Participants indicated that three types of waste are reclaimed for recycling purposes (7.6% of households reclaimed food and beverage containers, 1.3% reclaimed glass and 2.7% of households reclaimed plastic waste), and that all eight of the waste streams generated (refer to Figure 4-1) are reused.

As indicated in Figure 4-4, plastic is the waste stream which the majority of households (39.8%) reused. It is mostly preferred for reuse due to its durability, low cost, strength, and light-weight characteristics. Examples of plastic reuse in rural areas were mentioned by Nxumalo *et al.* (2020), where rural households in Eswatini reused plastic containers and bottles for storage of food products such as teabags, salt, soup, cooking oil and other food stuffs. Plastic bags are commonly used as by school children for packing of lunches and for storage of books and stationery. Thirty-six (36 or 17.6%) of households indicated that they reused food and beverage containers/packaging, while 27 households (13.6%) indicated that they “reused” food waste, where they mentioned methods, such as composting and use as animal feed. In a study by Viljoen *et al.* (2021) food waste was reused by majority of the respondents as dog or pig feed, while others separated it for making compost. E-waste was the least type of waste generated (Figure 4-1) and reused by households, with 2.8% of households in Matobole village indicating that they reused E-waste (mainly by donating/gifting an old/second hand electronic device to someone else).

Examples of plastic reuse in rural areas were mentioned by Nxumalo *et al.* (2020) where rural households in Eswatini reused plastic containers and bottles for storage of food products such as teabags, salt, soup, cooking oil etc. Plastic bags are commonly used as school bags by school children and for storing food in fridges and freezers.

4.2.5 Waste storage

Households were asked if they receive waste bins or refuse bags from the municipality, and were requested to indicate what they use for waste storage in case they do not receive bags or bins. All of the participants indicated that the municipality do not supply them with waste bins or refuse bags. The practices, methods and/or infrastructure that they use for the storage of waste are illustrated in **Figure 4-5**.

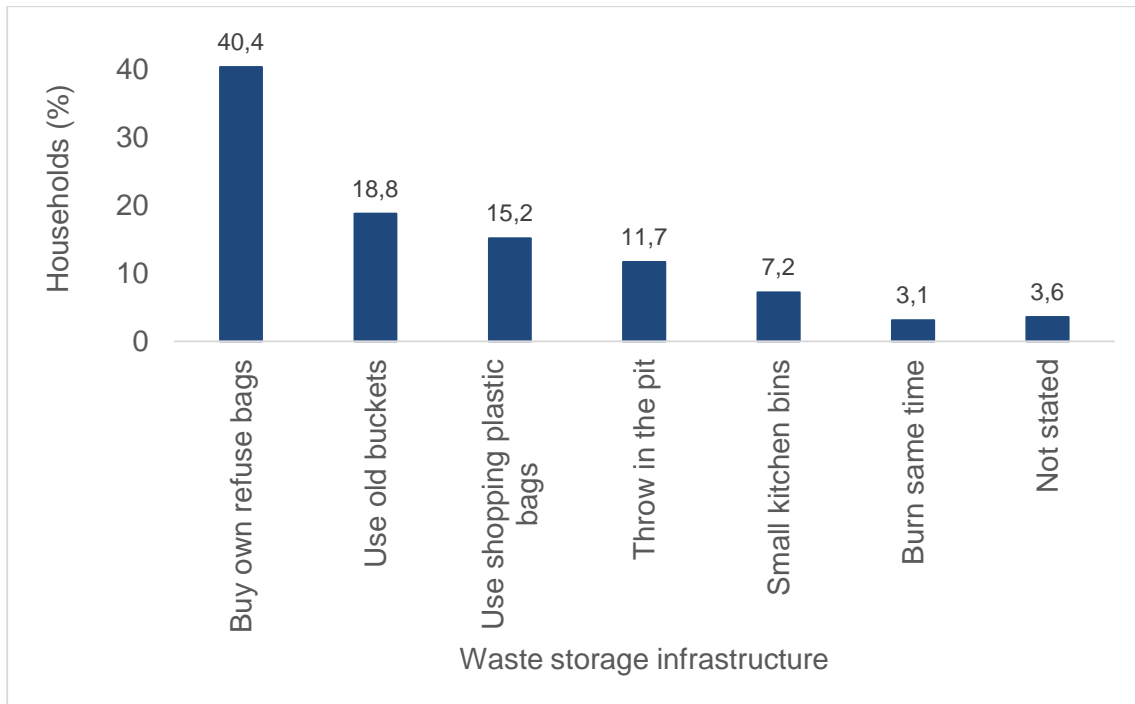


Figure 4-5: Waste storage infrastructure used by households in Matobole Village (n = 205)

The majority of households (82 households or 40.4%) indicated that they buy their own refuse bags, while 15.2% of households stated that they reuse plastic shopping bags to store waste before disposal. Approximately 19% of households used old buckets, and 7% made use of small kitchen bins.

Thirty of the households indicated that they did not use any waste storage infrastructure or methods. Many respondents mentioned that having no storage space was the main problem (also see Section 4.3.1.1 below). Niyobuhungiro and Schenck (2022) in their study addressing drivers of indiscriminate dumping also mentioned that most households do not have storage space for generated waste which leads to uncontrolled dumping of waste. Twenty-four (24 or 11.7%) of the households indicated that they dispose of waste upon generation by throwing it in a pit, while 3.1% indicated that they burned waste upon generation. About 3.6% of households did not indicate their waste storage method.

Rathnamal *et al.* (2021) mention in their study that about 50.52% of rural households store waste in either closed or open containers in open areas. UNEP (2018), similarly, reported that about 61.4% of rural households in Ghana use open containers for waste storage, while 28.3% use closed containers, and 10.3% use polythene bags and sacks. Research conducted in rural villages in Bushehr indicated that households make use of plastic bins, reused plastic bags, and

oil drums made from low-grade tin plates (Abduli *et al.*, 2008) for the storage of waste, in the absence of receiving waste storage infrastructure from the municipality.

According to Olukanni *et al.* (2020) income level plays a significant role in the storage of waste by rural households. While households with higher or better income are able to afford closed bins and refuse bags, low-income households mainly store their waste in open containers, reused bags and open spaces. The open storage of waste is undesirable as it attracts vermin, and increase the potential for environmental pollution (Boateng *et al.*, 2016).

4.2.6 Waste collection

It was not until May 2022 that some small parts of the Matobole Village started receiving waste collection services from the municipality. A waste collection project was initiated by a non-profit organisation (NPOs) called United Youth Organisation. The organisation was established in 2017 but started being active in 2020. It is based in a nearby village called Koppermyn Village. With funding from National Lottery, they were able to install street bins (**Figure 4-7**) in some villages around Ga-Maja, including Matobole Village. The project is in its early operational stage and has not been rolled out to the majority of the village. The street bin installation project commenced in April 2022 and the municipality started collection from street bins in May 2022.

The involvement of non-governmental stakeholders in waste collection initiatives are also seen in African countries such Mozambique, Nigeria, Egypt and Burkina Faso where waste collection and transfer services involve a number of actors including resident associations, the informal sector, community based organisations (CBOs) and NPOs (UNEP, 2018).

Since it is only a small fraction of the village that receive waste collection (as explained above), the majority of the respondents (183 households or 89.3%) indicated that waste is not collected. Fifteen of the households (7%) indicated that they receive waste collection services twice a week, while 3.6% of households indicated that waste is collected once a week (**Figure 4-6**).

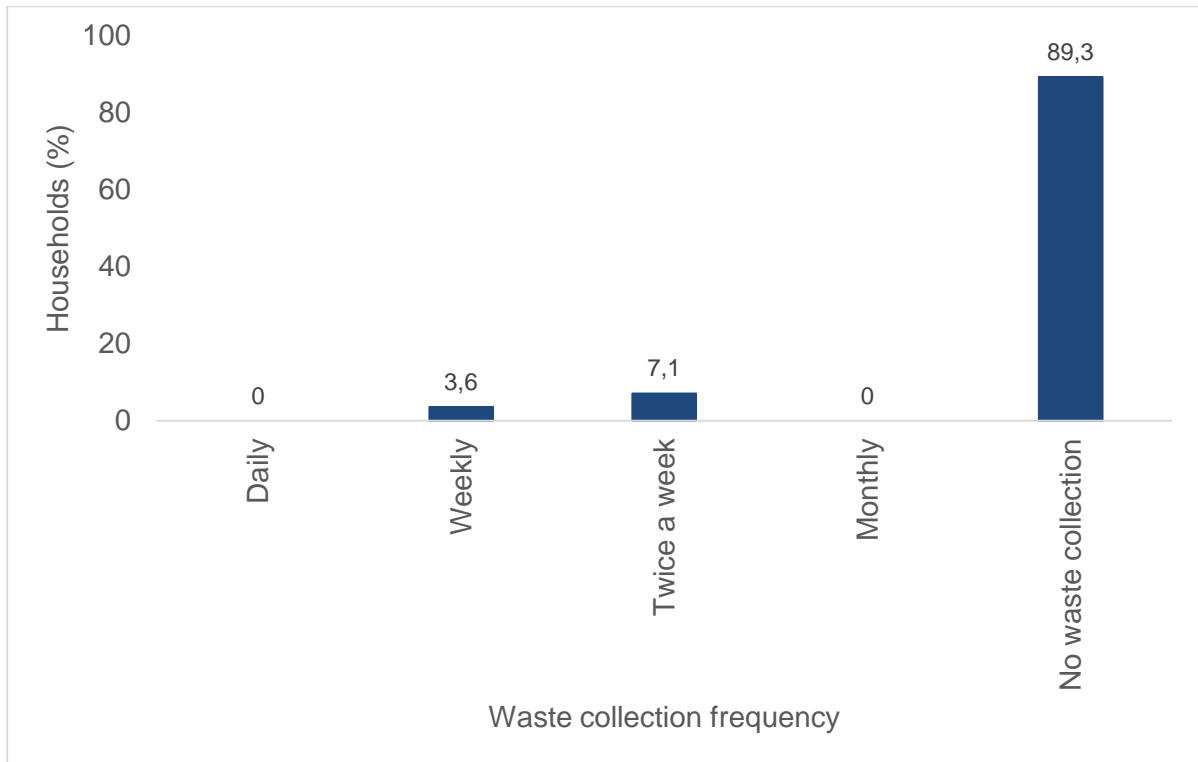


Figure 4-6: Waste collection frequency in Matobole village (n = 205)



Figure 4-7: Street bins used for waste storage before waste collection

Studies by Mihai (2017), Wang *et al* (2017), and Lima and Paulo (2018) confirmed that most rural areas in developing countries are not receiving waste collection service. These areas are often neglected by formal waste management services as a result of different factors, such as long travelling distances, geographical barriers, transportation costs, poorer socio-economic conditions, low population densities and sparse settlements (Mihai & Grozavu, 2019). Matobole

Village is 51.8 km away from Polokwane. This relatively long distance, together with transportation costs (Polokwane Local Municipality IWMP, 2016), might have contributed to the lack of waste collection services over the years. The municipality is rendering limited waste collection services in rural settlements but plans to make provision for transfer stations in rural areas including the Molepo/Chuene/Maja Cluster: Ward 2 where Matobole Village is situated (Polokwane Local Municipality IWMP, 2016).

Another factor contributing to a lack of service delivery is residents in rural areas who are unable to pay for waste management services (Olowa, 2018). This lack of waste collection services encourages other waste disposal practices such as open dumping, burning, burying and littering of household waste (see Section 4.2.7 below). These practices are most prevalent in rural areas of developing countries whose municipalities are struggling to provide waste management services and have a direct negative impact on the environment and reduce the quality of life for poor households (Niyobuhungiro & Schenck, 2022).

4.2.7 Waste disposal

Waste disposal options practiced by the households surveyed in Matobole village are indicated in **Figure 4-8** and included burial, burning and disposal in a pit. The majority of households (125 or 60.9%) indicated that they burned waste, while 43 of the households (20.9%) used an open pit, and 37 households (18%) indicated that they buried waste (Figure 4-8). These practices are reported as being practiced often in unserved rural areas (Aminu *et al.*, 2020; Haywood *et al.*, 2021). These methods of disposal are often practiced in rural areas because they are considered to be cheap and convenient and are many times influenced by socio-economic conditions and geographical demographics (Aminu *et al.*, 2020; Niyobuhungiro & Schenck, 2022). Factors influencing the choice of disposal methods used in Matobole Village were not investigated during this research.

None of the participants indicated that they practice composting, landfilling or littering/open dumping. However, the researcher discovered multiple instances of littering, as well as waste being dumped in open spaces in the village (**Figure 4-9**) while conducting the research.

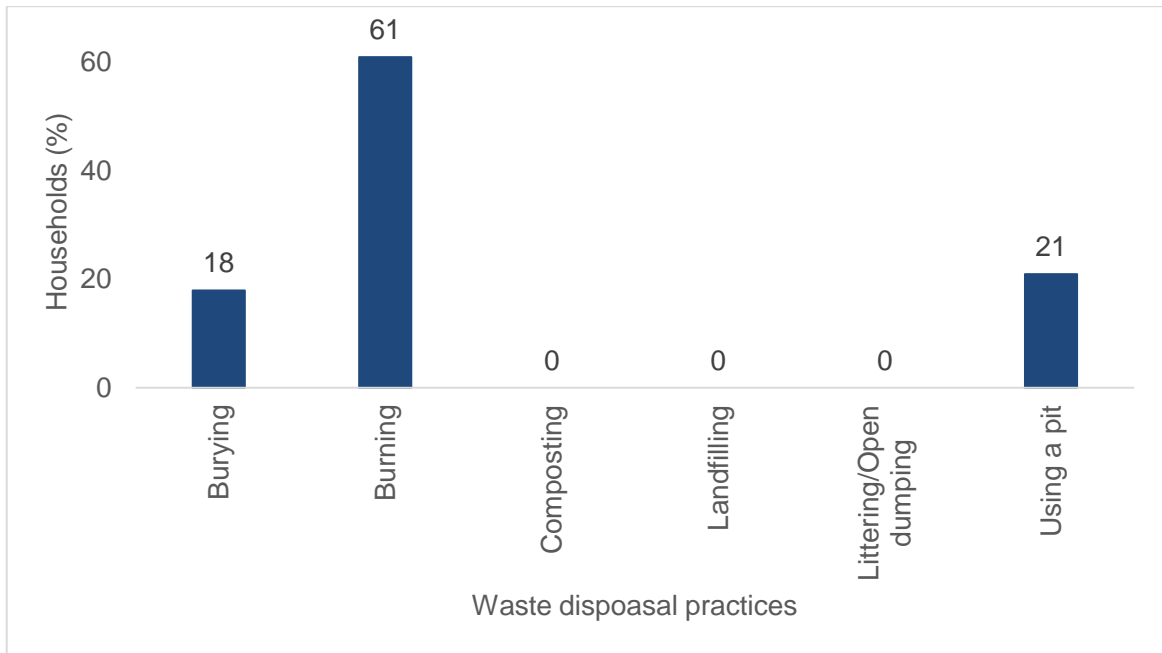


Figure 4-8: Waste disposal practices of households in Matobole Village (n = 205)



Figure 4-9: Waste dumped in open spaces and next to the river in Matobole Village

Although it was not reported as a means of disposal by the households included in this research, it was evident that open dumping was being practiced in Matobole Village. Many studies including those conducted by Abduli *et al.* (2008), Boateng *et al.* (2016), Viljoen *et al.* (2021), and Schenck

et al. (2022) mention open dumping as a common method of waste disposal in rural areas of developing countries, including Iran, Ghana and South Africa areas.

The majority of the households indicated that they burn waste as method of disposal. Burning of waste is prominent in rural households in developing countries as it is considered the “cheapest method of waste disposal” (Aminu *et al.*, 2020). This practice was listed as the preferred method of waste disposal by rural participants in a study by Limon *et al.* (2020) conducted in a rural municipality in the Philippines. The uncontrolled burning of waste is, however, undesirable because it causes the formation of dioxins, furans and polychlorinated biphenyls, which is detrimental to human health and the environment.

The use of open pits for waste disposal is predominant in rural areas of developing countries. This research indicated that approximately 21% of households in Matobole village use open pits to dispose their waste. The results of this research correspond with a study conducted by Mengistie and Baraki (2010) on the assessment of household waste management and hygiene practices in Kersa Woreda in Eastern Ethiopia, where 26.5% of the respondents used open pits to dispose waste.

Approximately 12% of households surveyed in Matobole Village indicated that they bury waste, which corresponds with findings by Aminu *et al.* (2020) where 13% of respondents buried their waste as a method of disposal. This method of disposal is often chosen (above open pit disposal) as a means to get rid of the offensive smell of waste.

To address the mostly undesirably nature of the waste management practices currently implemented in Matobole Village, and to seek for opportunities for improvement, the next section of the dissertation deals with Research Objective 2 “Exploring challenges and opportunities for waste management in Matobole Village”.

4.3 Results related to RO2: Waste management challenges and opportunities in Matobole Village

This section presents the results on waste management challenges and opportunities, which relates to research objective 2. The results were analysed thematically in accordance with the framework suggested by Mwangi and Thuo (2014) for “*conceptualising and identifying problems, challenges and mechanisms for waste management in developing countries*” as explained in Section 3.6 of this dissertation. This framework was also used by Roos *et al.* (2022) to explore opportunities and challenges for waste management in the South African context. Themes included (i) technical challenges, (ii) financial/economic challenges, (iii) environmental- and health

challenges, (iv) institutional challenges, and (v) challenges due to the characteristics of Matobole Village.

4.3.1 Waste management challenges

Table 4-1 outlines the perceived waste management challenges as mentioned by research participants of Matobole Village. Only 74 of the 205 participants responded to the questions on waste management challenges. Their responses are outlined in Table 4-1 and discussed below according to the five identified themes.

Table 4-1: The number and percentage (n = 74) of responses per code relating to perceived waste management challenges in Matobole Village

Themes and codes	Examples of phrases mentioned	Frequency	
		n	%
Theme A: Technical challenges			
(C1) Infrequent waste collection services ^{4*}	'waste not collected', 'infrequent collection', 'collect once a week'	67	91
(C2) Lack of storage infrastructure ⁸	'no storage infrastructure', 'no bins', 'no refuse bags', 'no municipal provision', 'old buckets', 'shopping bags'	59	80
Theme B: Financial/economic challenges			
(C3) Limited funding towards waste management ²	'buy', 'cannot afford', 'refuse bags', 'too expensive', 'no funds', 'no money'	70	95
Theme C: Environmental and health challenges			
(C4) Inappropriate waste disposal methods ³	'burning', 'open spaces', 'dumping in rivers', 'waste dumped', 'littering', 'pollution', 'emissions', 'gasses', 'effluent'	68	92
(C5) Safety of children and livestock ⁵	'health', 'unhealthy', 'safety hazard', 'unsafe', 'children', 'sharp objects', 'cattle and goat', 'plastics', 'toxic'	65	88
Theme D: Institutional challenges			
(C6) Lack of communication ¹	'unaware', 'no communication', from 'municipality', 'community', 'community leaders'	74	100

Themes and codes	Examples of phrases mentioned	Frequency	
		n	%
(C7) Lack of awareness and education on waste management ⁷	'no awareness', 'no knowledge', 'don't know', 'waste types', 'separation', 'recycling', 'want to learn'	62	82
Theme E: Characteristics of Matobole Village			
(C8) Unavailability of space for waste disposal ⁹	'unavailable space', 'no space to dispose waste', 'crop production as a priority'	56	76
(C9) Distance to access the street bins ⁶	'waste bins too far', 'distance', 'cannot walk', 'tired', 'children', 'elderly'	63	85

**Ranking of challenges is indicated from 1 to 9 based on frequency of mention.*

4.3.1.1 Technical challenges

Technical challenges identified by participants included infrequent waste collection (C1) and the lack of storage infrastructure (C2). Infrequent waste collection services (C1) were ranked as the fourth most frequently mentioned challenge, which was noted by 67 of the 74 participants (91%) who responded to this survey question. The message from most of the participants was that the majority of the village did not receive collection services, while small parts of the village either received “sporadic” or “infrequent” collection services at collection intervals of once a week or once in two weeks. One of the participants reported that:

“The challenge is that the municipality does not cover the whole area when they collect waste. and [in the areas] where they collect [waste] they do it once a week or in once in two weeks. Because the waste is not stored in closed bins, it gets scattered all over the streets.”

Another participant noted that:

“It is unfair that only some of the households receive waste collection. The entire village should be treated equally. We all want to receive waste collection services. It will improve the conditions in Matobole Village.”

In research by Limon *et al.* (2020), Viljoen *et al.* (2021) and Schenck *et al.* (2022) participants complained about delayed collection schedules and waste pick-up services provided by their municipalities. Waste was either not collected weekly or houses were being skipped if the collection trucks were full. This results in littering due to the design of the bins that does not accommodate individual types of waste and encourages a habit of burning or dumping of waste in uncontrolled dumps by rural households.

A lack of storage infrastructure (C2) such as bins, skips and bags, was the eighth most frequently mentioned challenge noted by 80% of participants. Most participants mentioned that they had to use “old buckets” or “plastic shopping bags” to store waste, while others said that they have resorted to throwing away waste in a “disposal pit immediately after generation”. For the latter, this means that they are unable to aggregate and store the waste, to dispose it in the street bins provided. One of the participants specifically noted that:

“The municipality does not provide refuse bags, so we use old buckets to store waste at night then throw it into the pit or burn in the morning. Only when we have plastic shopping bags, we can take the waste to the street bins for collection.”

Similarly, studies by Abduli *et al.*, (2008), Rathnamal *et al.* (2021), as well as Niyobuhungiro and Schenck (2022) mentioned that the lack of waste storage infrastructure has resulted in rural households using other means of waste storage such as closed/open containers, polythene bags, sacks, oil drums made from low grade tin plates, and reused plastic.

4.3.1.2 Financial/economic challenges

The second most frequently mentioned challenge, noted by 95% of participants was (C3) limited funding towards waste management. The core message mentioned by participants was the fact that they did not have funds for waste collection services, and that they also did not have or want to spend money to purchase their own refuse bags. They believed that it was the responsibility of the municipality to supply the households in the village with refuse bags, because “they cannot afford to buy [their] own refuse bags as many of the residents are unemployed and the government grants that [they] receive is used for food and essential goods”. One participant mentioned that:

“We depend on government grants and the little money we get we use for food. We cannot afford to buy refuse bags and bins. The municipality must provide that for us if they want us to use the bins they have installed. And besides, it is not the entire village that have those bins”.

This seems to be a belief or a desire by most communities in South Africa as revealed by Roos *et al.* (2021) and Viljoen *et al.* (2021). In their studies, respondents mentioned the need for bins and black bags from the municipality in order to participate in waste management activities such as waste recycling and separation. A lack of waste management infrastructure is also mentioned as a challenge in reports such as the Africa Waste Management Outlook (UNEP, 2018) and highlighted as a focus area in the National Waste Management Strategy (DEFF, 2020).

4.3.1.3 Environmental and health challenges

Environmental and health challenges mentioned by participants included: inappropriate waste disposal methods (C4), where participants mostly mentioned the potential for environmental pollution, and the safety of children and animals (C5).

Inappropriate waste disposal methods (C4) were the third most frequently mentioned challenge (mentioned by 68 or 92% of respondents). The mentioned phrases such as 'littering', 'dumping in open spaces', 'dumping in rivers', 'disposal in open pits', 'burning', 'pollution', 'emissions', 'toxic gasses', 'effluents'. Although these practices were common amongst households in Matobole Village (due to a lack of waste service provision), respondents' statements indicated that they were aware of the fact that these practices were undesirable and may have a negative impact on the environment. They specifically also mentioned the nuisance that these practices are causing and the potential safety hazards that it poses to children and animals (C5).

Participants mentioned that open burning "emits smoke" and they were cautious of "toxic gases" released from burning waste, which causes "coughing" and "bad smells in their houses". Some complained that they "cannot hang their laundry outside due to smoke from neighbouring households when waste is being burned". Similar challenges were mentioned by the research participants in the study by Viljoen *et al.* (2021) where participants mentioned challenges with smoke and emissions because of waste burning practices.

Open dumping is common in rural areas including Matobole Village and is mainly practiced because it is the most convenient and requires the least amount of effort from waste generators (Boateng *et al.*, 2016; Viljoen *et al.*, 2021). Households included in this research mentioned that "waste are dumped in open spaces and streets", and that it is "wind-blown" or "intentionally dumped into rivers and streams". It was clear that participants had environmental- and health concerns about water being polluted by waste. One of the research participants reported that:

"We use river water for cooking and the waste dumped into this river pollutes the water and it becomes unusable. Unfortunately, we do not have any alternative but to use it and we get sick sometimes".

River dumping or waste disposal into water bodies was also practiced by rural respondents in rural Romania in a study by Apostol and Mihai (2012), due to poor waste management facilities. In their research, households were also reliant on rivers and streams for domestic use, and expressed concerns about water becoming unusable, and its effects on their health.

Households near open dumps complained about waste being "scattered around the village" and "blown into yards". This was also highlighted as one of the concerns in Hantam Municipality in the

research conducted by Viljoen *et al.* (2021) where residents noted the issue of waste (plastics and papers) being blown into their yards from open dumps and unfenced landfill sites.

Uncontrolled dumping of waste is one the major environmental issues, globally, and results in pollution, produces toxic gases, serves as breeding ground for pests, insects and infectious diseases and puts households at risk of getting ill (Sheheli, 2007; Niyobuhungiro & Schenck, 2022). The respondents in this research especially expressed their concerns about waste causing risks to the safety of children and livestock (C5). This was the fifth most frequently mentioned challenge raised by 65 (or 88%) of the participants.

As mentioned earlier (and indicated in **Figure 4-9**), waste is dumped in open areas and littering is observed in many areas in Matobole Village. Participants mentioned their concerns regarding “sharp objects” and “toxic/hazardous waste” being a safety hazard to children, and that “plastics” and objects that sheep and goat may ingest, may pose a risk to livestock.

These concerns were shared by the participants in the research by Viljoen *et al.* (2021). Some of their participants were blaming parents for their lack of responsibility to keep children away from the waste dumps, while others felt that the municipality should be held responsible because of a lack of waste collection services. The issue of safety was also mentioned by Schenck *et al.* (2019) and Yu *et al.* (2020) where waste pickers are at risk of contracting diseases while picking waste from the bins without proper personal protective equipment.

4.3.1.4 Institutional and political challenges

It was interesting to note that a lack of communication (C6) was regarded as the biggest waste management challenge by the respondents in this research. This challenge was mentioned by all 74 (100%) of the participants who responded to the question and ranked as the most frequently mentioned challenge. The participants’ responses indicated that they perceived communication to be lacking, in general, with reference to internal communication (amongst community members and between community leaders and members) as well as external communication (between the municipality and the community/community leaders). It seemed as if most of the frustrations of community members were linked to a lack of communication about “waste collection services”, “waste collection frequency” and the “reason why some parts of the village are receiving bins and services and others not”. Participants specifically mentioned that the collection project that was implemented in May 2022 was a surprise as there was no communication with regard to the implementation of the project in the village. Especially households not receiving waste collection services wanted to know how the waste bin and waste collection projects will be rolled out. It was

clear that these participants felt excluded and uncertain about the future of waste management in the village. One participant report that:

“We did not know about the collection of waste as it was not communicated to us and it is not even covering our part of the village. So, we do not know if waste will ever be collected from our side or not and when it will be collected. We feel left out”.

According to Stępień & Białecka (2015) information and communication play an important role in any organisation and for any system to work. Communicating with households within Matobole Village is essential towards achieving effective waste management in the village. Morton & Cross (2012), Kirkman & Voulvoulis (2017), as well as Schenck *et al.* (2022) have reported that informed households, receiving sufficient communication on waste management, are encouraged to participate in waste management programmes, raise issues and provide suggestions and opportunities for future improvements. Sufficient information-sharing and communication could also improve awareness and knowledge on waste related matters.

A lack of awareness and education on waste management (C7) was raised by 62 (82%) of the respondents, and was ranked as the seventh most frequently mentioned waste management challenge. Participants indicated that they had “no knowledge of waste management” and are “not aware” of any waste management activities in the village. They also indicated that they many times “do not know what the correct practices are for waste management”. This challenge corresponds with a study by Limon *et al.* (2020) where participants, who were unaware of its potential negative effects, buried hazardous waste with the belief that it would not create harmful effects compared to when it is disposed above the ground. This belief can be deduced to residents lacking awareness and knowledge on acceptable waste management practices. This challenge contributes greatly to the existence of open dumps in rural areas and across the globe (Mihai & Taherzadeh, 2017). When there is no communication, it is highly unlikely that households will be aware of any waste management related projects taking place in their areas and participate. Schenck *et al.* (2022), Niyobuhungiro and Schenck (2022), as well as Tsheleza *et al.* (2022) also explicitly mention the importance of knowledge and awareness towards improving waste management practices, especially in rural areas. Education and awareness are also mentioned as a focus area of the National Waste Management Strategy (DEFF, 2020), which prioritises *“mainstreaming of waste awareness and a culture of compliance resulting in zero tolerance of pollution, litter and illegal dumping”*.

4.3.1.5 Characteristics of Matobole village (yards and streets)

The least number of participants (however, still significant mentioned by 56 respondents or 76%) mentioned the unavailability of space for waste disposal (C8) as a challenge. They raised

concerns about “not having any dedicated space (such as communal skips) to dispose waste” and “not having enough space to disposal of waste in their yards”, since the land is mainly used “to grow crops”. Participants in a study by Viljoen *et al.* (2021) also mentioned the challenge of space in their yard as they need more space to bury dead animals.

Distance to access the street bins (C9) was ranked as the sixth most mentioned challenge and noted by 63 (85%) of the participants. These participants indicated that they are unable to access the bins due to their location. In parts of the village where there are bins, the bins are located at the far end of long streets, which result in long walking distances. Respondents raised concerns about “waste bins being located too far from households” and that they get too “tired” to walk to these bins, especially mentioning the impacts of distance challenges to small “children” and the “elderly”.

One participant, who lived in a household in an area of the village where street bins have been installed, noted:

“The waste bins that have been installed are not practical as they are far from most houses. We have to walk far to reach them. This becomes difficult if you need to carry a heavy bag of waste. We cannot ask our children to take the waste away, since the bins are too far for them.”

This corresponds with a study by Haywood *et al.* (2021) and Niyobuhungiro & Schenck (2022) conducted in low-income settlements of South Africa and in Ethekewini in South Africa respectively. Participants from both studies were expected to take waste to communal collection points which were located far and cited distance to these points as reason they have resorted to other methods of disposal such as burning and burying of waste because they were not willing to walk long distances. Therefore, long distances from residence to collection facilities have a negative impact on waste management in rural areas as proven by Wang *et al.* (2018). Even municipalities are struggling to provide waste collection services in rural areas due to long distances between villages, and long distances from collection points to waste disposal sites (Niyobuhungiro & Schenck, 2022).

4.3.2 Waste management opportunities

Perceived waste management opportunities by participants of Matobole Village are outlined in **Table 4-2** and the key finding are discussed below according to the identified themes (A to C). Similar to the question on waste management challenges, only 74 of the 205 participants responded to this question.

Table 4-2: The number and percentage (n = 74) of responses per code relating to perceived waste management opportunities in Matobole Village

Themes and codes	Examples of phrases	Frequency	
		n	%
Theme A: Financial/economic opportunities			
(O1) Income generation ^{4*}	'recycling', 'income', 'money generation', 'livelihood'	42	57
(O2) Job creation ³	'job creation', 'jobs', 'work', 'EPWP'	43	58
Theme B: Environmental and health opportunities			
(O3) Safe and clean environment ¹	'less injuries', broken glass', 'clean environment'	56	76
Theme C: Institutional opportunities			
(O4) Knowledge and awareness ²	'participation', 'knowledge', awareness', 'communication'	51	69

**Ranking of challenges is indicated from 1 to 4 based on frequency of mention.*

When comparing the categories and the frequency of mentioned waste management opportunities (Table 4-2) to the mentioned challenges (Table 4-1), it is clear that respondents perceived many more challenges related to waste management than they perceived waste management as being an opportunity. This may be due to limited awareness or knowledge of potential opportunities, or that they do not perceive waste management as presenting any opportunities (due to the options available in the area, i.e., no buy-back centres, or recycling facilities in close proximity). The reasons for raised opportunities and challenges were not investigated, and may be an area for future research.

Three themes of opportunities emerged from the thematic analysis, namely (i) financial/economic opportunities; (ii) environmental and health opportunities, and (iii) institutional opportunities.

4.3.2.1 Financial/economic opportunities

Forty-two respondents (57%) mentioned income generation (O1) as a potential opportunity related to waste management. Of all the opportunities mentioned, this was the least frequently mentioned opportunity. Opportunities for income generation that were mentioned by respondents included reference to "livelihoods" and "income/money" from "recycling". The 12.7% of households which reported that they reclaim waste mentioned that they can generate more income if they had "more knowledge on other types of recyclables they can collect" and "where

they should take them besides in town which is over 50 km away from the village”, as well as having “recycling programmes” and “education” provided by municipality. They are currently reclaiming/harvesting beverage containers, plastic and glass wastes (refer to Figure 4-4). One participant was noted saying:

“We do collect cool drink and juice cans from weddings and other events in the village, but they stay in our backyards for long periods while we are waiting to have money to take them to town. Even then, we are not sure that the money that we spend on transport will be covered by selling the waste to recycling businesses”.

The village does not have any buy-back centres or recycling facilities. Instead, reclaimed waste has to be taken to the Mankweng buy-back centre which has been constructed and donated to Polokwane Municipality by the Department of Environmental Affairs (Polokwane Local Municipality Draft IDP, 2021-2026) and to a material recovery facility also in Mankweng. There are other private recycling programmes within Polokwane Local Municipality at Weltevreden landfill site, Makro (electronic recycling station) and in the industrial area (Polokwane Local Municipality IWMP, 2016). The challenge with these buy-back centres and recycling facilities is that they are far from Matobole Village and cannot be easily accessed due to distance and not having own transportation (See above quote by one of the respondents).

The NWMS of 2011 highlighted waste recycling as one of the greatest responses to waste management challenges in South Africa. Not only is waste recycling a means to divert waste from landfill, but it provides an opportunity to generate an income for the poor (DEA, 2011a). In 2007, rural households surveyed in a study by Lal *et al.* (2007) in Fiji earned a yearly average of \$3 from recycling. Similarly, waste pickers in a study by Yu *et al.* (2020), conducted in Bellville near Cape Town, indicated that their daily sale of recyclable ranges from R13 and R400 which can lead to an average of R2 900 per month taking into account the number of workdays worked per week. Although this amount is better than nothing, it is still below the average income of R3 645 of elementary occupation workers. Godfrey and Oelofse (2017) mentioned that there has been an increase in the number of informal waste pickers who earn a living through waste recycling. This increase in the number of waste pickers in South Africa can be attributed to the increase in unemployment which has forced people to look for employment in other sectors including the informal waste sector.

Although the financial/economic opportunities related to waste management is recognised as an opportunity, the challenges/obstacles in South African rural areas are recognised by authors such as Nyika *et al.* (2019), Polasi *et al.* (2020) and Viljoen *et al.* (2021).

The waste sector has been recognised by the South African government as a sector that can contribute to job creation. The NWMS 2011 noted that both waste collection and recycling could

make a meaningful contribution in the creation of jobs and GDP in South Africa and that they have the potential to expand.

Job creation (O2) was mentioned by 43 (58%) of the participants, and ranked as the third most frequently mentioned opportunity. Participants in this study believe that the municipality can create jobs in waste separation by implementing separation at source programmes and hire people from their community to separate waste on behalf of households. They also specifically mentioned job opportunities related to the Expanded Public Works Programme (EPWP). Godfrey *et al.* (2014), Sharma *et al.* (2019) and Yu *et al.* (2020) also mention the job creation opportunities related to waste management, both in the formal and informal sectors. Roos *et al.* (2022), however, warns against creating unrealistic expectations of how and to what extent waste management could reasonably contribute to job creation and the generation of income. Financial opportunities should be based on feasibility studies, which would differ based on the characteristics of the area.

4.3.2.2 Environmental health opportunities

Improved waste management leading to a “safe and clean environment” (O3) was the most frequently mentioned opportunity, mentioned by ranked the highest opportunity mentioned by 56 of the 74 (76%) respondents who answered the question. Reflecting on their responses, it is clear that participants regarded improved waste management as a means of addressing pollution issues, and thereby providing for a cleaner and safer living environment. One participant reported that:

“We do not have waste services in our village and we dump waste in the field. It is dangerous for our kids and for our livestock and animals. If the municipality can collect waste in our village, our yards will be clean and our children and animals will not be exposed to the waste we throw away in the field. We will also not need to burn waste, which will cause less pollution of the air.”

This opportunity aligns with SDG 3 and SDG 11, which are aimed at “*good health and well-being of rural households through the minimisation of waste related environmental factors contributing to ill-health and preventable diseases*” and “*that the environment is kept from harm and that carbon and greenhouse gas emissions reduced by supporting the development of cities and communities with access to sufficient waste services*” (UNEP, 2015).

4.3.2.3 Institutional and political opportunities

Increased knowledge and awareness (O4) were mentioned as an opportunity by 51 (69%) of the research participants. This was the second most frequently mentioned waste management opportunity. Respondents specifically referred to their expectation that the municipality should

provide for “information-sharing”, “training” and “awareness”, and that communities should be given an opportunity to “participate” in the municipality’s waste management processes and decisions in order to increase their “knowledge” of waste management. One of the respondents emphasised that:

“The municipality and our community leaders must involve us in waste management programmes they plan to implement in our village. If we are not involved we will never learn and we will not be able to comply and practice proper waste management methods in our households and in the community. We are willing to attend any educational seminars, training and awareness campaigns to improve our knowledge on waste management”.

Awareness and knowledge on waste management are highlighted as important factors influencing waste management behaviour (Strydom, 2018; Roos *et al.*, 2022) and it is reported that individuals with awareness and knowledge of waste are generally more willing to engage in responsible waste management behaviour (Strydom, 2018). As mentioned in Section 4.3.1.4, the current lack of awareness and knowledge (C7) is regarded as one of the waste management challenges in Matobole Village.

Knowledge and awareness in waste management are important in promoting waste separation at source, recycling and the overall handling of waste from point of generation to disposal. Knowledge and awareness can be improved through different methods such as seminars, town hall meetings, workshops, educational tours and exhibitions, radio broadcasts, television, and interactive programmes, as suggested by respondents in a study by Aminu *et al.* (2020) in Ogun State, and Schenck, *et al.* (2022).

4.4 Chapter summary

This chapter presented and discussed the results of a survey with 205 households, which focused on waste management practices, challenges and opportunities in an unserved, rural area, Matobole village.

The results of the research indicated that a range of waste streams are generated by households in the village. Food waste, and food and beverage packaging, were the two waste streams that were reported to be generated by most households. Respondents believed that monthly income, household size and education level were the three most significant factors influencing waste management in Matobole village.

None of the households separated waste at source, but some households indicated that they reused waste, and that they reclaimed waste for recycling purposes. Respondents indicated that most of the generated waste is being reused in some way or another, while plastic and food and beverage packaging were the two waste streams that were being reclaimed for potential recycling.

Several waste management practices are being exercised in Matobole village. A significant number of households indicated that they reused waste, and some indicated that they reclaim waste for recycling purposes. Most of the households resorted to the burning, burial or open pit disposal of waste, since they did not receive waste collection services from the municipality.

It was reported that refuse bags and bins are not provided by the municipality, and the households had to buy their own refuse bags, or store waste in shopping bags or old buckets/containers. Many of the respondents indicated that they did not store waste, since they discarded or burned it immediately after generation. The majority of the households did not receive waste collection services, despite a waste bin and collection project being rolled out earlier in 2022. These households had to resort to undesirable waste disposal practices, such as burning, burial, and disposal in open pits.

When asked to identify challenges and opportunities for waste management, it was evident that waste management was perceived as being a challenge, rather than an opportunity in Matobole village. Nine perceived challenges were identified and included: infrequent waste collection services, a lack of storage infrastructure, limited funding towards waste management, inappropriate waste disposal methods, safety of children and livestock, lack of communication, lack of awareness and education, unavailability of space for waste disposal, and long distances to access street bins. Only four categories (codes) of opportunities were identified, which included: the potential to earn an income, job creation, creating a cleaner and safer environment, and increasing knowledge and awareness on waste management.

Chapter 5 presents the conclusions and recommendations related to the research objectives.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides the conclusion this research which aimed to investigate solid waste management in the unserviced rural area of Matobole Village. The two research objectives related to the research aim were to:

1. Determine solid waste management practices in Matobole Village (RO1); and
2. Explore challenges and opportunities for solid waste management in Matobole Village (RO2).

The findings of the research are based on survey responses of 205 households in Matobole Village. Opportunities and challenges were identified by 74 of these households.

The chapter further provides recommendations for improvement and for recommendations for future research.

5.2 Conclusions

The sub-sections below provide the conclusions per research objective.

5.2.1 Conclusion relating to RO1: Waste management practices in Matobole village

Practices in Matobole Village included waste reclamation/harvesting for recycling purposes, reuse, storage, disposal, and collection. These practices corresponded with practices in other rural households in South Africa and around the world as noted in studies by Abduli *et al.* (2008), Boateng *et al.* (2016), Rathmal *et al.* (2021) and Viljoen *et al.* (2021).

The results of the research indicated that a range of waste streams are generated by households in the village. Food waste, and food and beverage packaging, were the two waste streams that were reported to be generated by most households. These findings were similar to the research findings of Suthar and Singh (2015) and Machate, (2020), where food waste and food and beverage packaging were also identified as the most prevalent waste streams. Other waste streams generated included paper, plastic and glass waste. These types of wastes correspond with waste generated in rural areas of other developing countries such as Ghana, Nigeria and Kenya (UNEP, 2018).

Respondents believed that monthly income, household size and education level were the three most significant factors influencing waste management in Matobole village. This corresponded

with the research by Roos *et al.* (2022) where gender, household size and education level showed a significant correlation with waste management practices amongst households in Abaqulusi Local Municipality in KwaZulu-Natal, South Africa.

None of the households separated waste at source, however, 85% of households indicated that they reused waste, and approximately 13% of households indicated that they reclaimed (mainly food and beverage containers, plastic and glass waste) for recycling purposes. Approximately 40% of the households who indicated that they reused waste, mainly reused plastic wastes. Respondents indicated that they reused plastic wastes as bins and to store food items (mostly bought in bulk). As reported by Nxumalo *et al.* (2020) and Viljoen *et al.* (2021), plastics are often reused by rural households and are often preferred because of its durability, low cost, strength, and light-weight properties (UNEP, 2018).

Respondents did not receive any waste storage bins or bags from the municipality, and waste were either stored in refuse bags which the households bought themselves (40%), or in reused plastic carrier shopping bags (15%) or old buckets (19%). Some of the respondents reported that do not store waste, and that they dispose it immediately into a disposal pit (12%) or burn it immediately (3%). The same storage methods and infrastructure were used by respondents in studies by Abduli *et al.* (2008), Olukanni *et al.* (2020) and Rathnamal *et al.* (2021) in other rural areas.

Waste collection is still a challenge as the majority of households surveyed (89.3%) reported that they were not yet serviced by the newly implemented collection project. The project was implemented in May 2022 and is still in its early stages, hence there is still a lack of waste collection in the village. Generally, rendering waste collection services in rural households in developing countries are still an area of concern, where rural areas are the most neglected (Mihai, 2017) due to factors such as long travelling distance, transportation costs, and geographical barriers (Mihai & Grozavu, 2019).

Disposal methods practiced by households in Matobole Village included burning (61%), disposal in an open pit (21%) and burying waste (18%). These practices are undesirable due to its negative impacts on the environment and human health, however, commonly practiced in rural areas (Aminu *et al.*, 2020; Haywood *et al.*, 2021) because rural households consider these methods to be convenient and cheap (Aminu *et al.*, 2020; Niyobuhungiro & Schenck, 2022).

To address the mostly undesirably nature of the waste management practices currently implemented in Matobole Village, and to seek for opportunities for improvement, the research

also explored the perceived challenges and opportunities for waste management in Matobole Village. Conclusions are presented in Section 5.2.2.

5.2.2 Conclusion relating to RO2: Perceived challenges and opportunities for waste management

The sub-sections below conclude on the perceived challenges and opportunities as mentioned by the study participants. Of the 205 participants that responded to the survey, only 74 participants responded to the questions related to challenges and opportunities for waste management. These responses were still considered to be valuable towards understanding challenges and opportunities in Matobole village, considering the current knowledge gap.

Challenges and opportunities were thematically analysed in accordance with a framework proposed by Mwangi and Thuo (2014) for *“conceptualising and identifying problems, challenges and mechanisms for waste management in developing countries”* informed the categorisation of responses. This framework has been applied by Roos *et al.* (2021) within the South African context.

5.2.2.1 Waste management challenges

Challenges mentioned by respondents fell into all four of the categories proposed by Mwangi and Thuo (2014) and included (i) technical-, (ii) financial/economic-, (iii) environmental and health- and (iv) institutional challenges, as well as (v) challenges related to the rural characteristics of Matobole Village.

The most frequently mentioned waste management challenge was a lack of communication (C6), mentioned by all 74 (100%) of the respondents. Respondents perceived a lack of communication from the municipality and community leaders to be a stumbling block towards improved waste management in the village. This problem was also experienced by households in Tha Khon Yang area in Thailand where poor communication was cited as a problem by the community and entrepreneurs. Effective communication is essential in encouraging people to take responsibility for waste management and to address barriers to community participation in waste management (Kubanza, 2021). Effective methods of communication should also be used to ensure that the information reaches relevant people and on time (Yukalang *et al.*, 2017),

Other key challenges included limited allocation of funding towards waste management (C1) (mentioned by 95% of respondents), inappropriate waste disposal methods (C4) (mentioned by 92% of respondents), infrequent waste collection services (C1) (mentioned by 91% of

respondents) and risks to safety of children and livestock (C5) (mentioned by 88% of respondents).

The challenges mentioned by respondents from Matobole Village were similar to those found in the research by Yukalang *et al.* (2017) in Thailand and Kala *et al.* (2020) in Delhi, India. Respondents in this research mentioned challenges such as expenses involved in waste management, irregular waste collection, inadequate access to waste bins, inappropriate waste disposal methods such as burning and illegal dumping, lack of space, no economic incentives, the uncleanliness of the streets which poses as a hazard to children and livestock were mentioned as reasons for seldom or never participating in waste management.

Other less frequently mentioned challenges included lack of waste storage infrastructure (C2), lack of awareness and education (C7), unavailability of space for waste disposal (C8) and distance to access street bins (C9).

These challenges are not uncommon in rural areas. Viljoen *et al.* (2021) reported that rural areas are susceptible to inadequate waste management practices. Similarly, Mihai (2017), Haywood *et al.* (2020), and Vinti and Vaccari (2022) reported challenges related to waste management in rural areas of Romania, South Africa and other low- to middle-income countries such as India, Morocco, and Iran.

5.2.2.2 Waste management opportunities

When comparing the categories and the frequency of mentioned waste management opportunities (Table 4-2) to the mentioned challenges (Table 4-1), it is clear that respondents perceived many more challenges related to waste management than they perceived waste management as being an opportunity. This may be due to limited awareness or knowledge of potential opportunities, or that they do not perceive waste management as presenting any opportunities (due to the options available in the area, i.e., no buy-back centres, or recycling facilities in close proximity). The reasons for raised opportunities and challenges were not investigated, and may be an area for future research.

Three themes emerged from the thematic analysis of perceived opportunities, namely (i) financial/economic opportunities; (ii) environmental and health opportunities, and (iii) institutional opportunities.

The most frequently mentioned opportunity was access to a safe and clean environment (O3), mentioned by 76% of participants. The respondents believed that improved waste management services, especially waste collection service, would address the adverse impacts of waste on the

environment and would reduce safety hazards to children and livestock. Some respondents even made mention of “their rights to a clean environment”, which could relate to the Environmental Right, as outlined in Section 24 of the Constitution of the Republic of South Africa (RSA, 1996).

The second most frequently mentioned opportunity for waste management was improved knowledge and awareness (O4), mentioned by 69% of participants. Strydom (2018) and Roos *et al.* (2022) mention the important role that knowledge and awareness play towards achieving responsible waste management. The participants expressed their willingness to participate in awareness and education interventions, such as workshops, campaigns and seminars. Many participants also indicated that they were eager to learn more about responsible waste management practices.

Job creation was mentioned as an opportunity by 58% of the respondents, while income generation was mentioned by 57% of respondents. Job opportunities and income generation related to waste management is an opportunity that is mentioned by many authors such as Godfrey *et al.* (2014), Sharma *et al.* (2019) and Yu *et al.* (2020). The informal waste sector has contributed significantly to waste management objectives in South Africa over the past five years. It is, however, important to note that the creation of job opportunities related to waste management is dependent on a number of factors, and should be informed by proper feasibility studies. Roos *et al.* (2022) caution against creating unreasonable expectations of what waste management could reasonably contribute to job creation and income generation.

One theme that was clear from the responses of participants, was that they expected the municipality to take responsibility for realising these objectives (i.e., the municipality should deliver services, communicate, present education and awareness opportunities, etc.). The opportunities mentioned by respondents should be considered in the light of the resources available to address the challenges mentioned (Table 4-1) and leverage opportunities for improvement (Table 4-2).

5.3 Recommendations and areas of future research

Based on the findings of this study, the following recommendations are made:

- The ideal short-term solution to address the lack of waste storage infrastructure and lack of waste collection services experienced by the majority of Matobole village would be to complete the roll-out of the current “street bin” installation and waste collection programme to the rest of Matobole Village.
- Municipalities should prioritise the introduction of waste management services in rural areas. Government should, where practicable, provide educational and awareness programmes to rural households on the safe and proper handling of waste from point of

generation to disposal, as well as on its impact on human health and the environment. Municipalities can create awareness through a range of programmes such as talks at schools, clean-up campaigns, celebrating environment days and community events.

- Whilst in the process of addressing waste collection services in Matobole Village, the municipality should intervene and address improper waste disposal options by providing more acceptable means (such as storage in large skips, providing access to transfer stations, etc.).
- Currently, limited informal waste reclamation practices exist in Matobole Village. Waste recycling can have a significant impact on reducing the problems associated with improper waste disposal methods practised in rural areas. Therefore, recycling programmes and infrastructure should be introduced and provided in rural areas.

The following recommendations may be useful for further research:

- This research investigated only the types of waste generated in households and not quantity of waste generated. It is recommended that further studies be conducted on the quantity of waste generated in rural households, and that it should include an in-depth waste characterisation study, which could be used towards finding feasible solutions for waste management in Matobole Village.
- It is further recommended that future studies make correlation between waste management practices and the respondents' socio-demographic profile, which may highlight areas of correlation between poor practice and certain socio-demographic groups. This information may be useful when specific groups need to be targeted for interventions.
- It is also advised that a wider range of rural areas in the Limpopo Province be included as part of future research focused on waste management in unserved areas.

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ANNEXURE A: QUESTIONNAIRE PARTICIPANT CONSENT FORM

Dear Sir/Madam

Thank you for showing an interest in this research project. Please read through this document carefully before participating.

Research title

Investigating solid waste management practices in unserved rural areas: A case study of Matobole Village, Limpopo Province.

Introduction

My name is Mamosegane Thabitha Modiba, with student number 34962182. I am a registered student at North-West University for Masters in Environmental Management: Waste Management. I am under the supervision of Simone Van Rooyen (Supervisor) and Dr Claudine Roos (Co-supervisor). It is a requirement for a registered student to conduct this research to obtain the said qualification. The research focuses on waste management practices, challenges, and opportunities in unserved rural areas. It aims to understand how households in rural areas manage waste without municipal services and how waste management services impact their daily lives.

This document serves as an invitation to participate in the study as a resident of Matobole Village. It provides information that will assist you in understanding the purpose of the study and making an informed decision on whether to participate in the study or not.

Purpose of the study

The study aims to investigate waste management practices, challenges, and opportunities in Matobole Village. The village does not receive waste management services from the municipality. The research will seek to understand how households manage their waste concerning waste generation, collection and disposal.

Methodology of the study

Participants will be handed a questionnaire with both closed and open-ended questions. The questionnaire will be collected on the agreed date between the researcher and the participant (possibly three to five days). Should clarity on the questions be required, participants can contact the researcher at any time during the day.

Study benefits

This study will add to the body of academic knowledge on solid waste management practices, challenges and opportunities in unserved rural areas.

Confidentiality

All personal information will be kept strictly confidential. Participants' names will not be included or used in the report.

Possible risk

Participation in the study poses no risk to participants.

Rights of participants

Participation in the study is voluntary. Participants can withdraw from participating at any time with no penalty.

Compensation

Participants will not be compensated for participating in the study.

Ethical approval

This study was approved by the Faculty of Natural and Agricultural Sciences Ethics Committee (NFAS-REC) of the North-West University Potchefstroom Campus. My ethics number is NWU-01224-22-A9.

Participant consent

I have read and understood this information document. My questions prior to answering the questionnaire have been answered to my satisfaction. I understand that I am free to request further information at any time.

I know and understand that:

1. My participation in the study is voluntary,
2. My personal information will be kept confidential,
3. I am free to withdraw from participating in the study at any time,
4. By signing this document, I agree to participate in the study.

Signature of participant:		Date:	
Printed name:			

ANNEXURE B: A STRUCTURED SURVEY QUESTIONNAIRE

Please tick the appropriate boxes or write your answers in the spaces provided.

Section A: Socio-demographics

Tick only one box per question in Section A.

1. Gender?

Male		Female		Other		Prefer not to say	
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2. Age?

18 – 25		26 – 35		36 – 45		46 – 55	
56 – 65		>65					

3. Ethnicity?

African		Asian		Colored		Indian	
White		Other					

4. Level of education?

Tertiary		High school		Primary school		Never went to school	
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5. Employment type?

Full-time		Part-time		Self-employed		Unemployed	
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6. Household size?

1		2 – 3		4 – 5		>6	
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7. Net household income per month?

R1 – R12 816		R12 817 – R32 058		R32 059 – R51 299		>R51 300	
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8. Occupation?

Agriculture		Banking		Engineering		Government	
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Hospitality		Legal		IT & Telecommunications		Manufacturing	
Mining							

Section B: Waste management practices

More than one box may be ticked per question in Section B, unless indicated otherwise.

Waste management in general

1. Which of the following practices do you think form(s) part of waste management?

Waste generation		Waste separation		Waste storage	
Waste recycling/reuse		Waste disposal		Waste collection	

2. Who do you think is responsible for waste management in your village?

Households		Community leaders		Municipalities	
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3. Which gender plays the biggest role in waste management in your household?

Tick only one box.

Males		Females	
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Waste generation

4. What type of waste do you generate in your household?

Cardboard & paperboard		E-waste		Food & beverage containers	
Food waste		Glass waste		Paper waste	
Plastic waste		Wood waste			

5. Which of the following factors influence(s) the amount of waste generated in your household?

Age of the household		Education level in the household		Gender of the household head	
Location of the household		Monthly income of the household		Size of the household	

Waste separation, recycling, and reuse

6. Which of the following waste management practices does your household perform?

Waste separation		Waste recycling		Waste reuse	
None					

7. If your household performs waste separation, recycling, and reuse, who plays the biggest role therein?

Father		Mother		Child(ren)	
Helper/Maid		Everyone			

Other:

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8. Type of waste separated, recycled, and reused

8.1. If your household performs waste separation, what type of waste do you separate?

Cardboard & paperboard		E-waste		Food & beverage containers	
Food waste		Glass waste		Paper waste	
Plastic waste		Wood waste			

Other:

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8.2. If your household performs waste recycling, what type of waste do you recycle?

Cardboard & paperboard		E-waste		Food & beverage containers	
Glass waste		Paper waste		Plastic waste	
Wood waste					

Other:

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8.3. If your household performs waste reuse, what type of waste do you reuse?

Cardboard & paperboard	E-waste	Food & beverage containers
Food waste	Glass waste	Paper waste
Plastic waste	Wood waste	

Other:

.....

.....

9. If your household does not perform waste separation, recycling, and reuse, why not?

Cannot see the importance of waste separation, recycling, and reuse	Do not know which waste to separate, recycle and reuse	It is not convenient to separate, recycle and reuse waste
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Other:

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10. Does your village have waste separation, recycling, and reuse programmes in place?

Waste separation programme(s)	Waste recycling programme(s)	Waste reuse programme(s)
I do not know	No	

Waste storage

11. Do you receive refuse bags or waste bins from the municipality or any other service provider to store your waste?

Tick only one box.

Yes	No
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12. If your answer to Question 11 is NO, what do you use to store your waste?

Write your answer in the space provided.

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Waste disposal

13. Do you dispose your waste inside or outside your yard?

Tick only one box.

Inside		Outside		Both	
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14. Which waste disposal practice(s) does/do your household perform?

Burying		Burning		Composting	
Landfilling		Littering/Open dumping		Using a pit	

15. How often do you practice waste disposal as per your answer to Question 14 in one (1) week?

Tick only one box.

Once		Twice		Thrice		
More than three times						

16. What is/are the impact(s) of your household's waste disposal practice(s) as per your answer to Question 14 on the environment?

Air pollution		Groundwater pollution		Death/poisoning in animals	
Soil pollution		Surface water pollution			

17. What is/are the impacts(s) of your household's waste disposal practice(s) as per your answer to Question 14 on your health?

Eye and skin irritations		Fever		Gastrointestinal issues	
Headache		Infectious diseases		Respiratory problems	
Risks of accidents and injuries					

18. Besides waste disposal, what other practice do you use to manage your waste?

Compost the waste		Donate the waste		Recover/treat the waste	
Sell the waste		Take the waste to a drop-off centre		None	

Other:

.....

Waste collection

19. Does your village receive waste collection services from the municipality or any other service provider?

Tick only one box.

Yes		No	
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20. If your answer to Question 19 is YES, how frequently does your village receive waste collection services?

Tick only one box.

Daily		Twice a week	
Weekly		Monthly	

21. If your answer to Question 19 is NO, why do you think your village is not receiving waste collection services?

Budget constraints		Collection distance		Lack of equipment	
Lack of infrastructure		Road access			

Other:

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Section C: Waste management challenges and opportunities

Write your answers in the spaces provided.

1. What challenges (problems) negatively impact waste management (generation, separation, recycling, reuse, storage, and collection) in your village?

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2. What opportunities (circumstances) may positively impact waste management (generation, separation, recycling, reuse, storage, and collection) in your village?

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