EVALUATING THE ROLE OF INFORMAL WASTE SECTOR IN MUNICIPAL SOLID WASTE MANAGEMENT IN VHEMBE DISTRICT MUNICIPALITY, LIMPOPO PROVINCE, SOUTH AFRICA

by

FUNANANI KHANGALE SAMPSON MATHIVHA

Submitted in accordance with the requirements for the degree of

MASTER OF SCIENCE

In the subject

ENVIRONMENTAL MANAGEMENT

at the

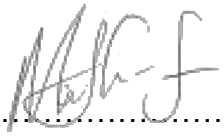
UNIVERSITY OF SOUTH AFRICA
COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES
DEPARTMENT OF ENVIRONMENTAL SCIENCES

SUPERVISOR: MR ND BALOYI
CO-SUPERVISOR: MS TP TSHIMBANA

MARCH 2023

Declaration

I, the undersigned **Funanani Khangale Sampson Mathivha** student number **49998218** hereby declare that this thesis is my own original work in design and execution, with the exception of quotations and references, which are attributed to their sources. Furthermore, this thesis has not been submitted for a similar degree or any other degree in this or any other university.

Signature……  …….

Date2023 March 30……...

Acknowledgements

Sincere thanks and foremost appreciation go to my supervisor, Mr. ND Baloyi and co-supervisor, Ms. TP Tshimbana for your endurance and tireless effort and your ability to go an extra mile in assisting me to achieve progress throughout all the stages of this thesis.

Amongst others, I am grateful for the permission I received from Vhembe District Municipality and from Makhado, Thulamela, Musina and Collins Chabane. This study would not have been a success if it was not for the informal waste pickers, municipal officials and buyback centres within Vhembe District that willingly participated in this study and provided me with all the information required to make this study completed, for that I am most grateful.

My sister, Khathu for getting out of her way to direct me accordingly throughout the whole process of this study. My mother, Livhuwani, my spouse Nomsa and my kids for encouraging me to keep strong and never give up when I was under pressure. You have been my pillar of strength and support in every step of the way. Thank you so much.

Above all, I would give great thanks to the Almighty, My God above for being with me and locating me the above-mentioned wonderful team that assisted me with this great work.

Dedication

I dedicate this work to my late father, Mr. Takalani Tony Mathivha (May your soul continue to rest in peace). You were always amused by my studies and you longed to see a success out of everything I touch, this one is for you. A special feeling of gratitude to my mother, spouse, my siblings and my kids. You mean the world to me; I love you 10 Million.

Abstract

To date, solid waste managers are still dwarfed by the growing challenge of delivering municipal solid waste management service to the public. This is because of the growing rate of waste generation resulting from urbanisation, rapid population growth and world economic development. Currently, the world generates over 3.6 million tons of waste daily and at this rate, within the next 3 years, it is expected to rise to a booming 6 million tons per day. Municipalities in South Africa still use landfilling as a disposal method for solid waste management, and significant consequences such as soil contamination and underground water contamination are inevitable, ultimately threatening human health. Unemployed, poor individuals and side-lined groups, who constitute the informal waste sector, play very critical role of roaming around cities, towns and disposal sites recovering valuable waste materials as a survival strategy. Although to the informal waste sector, valuable waste recovery is a means of living, that is, to earn money, they are critical role players in the world's goal of moving towards a circular economy. While the municipality chooses to bury waste, this sector chooses to refer it back to the economy, which leads to zero waste in landfills and protects the health of the environment.

This study was conducted using a mixed methods research design. The study was conducted in Vhembe District Municipality following a convenience sampling method. A sample consisting of 80 waste pickers, 4 waste managers and 10 buyback centre directors participated through closed-ended questionnaires, face-to-face interviews and online surveys. Data collected through questionnaires was analysed using SPSS version 25.0, and data collected through structured interviews was analysed following the eight data analysis steps proposed by Tesch.

The results of this study indicate that the informal waste sector in Vhembe District is a black-dominated industry, with females being the most dominant and those involved having no formal education except for a few graduates who simply saw a business opportunity. Little recognition is given to the informal waste sector by authorities and policy makers. Society undermines and rejects this sector. Furthermore, they are

exploited, abused and associated with waste by the public. This limits their activities, but they play a significant part in creating jobs, saving municipalities millions in collection and disposal costs and ensuring a healthy living by sustainably conserving the environment indirectly.

Keywords: Waste pickers, circular economy, solid waste management, recycling, valuable waste recovery

Nkomiso

Kutafika sweswi, vafambisi va thyaka ro tiya va ha tsongahatiwa hi ntlhontlho lowu kulaka wa ku phakela vaaki vukorhokeri bya malawulelo ya thyaka ro tiya bya masipala. Leswi swi hikwalaho ka mpimo lowu kulaka wa ku endliwa ka thyaka leri tumbulukaka kusuka eka ku endliwa ka madoroba, ku kula ka rixaka ko hatlisa na nhluvukiso wa ikhonomi ya misava. Eka nkarhi wa sweswi, misava yi endla kutlula 3.6 wa timiliyoni ta tithani ta thyaka siku na siku naswona hi mpimo lowu, ku nga si hela malembe ma3 lama taka ti languteriwile ku tlakuka kufika eka 6 wa timiliyoni ta tithani hi siku leti andzaka. Timasipala ta le Afrika-Dzonga ta ha tirhisa ku cukumetela etaleni tanihi endlelo ro cukumeta ra malawulelo ya thyaka ro tiya, naswona switandzhaku swo tivikana swo tanihi nthyakiso wa misava na nthyakiso wa mati ya le hansi ka misava a swi siveleki, ekuheteleleni swi xungeta rihanyo ra vanhu na swona. Vanhu lava nga swela, lava nga tirhiki na mitlawa leyi tsan'wiweke, leyi yi vumbaka sekitara ya thyaka ya nkamafundza, va tlanga xiave xa nkoka swonghasi xa ku rhendzeleka na madorobakulu, madoroba na tindhawu to cukumetela eka tona va ri karhi va hlawulela timatheriyali ta thyaka ta nkoka tanihi qhinga ro tihanyisa. Hambileswi eka sekitara ya thyaka ya nkamafundza, ku hlawuleriwa ka thyaka ra nkoka swi nga ndlela yo tihanyisa, hileswaku, ku nghenisa mali, i vatlangaxiave va nkoka swonghasi eka xikongomelokulu xa misava xa ku cincela eka ikhonomi yo rhendzeleka. Tanihiloko masipala wu hlawula ku yimbela thyaka, sekitara leyi yi hlawula ku ri kongomisa ri tlhelela eka ikhonomi, leswi swi vangaka nkathyaka emataleni ya naswona swi sirhelela rihanyo ra mbangu.

Ndzavisiso lowu wu endliwile hi ku tirhisa dizayini ya ndzavisiso ya maendlelo lama pfanganisiweke. Ndzavisiso lowu wu endliwile eka Masipala wa Xifundzatsongo xa Vembe ku ri karhi ku landzeleriwa endlelo ra sampulu yo ya hi maolovelo. Sampulu leyi yi vumbiwaka hi 80 wa varhwalathyaka, 4 wa vafambisi va thyaka na 10 ra valawuri va tisenthara to xava hi vuntshwa yi teke xiave hi ku tirhisa swivutiso swa ndzavisiso leswi nga na makumu yo pfuleka, tiinthavhiyu to va mi langutanile na mivalango ya le ka inthanete. Switiviwa leswi hlengeletiweke hi ku tirhisa swivutiso swa ndzavisiso swi xopaxopiwile hi ku tirhisa SPSS ya vhexini ya 25.0, naswona switiviwa leswi

hlengeletiweke hi ku tirhisa tiinthavhiyu leti nga na xivumbeko swi xopaxopiwile ku ri karhi ku landzeleriwa nhungu wa magoza ya nxopaxopo wa switiviwa lama ringanyetiweke hi Tesch.

Mivuyelo ya ndzavisiso lowu yi komba leswaku sekitara ya thyaka ya nkamafundza eka Xifundzatsongo xa Vembe i indasitiri leyi taleriweke hi vantima, ku ri na vaxisati lava nga vona va nga tala kutlula hinkwavo na lavaya va khumbekaka eka ku pfumala dyondzo ya mafundza ku ri karhi ku nga katsiwi mathwasana ya tidigiri mangarimangani lama ya nga lo vona xivandlanene xa bindzu. Valawuri na vaendlatipholisi va tekela enhlokweni switsongo sekitara leya thyaka ya nkamafundza. Vaakandhawu va tekela ehansi na ku nyenyemuka sekitara leyi. Ku ya emahlweni, va tirhisiwa hi ndlela yo homboloka, va xanisiwa naswona va voniwa tanihi thyaka hi vaaki. Leswi swi tsongahata migingiriko ya vona, kambe va tlanga xiphemu xo tivikana eka ku tumbuluxa mitirho, va hlayisela timasipala timiliyoni eka tihakelo to rhwalela na to cukumeta na ku tiyisisa leswaku ku va na ku hanya loku nga na rihanyo hi ku hlayisa hi ndlela leyi yaka emahlweni mbangu hi ndlela leyi nga kongomiki.

Maritokulu: Varhwalathyaka, ikhonomi yo rhendzeleka, malawulelo ya thyaka ro tiya, ku vuyelerisa, ku hlawulela thyaka ra nkoka

Abusitirakiti

U swika zwino, vhalanguli vha zwa u hwalela mashika vha kha ḓi vha vho hanganea zwi tshi ḓa kha u ḓisa tshumelo ya masipala ya u langa u hwalelwa ha mashika tshitshavhani. Izwi zwi khou itiswa nga tshikalo tsha nyaluwo ine ya khou ḓiswa nga u bvelela ha ḓorobo, u anda ha vhathu na nyaluwo ya ikonomi ya ḽifhasi. Zwa zwino ḽifhasi ḽi khou bveledza miḽiyoni dza 3.6 wa dzithoni dza mashika ḓuvha ḽinwe na ḽinwe, hafhu kha heyi nyaluwo, zwi anganyelwa uri kha minwaha miraru i ḓaho, i ḓo vha i tshi khou hovhelela henefha ka miḽiyoni dza 6 wa dzithoni dza malaṱwa nga ḓuvha. Mimasipala ya Afrika Tshipembe i kha ḓi shumisa u tou thupha mashika fethu hugede sa yone nḓila ya u langula mashika. Masiandaitwa a izwi ndzi u tshikafhadziwa ha mavu na maḓi a re fhasi mavuni, zwine zwa shushedza mutakalo wa vhathu. Vhathu vha sa shumi, vhashai na zwigwada zwa vhathu zwi sa dzhielwi nṱha, vha mona-mona na fhethu hu laṱwaho mashika mahayani na dziḓoroboni vha tshi ṱoḓa zwithu zwine vha nga zwi dobela vha ya u zwi rengisa sa nḓila ya u ditshidza. Naho kha ndangulo ya u laṱwa mashika na u a hwalelwa hao iyini ndowetshumo i sa divhei sa ya tshiofisi, ndi zwa ndeme sa nḓila ya u ḓitshidza kha vhathu vhane vha ḓidzhenisa kha iyo nḓowetshumo. Zwi dovha hafhu zwa tamba tshipiḓa tsha ndeme kha u bveledza ikonomi ya shango. Naho masipala u tshi nanga u tou fukedza mashika, hetshi tshigwada tshi a a fukula tsha a humisela kha ikonomi, zwine zwa dovha zwa thusa kha u ita uri shango ḽi si ḓale mashika, zwa dovha hafhu zwa vha zwavhuḓi kha mutakalo wa mupo na wa vhathu.

Tsedzuluso iyi yo itiwa hu tshi khou shumiswa maitele o vanganaho a u ita thodisiso. Thodisisio yo itwa kha masipala wa Vhembe ho nanguludzwa vhane vha ḓo dzhenelela kha ṱhoḓisiso nga u vha vha vha tshi khou wanala. Ho topoliwa vhashumi vha fumalo (80) vhane vha shuma u hwalela mashika, vhalanguli vhana (4) na dzidayirekhta dza fumi (10) dza fhethu hu no rengiselwa hone zwithu zwe zwa vha zwo latiwa, vhothe vho dzenelela u vhudziswa-vhudziswa mbudziso dzo valeaho, musi ho livhanwa zwifhaṱuwa na nga vhudavhidzani ha tshithekinolodzhi. Mawanwa hu tshi khou shumiswa khwesheneya o senguluswa hu tshi khou shumiswa phurogireme-thusedzi ya u sengulusa ya SPSS

vesheni ya 25.0. Mwanwa a musi hu tshi khou shumiswa mbudziso dze dza vha dzo dzula dzo dzudzanywa o senguluswa hu tshi khou shumiswa maga a malo (8) a Tesch.

Mvelele dza ṱhoḓisiso iyi dzi khou sumbedza uri u hwalela zwithu zwa kale zwo latwaho ndi bindu ḽa vhathu vharema, nahone vhunzhi havho ndzi vhafumakadzi, vhane a vha ngo funzea. Fhedzi hu dovha a ha wanala uri kha vhenevho, hu na vhaṱuku-ṱuku vhane vha vha na pfunzo dza nṱha, vhe vha wana u hwalela zwithu zwa kale zwo laṱwaho, hu tshikhala tsha vhubindudzi na nḓila ya u ḓisikela mishumo. Muvhuso a u dzhieli nṱha vhubindudzi hovhu ha u hwalela zwithu zwo laṱwaho na u rengiswa hazwo. A hu na mbekanya-maitele kha muvhuso zwi tshi ḓa kha uri nḓowetshumo ya u dobela zwithu zwo laṱwaho zwi tshi dovha zwa shumiswa i fanela u tshimbila hani. Tshitshavha na tshone tshi dzhiela fhasi na u nyefula uyu mushumo. Izwi zwi ita uri vhane vha shuma uyu mushumo vha si kone u shuma zwavhuḓi, naho vha tshi khou ḓisikela mishumo na u thusa masipala u vhulunga masheleni manzhi e a vha a tshi ḓo shumisiwa kha u kunakisa mupo nga u dobela mashika na u ita uri vhupo vhu vhe hu dzuleaho khathihi na u vhulungea.

Maipfi Mahulwane: Vhadobeli vha mashika, ikonomi ya shango, ndangulo ya mashika, ndovholoso ya u shumiswa ha zwithu zwo laṱwaho, u vusuludzwa ha mashika are a ndeme

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1. Background of the study

For over 30 years waste recovery and recycling has been feeding, clothing, covering, and serving as a means of living for waste pickers in South Africa (Godfrey and Oelofse, 2017). South Africa is estimated to have between 60 000 and 90 000 informal waste pickers because of high rate of unemployment, rapid increase in population as well as urbanisation (Schenck *et al.*, 2019). To date, the informal waste sector has been serving as an employer to these individuals (Godfrey and Oelofse, 2017; Simatele *et al.,* 2017). Waste management authorities worldwide have realised that not only does the informal waste sector provide a living to its employees, but it also contributes to reducing waste in towns and minimising of the impact of waste (Mwanza *et al.*, 2019). Informal waste pickers are poor individuals and side-lined groups who roam around cities and towns as well as dumping and landfill sites collecting and recovering recyclable waste materials with the purpose of selling and earn an income (Fedilis and Colmenero, 2018; Karuiki *et al*., 2019).

Informal waste pickers are categorised based on their area of duty; there are those who move from house to house trading waste for cash known as Itinerant Waste Buyers, those who recovers recyclables from the streets referred to Street Waste Pickers, those who recovers waste while been transported known as the Refuse Removal Team and lastly, those who are found within dumping and landfill sites are known as Reclaimers (Aparcana, 2017; Fattor and Vieira, 2019). However, the informal waste sector is dominated by waste pickers who works in open air dumpsites (Siman *et al*., 2020). People pursue informal waste picking as a business because it does not cost too much to invest in because waste is abundant largely in urban towns (Danese, 2021). The informal waste sector plays a significant role in municipal solid waste management of towns through recovering valuable waste materials, diverting them from the waste system (Steuer *et al*., 2017). Furthermore, due to their nature of operation, informal waste pickers are not limited to operate only in designated areas as municipalities. Thus, they can access waste all

over including rural areas reducing the backlog of waste service delivery in these rural areas (Uddin and Gutberlet, 2018).

The informal waste sector also plays an important role of cost saving within municipal solid waste management systems and they also reduce the amount of waste activities and quantities to be collected for disposal by landfill (Sandhu *et al*., 2017). Thus, informal waste pickers are the core of recycling, carrying out the hardest part of recovering and separating recyclables from mixed wastes and packaging them for further processing (Gall *et al*., 2020). In light of the above, informal waste pickers are regarded as “invisible heroes” in municipal solid waste management due to their positive contribution to environmental management, waste management cost saving and local economy (Caranbauer, 2021).

Numerous studies have been conducted in the four local municipalities within Vhembe District, but these studies mainly focused on the effectiveness of municipal solid waste management strategies, landfill operation and public participation on waste management (Mabadahanye, 2017; Maluleke, 2017; Nefale, 2018; Mathako, 2019). These studies only touched a little on the informal waste sector as part of the strategies and part of the landfill. Municipalities within Vhembe District do not practice waste separation at source, and they do not have zero waste strategy (3R’s) which leads to large amounts of waste being disposed-off at landfill sites (Mathako, 2019).

Waste management is not prioritised as a major concern during budget allocation as more money is allocated to roads and infrastructure projects which leads to poor management of waste as a result of old resources and lack of modern resources (Maluleke, 2017; Mathako, 2019). Thulamela Municipality within Vhembe District is mainly dominated by rural settlement and most of its villages do not have any access to waste management services as they do not pay for any services offered by the municipality (Mabadahanye, 2017). Therefore, a study on the role of the informal waste sector in municipal solid waste management will be beneficial to both the municipalities and the informal waste pickers within the district as this study will directly be focused on the informal waste pickers, their

role in municipal solid waste management, their contribution to society, challenges and risks they encounter as well as the support provided and required for smooth operation.

Despite their effort and positive contribution to society, the informal waste sector is still marginalised, undermined and labelled as dirty and outlaws of society (Karuiki *et al*., 2019). With waste management one of the major environmental concerns and gaining attention from authorities and policy makers, informal waste pickers activities are implanted in legal implications that are introduced to their line of operation (Siman *et al*., 2020; Danese, 2021). In addition, informal waste pickers' activities are disregarded, unacknowledged and rarely supported by society and as a result, they are highly exploited by recycling dealers or intermediaries (Siman *et al*., 2020). Informal waste pickers operate in deplorable conditions that threaten their health (Gutberlet, 2021) and their activities directly expose them to biological, chemical, physical, social, ergonomic and mechanical risks that put their health and life in danger (Gutberlet, 2018; Fattor and Vieira, 2019). In consideration of their working conditions, informal waste pickers are also exposed to physical injuries such as rush and cuts from accidents as well as diseases such as frequent headaches, loss of vision, stress, discomfort, back pains, nausea etc. from the toxic and harmful objects they encounter while recovering recyclables (Aparcana, 2017; Black *et al*., 2019; Fattor and Vieira, 2019).

In the Global South, informal waste pickers provide essential goods and services; however, because their activities are not regulated, they interrupt urban livelihoods and overall environmental sustainability (Gutberlet, 2021). Given that they provide essential services, informal waste pickers in South Africa form part of the solution to the national waste problem and therefore municipalities recognise them as crucial stakeholders and has established methods of integrating informal waste pickers into their integrated waste management plans (Mohr-swart *et al*., 2016; Simatele *et al*., 2017). Outcome 10 of the Medium-Term Strategic Framework (MTSF) which aims to protect and enhance our environmental assets and natural resources stipulates that for the South African country to address the challenge of poor solid waste management and pollution, there is a need to promote the waste hierarchy strategy and this will require product stewardship and the

rapid expansion of recycling infrastructure (Department of Planning, Monitoring and Evaluation, 2014). In support of the above, South Africa intends to make the extended producer responsibility (EPR) principle mandatory and his will require municipalities and industries to be involved informal waste pickers integration (Department of Forestry, Fisheries and the Environment, 2020).

1.2. Research problem

Municipal solid waste management has become an environmental concern because of the large amounts of waste being generated daily (Yousafzai *et al*., 2020). Currently, 3.5 million tons of waste is being generated daily and it is expected to rise to a booming 6 million tons per day by the year 2025, and if waste generation increases in this manner by the year 2100, waste generation rate per day will be over 11 million tons per day globally (Yousafzai *et al.,* 2020). This rapid increase in waste generation is a result of rapid population growth, urbanisation and economic development (Munyai and Nunu, 2020). To date, massive amount of waste is being referred to landfills for disposal and this creates significant environment problems, such as soil contamination which leads to underground water contamination and affects surrounding human health (Ferdous *et al*., 2021).

Authorities and policy makers have been trying to rule out the issue of landfilling and incineration due to the negative impacts they have on the environment and human health (Anshassi *et al*., 2019). Countries such as China, Mexico, India, and Bolivia have adopted recycling as means of living (Sasaki and Akari, 2013; Sandhu *et al*., 2017; Ferronato *et al.,* 2020; Gall *et al*., 2020). However, informal recycling does not only contribute as a means of living, it is also an environmental management strategy of reducing the quantities of waste being referred to landfills for disposal (Sasaki and Akari, 2013). Solid waste management in Africa is significantly challenging due to inadequate waste collection and disposal facilities (Mascarenhas *et al*., 2021). Ninety percent of waste in Africa is referred to landfills and unlicensed dumpsites with 70% of it being recyclable, however, only 4% is recycled (Mascarenhas *et al*., 2021). In addition to inadequate waste

management facilities, the management of waste is associated with the lack of understanding of how to properly handle municipal solid waste (Abdel-shafy and Mansour, 2018).

Informal waste pickers work very hard for many hours being exposed to physical, ergonomic, chemical, mechanical, biological and social agents, diseases and psychological health threats to separate and sell recyclable to make a living for themselves (Fattor and Vieira, 2019; Bonini-Rocha *et al*., 2021; Cruvinel *et al*., 2021; Zolnikov *et al*., 2021). Recovering recyclables from waste in dumpsites and landfill sites expose informal waste pickers to many hazardous aspects such a heavy metals, sharp objects, medical waste and various infectious discuses (Cruvinel *et al.,* 2019). Waste dumpsites are home to one of the most notorious vectors of diseases such as mosquitoes, which are responsible for transmitting many diseases such as Malaria, Chikungunya virus, Dengue virus, Zika virus and Yellow fever virus (Cruvinel *et al.*, 2021).

Informal waste pickers conduct waste recovery and recycling activities minimising waste amounts at zero cost to the custodian of waste management, the municipality but often struggle to gain attention and recognition as their lives are associated with social, spatial, economic and political inequalities because of their low socio-economic status and association with waste (Wittmer, 2021). Furthermore, informal waste pickers are highly exploited by recycling dealers and middleman due to lack of facilities, knowledge of the recycling industries and that there is no set rate for recycling by authorities and policy makers (Hartmann, 2018). Many informal waste pickers in developing countries such as South Africa have yet to improve their methods as they still operate in unacceptable and dangerous conditions (Black *et al*., 2019).

Municipal Solid Waste Management is very difficult in African countries due to poor financial resource, limited technical capabilities and poor infrastructure (Shi *et al*., 2021). Due to rapid population growth and increasing urbanisation that leads to growth in waste generation rate, there is a need for recycling in South Africa as it will help with the reduction of waste being dumped in already overwhelmed landfill sites (Issock *et al*.,

2021). Recycling is also crucial to minimise the consumption of plastic as it has increased at a high rate and is expected to double in the next two decades (Olatayo *et al*., 2021). Taking note of the above, informal waste pickers are key role players in recycling and they promote integrated management of municipal solid waste (Siman *et al*., 2020). The inclusion of informal waste pickers in municipal solid waste management reduces the amount of waste from the waste stream and puts it back in production while also saving municipality from waste management costs (Zon *et al*., 2020). However, there are many challenges encountered by these waste pickers such as technical and administrative difficulties (Zon *et al*., 2020).

Numerous studies describe informal waste pickers as poor individuals who depend on recovering recyclables from waste dumpsites and landfill sites and sell to dealers or middlemen to earn a living. However, recent evidence indicates that it is not only the poor who are into informal recycling, even individuals from the middle-high income status have taken an interest in recycling as a means of acquiring wealth (Fedilis and Colmenero, 2018; Guibrunet, 2019; Karuiki *et al*., 2019; Mwanza *et al*., 2019; Gall *et al*., 2020; Caranbauer, 2021). There are limited studies that address the role of the informal sector in municipal solid waste management in Vhembe District Municipality. The District Municipality generates an average of 10 219 tons of waste because of its high population, increased industrialisation, and urbanisation (Vhembe District Municipality IDP, 2021). As per the 2016 Stats SA, Community Survey Vhembe District had a population of 1 393 949 people (Vhembe District Municipality IDP, 2021). There was a need to conduct a study on the role of the informal waste sector in municipal solid waste management in the district.

1.3. Research rationale

Municipal solid waste management is a key component in urban environmental systems planning as it is associated with protection of environmental health and human well-being (Heidari *et al*., 2019). Developing countries such as South Africa, Brazil, Botswana, and India are still challenged regarding proper handling of municipal solid waste due to the

accelerating rate at which waste is being generated (Simatele *et al.,* 2017; Fiksel and Lal, 2018; Phonchi-Thekiso *et al*., 2020; Zon *et al.,* 2020). The driving factors behind the increase in waste generation rate include improved standards of living, rapid population growth, urbanisation and economic development (Kamdar *et al*., 2019). Proper handling of waste involves reduction of waste quantities from the waste stream which contributes to the protection of environment and human health (Heidari *et al*., 2019). The formal sector (municipalities and private sectors) does not guarantee an environmental sound solid waste management system, and this has compelled authorities and policy makers to search for methods to manage solid waste and this includes sanitary handling of waste and recycling (Aparcana, 2017).

Recycling is listed amongst the best waste management strategies; however, it has not been fully adopted (Conke, 2018). Informal waste pickers are key role players in recycling because they contribute to the circular economy while also assisting the formal waste sector which only focuses on collection and disposal of waste (Botello-Alvarez *et al*., 2018; Siman *et al.,* 2020). This study focuses on the informal waste sector because of its potential to assist local governments to achieve zero waste to landfill while also contributing to the circular economy by creating job opportunities for the marginalised poor individuals, thereby allowing them to earn a living. Since informal waste pickers are often not recognised as service providers offering waste picking and town cleaning services and as a result, municipalities frequently discriminate them (Fuss *et al*., 2021). This study pays attention to the role informal waste pickers play within the municipal solid waste management system, how they assist the municipality and to what extent does the informal waste sector assists the municipality. Most individuals do not practice separation at source and as a result hazardous substance such as asbestos, batteries, pesticides, and medical waste are found in the municipal solid waste stream (Fulwani *et al*., 2020).

The existence of these hazardous substances in the waste stream poses health and safety risks to informal waste pickers as many of them do not wear any personal protective equipment (PPE) while carrying out their activities (Aparcana, 2017; Fulwani *et al.,* 2020). The study also focuses on the opportunities and challenges associated with

the activities informal waste pickers conduct while playing a role in municipal solid waste management using Vhembe District Municipality as a case study. Informal waste pickers reserve a space in the country's economy by recovering and trading recyclables, however, the custodian of solid waste management is local government (municipality), which makes it difficult for informal waste pickers to recover waste freely in the streets (Hartmann, 2018). As a result, informal waste pickers operate freely in open dumpsites and landfill sites where they are exposed to hazardous and health risks (Danese, 2021). Recycling contributes effectively to pollution prevention, energy saving and natural resource conservation (Ma *et al*., 2019; Ferdous *et al*., 2021). In the City of Johannesburg, South Africa informal waste pickers have gained recognition and have been integrated into the city's waste management system (Baker *et al*., 2016; Simatele *et al*., 2017).

The informal waste sector is an important sector to society because although their goal is to earn a living they contribute to environmental protection, circular economy, tourism and sustainable development through waste recovery and recycling (Anshassi *et al.,* 2019; Mwanza *et al.,* 2019; Yoo *et al.,* 2019). Although informal waste pickers are important stakeholders in waste management, they are deemed unclean and sometimes they are denied access to recyclable materials as they appear to be making a mess in some public or private areas (Cetrulo *et al*., 2018). They are frequently dehumanized and stigmatized resulting negatively on both waste pickers and the environment as they are not able to contribute their expertise in the development of recycling systems (Department of Forestry, Fisheries and the Environment, 2020). The most crucial challenge informal waste pickers experience daily is exploitation by recycling dealers or middlemen because they do not have the capacity and resources to recycle waste themselves or transport money to transport waste to major recycling factories because they are not aware of the recycling rates within the recycling industries (Hartmann, 2018). Thus, in this study, the researcher evaluated the type of work informal waste pickers do on behalf of the recycling industry. The study also assessed the hours they spent working and the recycling rate being used recently as compared to the national and international one.

1.4. Research aim and specific objectives

1.4.1. Aim

The research aim of the study was to evaluate the role of the informal waste sector in municipal solid waste management in Vhembe District Municipality, Limpopo Province, South Africa.

1.4.2. Specific objectives

To achieve the outlined aim of this study, the following specific objectives were pursued:

- To identify challenges and opportunities associated with the involvement of the informal waste sector in municipal solid waste management
- To identify the occupational health and safety challenges the informal waste sector encounter on their day-to-day operations.
- To evaluate the support provided by the national, provincial and local government to the informal waste sector
- To evaluate municipality strategies of integrating the informal waste sector into municipal solid waste management system

1.5. Limitations of the study

Due to the Corona Virus (Covid-19) pandemic facing the world and the lockdown regulations put in place by the South African Government, conducting of face-to-face interviews and distribution of questionnaires was limited to only informal waste pickers who agreed to follow Covid-19 protocols. To minimise the risk of infection, the researcher employed the use of online questionnaires and use of internet, social media as well as mobile phones for primary data collection from municipal officials and recycling buy back centres workers. Collins Chabane Local Municipality is a new entity that has recently been introduced and it is made up of settlements and towns that belonged to Makhado and Thulamela local municipalities. The municipality's landfill has not yet started operating; hence, they dispose their waste at Thulamela Landfill Site. This resulted with

the municipality not having enough information about their informal waste pickers and they do not have a record of how many tons of waste is recovered for recycling. Because of this, document analysis within Collins Chabane Local Municipality did not have all the required information regarding informal waste pickers in landfill.

1.6. Research ethics

Ethical considerations are the concern that arise over the proper way to execute a study without harming the respondent (Schurink, 2005). The researcher is aware that it is their responsibility to be sensitive and respectful to all respondents. The researcher is also fully aware of the ethical code of the University of South Africa. Prior commencement of the research project, the researcher obtained Ethical Clearance from the Health Research Ethics Committee of the College of Agriculture and Environmental Sciences, University of South Africa referenced 2020/CAES_HREC/126 (see appendix E) Furthermore, a letter to request permission to conduct a study was submitted to Vhembe District Municipality, Makhado , Thulamela, Collins Chabane and Musina local municipalities and permission was granted (see appendix F) The researcher explained the aim and objectives of the study as well as the procedures to be followed prior respondents take part in the study. The researcher clearly explained to the respondents that participating in the study is voluntary and should they wish to withdraw from participating, they have the right to do so at any time. Respondents were requested to complete a knowledgeable consent form (see appendix H) and information provided by the respondents was treated as confidential. Access to information pertaining to this study will be limited to the researcher and academic supervisors. All information obtained from participants will be destroyed upon completion of the study and a research report will be made public without disclosing any personal information and facial pictures of the participants.

1.7. Delineation of the study

The study took place in Vhembe District Municipality only and no data was collected outside the study area. The district is made up of 4 local municipalities namely, Makhado, Thulamela, Musina and Collins Chabane Local Municipalities. The researcher

administered questionnaires to waste pickers in Makhado, Musina, and Thulamela Landfill Sites. Collins Chabane Landfill Site was not included because it is not functional. The researcher further administered questionnaires with waste pickers around Makhado, Thohoyandou, Musina and Malamulele Town so as to cover street waste pickers. The researcher focused on waste pickers that are 18 years and above and excluded those who are below 18 years as they are regarded as children and cannot give consent. Interview were conducted with municipal officials from all the four municipalities and 10 buyback centres from the district only.

1.8. Outline of the dissertation

The structure of this thesis is provided below to inform the reader with the overview of the contents and substance of each chapter.

Chapter 1 provides a detailed background of the study, problem identification, and motivation of the study, research aim and objective description of the study areas as well as the limitations to the study.

Chapter 2 sets to review studies that informed this study. This chapter briefly discussed the terminology involved in the informal waste sector, the role of the informal waste sector in municipal solid waste management, challenge and health and safety risk associated with informal waste sector activities, municipal solid waste management and the integration of the informal waste sector into municipal solid waste management.

Chapter 3 describes the set of tools and methods that were used to collect and analyse data on the informal waste sector within the study area. This chapter also outlines ethical considerations of the study.

Chapter 4 presents the results and discussion of the study. This chapter provides the data gathered using the set of tools and methods described in chapter 3. This chapter

also analyses and draws up major findings about the role of informal waste sector within the study area.

Chapter 5 provides a summary of the finding from the study and gives a conclusion. This chapter also makes recommendations on what could be done to improve the informal waste sector as well as areas that need further research.

CHAPTER2: LITERATURE REVIEW

2.1. Introduction

This chapter provides a review of literature on the role of the informal waste sector in municipal solid waste management systems. The literature review is broken down into 7 sections which are (1) Terms and definitions, (2) Municipal solid waste management at a global perspective, (3) The role of the informal waste sector in municipal solid waste management, (4) Challenges encountered by the informal waste sector, (5) Occupational health and safety risks experienced by informal waste pickers (6) Integration of the informal waste sector into the municipal solid waste management system (7) Summary of findings.

2.2. Terms and definitions

2.2.1. Informal waste pickers

Informal waste pickers are vulnerable and socio-economically marginalised individuals or groups who moves around streets, landfill sites and dumpsites recovering and sorting valuable waste materials and sells them to recycling dealers as a survival strategy to evade poverty (Rendon *et al.,* 2021). In developing countries such as Vietnam, China, Mexico and South Africa, collection and sorting of recyclable waste materials is mainly carried out by informal waste pickers (Simatele *et al.*, 2017; Botello-Alvarez *et al.,* 2018; Xue *et al.,* 2019; Nguyen *et al.,* 2021). In contrast of the above, informal waste pickers are key role players in recycling and thereby significant contributors to the circular economy (Fuss *et al.,* 2021). Informal waste pickers view urban waste as a resource for their livelihoods and therefore roam around collecting recyclable waste material (Hartmann, 2018). Furthermore, informal waste pickers indirectly contribute to environmental conservation through their activities (Zon *et al.,* 2020). Since they operate informally, they are unregulated by governmental rules and are not subject to tax obligations, however, without any rules and procedures to protect them they are exposed to exploitation and rejection by society (Hartmann, 2018).

2.2.2. Circular economy

The circular economy is an economic system that aims at reducing, reusing and recycling materials within the production and consumption industry with the aim of achieving sustainable development at both macro and micro-economic level (Gall *et al*., 2020). In view of the above, the circular economy enhances the quality of the environment, social equity while also ensuring economic development for present and future generations (Kirchherr *et al.,* 2017). Production companies and governments regard the circular economy as a solution to the increasing pressure on natural resources and raising concerns on environmental impacts on climate change (Christensen, 2021).

The circular economy aims to develop methods to prosper the economy while also protecting the environment at the same time (Blomsma and Brennan, 2017). Furthermore, the circular economy is made up of two aspects namely, the Economic aspect and the Material aspect (Christensen, 2021). The economic aspect of the circular economy deals with economic costs and revenues generated as material flows through the economy, the business model that is deployed and the regulations and legislations that constitute the economic framework for the business (Christensen, 2021). The material aspect focuses on creating a closed loop structure of material flows in the economy by reducing resource inputs, waste, pollution and carbon emissions (Petkovic *et al.,* 2021). Moreover, the circular economy aims to convert materials and energy waste into capital for production of other goods, eradicating waste and ensuring continuous use of resources (Petkovic *et al.,* 2021). A general structure of circular economy operation is indicated in figure 2.1.

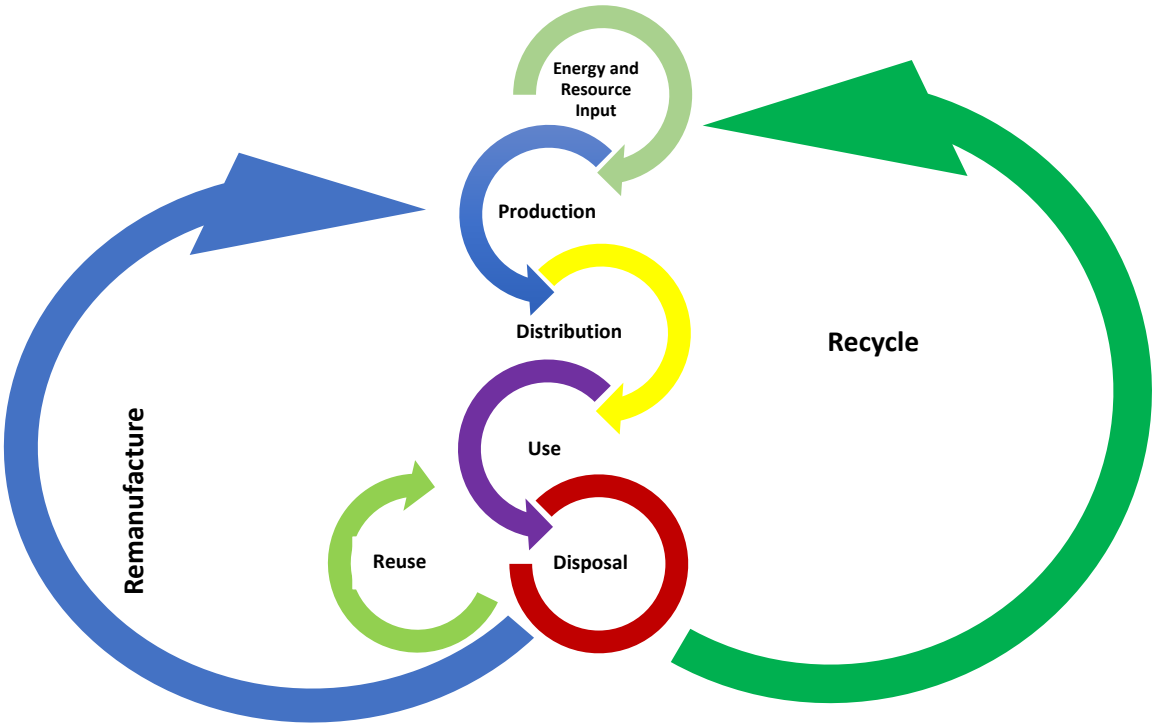


Figure 2.1: The circular economy (Source: Petkovic *et al.,* 2021).

2.2.3. Municipal solid waste

Waste is any material that is not needed by the owner, producer, or processor (Ogwueleka and Naveen, 2021). Therefore, municipal solid waste is referred to as all non-hazardous, non-liquid discarded or useless materials that are handled by the municipality or disposed of at municipality landfill site and includes waste from household, industries, hospitals, schools, businesses, and construction sites (Stafford, 2020). Moreover, municipal solid waste is categorised into Garden waste, organic waste (food residue), electronic waste (E-waste), building rubbles/ construction and demolition waste, and General waste (i.e., paper, plastic, glass, carton, boxes, textile etc.) (Ayodele *et al.,* 2018). Municipal solid waste is a major growing environmental concern because of its rapid increasing generation rate that is resulting from the world rapid demographic growth, economic development and increasing demand in goods and services (Iyamu *et al.,* 2020; Deus *et al*., 2021; Shah *et al.,* 2021). Globally, around 1.2 kg per person of waste is generated daily which amounts to about 2.1 billion tons per year and these large amounts

of waste are taking up large landfill space resulting in negative environmental impacts (Kaza *et al*., 2018; Alderete *et al*., 2021).

2.2.4. Waste management

Waste management entails proper handling of waste from point of generation via temporary storage, collection and transportation, treatment until disposal and monitoring of these activities as per procedure manual of the waste management facility (Singh, 2019). Ineffective and improper waste handling result in negative environmental and human health impacts including socio-economic impacts (Aparcana, 2017). Cities and Towns worldwide still struggles with improving their waste management practices (Azevedo *et al*., 2021). Management of waste from industries, businesses, hospitals, town and city streets is the responsibility of the local government whilst the responsibility for the management of waste at household belongs to the generator (Yang, 2022). In developing countries, waste management managers encounter continuous growth of slums, lack of general infrastructure, inadequate budget, corruption, ineffective education and disbelief from community towards the government which makes it difficult to implement waste management good practices (Azevedo *et al.,* 2021).

2.2.5. Waste minimisation

Waste minimisation is considered a process of reducing the amount of waste generation and waste activities by society and it includes reuse and recycling (Janani and Lalithambigai, 2021). Moreover, waste minimisation is a significant waste management approach because it assists with the protection of the environment as well as human health (Bissmont, 2020). Not only does waste minimisation protect human and environmental health, it also benefits society with energy and resource saving, cost savings from legal complications and material extraction and purchasing, reduces the demand for landfill airspace, reduce the impact of pollution and illegal dumps as well as create a good environment for business such as tourism (Ojovan *et al.,* 2019).

Waste minimisation revolves around the 3R's of sustainability namely, Reduce which entails reduction of the amount of waste generated from the source, Reuse which entails reusing previously used materials such as containers, and Recycle which entails recovering, repairing and remanufacturing materials that have reached their end-of-life and place them back to the market as new product (Ojovan *et al.,* 2019). Based on the opinion that the main goal for any waste management approach is to reduce the amount of waste generated, the Environmental Protection Agency developed a waste management hierarchy to assist authorities, policy makers and waste management managers as guidance with decision making regarding waste management activities and action (Ali *et al.,* 2021). The hierarchy reflects the most preferred waste management practices to the least preferred practices (Ali *et al.,* 2021).

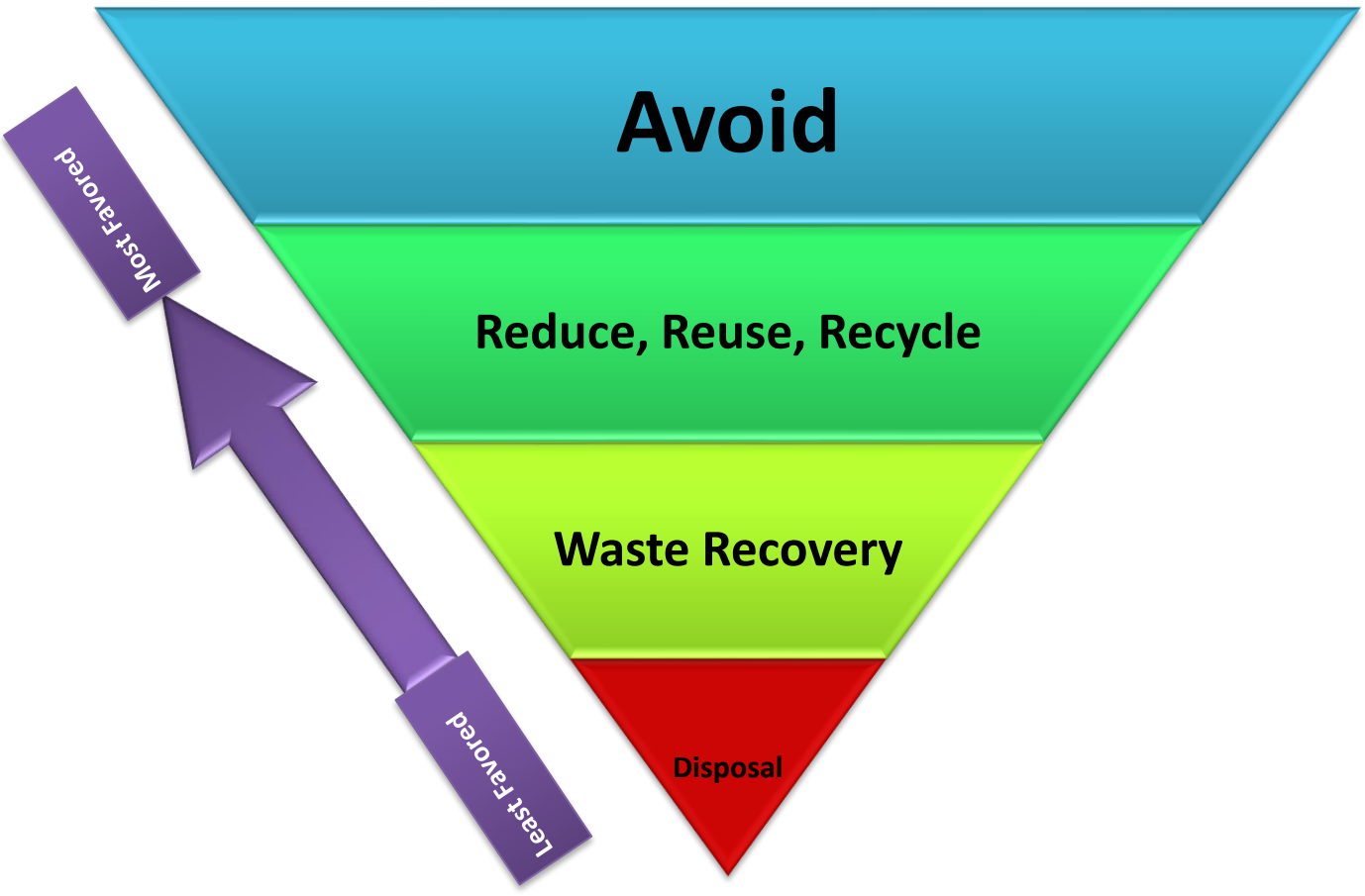


Figure 2.2: Waste management hierarchy (Source: Ali *et al.,* 2021).

2.2.6. Recycling

Recycling is a process of putting back to use discarded valuable waste materials and this process involves recovering, sorting and remanufacturing and conversion of waste materials into new products (Environmental Protection Agency, 2020). Recycling is subdivided to formal and informal recycling wherein formal recycling is recycling that is organised, governed and monitored at various spheres of the government (i.e., Local, Provincial, National and International) (Rendon *et al.,* 2021).

Activities practiced within the formal recycling follow policies and procedures developed by policy makers and authorities (Jaffe *et al.,* 2018). Whereas informal recycling is an activity practiced by socio-economically marginalised groups and individuals through collection, reusing and recycling of waste materials for money and these individuals or groups practice this recycling activities as either a single source of income or as a supplementary income assistance (Jaffe *et al.,* 2018). Informal recycling activities are the base or foundation of the formal recycling sector, meaning that with informal recyclers the formal recycling sector will yield low performance (Eriksen *et al.,* 2019). Recycling of household solid waste is significant for the reduction of municipal solid waste and an important aspect of natural resource conservation from a life cycle management perspective (Chen and Gao, 2021).

2.2.7. Waste disposal facility

Waste disposal facility is the final stage in the whole process of waste management as per the waste hierarchy. Different options of waste disposal exist globally, and this includes on site disposal, communal disposal, landfill sites, composting facilities and recycling facilities (Li *et al.,* 2022). Despite the existing disposal options, landfilling remains the most used solution for waste disposal (Sotamenou *et al*., 2019).

2.3. Municipal solid waste management at a global perspective

One of the general concerns societies face today is the need for sustainable development and to achieve this environmental, social and economic aspects should be taken into consideration when planning (Malare *et al.,* 2017). With the world's population increasing drastically, increased urbanisation, and industrialisation, achieving sustainable development will depend on effective environmental management of projects to deal with issues such as climate change, resource exploitation and solid waste (Puppin de Oliveira, 2019).

Municipal solid waste management is a relevant method globally to assist with protecting the environment and human health as well as socio-economic issues (Cervantes *et al.,* 2018). Improper handling of municipal solid waste threatens the health of society and the environment, therefore, there is a need for an environmentally friendly municipal solid waste management system (Ali *et al.,* 2019). Municipal solid waste management is considered the most challenging waste management stream resulting from two sectors of society namely, household, and commercial sectors (Heidari *et al.,* 2019). Factors such as economic growth, rising incomes, population growth, and improved standards of living are major contributors towards increased waste generation rates (Deus *et al.,* 2020).

Poor waste disposal systems not only threaten the terrestrial ecosystems, but also the riverine and costal ecosystem (Wynne *et al.,* 2018). This is because humans tend to dispose waste illegally in valleys, rivers, and coastal areas and this inhibits the marine ecosystem from performing important services to the economy worldwide (Wynne *et al.,* 2018). Nowadays, the circular economy has been identified as the solution for environmental and social problems such as general waste management (Marquez and Rutkowski, 2020). The movement towards a circular economy was encouraged by the fact that the world has reached a tipping point concerning humankind sustainability (Ajwani-Ramchandani *et al.,* 2021). The best waste management approach to reduce environmental problems is through waste minimisation (Van de Werff *et al.,* 2019).

Recycling is considered a key contributor to waste minimisation , alongside reuse, and reduce which makes up the 3R's of sustainability (Hesran *et al.,* 2019).

Households can play a significant role of minimising residual waste and increase the volume of recyclables by participating in municipal solid waste management through separation of waste at the source, change their purchasing and consumption behaviour (Van de Werff *et al*., 2019). However, the world is still struggling to improve urban household solid waste management behaviour (Azavedo *et al.,* 2021). Waste prevention is another approach that is effective in waste management that can be done at household as it is done before materials are even considered waste (Hou and Sarigollu, 2021). Furthermore, waste classification is also an important waste management method that could yield positive results; however, it also relies on the full participation of residents for its effective implementation (Wang *et al.,* 2021).

To reduce the effects of solid waste on the environment and on human health, waste minimisation, recycling, sanitation, closure polluted dumpsites or conversion of dumpsites to sanitary landfill sites, improving gas recovery from landfill, promoting composting and waste to energy should be considered as solutions to the global waste problem (Shah *et al.,* 2021). Because of improper handling of waste and inappropriate waste disposal methods environmental pollutions are generated and furthermore, leachate from landfills contaminates both surface and ground water which threatens the health and lives of citizens residing next to landfills and dumpsites (Suthar and Babu, 2017).

Municipal solid waste management is a public service offered by local authorities and it is driven by three main factors; complexity, cost and environmental concerns (Romano *et al.,* 2019). Developing countries such as Pakistan, Nigeria and Brazil generate lower quantities of waste as compared to industrialised countries, but their waste management systems are not environmentally sustainable which is caused by poor collection services (Ayodele *et al.,* 2018; Cetrulo *et al.*, 2018; Azam *et al.,* 2020). The waste management problem appears to be increasing each year, this is due to rapid population growth, consumerism and the linear approach to industrialisation, and it has become a severe

issue in the 21st century (Minelgaite and Liobikiene, 2019). Santiago de Chile, South Africa, Zimbabwe and Nicaragua have financial and administrative challenges regarding waste management, which makes it difficult for them to carry out waste management responsibilities (Simatele *et al.,* 2017; Hartmaan, 2018; Navarrete-Hernandez and Navarrete-Hernandez, 2018; Munyai and Nunu, 2020).

Many municipalities do not have a strategy in place for waste management but only depend on waste management methods (Mannie *et al.*, 2016). Furthermore, waste management officials lack understanding of waste management in an environmental management perspective, lack training and municipal political leaders are not aware of the importance of having a proper sustainable solid waste management system (Mannie *et al.,* 2016). Regarding the environment, there is a critical concern, which is the lack of control and inadequate management of solid waste in urban centres (Malare *et al*., 2017).

The capacity of governments to manage waste is limited which makes waste management services insufficient and inefficient (Cervantes *et al*., 2018). Improper solid waste management does not only contribute to land degradation but also to the aspect of climate change by 5% because large quantities of waste produce methane and carbon dioxide, which are greenhouse gases (Zaman and Swapan, 2016). Many local governments manage solid waste inefficiently because of limited budget allocation from central government (Lalitha and Fernando, 2019).

During budget allocations, authorities mainly focus on infrastructure and electricity and as a result allocate insufficient budget to the waste management sector (Lalitha and Fernando, 2019). Incineration of residual waste is a widely adopted method that offers a chance to recover energy, which reduces combustion of fossil fuels for power generation. However, land filling is the most common waste disposal method adopted globally because of its convenience of execution. Many developing countries are now implementing integrated municipal solid waste management because of water pollution, shortage of landfill development of more landfill sites and the mounting resistance from the public about landfill disposal (Singh, 2019). Many policy makers are adopting

sustainability practices following one of the three most followed approaches zero waste, circular economy and sustainable materials management (Anshassi *et al*., 2019).

One of the most important concepts to ensure sustainable waste management is through the implementation of the 3R's (Reduce, Re-use and Recycle) of sustainability (Yoo *et al*., 2019). These 3R's are primarily driven by cost reduction motivation but also beneficial for the sustainability of a firm (Yoo *et al*., 2019). Waste management policies, legislations and regulations have been put in place to ensure effective waste management in many developing countries, but they do not guarantee improvement of the current municipal waste management systems (Cetrulo *et al.*, 2018). There are models that were developed and integrated in Municipal Solid Waste Management that aim to reduce the quantity of municipal solid waste that is being referred to the landfill for final disposal, which includes minimisation of waste strategies, separation at source and recycling (Botello-Alvarez *et al.,* 2018). In South Africa, the responsibility of waste management belongs to municipalities (Nahman and Godfrey, 2010).

South Africa is predominantly affected by food waste from agricultural services and the issue of illegal dumps and unlicensed landfill sites (Ramukhwatho *et al.,* 2016). In the city of Johannesburg, there are four existing landfill sites with a remaining lifespan of +/-10 years of landfill airspace for disposal (Makhosasazane *et al.,* 2016). Informal waste pickers in South African landfill sites form part of a solution to the waste management problem in the country by diverting waste from being disposed (Mohr-swart *et al.,* 2016). South African municipalities regard the informal waste sector as an important stakeholder in municipal solid waste management and has establish methods of integrating informal waste pickers into their waste management plan (Simatele *et al.,* 2017).

2.4. The role of the informal waste sector in municipal solid waste management

Authorities and policy makers worldwide have come to the realisation that the solution to the global waste management problem can be achieved through following the circular economy model (Gall *et al.,* 2020; Marquez and Rutkowski, 2020; Fuss *et al.,* 2021). This

is because the circular economy sustains resources by ensuring that materials and products remain in use for as long as possible (Taleb and Farooque, 2021). In view of the above, the circular economy ensures continuous use of materials and products through the process of recycling industry whether formal or informal is highly dependent on the informal waste sector, therefore the informal waste sector plays a very crucial role of sustaining the recycling industry (Botello-Alvarez *et al.,* 2018).

Though to informal waste pickers it is a form of employment and a means of surviving informal waste pickers plays a very important role in municipal solid waste management of diverting valuable waste material from being referred to landfill and later cause detrimental effects to the environment (Aparcana, 2017). These informal waste pickers roam around the streets and towns collecting and sorting recyclable waste materials and given that most of the municipal solid waste are recyclable they also play a role of cleaning the area as well as reducing waste management costs for municipality (Mwanza *et al.,* 2019).

Unlike the formal and private sector, the informal waste sector is not limited to suburbs and urban towns due to policies and procedures, they can manoeuvre even to the least rural areas that are inaccessible to municipality because of the lack of infrastructure and thereby assist municipality with the reduction of the waste collection in rural areas backlog (Tiew *et al.,* 2019). Municipalities and businesses have yet to implement waste management that guarantees environmental protection and sustainability as they are still attached to the old system of collection and disposal (Musemwa and Oelofse, 2016). There is a significant need for municipality to move from the old model of waste management to the new model that promotes environmental protection as well as economic development and recycling is a major contributing factor in this matter (Rendon *et al.,* 2021). Informal waste pickers play a vital role in recycling and thereby have already started implementing an environmentally friendly waste management system (Wittmer, 2021).

Informal waste pickers collect and recover valuable waste materials such as paper, plastic, carboard, aluminium cans and glass bottles for re-use and recycling and thereby implement the first stage of the circular economy for reducing environmental impacts and spreading local economies (Ferronato *et al.,* 2020). The informal waste sector is formed by small marginalised poor individuals or groups who are not recognised by society, and they commonly operate in open dumpsites in low- and middle-income countries (Zolnikov *et al.,* 2021). These poor individuals find it easy to pursue the informal waste sector because informal waste picking and recycling requires a small investment such as a trolley and receptacles (Danese, 2021).

Municipalities still face challenges regarding waste separation at source to promote recycling, hence, inclusion of informal waste pickers is a critical aspect for environmental friend municipal solid waste management system (Zon *et al.,* 2020). Furthermore, informal waste pickers play a significant role of closing the loop of over extraction and overuse of resources while also minimising the workload for the municipal solid waste management team (Chien *et al.,* 2021). The informal waste sector is predominately composed of individuals with no proper education and cannot afford employment by the formal sector (Rendon *et al.,* 2021). However, in the last few decades, research indicated that they have positive impacts on municipal solid waste management and have pushed for inclusion of the informal waste sector in the formal recycling system (Aparcana, 2017; Rendon *et al.,* 2021).

2.4.1. The role of the informal waste sector in municipal solid waste management in developing countries

In Brazil, municipal solid waste management is a complex activity because on top of economic and environment aspects is also socio-economic aspects represented by informal waste pickers (Pincelli *et al.,* 2021). This is because of the work informal waste pickers do in municipal solid waste management of collecting, classifying and commercial recyclable waste earning recycling rates of 20 to 30% for municipal solid waste (Pincelli *et al.,* 2021). Informal waste pickers in Belo Horizonte, Brazil conduct house to house collection of waste followed by sorting and separation of recyclables at working sheds

which reduces the amount of waste the municipal has to collect at households (Fuss *et al.,* 2021). Furthermore, these informal waste pickers are regarded as essential role players in recycling and are divided into small groups/ sector which are formed without structure with precarious conditions of safety and hygiene and large cooperative that are organised and have machinery, processes, and production management (Aparcana, 2017; Fattor and Viera, 2019).

It has also been widely assessed that informal waste sector contributes to the recycling in a positive way (Xue *et al.,* 2019). As per the waste management hierarchy, recycling is considered the best option to reduce the impacts in line with end-of-life wastes (Mwanza and Mbohwa, 2017). This is because not only does recycling plays a significant role in municipal solid waste management of reducing waste that have an economic value from the waste stream, but it also provides the opportunity of using old recyclable materials to manufacture new products, hence, ensuring continuous use of product and resources (Mwanza and Mbohwa, 2017). Considering the above aspects, Brazilians municipalities are urged to develop integrated municipal solid waste management plans based on strategies to promote inclusion of informal waste pickers to improve the current separation at source waste collection model (Ibanez-Fores *et al.*, 2018). Furthermore, informal waste does not only conserve natural resources and ensures a clean environment, but their activities also create employment and wealth for the many poor individuals within the country (Conke, 2018). In China and Vietnam, the responsibility of waste collection is mainly by informal waste pickers because their recycling rate is very low compared to the formal sector (Chen and Gao, 2021).

Although the people's Republic of China has put lot of effort in improving municipal solid waste management system, the waste collection team still completes with the informal waste sector (Steuer *et al.*, 2017). After the realisation that it is difficult for residents with low- level education to separate waste according to type of coded trash bins developed in China and many Chinese' cities have resorted to involving all stakeholders in waste management and assign responsibilities to each stakeholder (Lishan *et al.,* 2021). Part of this stakeholders is the informal recycling sector composed of informal waste pickers,

junk buyers and intermediate dealers who play a role of collecting, separating and processing of waste materials (Xiao *et al.*, 2021). However, the informal recycling sector only collects valuable waste materials such as paper, cans, plastic and glass (Xiao *et al.,* 2021). The informal waste sector in Beijing, China plays an important role of recycling paper and the recycling industry regards the informal recycling system as the main contributor to municipal solid waste recycling (Steuer *et al.*, 2017).

During economic reforms in 1980's, the Chinese government limited waste collection and processing service to urban areas and with growing migratory flows from rural suburbs into the cities, parts of municipal solid waste management has increasingly become the responsibilities of the informal waste sector as a means of living by migrants (Steuer *et al.*, 2017). Taking into consideration that resource recycling increases sustainability of the environment and has a potential to supply society with resources, China has observed integration of informal waste collection as an effective method to achieve resource recycling (Xue *et al.*, 2019). Furthermore, households prefer informal waste recycling other than the formal waste collection system (Xue *et al.*, 2019).

As a new trend plastic is replacing materials such as wood, metals, and glass because they are cheaper, flexible and easy to manufacture and recycle (Choudhary *et al.,* 2019). Polyethylene Terephthalate also known as PET is the most produced and used form of plastic, that is used for purpose of packaging bottled water, lotions and soft drinks (Eriksen *et al.*, 2019). PET is recyclable and in India, discarded PET bottles are collected by rag pickers as part of the informal waste sector and is sold to Kabadiwallas, who then remove caps, neck rings and labels and then shred wash and sell the shredded flakes for use as raw materials of fibres and filaments (Choudhary *et al.*, 2019).

It has been identified that per capital waste generations in India increases much slower now with the inclusion of the informal waste sector in municipal solid waste management than what it was when the informal waste sector was still in its emerging stages (Nandy *et al.*, 2015; Fiksel and Lal, 2018). The informal waste sector contributes to society through converting waste at source and recycling (Mwaza *et al.*, 2019). In view of these

aspects, women waste pickers in India participate in waste economy while also bridging the gap/backlog municipal solid waste management systems fails to deliver waste and recycling services (Wittmer, 2021). Due to the rapid urbanisation of the world's population, improved standards of living and economic development, there has been an increase in waste generation problem in countries that have not yet prioritised the inclusion of informal waste pickers in their municipal solid waste management system (Luiz da silva *et al.*, 2019).

2.4.2. The role of the informal waste sector in municipal solid waste management in Sub-Saharan Africa

Poor households and individuals in Kinshasa in the Democratic Republic of Congo have resorted to multiple informal sector activities as a way of coping with the increasing poverty levels in the country brought about continuous wars in the country (Simatele and Etambakonga, 2015; Muheirwe *et al.,* 2021). Amongst these informal activities is recovering valuable waste materials and trade them for cash to make a living (Muheirwe *et al.,* 2021). The waste management problem seems to be growing rapidly in Nigeria and it might still be the same in future (Ezeudu *et al.,* 2019). In contrast of the above aspect, the Nigerian government might have to develop strategies against waste towards incorporating the circular economy and its current waste management system (Ezeudu *et al.,* 2019).

Informal waste pickers are major agents of the circular economy and in Nigeria, they play a role of separating waste and identify valuable waste materials for recycling reducing the amount of waste from the municipal solid waste management stream (Ogwueleka and Naveen, 2021). Therefore, informal waste pickers recover wastes and place them back into the economy which contributes to Sustainable Development Goals (SDG) 1, 5, 8, 11 and 12 which are economic, social and environmental focuses (Ogwueleka and Naveen, 2021). In Abidjan, Cote d'Ivoire waste management is handled by both the public and the private sector, however, their effort is futile as their methods do not effectively minimise waste (Andrianisa *et al.,* 2016). Informal waste pickers despite the health and social

problems associated with their line of work play an important role of creating a local economy for the poor which needs to be retained and maintained to keep the economy flowing (Andrianisa *et al.,* 2016). On the other hand, informal waste pickers in Ghana work in parallel with the formal waste collection team reducing collection costs as well as contributing to sustainable environmental management of resources although all their work is undermined and unrecognised by the society (Osei-Bonsu, 2020).

After the realisation that an effective waste management system will be difficult to implement because of poor road networks, inadequate financial resources, and low levels of political will to get involved in waste management activities, the Malawi government in Blantyre has incorporated the informal waste sector into their waste management system because of their ability to operate in such areas without any difficulties (Kasinja and Tilley, 2018). In Kenya, informal waste pickers have taken the responsibility of municipalities of collecting waste from households, offices and business premises as well as working in waste transfer stations and illegal and legal dumpsites (Barrett, 2021). In Liberia, informal waste pickers play a crucial role of plastic pollution reduction by recovering plastic from the ocean and coastal areas, within the city as well as in informal settlements where refuse removal services are not provided (Cities Alliance, 2021).

Furthermore, informal waste pickers in Liberia generate employment for the poor and they improve municipal solid waste management system through recycling (Cities Alliance, 2021). In the Sub-Saharan Africa, where the waste management system is characterised by poor infrastructure, low financial resources, and low human resources, the informal waste sector plays an important role of recovering waste for recycling, especially plastic recycling, as plastic is a major waste management concern (International Union for Conservation of Nature, 2021).

2.4.3. The role of the informal waste sector in municipal solid waste management in South Africa

South Africa, like many other developing countries still faces solid waste management challenge and as a result, there is over consumption of natural resources and negative

impacts on the health of the environment and humans (Issok *et al.*, 2021). In contrast of the above, the South African government has initiated a waste Research Development and Innovation roadmap that will facilitate movement from the old waste management system that follows a linear economy to a new model of circular economy (Olotayo *et al.*, 2021). The informal waste sector in South Africa has gained recognition from the government for the role they play of cleaning, recovering, recycling waste as well as creating jobs for the many poor individuals within the country (Simatele *et al.*, 2017). Taking note of the role informal waste pickers play in solid waste management and society, municipalities in South Africa such as the City of Johannesburg make inclusion of the informal waste sector into their integrated waste management plans (Simatele *et al.*, 2017).

The City of Johannesburg has initiated establishments such as recycling initiatives, programmes, competitions, and development of recycling buy back centres for utilisation by the informal waste sector as a token of appreciation for the significant role they play in solid waste management (Baker *et al.*, 2016). Additionally, in the City of Johannesburg, the government has realised the important role the informal waste sector plays in municipal solid waste management and have integrated them into their waste management system and offer them support through recycling initiatives, competitions, funding and development of buy back centres (Simatele *et al.,* 2017).

As they are driven by the need to make money, informal waste pickers are the most reliable supplier of recyclables as well as cleaning of town streets, unlike waste pickers from the formal sector whom even if they do not clean the town, they will still get paid, to the informal waste sector the “no work no pay” rule exists (Botello-Alvarez *et al*., 2018). Thus, with recognitions of the improvement the informal waste sector brings to municipal solid waste management, the South African government has set incentives or motions to formalise scavenging to yield more positive outcomes (Luiz da silver *et al.*, 2019). Informal waste pickers are a solution to the global waste management challenge because they can access areas that the formal sector cannot and reduce the amount of waste generated (Tiew *et al.*, 2019).

In 2015, due to the relentless efforts of informal waste pickers who recover valuable waste materials from landfills and kerbside, South Africa's recovered and recycled 57.1% of plastic and packaging materials saving South African municipalities millions of Rands (Godfrey and Oelofse, 2017; Department of Forestry, Fisheries and the Environment, 2020; Samson *et al*., 2021). Vhembe District Municipality is still challenged regarding separation at source for recycling at household level (Nefale, 2018). As a result, many recyclables are thrown away ending up in landfills and illegal dumpsites (Mathako, 2019). Informal waste pickers in Vhembe District Municipality play a significant role collecting valuable waste from landfills and dumpsites which minimises the piles of waste to be buried (Nefale, 2018).

The district's waste management system is under pressure because of poor education and awareness related to recycling from an economic perspective, inadequate equipment and facilities and poor service delivery (Mabadahanye, 2017). Moreover, the waste management section within the district does not receive much attention from authorities, resulting in most of the budget being allocated to the roads and infrastructure compelling the waste management section to continue using old equipment and facilities, yielding poor waste management service delivery (Maluleke, 2017; Mathako, 2019). In contrast of the above, Vhembe District Municipality and its 4 municipalities have begun to recognise the informal waste sector due to their ability to reduce the waste management backlog without even knowing of their contribution (Nefale, 2017).

2.5. Challenges encountered by the informal waste sector

Transition from an economy towards a circular economy seems to be a global desire that involves closing and slowing loops of materials and product flows (Araya-Cordova *et al*., 2021). In this contrast, recycling has been deemed they key role player towards achieving this transition (Valanzuela-Levi, 2021). The informal waste sector has an important role of income generation and contributes to waste recycling, despite that this sector is still not recognised (Tong *et al*., 2021). Informal waste pickers are deemed unclean and often

rejected and prevented from collecting valuable waste from business premises with the sense that they may scare customers (Cetrulo *et al*., 2018).

Based on their type of work, which is small scale, low technology, low paid, unrecorded, and unregulated work, the best option for them is to sell valuable waste materials to intermediaries and recycling dealers which results in them being exploited (Xue *et al*., 2019). Even though informal waste pickers are exploited, they have no other option because they lack resources, equipment and finance to be able to further process recyclable materials (Guibrunet, 2019). Informal waste pickers play a significant role of saving municipality millions of Rands in waste management cost, yet they are side-lined and left to operate on the fringes of the economy and are exposed to several risks that directly impact sustainability of their livelihoods (Schenck *et al*., 2019).

Informal waste pickers are marginalised, vulnerable and impoverished due to a variety of factors which include lack of access to basic services, social stigma, limited financial resources, abuse and exploitation by officials, high susceptibility to international oscillation in the recycling market, political oppression as well as neglect by society (Hartmann, 2018). As a waste minimisation strategy, municipalities privatise waste management services and this threatens informal waste activities as private waste management service providers take over all waste activities including recycling which means that informal waste pickers must seek approval from the private organisation in order to recover valuable waste materials (Sandhu *et al*., 2017).

Informal waste pickers operate in precarious working conditions with low income and without any form of protection (Sapkota *et al*., 2020). They are often uneducated, physically disabled or foreigners and this results in being exploited or underpaid for the valuable waste materials they collect especially in areas that have only one (1) buyer (Rendon *et al*., 2021). Moreover, informal waste contributes to environmental protection and growth of the local economy they ae excluded from policies and programs in waste management systems (Uddin and Gutberlet, 2018). Furthermore, informal waste pickers collect waste, recover waste, conserve resources, control litter and generates income

through recycling activities yet they are not remunerated for the services they provide to society (Uddin and Gutberlet, 2018).

With consideration to the type of work they do, informal waste pickers are usually symbolically connected to waste and often receive judgment from society as people who use drugs, resulting in them being denied access to public spaces as they appear to be causing disorder (Jaffe *et al*., 2018). To date, the Indian government waste management strategies reflect little interest with the inclusion of their informal waste sector, however favour goes to private waste management service providers (Sandhu *et al*., 2017). Informal waste pickers are often subject to systematic marginalisation and regarded as dirty outlaws of society having to cope with asymmetric power and volatile prices of recyclable threatening their daily income of which under favourable conditions can even be above the minimum wage in Kenya, Mongolia, and Mexico (Uddin and Gutberlet, 2018; Guibrunet, 2019; Karuiki *et al.,* 2019; Gall *et al*., 2020).

Being driven by factors such as family poverty and low recycling rates, informal waste pickers are compelled to work with their children without paying them which affects the children mentally and holds them back from performing well at school (Aparcana *et al*., 2017). Informal waste pickers are self-employed workers who recover valuable waste materials and sell materials as a means of generating income (Wittmer, 2021). However, they are exposed to variety of challenges that include stigmas, exclusion from society and life-threatening risk factors in their everyday lives and livelihoods (Wittmer, 2021).

Basically, the informal waste sector is driven by the recycling market and the lack of market knowledge which makes informal waste pickers vulnerable to competition with recycling dealers that make profit from selling recyclables from informal waste pickers to the recycling industry (Dutra *et al.,* 2018). Informal waste pickers particularly those that are in the recycling sector only are faced with the challenge that recycling rates are far below their potential leaving informal waste pickers working long hours to make little money (Pincelli *et al*., 2021).

Waste management systems are developed with consideration to the country established strategies within their national public policies, which are closely linked to institutional, legal, political and economic context of each area (Marquez and Ruthowski, 2020). However, these policies often do not put much into waste management and recycling (Lalitha and Fernando, 2019). Recycling highly depends on source separation which is mostly done at household level and if individuals refuse to cooperate this negatively impacts the recycling industry (Conke, 2018). In contrast of the above, informal waste pickers are faced with a challenge of rejection from households due to their activities associated with social stigma (Conke, 2018).

Although informal waste pickers save millions of Rands in waste management costs, municipalities do not recognise them as waste management service providers and frequently discriminate against them (Fuss *et al*., 2021). The informal waste sector has always been an invisible part of the municipal solid waste management system (Sandhu *et al.,* 2017). In developing countries such as India, they are often overlooked and ignored by decision makers and policy framework (Sandhu *et al.,* 2017). Without the recognition of authorities and policy makers, informal waste pickers do not get any form of protection against exploitation, bullying and political interference and they stand a little chance of getting financial support (Siman *et al*., 2020). As the informal waste sector is comprised of poor marginalised groups and individuals, it often lacks financial resources to purchase equipment that will enable it to effectively carry out informal waste activities (Siman *et al*., 2020).

Being excluded in policies and neglected by the government leads to compromise of financial wellness and working conditions of the informal waste pickers (Simatele *et al*., 2017). Furthermore, with the push towards circular economy, there is involvement of the use of modern information technologies and often the informal waste sector may not be able to access due to financial constraints (Hull *et al.,* 2021). Informal waste pickers reside adjacent to or in landfill sites or illegal dumpsites close to their source of income in shelters made from waste materials without any access to any basic services such as water and electricity (Department of Forestry, Fisheries and the Environment, 2016). Also, informal

waste pickers lack labour rights to protect them from various hazards that may cause adverse effects (Zolnikov *et al*., 2018).

Informal waste pickers worldwide operate under harsh conditions such as extreme heat or heavy rainfall, long hours and must travel long distances to collect and sell valuable recyclable without any means of transport (Department of Forestry, Fisheries and the Environment, 2016). Regardless of its size and significant role in solid waste management, informal waste pickers are still associated with poverty and health risks (Guibrinet, 2019). In Mekong Delta, Vietnam, although informal waste pickers play an important role of income diversification to the poor and primary contribution to recycling, there is still no record or mention of their sector in any government official policy (Tong *et al*., 2021). With the push towards formalising the informal waste sector, role, regulation requirements and procedures pose a threat to the way informal waste pickers operates and this result in others not being able to work due to requirements such as citizenship and physical abilities (Sandhu *et al.,* 2017).

In India, the development of the National Environmental Policy promotes recognition and inclusion of the informal waste sector municipal solid waste management. However, authorities and policy makers in India have no budget in place for this initiative (Da Silva *et al.*, 2019). The informal waste sector is highly dependent on recycling and generating income through recycling which relies upon high market demands, thus without any demand they yield little or no profit (Xue *et al*., 2019). Many informal waste pickers loose profit due to poor separation of recyclable, dirty recyclables, and uncategorised waste by colour (Conke, 2018). Moreover, they are compelled to pay a lot of money to transport waste recycling centres and they must pay using the very same money they will get from selling the recyclables and this leaves them working only to put food on the table and not to meet other social needs (Conke, 2018).

In low-income countries such as Mongolia, Thailand, Zambia and Cote’d Ivor, the government does not recognise the informal waste sector as a key role player in effective solid waste management but recognises them as a problem to society based on their

unhygienic working conditions and as a result no effort is given towards improving their work or livelihoods (Andrianaisa *et al.,* 2016; Uddin and Gutberlet, 2018; Vassanadumrongdee and Kittipongvises, 2018; Mwanza *et al*., 2019). In the city of Johannesburg, South Africa, informal waste pickers are faced with challenges that they are excluded from decision making even on matters that directly affect them, they are ignored and informed at a later stage of the decisions that were taken and on the development that were initiated (Samson, 2019).

Although the city policy aims to support informal waste pickers little funds are located by municipality to enable officials to work with informal waste pickers as well as lack of support from sister department towards the effort that the municipality is making to integrate the informal waste sector in its municipal solid waste management system (Samson, 2019). Labeled 'invisible heroes' in solid waste management, informal waste pickers are time and again referred to as vulnerable, yet authorities and policy makers often do not intervene for safer working conditions due to the unregulated and informal nature of the work they do (Carenbauer, 2021). Furthermore, the informal waste sector is unable to achieve its full potential because of factors such as lack of political will have to assist them or support them, lack of national policy related to waste management, absence of rules and regulations, insufficient funds allocated for informal waste activities, no educational programs to capacitate informal waste pickers about recycling and no national policies and procedures to develop a circular economy (Araya-Cordova *et al*., 2021).

2.6. Occupational health and safety risks experienced by informal waste pickers

Globally, millions of informal waste pickers carry out informal waste activities such as collecting, recovering and sorting of valuable solid waste materials in dangerous and unhygienic working conditions daily (Abdel-Shafy and Mansour*,* 2018; Black *et al.*, 2019; Mwanza *et al.*, 2019). Majority of waste pickers operate within landfill sites and dumpsites and are confronted with risk of getting injuries from sharp objects, animals and insects bites, musculoskeletal problems, ophthalmological and respiratory infections (Aparcana,

2017; Awasthi *et al.*, 2019). Separation of waste of the source is still a major challenge to society worldwide; hence, municipal solid waste may include heavy metals, asbestos, solvents, pesticides, paints and sometimes household health care risk waste substances that may cause harm to informal waste pickers (Fulwani *et al.,* 2020).

Waste recovery largely occurs in landfills where there are various hazards and risks that the informal waste sector encounters that range from biological, chemical, ergonomic, physical, mechanical and social in nature (Zolnikov *et al.*, 2021). Informal waste pickers in landfills are exposed to water, air and soil pollution, bad odour and a variety of vermin and insects daily (Franco de Diana *et al.*, 2018). Furthermore, their workplace often has no sanitary services nor sewage drainage and as a result creates an unbearable working condition with health impacts (Franco de Diana *et al.,* 2018). Informal waste pickers often work in precarious conditions, exposed to waste, which is a hazard on its own, poor hygiene practices, lack of protection from occupational and environmental hazards, and poor living conditions which put them in significant health risk (Sapkota *et al.*, 2020).

Informal waste pickers involved in valuable solid waste recovery are often subject to egregiously dangerous exposure such as communicable diseases from needle sticks, bioaerosol inhalation, vector-borne diseases, heat stress, injuries, burns and toxic exposures (Cruvinel *et al.*, 2020). Dumpsites and landfill sites are home to the most notorious vector-borne diseases transmitter, mosquitoes which are responsible for transmitting various diseases such as malaria, and as informal waste pickers live and work of landfill sites their health is at risk of being infected (Cruvinel *et al.*, 2020).

Apart from living in low standards vulnerable living areas, informal waste pickers do their work in inadequate and unsanitary sites exposing them to social stigma and stress (Cruvinel *et al.*, 2020). Considering the poor working conditions informal waste pickers operate in a way which exposes them to occupational risks, one occupational hazard connected to informal waste picking that is common, is exposure to sharps such as glass, syringes, and other medical waste objects that are often contaminated with biological

hazards and can transmit infections such as sexual transmitted infections (Ganem dos Santos *et al.*, 2020).

With consideration to informal waste pickers, occupational exposures such as social vulnerability, impoverished setting, low education and lack of access to health facilities, informal waste pickers chances of getting an infection of STI such as Syphilis, HIV and Hepatitis are very high (Ganem dos Santos *et al.*, 2020). Millions of waste pickers lack proper knowledge of waste handling and do not put on any form of protective clothing (PPE) because they are heavy and slow them down (Zon *et al.*, 2020). Without proper PPE, informal waste pickers are exposed to occupational accidents such as cuts and scratches from sharp objects that could have been easily avoided by wearing of gloves (Zon *et al.*, 2020). Waste recovery is an activity that directly affects workers' health (Fattor and Viera, 2019).

Because informal waste pickers operate long hours under extreme weathers and do a lot of heavy lifting, they are exposed to various accidents and diseases such as Malaise, Headaches, Nausea partial or permanent loss of vision and hearing, stress, discomfort, low back pain, leptospirosis, musculoskeletal disorder, falls, mutilations, cuts and run-ins (Fattor and Viera, 2019). Informal waste picking and recycling is an activity often initiated by women/men belonging to the 35-40 age group to take care of their families and at their age, they face unhealthy working conditions exposing them to occupational risks which predispose the prevalence of musculoskeletal as chronic back problems (Bonini-Rocha *et al.*, 2021). In India, municipal solid waste is generally mixed and not separated before disposal and they often contain hazardous waste (Thukur *et al.*, 2018). This becomes a health hazard because Indian informal waste pickers operate without any PPE and they have a saying that if a person is wearing gloves, they are not one with waste (Thakur *et al.,* 2018).

In Brazil, informal waste pickers in landfill site identified that accident are mostly associated with people who wear protective clothing (Zolnikov *et al,* 2018). Those who do not wear protective clothing are most likely to be infected because they ignore when

accidents occur (Zolnikov *et al.,* 2018). Because landfill sites and dumpsites are associated with toxic and bad odour/stench, working permanently within the sites eventually affects informal waste pickers' respirator systems (Zolnikov *et al.*, 2021). Informal waste pickers in Brazil have been included in the Brazilian occupational code by the Ministry of labour, however, approximately 229 568 who rely on waste picking are in a situation of health vulnerability and poor quality of life (Bonini-Rocha *et al*., 2021).

Globally, informal waste pickers build houses from waste materials they have recovered adjacent or within landfill sites (Schenck *et al.,* 2019). Eventually, they start families and have kids in those unhygienic conditions, and this puts the metal health and educational progress of the children at risk (Aparcana, 2017). Not only does the above aspect threatens their health and educational background, but this living condition usually does not have any form of security be it emergency response or police department hence, it becomes a dwelling place for criminal activities and put their lives in danger.

Having to endure extreme working conditions informal waste pickers resort using substances to ease the pain and to relieve their stress such as Marijuana, alcohol, chewing tobacco and glue, which as a result becomes an addiction and danger to their health (Fulwani *et al.,* 2020). Informal waste picking is an activity recognised as hazardous or unhealthy form of physical labour practiced by individuals who are stigmatised and excluded in society (Wittmer, 2021). Considering the above, informal waste pickers are exposed not only to physical and health threats but also to aspects such as emotions, perception, priorities, values and aspirations that address why a person does what they do daily (Schenck *et al.,* 2019).

In South Africa, it was identified that landfills are home to polluted waters, rotten meat and food staffs, faeces matter from soiled disposable diapers, dust, heavy loads of waste, sharps and glass, and these risk factors may cause adverse outcomes to be more prominent on informal waste pickers (Schenck *et al.,* 2019). The health of informal waste pickers plays crucial role in their performances on recycling and re-use, hence improving and protecting the environment as well as conserve natural resources from over

extraction (Guibrinet, 2019). The lack of policy integration and dissemination of the informal waste sector from municipal solid waste management impacts the financial status and working conditions of informal waste pickers (Simatele *et al.,* 2017). On its own waste collection is a challenging task due to different topography, climatic conditions and limited space for waste containers movement (Botti *et al.,* 2020). Considering the above, informal waste pickers who practice door to door household waste collection suffer from ergonomic risk factors due to characteristics of the containers they use to carry the waste and the activity itself (Botti *et al.,* 2020).

Because the informal waste sector is comprised of mostly untrained and uneducated individuals, they do not work towards improving the sector or working conditions, their main aim is to make profit and the unhygienic working condition endangers their health (Fedilis and Colmenaro *et al.,* 2018). In developing countries such as India, informal waste pickers are exposed to a variety of occupational health and safety hazards such as toxics from chemical residues, solvents, flies, pests, microbiological contaminates and emissions from the degradation of the organic fraction (Thakur *et al.,* 2018).

Landfilling is still the most used waste disposal method globally and this involves movement of heavy machineries and sometimes mixture of different formed gases may result in development of fire, which puts the lives of the landfill informal waste pickers and surrounding public in harm's way (Das *et al.,* 2019). In Paraguay within the Cateura landfill in Asuncion district, due to ineffective waste disposal and management system women who recovers valuable waste materials within the landfill are exposed substances that affects or damage their genetics (Franco de Diana *et al.,* 2018).

2.7. Integration of the informal waste sector into the municipal solid waste management system

Authorities and policy makers have recently started recognising the informal waste sector as role players in municipal solid waste management (Simatele *et al.,* 2017). Therefore, there have been calls that governments should move away from policies that do not include informal waste pickers to promote co-working and environmentally friendly waste

management (Guibrinet, 2019). Informal waste pickers are part of the waste management solution as they provide sustainable management, reduce the amount of waste collected by waste management team, pollution prevention and with the extension of landfill life span (Navarrete-Hernandez and Navarrete-Hernandez, 2018).

Municipalities are pushed to restructure their solid waste management system to a circular economy (Fuss *et al*., 2021). This is because the circular economy abandons the idea of products and materials over becoming waste instead it keeps them in a circular system to be used continuously (Gall *et al*., 2020). Recycling has been recognised as a key contributor to achieving a circular economy and informal waste pickers are first in line through valuable waste recovery, sorting and selling to intermediaries (Siman *et al.*, 2020; Taleb and Farooque. 2021). In contrast of these aspects, authorities and policy makers have identified the need to recognise the contribution of the informal waste sector in municipal solid waste management, while improving their working condition as well as socio-economic standards (Aparcana, 2017).

Because the informal waste sector is unregistered, unregulated and not organised, there has been trials towards formalisation of the sector throughout the years but to date there are challenges preventing successful formalisation of the sector (Aparcana, 2017). Integrating the informal waste sector into municipal solid waste management has been identified to be needed and feasible globally, however, this move requires great investment and efforts from all relevant stakeholders and authorities (Tong *et al*., 2021). It is necessary to recycle waste to achieve sustainable environmental management through the whole production-consumption process (Yildiz-Geyhan *et al.,* 2017). Towards achieving the circular economy goal, it is important to recognise that it cannot be achieved in isolating but through the involvement of all related stakeholders (Hull *et al*., 2021). In view of the above, the Chinese government has realised that it cannot ban the informal recycling sector because households prefer collection of waste from them and that the formal recycling sector has high recycling rates, which makes it underperforms as compared to the informal (Chen and Gao, 2021).

In Beijing, they have also tried to ban the informal recycling sector and replace it with the formal. however, all efforts were in vain especially regarding recovering and sorting (Steuer *et al*., 2017). Failure of these attempts to formalise the informal waste sector is because of barriers such as lack of infrastructure and resources (Aparcana, 2017). Based on the size and significance of the informal waste sector municipal solid waste management with additions of the challenges they encounter in their everyday life such as exploitation, poverty and occupational health and safety risks, government should integrate the informal waste sector into the municipal solid waste management system (Guibrunet, 2019).

In developing countries such as Chile, Nicaragua, Malaysia and Brazil, the government has recognised the significance of informal waste pickers and have developed policies that emphasise the inclusion of informal waste pickers into the municipal solid waste management system (Zon *et al*., 2020; Hartmann, 2018; Moh and Manaf, 2017; Navarrete-Hernandez and Navarrete-Hernandez, 2018). Because of the major role of cost saving, resource conservation and town cleaning in the Kingdom of Saudi Arabia and Russia formalisation of the informal waste sector has been successful and effective towards the global waste management problem (Ouda *et al*., 2017; Luiz da Silva *et al*., 2019).

Brazil has over 5000 cities that differ in socioeconomic levels of which some of these cities do not have informal waste pickers, which is result of the lack of investment and effort towards the informal waste sector (Dutra *et al.,* 2018). In Mexico, Latin America, suggestion has been made that policy makers should establish policies that will enable the inclusion of the informal waste sector in municipal solid waste management system (Guibrinet, 2019). The Malaysian government has declared and dedicated a day as a National Recycling Day to recyclers through exhibitions and awards for the marvellous work they do (Tiew *et al.,* 2019). The Brazilian waste management policy enables a network between the formal, the private and informal waste sector that assist the informal waste sector through the development of material recovery facilities and recycling buyback centres (Pincelli *et al.,* 2021). Although many developing countries have

recognised the informal waste sector for the significant role it plays in municipal solid waste management, in India, Delhi waste management and recycling has been privatised and therefore, informal waste pickers are denied access to valuable waste materials (Hartmann, 2018).

During the proceeding of the United Nations Conference of Environment and Development in 1992, recommendations were made that countries should address the issues of waste management and recycling as they are major growing concern (Agovino *et al.,* 2018). Furthermore, it was declared that governments should develop programmers and initiatives to raise awareness and capacitate citizens about recycling (Agovino *et al.,* 2018). In light of the above, City of Johannesburg in South Africa established recycling facilities enhance performance of informal waste pickers activities (Simatele *et al.,* 2017). While within the Vhembe District, municipalities recognise the informal waste sector and support them through recycling workshop, training, advice, assistance with funds applications and grating a platform for networking with major recycling firms (Nefale, 2018). Municipalities within Vhembe District cannot support the informal waste sector financially because authorities and policy makers still undermine the waste management section and little budget is allocated which only covers collections and disposal services only (Mathako, 2019).

Formal waste collectors face difficulties in recovering enough valuable waste materials because of higher operational cost and poor competitiveness on collection prices compared with informal waste pickers, therefore, integrating informal waste pickers into the formal waste sector will be beneficial to control the flow of recyclables and cut the formal collectors operation cost (Wei *at al.,* 2021). Indian's cultural, ethnic and cast-base divide of social makes recent policy aimed at improving the informal waste pickers working conditions and activities difficult to engage (Luiz da Silva *et al.,* 2019). In Mexico, there has been suggestions that the government establishes co-working relationship that will enable informal waste pickers to be part of the municipal solid waste management system (Guibrinet, 2019).

The informal waste sector yield both positive and negative results in regarding health and social problems, however, it provides significant economic and environmental benefits (Andrianisa *et al.,* 2016). In contrast of these aspects, it might be counterproductive to integrate the informal waste sector into municipal solid waste management planning, building on their activities and vast experience, while also improving their working and living conditions as well as those who are affected (Andrianisa *et al.,* 2016). Recycling as an integral strategy of waste minimisation, can either be formal or informal which relies entirely on source separation, collection, sorting, processing and trading of valuable waste materials (Jaligot *et al.,* 2016).

Towards a circular economy, the government of Vietnam recognises the importance of integrating the informal waste sector into the wider waste management system because their activities are more effective and environmentally friendly than formal waste activities (Tong *et al.,* 2021). In many urban centres of the global south, informal waste pickers are a familiar presence to the public and households, thus they are given preference considering waste collection and recovery creating a difficult competition for the formal waste sector (Danese, 2021). This leads the formal waste sector to resort to recruiting informal waste pickers to do primary activities (i.e., collecting, sorting and processing) for them to improve their performance in the recycling industry (Wei *et al.,* 2019).

In Belohorizonte, Brazil, the informal and formal waste sectors still run in parallel, wherein the informal waste sector assists small and medium-sized middlemen businesses by developing a platform to earn income by selling valuable waste materials at low prices (Fuss *et al.,* 2021). Following the introduction of the circular economy concept, in Kampala, Uganda, the waste management team works together with informal waste pickers, allowing informal waste pickers to recover valuable then collects, residue for final disposal (Katusiimeh *et al.,* 2013). In South Africa, the informal waste sector has recently gained recognition and only few cities have begun with the inclusion of informal waste pickers in municipal solid waste management system such as in the city of Johannesburg (Simatele *et al.,* 2017). Further investigations are still underway for methods to integrate

the sector because they have identified that informal waste pickers put more effort and do more work in recycling than the formal waste sector (Schenck *et al.,* 2019).

2.8. Challenges associated with the integration of the informal waste sector into the municipal solid waste management system

Integrating informal waste pickers into the formal sector could improve waste collection and recycling, however, there is no guarantee that it will improve their income, working conditions and efficiency in a sustainable, safe, and equitable way (Kasinja and Tilley, 2018). Because the informal waste sector operates differently from municipalities and industries, there cannot be a one size fits all approach to integrating them into municipal solid waste management system (Department of Forestry, Fisheries and the Environment, 2020). Informal waste pickers have adapted to their way of working, flexible hours, being their own boss, paid for materials at any given time or day, and having to work close to home (Andrianisa *et al.,* 2017). Although integrating informal waste pickers into the formal system will yield positive results in their line of work changing their behaviour and mind-sets will be a challenge (Department of Forestry, Fisheries and the Environment, 2020). This is because many informal waste pickers are entrepreneurs at heart ad will not be keen to be an employee (Institute of Waste Management Southern Africa, 2016)

Informal waste pickers integration requires interventions from all spheres of the government, private organisations, finance and technology (Chada, 2020). Therefore, the process for integration is slow and cannot be done at a glance (Department of Forestry, Fisheries and the Environment, 2020). The informal waste sector does not require any formal education nor documentation, anyone can operate and start trading for cash (Simatele *et al*., 2017). It is crucial that when integrating the informal waste sector municipalities and industries do not only consider integrating waste recovery and recycling, however, they should consider their way of work and trade (Schenck *et al.,* 2019). The City of Johannesburg officials identified challenges with integration of the informal waste sector which includes; insufficient funds allocations for work with reclaimers, mistrust between officials and informal waste pickers, waste pickers

registration, lack of knowledge and clarity on how to integrate informal waste pickers who are non-South African (Timm *et al.,* 2020). The informal waste sector has no information system, thus the sector lacks consistent information on their way of operation and the informal waste pickers information, which limits the formal sector to include them into their systems (Zon *et al*., 2020).

For integration of informal waste pickers to thrive it must meet informal waste pickers needs and this can only be achieved if they are involved from the planning phase throughout all the phases of the integration (Department of Forestry, Fisheries and the Environment, 2020). Informal waste pickers might be against integration if they feel that being integrated will subject them to labour laws and tax obligations as the informal waste sector is regarded as unreported work that is free from those aspects (Dawn, 2023). Individuals in the informal waste sector are difficult to identify through a formal process, they ae hesitant towards consultations, some of them are illiterate and cannot read and understand information, they lack confidence and they are solely dependent on the informal economy ad have no other skills to get employed in other sectors (WSP, 2018).

2.9. Summary of findings

Municipal solid waste management is still a global challenge to date (Yousafzai *et al.,* 2020). This because of the increasing amounts of waste being generated daily due to rapid population growth, urbanisation and economic development (Puppin de Oliveira, 2019; Munyai and Nunu, 2020; Phonchi-Thekiso *et al*., 2020; Zon *et al.,* 2020). Large amounts of waste are being referred to landfill sites and dumping site for final disposal and this threatens the health of the environment as well as the health of humans (Wynne *et al.,* 2020). With consideration to the above aspect, there is a need for municipalities to reconsider their perspective towards solid waste management and move from their current waste management system to a new model that deals with issues of climate change, resource exploitation, sustainable development and sanitary waste management (Puppin de Oliveira, 2019). Recycling alongside reduce and reuse (the 3R's) are

considered the best waste minimisation approaches to achieving the global zero waste goal (Hesran *et al.,* 2019).

Informal waste pickers are key contributors in the recycling industry as they are primary suppliers of valuable waste materials (Botello-Alvarez *et al*., 2018; Fuss *et al.,* 2021). Informal waste pickers do not only contribute to recycling, but they play a significant role in municipal solid waste management through waste management cost reduction, street cleaning, and diversion of waste from landfill (Botello-Alvarez *et al.,* 2018; Mwanza *et al.,* 2019; Gutberlet, 2021). Despite their contribution to resource conservation, town cleaning, solid waste management costs, and the circular economy, informal waste pickers are still not recognised and undermined by society (Tong *et al.,* 2021).

Informal waste pickers do not have any access to basic services, social stigma, limited financial resources, abuse and exploitation by officials, high susceptibility to international oscillation in the recycling market, political oppression as well as neglect by society (Hartmann, 2018). Apart from social challenges, informal waste pickers encounter occupational health and safety risks of getting injuries from sharp objects, animals and insects bites, musculoskeletal problems, ophthalmological and respiratory infections because of the unhygienic working conditions they operate in (Aparcana, 2017; Awasthi *et al.*, 2019). With recognition of their important role in municipal solid waste management, the need to improve their working conditions as well as their standard of living socially and economically, integrating the informal waste sector in municipal solid waste management has been identified as the best solution to the waste management problem (Tong *et al.,* 2021).

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1. Study area

The study was carried out in Limpopo Province within the Vhembe District Municipality. Vhembe District Municipality is located at the far north region of the Limpopo Province at Latitude 22.7696°S and Latitude 29.9741°E as indicated in figure 3.1 (Vhembe District Municipality Integrated Development Plan, 2021). The district shares boarders with Capricorn district from the Southwest region of the province, and on the Southeast region which shares boarders with Mopani District (Vhembe District Municipality Integrated Development Plan, 2021). Furthermore, Vhembe shares boarders with South African neighbouring countries; Zimbabwe and Botswana from the Northwest part and Mozambique through Kruger National Park (Vhembe District Municipality Integrated Development Plan, 2021).

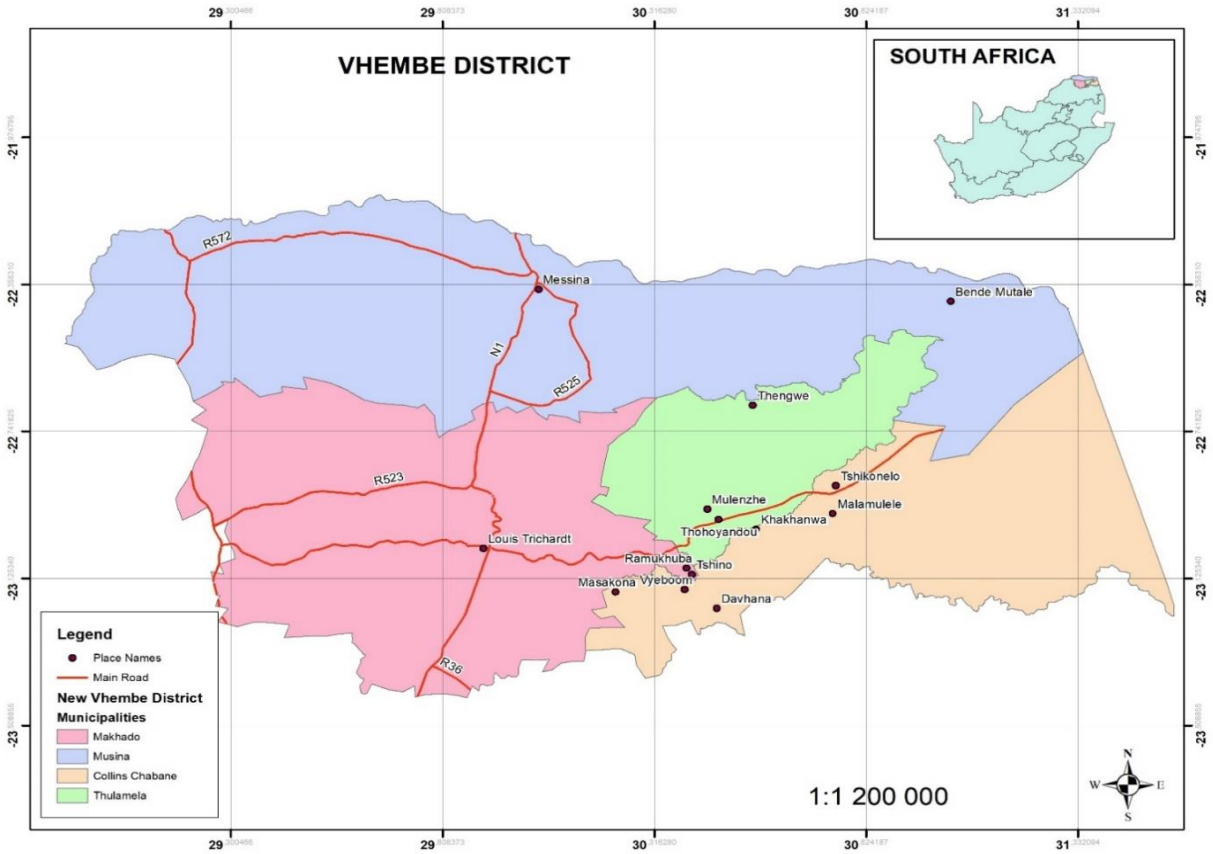


Figure 3.1: Map of the study area

Figure 3.2 shows that Vhembe District Municipality covers an area of 27 996, 148 km^2 of land and it is composed of four local municipalities namely, Musina Local Municipality which is located on the northern part of the district at 22°20'17'' S and 30°02'30'' E covering 11 297.41 km^2 of the district, Makhado Local Municipality located at the Southwestern part of the district at 23°00'00'' S and 29°45'00'' E covering 8 310.586 km^2 of the district, Collins Chabane Local Municipality located on the south-eastern part of the district at 22°35' S and 30°40' E covering 5 467.216 km of the district and Thulamela Local Municipality located at the centre of the district at 22°57' S and 30°29' E covering 2 893. 936 km^2 of the district (Collins Chabane Local Municipality Integrated Development Plan, 2021; Makhado Local Municipality Integrated Development Plan, 2021; Musina Local Municipality Integrated Development Plan, 2021, Thulamela Local Municipality Integrated Development Plan, 2021).

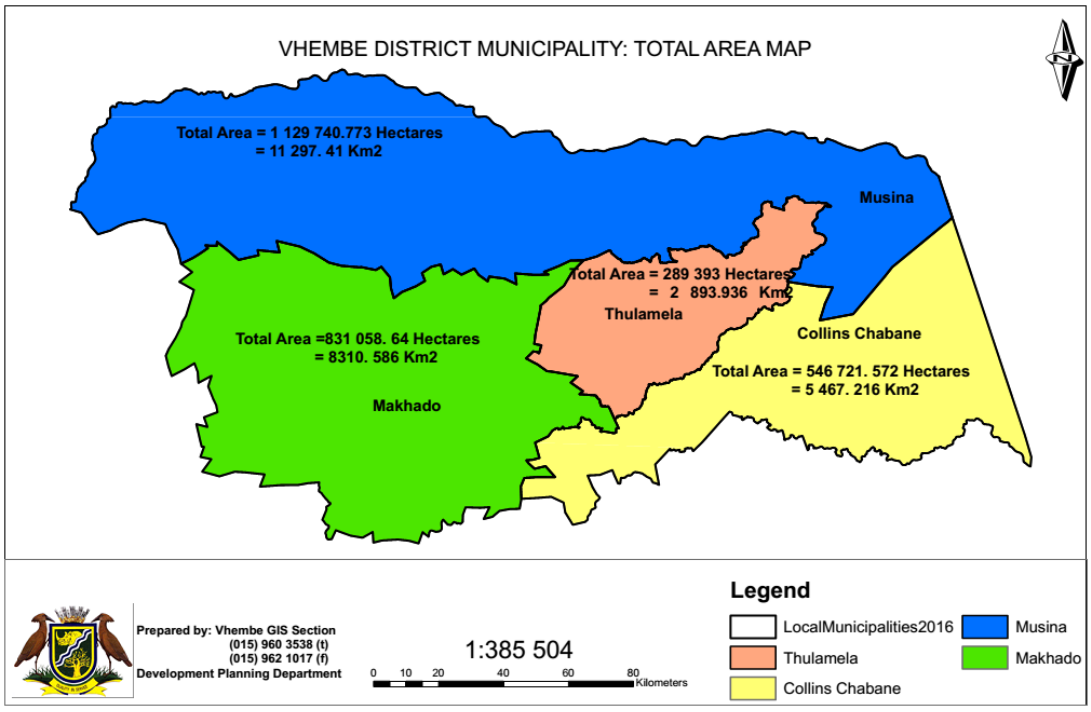


Figure 3.2: Vhembe District Municipality (Source: Vhembe District Municipality Integrated Development Plan, 2021)

Informal waste pickers within Vhembe District Municipality predominately operate within municipal landfill sites as well as in the Central Business Districts (CBD) of the four municipalities because waste generation is critically high in CBD's and landfilling is still the main approach to waste disposal within the district. Therefore, the study was conducted in Louis Trichardt Town, Musina Town, Thohoyandou Town and Malamulele shopping complex. The study further extended to Makhado, Thulamela and Musina landfill sites.

3.2. Demographic

3.2.1. Demographic profile of Vhembe District Municipality

3.2.1.1. Population of Vhembe District Municipality

Vhembe District municipality has a population of 1 393 948 individuals of which 497 237 is from Thulamela Local Municipality, 416 781 is from Makhado Local Municipality, 347 947 is from Collins Chabane Local Municipality and 132 009 is from Musina Local Municipality (Vhembe District Municipality Integrated Development Plan, 2021).

3.2.1.2. Gender and age

Table 3.1: Vhembe District Municipality population per age group

Municipality	0-14 years	15-34 years	35-64 years	65 years+
Vhembe	476 904	533 923	285 503	97 671
Thulamela	168 496	192 769	102 497	33 475
Makhado	141 373	153 293	89 158	32 957
Collins Chabane	126 835	129 019	66 016	26 104
Musina	40 200	58 842	27 832	5 135

(Source: Vhembe District Municipality Integrated Development Plan, 2021).

Table 3.1 shows that Vhembe District Municipality is dominated by youth (15-34 years), followed by children (0-14 years), then adults (35-64 years) and the lowest is the elderly (65+ years). This means that the district is mainly composed of the youth.

3.2.1.3. Ethnicity

Table 3.2: Vhembe District Municipality population per ethnicity

Population per ethnicity						
Municipality	**African**	**White**	**Coloured**	**Indian/Asian**	**Other**	**Total**
Vhembe	1 375 053	111 70	2 689	5 029	9	1 393 950
Makhado	406 543	7 024	1 308	1 843	9	416 727
Thulamela	493 780	229	749	2 479	-	497 237
Collins Chabane	347 109	271	294	301	-	347 975
Musina	127 621	3 645	337	406	-	132 009
NB: other refers to individuals who did not disclose their race						

(Source: Vhembe District Municipality Integrated Development Plan, 2021)

Table 3.2 indicates that the district is dominated by the African race population, followed by the white population then the Indian and the coloured population. This means that most of the study respondents are African population.

3.3. Research design

This study was both qualitative and quantitative thus it was conducted using the mixed method research design. Mixed method research is a research design which involves philosophical assumption that provides the guidelines for collection of data and analysis and the mixture of both qualitative and quantitative approaches throughout the research

process (Creswell, 2006). This study required information on quantities of waste received by municipal landfill sites, number of waste pickers in the district, and quantities of waste recycled per month in the district as well as population. The study also collected information that is qualitative such as occupational health and safety status of waste pickers.

Mixed method research design was best for this study because this design allowed the researcher to use all data collection tools, using both approaches, which provide more complete understanding of the research problem, accurate results than both qualitative and quantitative research designs alone (Mahmood, 2013; Creswell, 2014). Mixed methods research design allowed the researcher to use both words and numbers to convey results and findings to a wider audience. Limitations to mixed methods research design include time consumption, which requires more resources and costly, and it is difficult to validate data.

3.4. Case study selection

A case study is a detailed investigation of a contemporary case within a real-life context (Taylor, 2020). Case studies are useful when researchers do not fully understand the phenomenon and needs to obtain in-depths understanding of the event, project or organisation in its real-life setting (Crowe *et al.,* 2011). The researcher followed the case study approach because detailed information about the informal waste sector and their integration with the formal sector was required. Furthermore, the researcher needed to gather detailed information on socio-economic, environment and health aspects associated with waste pickers work in real-life.

The study followed an evaluative case study using a mixed method approach. An evaluative case study makes inquiries that focuses on the importance of a project or event (Taylor, 2020). Selection of a case study is dependent on the aim of the study, research access and the time invested on the research (Taylor, 2020). The aim of this study was to evaluate the role of the informal waste sector in municipal solid waste management

and it was based in an area that the researcher had little knowledge of the study area, therefore, they had access to participants and institutions.

The criteria followed when selecting this case study;

- The researcher carefully formulated research questions based on previous literature.
- Clarify the nature of the study and the time that will be covered by the case study.
- Identify common groups, locations, or organisations.
- Identify gaps in previous studies.
- Study the case in two or more points over time to focus on changes.

3.5. Study population and sampling

This study was interested in informal waste pickers and the role they play in municipal solid waste management. Sampling is a method by selecting participants that will represent a population under study (Turner, 2020). Convenient sampling was used to select waste pickers to respond to questionnaires. This refers to non-probability sampling which entails carefully selecting subjects because of being easily accessible (Turner, 2020). Waste pickers that were found at the landfill sites and streets during a visit were considered and involved in the study.

The total number of waste pickers recorded in 2019 within Vhembe District Municipality was 320 of which 69 of these waste pickers are street waste pickers and 251 are landfill reclaimers (Mathako, 2019). Waste pickers below the age of 18 were left out because of their inability to make informed decisions according to the South African Law. A convenience sample is a group of individuals representing a certain population, which are selected based on their availability (Elmusharaf, 2012). This method was the best for this study because waste pickers are always on the move, unknown, unregistered and very difficult to find. Thus, this sampling method helped in saving the researcher time, money, and effort.

The sample size of the landfill waste pickers was 72.

The sample size of the street waste pickers was 18.

The sample size was determined using the following equation to ensure that the sample size covers the population of the waste pickers in the area.

Landfill waste pickers

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{251}{1+251(10\%)^2} = 72$$

Street waste pickers

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{69}{1+251(20\%)^2} = 18$$

Where;

n = sample size

N = Population Size

e = margin of error

The study interviewed the actual number of respondents determined by the formula above for the sample size. Table 3.3 below indicates the total number of respondents that participated in the study. Ninety-four respondents participated in the study this included 18 street waste pickers, 72 dumpsite waste pickers, 4 waste management managers and 10 directors from buyback centres.

Table 3.3: Percentage of respondents

Respondent	No	Percentage
Street waste pickers	18	16.92%
Landfill site reclaimers	72	67.68%
Waste management managers	4	3.76%
Buyback centre's directors	10	9.4%
Total number of respondents	94	100%

3.6. Data collection

3.6.1. Primary data

3.6.1.1. Closed-ended questionnaires

This study administered 80 closed-ended questionnaires (see appendix A) to collect data from informal waste pickers regarding their knowledge of recycling rates and the recycling processes. The questionnaires were also used to gain understanding of the following:

- Demographic and social profile of respondents.
- Educational levels of the respondents.
- Respondents' employment status; and
- Attitude waste pickers receive from the public.
- The activities carried out by informal waste pickers.
- Challenges the waste pickers experience as well as the type of support the formal sector provides to the informal waste sector.

3.6.1.2. Structured interviews

Structured on-line interviews were used on 1 of each of the 4 municipalities' waste management manager to acquire information on the support and strategies they use to integrate the informal waste sector in municipal solid waste management (see appendix B). Structured interviews were also used to interview directors from 10 buyback centres are within the district of which 5 were face-to-face interviews and the other 5 were conducted on-line (see appendix C) to gain knowledge on recycling rates, support they offer to informal waste pickers and to identify exploitation and fairness.

Structured interviews are the best form of interviews suitable for the selected respondents because they ask different respondents the same questions and enable the researcher to gain understanding from the answers and compare and analyse them, which in turn will ensure or provide validity and reliability of the provided information (Lindisfarne Press, 2001). Structured interviews are useful for gathering demographics, understanding user knowledge, comparing results across groups on a fixed set of responses as well as gathering attitude and opinion data of the different respondents (Wilson, 2014). Therefore, this method was useful in this study because the study aimed to gain understanding about a group of individuals who are of different age, background, and status. Therefore, structured interviews provided response based on their characteristics.

Firstly, the researcher sent out letters (see appendix F) to municipalities seeking permission to conduct a research study and was granted permission from all the local municipalities (see appendix G). Interviews with municipality officials elaborates information on policies and strategies that governs waste management within Makhado, Musina, Thulamela and Collins Chabane Local Municipalities. They further elaborate information on integration and support informal waste pickers receive from the local government. Interviews with buyback centres (see appendix C) were used on to provide insight on the most dominant type of recyclable Vhembe District Recycles, recycling rates, level of exploitation, and major suppliers of valuable wastes within the district. The researcher sent an email of the questionnaire together with a consent form and called the

municipality to discuss the interview questionnaire, the municipality official responded and filled the consent form and send back to the researcher. With the buyback centres, the researcher visited the buyback centres give them the consent form and a chance to read it and sign it, then interviewed them on site.

3.6.1.3. Field observations

The researcher also employed field observation (see appendix D) as a primary data collection method. Field observation can be defined as method in which the researchers observe the ongoing behaviour of a phenomenon in study and then record the results for analysis (Appasamy and Nelliyat 2007). In this study, the researcher visited all four local municipalities (Thulamela, Makhado, Collins Chabane and Musina) to observe how waste pickers conduct their everyday duties as well the challenges they are faced with within their scope of work. The information gathered from observation assisted the researcher to gain knowledge and understanding of the working procedures, frequency as well as conditions of the workplace the information waste pickers operate on. Areas observed include landfill sites and central business districts from each municipality.

3.6.1.4. Online data collection

The researcher employed online data collection method to collect data from waste management authorities regarding their view of informal waste pickers, the support they offer to informal waste pickers and the strategies municipalities have or plan to implement to integrate informal waste pickers into their waste management system. Online data collection allows information to be captured immediately, which makes it easy and quick to do data analysis electronically (Schmitz, 2012). Online data collection allows the researcher to cover a large geographical area without incurring any travelling and accommodation costs (Schmitz, 2012). The researcher selected participants non-randomly depending on whether they could use and have access to the internet. The researcher used the following online data collection tools.

- Phone Calls – phone calls were administered to find out whether the participants will be able to participate online as well as to communicate on questions that needed clarity.
- Surveys - A user-friendly online survey was developed, and participants were provided with a link to the survey. The adopted survey consisted of short and simple questions, mostly multiple questions. The recorded information is not insensitive and will not be accessible to the public.
- Emails – emails were used to share the link to the survey as well as to gather copies of documents needed for secondary data collection for document analysis purposes.

3.6.2. Secondary data

3.6.2.1. Document analysis – municipal waste policy, integrated waste management plan and procedure manual

Data from municipal waste policy, integrated waste management plan and procedure manual was reviewed and analysed to identify the municipal's view on informal waste pickers and whether the municipality recognise the role of the informal waste pickers.

3.6.2.2. Document analysis – records from landfill sites weighbridges

The researcher reviewed weighbridge records for a period of 3 months to get information on the quantity of waste the landfill receives which assisted the researcher to gain knowledge of quantities of waste the district generates. Three months' record enabled the researcher to identify variation and see if there is an average waste quantity.

3.6.2.3. Document analysis – records from buy-back centres

The researcher requested records for a period of 3 months of recyclable received from waste pickers from buy-back centres within the district. Information from these records allowed the researcher to gain knowledge on the types of recyclables Vhembe informal waste pickers highly focus on and gain knowledge on the quantities waste that are diverged from landfilling per month.

Document analysis as a systematic procedure of collection by gathering data, by evaluating both printed and electronic documents (Bowen, 2009). Furthermore, documents contain information that were collected and recorded without the researchers' involvement (Bowen, 2009). Therefore, document analysis was useful to gain and understand knowledge on the informal waste sector that was recorded, that way the researcher was able to identify the role played by the informal sector, the quantities they reduce and the way in which they cooperate with the municipalities if recorded. Documents are ready-made sources of secondary data, their information is valid, they provide information that can be used for statistical purpose and comparison (Bowen, 2009).

3.7. Data analysis

Data analysis is a process of giving order, structure and meaning to mass collected data (Vosloo, 2014). In mixed method analysis, qualitative methods are used to analyse qualitative data and quantitative methods are used to analyse quantitative data (Combs, 2011). Therefore, data collected through closed-ended questionnaires in this study was analysed using the Statistical Package for Social Sciences (SPSS Version 25.0). Data collected through structured interviews with municipal officials and waste pickers was analysed following the eight steps proposed by Tesch in data analysis (De Vos and Schulze, 2002).

Step 1: The researcher carefully went through the entire transcript to obtain a sense of the whole thing and wrote down some ideas of the study.
Step 2: The researcher selected one interview and thoroughly read it to get meaning in the information and wrote down the thoughts coming into mind.
Step 3: After going through the records, the researcher made a list of topics, then group the same topics together.
Step 4: The topics were abbreviated as codes, and then applied next to the segments of the transcript. This assisted the researcher to see whether new topics or codes emerges.

Step 5: The researcher found the most descriptive word for the topics and converted them into categories.

Step 6: A decision was made on the abbreviations of each category and the codes were arranged alphabetically.

Step 7: The data material belonging to each category was grouped together and preliminary analysis was performed.

Step 8: The researcher recodes existing material/data if necessary.

Data collected through observation about waste pickers duties, procedures, challenges and awareness of occupational health and safety risks was compiled and presented in a form of a summary. Tables and graphs were used to present results from the study.

3.8. Data collection methods and data analysis techniques

Tables 3.4 and 3.5 outline each of the study objective's sampling and data collection methods, and how the data was analysed.

Table 3.4: Data collection and data analysis techniques

Objectives	Sampling method	Method justification	Data collection method	Data analysis
To assess the knowledge, attitude and practices of waste pickers in solid waste management	Convenience-sampling	Convenience-sampling was selected for this objective because the study required a sample (random waste pickers on site) of the population that is readily available and can be accessed without difficulties (Golzar *et al.,* 2022).	Interviews, field observations, questionnaires, and document review	Statistical Package for Social Sciences (SPSS Version 25.0)
To identify the socio-economic, health and safety, and environmental challenges and opportunities associated with the involvement of informal waste pickers in municipal solid waste management	Convenience-sampling	Convenience-sampling was selected because the method allows the researcher to generalise research findings and have very low levels of biasness (Koerber and McMichael, 2008)	Interviews, field observations, questionnaires, and document review	Statistical Package for Social Sciences (SPSS Version 25.0)
To evaluate the support informal waste pickers, receive from the formal sector (Government and Private sector)	Purposive sampling	Purposive sampling was selected for this objective because only a few specific formal sector individuals held important and meaningful information that would help to achieve this objective (Campbell *et al.,* 2020)	Interviews and document reviews	Tesch's Approach

To evaluate municipality strategies of integrating the informal waste sector into municipal solid waste management system	Purposive sampling	The study employed purposive sampling because the required information to achieve this objective was specific and crucial and could only be obtained from specific individuals (Campbell *et al.,* 2020)	Interviews and document reviews	Tesch's Approach
To assess possible strategies that can be adopted to improve the informal waste sector	Convenience-sampling	The study required information that is honest and non-bias from random waste pickers who are available on site. Therefore, convenience was selected as it allows the researcher to select available and accessible individuals who are available at that time and who will provide honest information (Rahi, 2017)	Interviews, field observation, questionnaires, and document analysis	Statistical Package for Social Sciences (SPSS Version 25.0)

Table 3.5: Data analysis model and variables

Objectives	Methodology	Methodology justification	Data analysis model	Variables
To assess the knowledge, attitude and practices of	Mixed-methods	To achieve this objective the researcher had to combine both quantitative	Statistical Package for Social Sciences	Waste pickers' social stigma, type of waste recovered most, why waste pickers practice

waste pickers in solid waste management		and qualitative elements, hence, mixed-methods (Schoonenboom and Johnson, 2017)	(SPSS Version 25.0)	waste recovery, where do they refer their recyclables, how many tons do they collect per day/month and where is their preferred place of work
To identify the socio-economic ,health and safety, and environmental challenges and opportunities associated with the involvement of informal waste pickers in municipal solid waste management	Mixed-methods	This objective also required both qualitative and quantitative data and mixed methods were employed to strengthen and validate the findings (Schoonenboom and Johnson, 2017)	Statistical Package for Social Sciences (SPSS Version 25.0)	Public behaviour, Recycling rates, exploitation, working hours, profit, occupational health and safety, water and sanitation and Personal Protective Equipment
To evaluate the support informal waste pickers, receive from the formal sector (Government and Private sector)	Qualitative	This method was selected because the researcher intended to collect behavioural and interactional attributes from municipalities from a respondent's perspective (Mcleod, 2023).	Tesch's Approach	Funding options, training. Access to waste management facilities by waste pickers and provision of information regarding assistance by the government
To evaluate municipality	Qualitative	This method was selected because the researcher	Tesch's Approach	Recyclers forum formed and supported by the municipality,

strategies of integrating the informal waste sector into municipal solid waste management system		intended to collect behavioural and interactional attributes from municipalities from a respondent's perspective (Mcleod, 2023).		recognition by the municipality, access to municipal waste facilities, involvement of the informal waste pickers in the Integrated Development Plan (IDP) and the Integrated Waste Management Plan (IWMP)
To assess possible strategies that can be adopted to improve the informal waste sector	Qualitative	The study employed qualitative research methodology for this objective because it required social and psychological information from the participants (Demuth and Mey, 2015)	Statistical Package for Social Sciences (SPSS Version 25.0)	Room for improvement within the informal waste sector, essential needs of waste pickers, health issues, access to drinkable water and clan toilets as well as what can be done for both the formal and informal waste sector to cooperate and yet be happy with their working conditions

3.9. Limitations and assumptions of the methodology

Having employed research methodology the researcher experienced limitations and draw up assumptions so that other researchers would be able to learn what challenges they can encounter during data collection phase and they could improve or place measures to better achieve their objectives earlier in the research project.

Data collection through interviews and administering questionnaires was challenging because it depended on the participants. The researcher encountered challenges firstly when collecting data from informal waste pickers in Malamulele Town. The waste pickers in Malamulele Town were difficult to find and scattered far apart so the whole process was time consuming and costly. This was also because the Municipality's Landfill Site has not commenced with operation thus, many of the town's waste pickers were at Thulamela landfill Site were the municipality is currently referring their waste. The researcher had to re-visit the town 3 times to be able to have a sample that can represent a population.

The researcher then moved to Thulamela Landfill Site where some of the waste pickers were hesitant to participate because of past experiences with other researchers who interviewed them but never came back to them with feedback and that they asked them questions that sounded like they wanted to help them but nothing has happened since the interviews. Another challenge with those who participated was that they had to stop working while completing the forms, however when the truck came in they will drop the form and run to recover more valuables, this compelled the researcher to administer the questionnaire in a rush.

Waste pickers from Makhado Landfill Site were cooperative, although they worked in shifts. Some of them start to work from 6am to 12pm, then the following shift will start from 12pm till 6pm, therefore, the researcher had to wait and also to visit the site several times to collect the data. The other challenge was that most of the waste pickers could not complete the forms on their own, the researcher had to help them throughout the completion of the whole form.

The site with more challenges was Musina Landfill Site where waste pickers were mostly foreign nationals who felt their job was being threatened and if they complete the forms they are agreeing to them being chased out of the landfill. The researcher was alerted that the site is a dangerous place as waste pickers are always fighting for valuables, some turn to mugging others and the researcher might be caught in between them fighting. Some of those who participated were generalising their answers to what the previous participant said, some will even take their forms to the previous and other participants and agree on answering the same answer. There are participants who felt like the researcher was there as an inspector and were threatened and felt like if they answer truthfully, they will be stopped from working which made them not want to take part of the study. There are those who participated only as a cry for help, their responses were leaned to reporting the municipality's abusive ways of treating them rather than being honest and truthful, they exaggerated their response to make the municipality and private companies look bad. One participant said "*truck drivers recover the best valuables and then allow us to recover later after them*"

3.10. Conclusion

This chapter clarified research methods, data collection tools and data analysis that were employed to execute this study. The chapter illustrates the relationship between the rationale of the study, the problem statement, and the aims and objectives. Furthermore, it explained the research methods and analysis that were employed to address each objective. Sample size, population size, and categories of participants were also detailed in this chapter. The following chapter will present results and discussions of the study.

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter will evaluate the role played by the informal waste sector within municipal solid waste management system in Vhembe District Municipality, covering all four local municipalities (i.e. Makhado, Thulamela, Musina and Collins Chabane) within the district. The chapter further evaluate the socio-economic factors associated with informal waste picking and health impacts. The chapter further makes comparison on the attitudes dumpsite waste pickers and street and town waste pickers receive from society, the rebates they receive from the different recycling dealers and buyback centres, recycling rates each municipality make as well as the educational and employment status of the waste pickers. Moreover, this chapter also interrogates the relationship between the informal waste pickers and the local government.

4.2. Results

In this chapter, data was analysed and research findings are presented. This chapter presents a demographic profile, educational background, and socio-economic status of the respondents. Furthermore, it presents waste pickers' activities, occupational health and safety challenges encountered by waste pickers, support the waste pickers receives from the formal sector as well as strategies that the municipality has planned for integration of informal waste pickers into municipal solid waste management system. The chapter also provides information from 10 buyback centres as well as municipal solid waste management system within the study area which also includes the challenges they encounter in their system. The chapter also presents discussion of the results from the study as well as comparing or relating them to previous literature related to the current study.

4.2.1 Demographic characteristics of informal waste pickers

Eighty closed-ended questionnaires were distributed and administered to participants within Vhembe District Municipality. The participants were from Makhado, Thulamela,

Musina and Collins Chabane local Municipalities. The researcher administered these questionnaires within Louis Trichardt, Malamulele, Thohoyandou and Musina Town as well as within Musina, Makhado and Thulamela landfill sites.

4.2.1.1 Age of respondents

Figure 4.1 indicates the age groups of the respondents. A total number of 80 respondents participated in this study. Seventeen percent of the respondents were aged between 18-29, while 49% of the respondents were aged between 30-39 while the remaining 34% were aged 40 years and above. Age group 30-39 resulted with the highest number of participants (49%), followed by 40 years and above (34%) and then lastly age group 18-29 (17%).

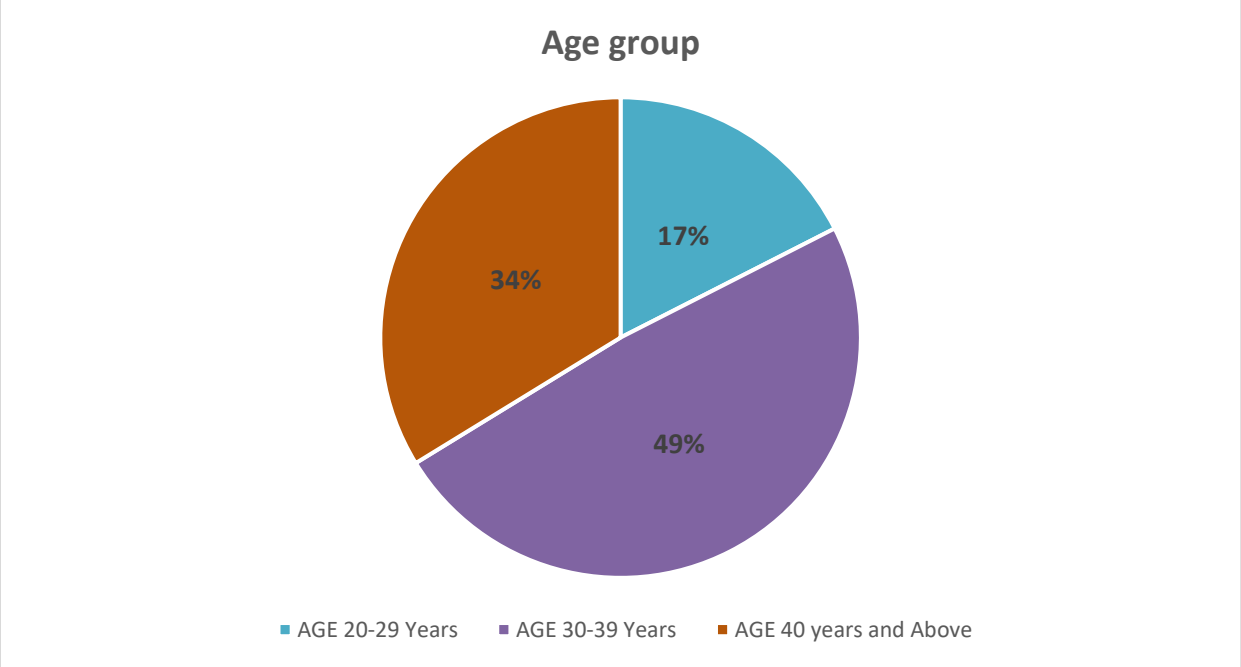


Figure 4.1: Ages of the respondent

4.2.1.2 Gender

Out of the 80 respondents that participated in this study, 29% were males while 71% were female as shown in figure 4.2. Females had the highest figure of participants as compared to males.

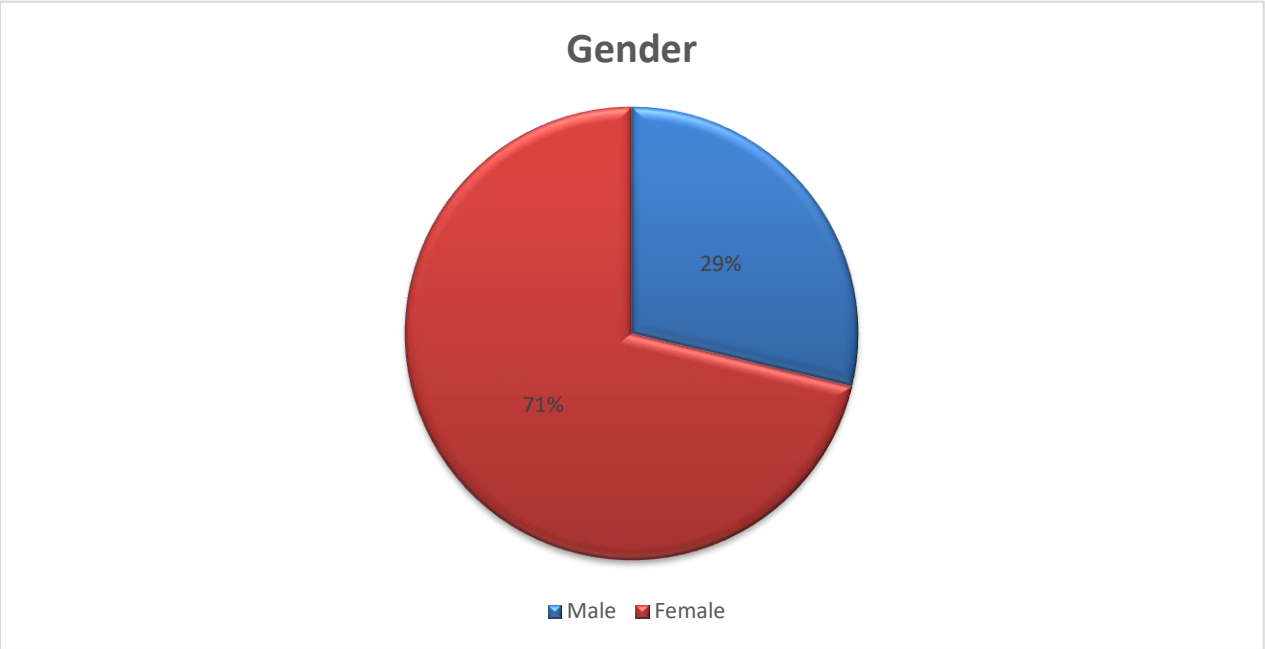


Figure 4.2: Gender of the respondents

4.2.1.3 Marital status and size of family of the respondents

This study also investigated the marital status of the participants, and they were grouped as single, married, divorced, widowed and separated. Forty five percent of the respondents are married who dominates the informal waste sector, followed by 27% of participants who are single, then 20% who are widowed, 5% are separated and 3% are divorced as indicated in figure 4.3.

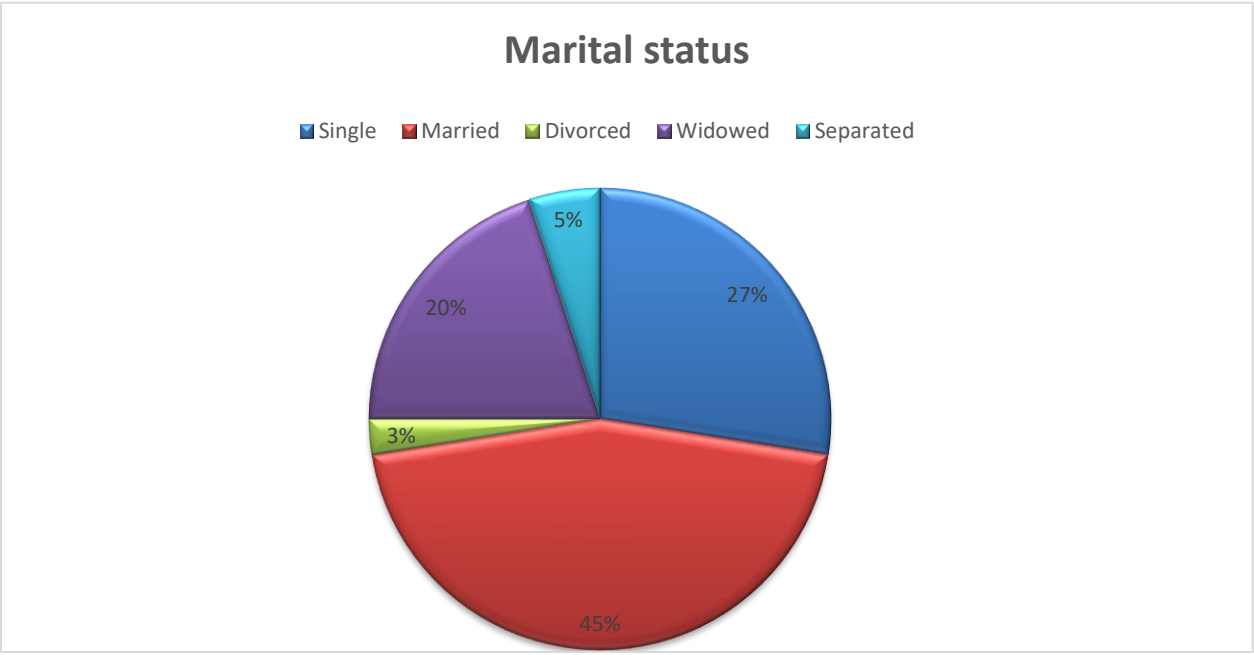


Figure 4.3: Marital status of the respondents

Furthermore, this study also investigated the size of the participants' family as shown in figure 4.4. Forty six percent of the respondents have a household of between 3-4 family members, 36% have 5 and above family members, 10% have 1-2 family members and 8% do not have a family.

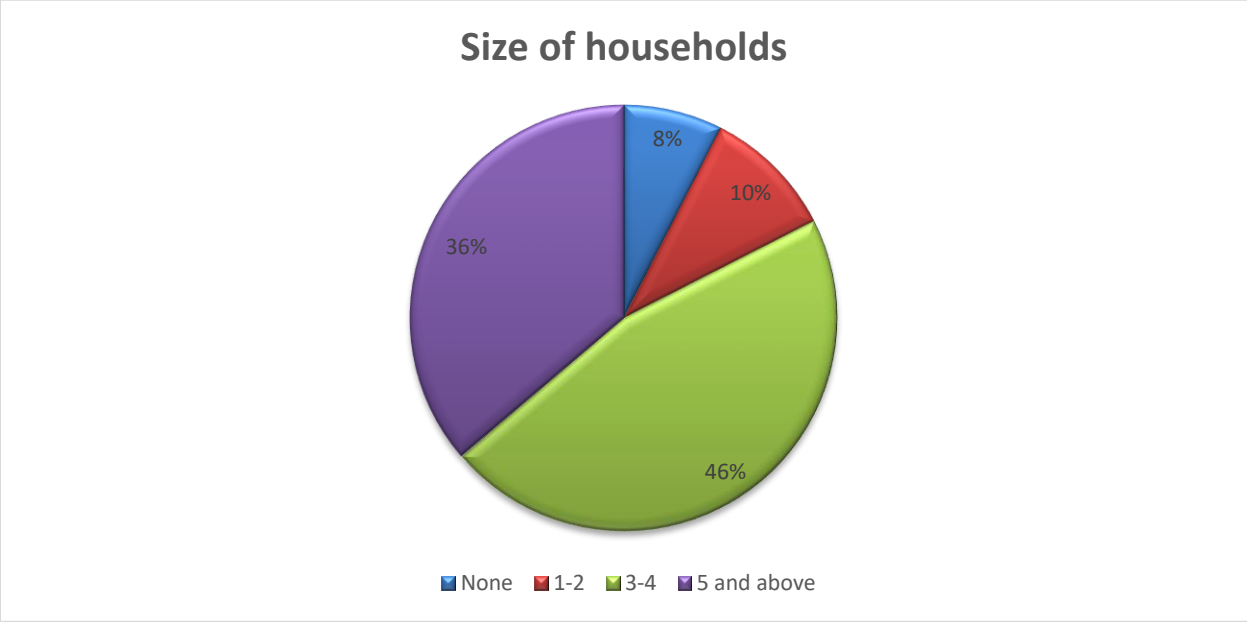


Figure 4.4: Size of household of respondents

4.2.1.4 Education background

Table 4.1 reflects educational background of the participants. This includes information regarding whether they attended school or not, the highest grade passed and tertiary education for those who made it to tertiary. Results for this study showed that 60% of the respondents attended some form of formal school, while the remaining 40% never went to any school. From those who attended school, 38% of the overall number of respondents fell in the Grade 10-12 group, 20% fell in the Grade 6-9 group, and 2% fell in the Grade 1-5 group while the remaining 40% is never attended school. Results pertaining tertiary education showed that 11% of the respondents obtained some form of certificate, while 15% have a Diploma and only 2% of the overall sample got a degree or a B-Tech leaving out 72% without a tertiary education including those who never attended school.

Table 4.1: Educational background of respondents

School Attendance		Highest Grade Passed			Tertiary Education		
Yes	**No**	**1 - 5**	**6 - 9**	**10 -12**	**Cert**	**Dip**	**Deg/BTech**
48	32	2	16	30	9	12	2
60%	40%	2%	20%	38%	11%	15%	3%

4.2.2 Socio-economic status of the waste pickers

Table 4.2 illustrates that 70% of the respondents are unemployed, while 24% are self-employed, followed by 4% who have retired and 2% who are formally employed. Furthermore, of these respondents, 69% have work experience of between 0 and 1 year, followed by 15% of the respondents who have 10 years and above of work experience, then 11% who have between 6-9 years' work experience and 5% has an experience of between 2-5 years. The results further showed that 87% of the respondents were never previous employed, 5% were previously employed as drivers, 5% were previously employed as tellers and call centre agents, while the remaining 3% were previously employed as salespersons. Eleven percent of respondents indicated that they do not have any other source of income, while 54% of the respondents get other income from social grants and 35% get other income from conducting odd jobs. Together their main source of income mixed with other source of income. 5% of the respondents indicated that monthly they have an income of between R0.00 – R400.00, 11% get a monthly income of between R500.00 – R1200.00, 25% get a monthly income of between R1300.00 – R2500.00 and the remaining 59% of the respondents get a monthly income of R2600 and above. Of all the respondents, 1% indicated that they are content and satisfied with their monthly income, while the remaining 99% indicated that their monthly income is not satisfactory.

Table 4.2: Socio economic status of the respondents

Characteristics	Frequency	Percentage
Current employment status		
Employed	2	2%
Self-Employed	19	24%
Retired	3	4%
Unemployed	56	70%
Level of experience		
1 year and Below	55	69%
2-5 years	4	5%
6-9 years	9	11%
10 years and above	12	15%
Previous employment		
Never Employed	70	87%
Salesperson	2	3%
Driver	4	5%
Other	4	5%
Other source of income		
Social Grants	44	54%
Odd Jobs	29	35%
Allowance	0	0%
None	9	11%
Monthly income level		
R00-R400	4	5%
R500-R1200	9	11%
R1300-R2500	20	25%
R2600 and above	47	59%
Monthly income satisfaction		
Yes	1	1%
No	79	99%

4.2.3 Informal waste pickers activities

4.2.3.1 Description of the informal waste pickers

Table 4.3 indicates the description of the informal waste pickers within Vhembe District Municipality. The results from this study indicated that 75% of the respondents are full-time waste pickers, whereas 25% are part-time waste pickers. Furthermore, the study considered the type of waste pickers and the results revealed that 20% were street waste pickers and 80% were reclaimers / dumpsite waste pickers. None of the respondents were itinerant waste buyers or any other form of waste picker. Considering the experience or years the respondents have in informal waste picking, the results revealed that 41% have between 11-15 years, 21% have between 6-10 years, 15% have 16 years and above of experience, and 13% have between 0-5 years' experience in informal waste picking. Regarding their preferred area of work, 67% of the respondents indicated that they prefer working at the landfill site, 20% prefer roaming around the streets of the CBD, 3% prefer going around in urban areas, while 10% prefer working with a transfer station and none prefer working within rural areas.

Table 4.3: Description of the informal waste pickers

Characteristics	Frequency	Percentage
Full/part-time waste picker?		
Full-time	60	75%
Part-time	20	25%
Type of waste picker		
Itinerant Waste Buyer	0	0%
Street Waste-Picker	18	20%
Reclaimer/Dumpsite Waste Picker	72	80%
Other	0	0%
Reason for waste picking		
Survival	80	100%
Environmental Protection	0	0%

Other	0	0%
Experience in waste picking		
0-5 Years	10	13%
6-10 Years	25	21%
11-15 Years	33	41%
16 Years and above	12	15%
Preferred area of work		
CBD	16	20%
Landfill	54	67%
Rural	0	0%
Urban	2	3%
Transfer Station	8	10%

4.2.3.2 Types of recyclables collected / recovered by informal waste pickers in Vhembe District Municipality

Figure 4.5 indicates types of waste or recyclables collected / recovered by the respondents. The results from this study indicated that respondents do not recover only 1 type of recyclables but various recyclables. Six percent of the respondents collects Metal, Glass, Paper, Aluminium, Plastic (PET) and Carton (Met.Gl.Pap.Al.PET.Car), 6% collects Paper, Aluminium, Plastic (PET) and Carton (Pap.Al.PET.Car), 8% collects Metal, Paper, Aluminium, and Plastic (PET) (Met.Pap.Al.PET), 11% collects Metal, Aluminium and Plastic (Met.Al.PET), 16% collects Glass, Paper, Aluminium and Plastic (Gl.Pap.Al.PET), 22% collects Aluminium, Paper and Plastic (PET) (Al.Pap.PET), and 31% of the respondents collects Metal, Glass, Paper, Aluminium and Plastic (PET) (Met.Gl.Pap.Al.PET).

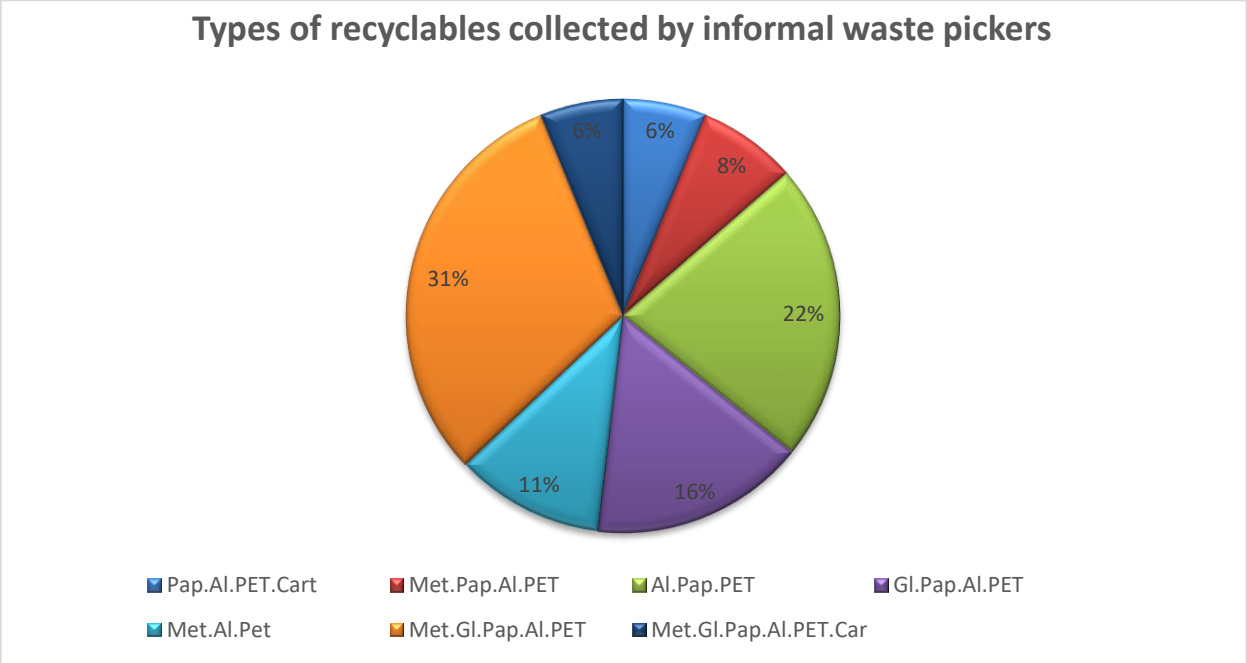


Figure 4.5: The type of waste/ recyclables collected / recovered by informal waste pickers

Figure 4.6 shows boxes and different types of plastic (PET) stored by an informal waste picker. Informal waste pickers within Makhado Landfill Site recover valuable waste from disposal cell sort and store them in a recycling shelter constructed for recycling purposes by the municipality. As the municipality has a panel of service providers that come regularly to the landfill to trade cash for recyclables, the informal waste pickers therefore separate the waste and store them separately in bulk bags and wait for the service providers to come and trade with them. The service provider comes with their scale, measure the amount of recyclables and pay the respectful informal waste picker as per their charging rate. The respondents indicated that they collect from 1 kg up to 10 kg of recyclables per day depending on the types of recyclables. The municipality also measures the amount of waste diverted from the landfill through measuring waste that is taken by the service providers out of the landfill. This enables the municipality to know the recycling rate it diverts waste from the landfill.

Figure 4.6: Stored recyclables waiting for scaling and trading at Makhado Landfill site

4.2.3.3 Preferred recyclables trading centres

Figure 4.7 illustrates where informal waste pickers take their recyclables after sorting for trading. Five percent of the respondents trade their recyclables with local buyback centres, whereas 20% trade their recyclables with recycling dealers. However, 75% of the respondents which is the highest indicated that they trade with both Buyback Centres and Recycling Dealers.

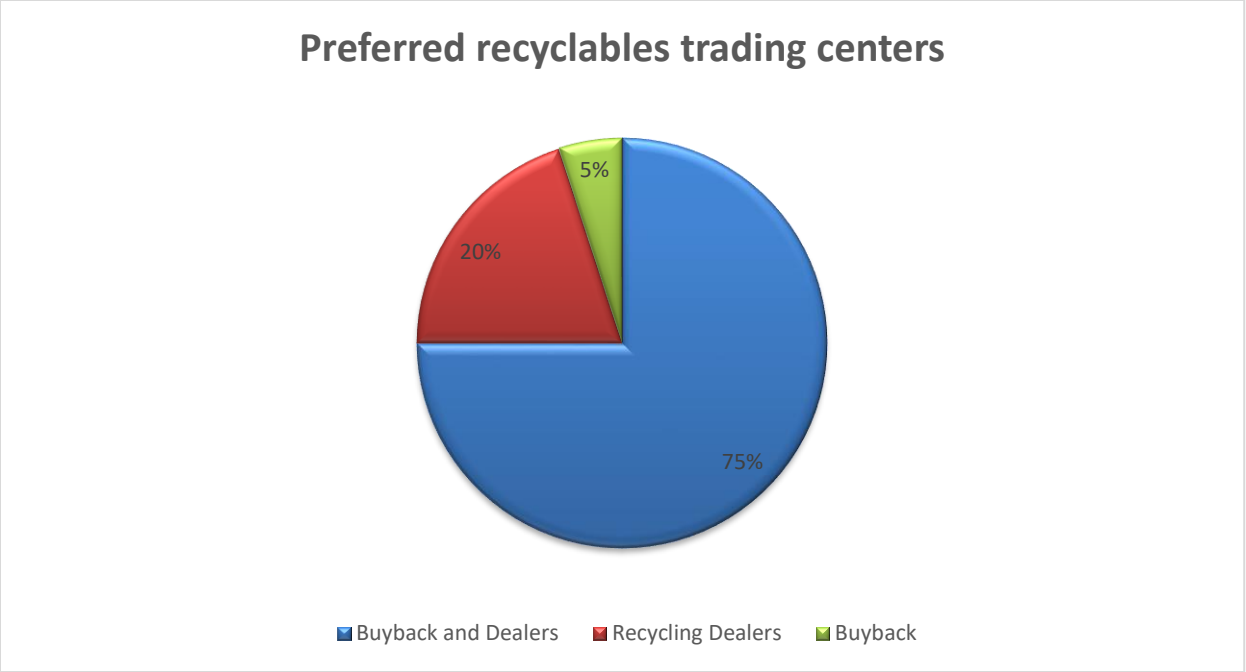


Figure 4.7: Informal waste pickers preferred recyclables trading centres

4.2.3.4 Recyclables rebates per kilogram (Kg)

The results from this study revealed that informal waste pickers get different rebates depending on who they trade their recyclables with. Furthermore, it was identified that the rebates sometimes vary from what has been stipulated by the dealer or buyback centre due to the demand of the recyclables by major recycling companies. But because of the lack of resources and transport, informal waste pickers must resort to whoever comes first to buy their recyclables, especially dumpsite waste pickers. Figure 4.8 indicates that recyclables do not have a fixed trading price in Vhembe District as the results showed that metal is traded at R10, R12, 13, and R14, glass goes for R0.20, R0.35, R0.40, paper including boxes goes for R1.00, R0.80, R1.20, R0.75, R0.50, R1.10, aluminium goes for R8, R10, R13, R14, plastic goes for R1.20, R1.00, R1.60, R1.80, R1.50, R3.00, R2.70, and carton goes for R0.40, R0.60, R0.75.

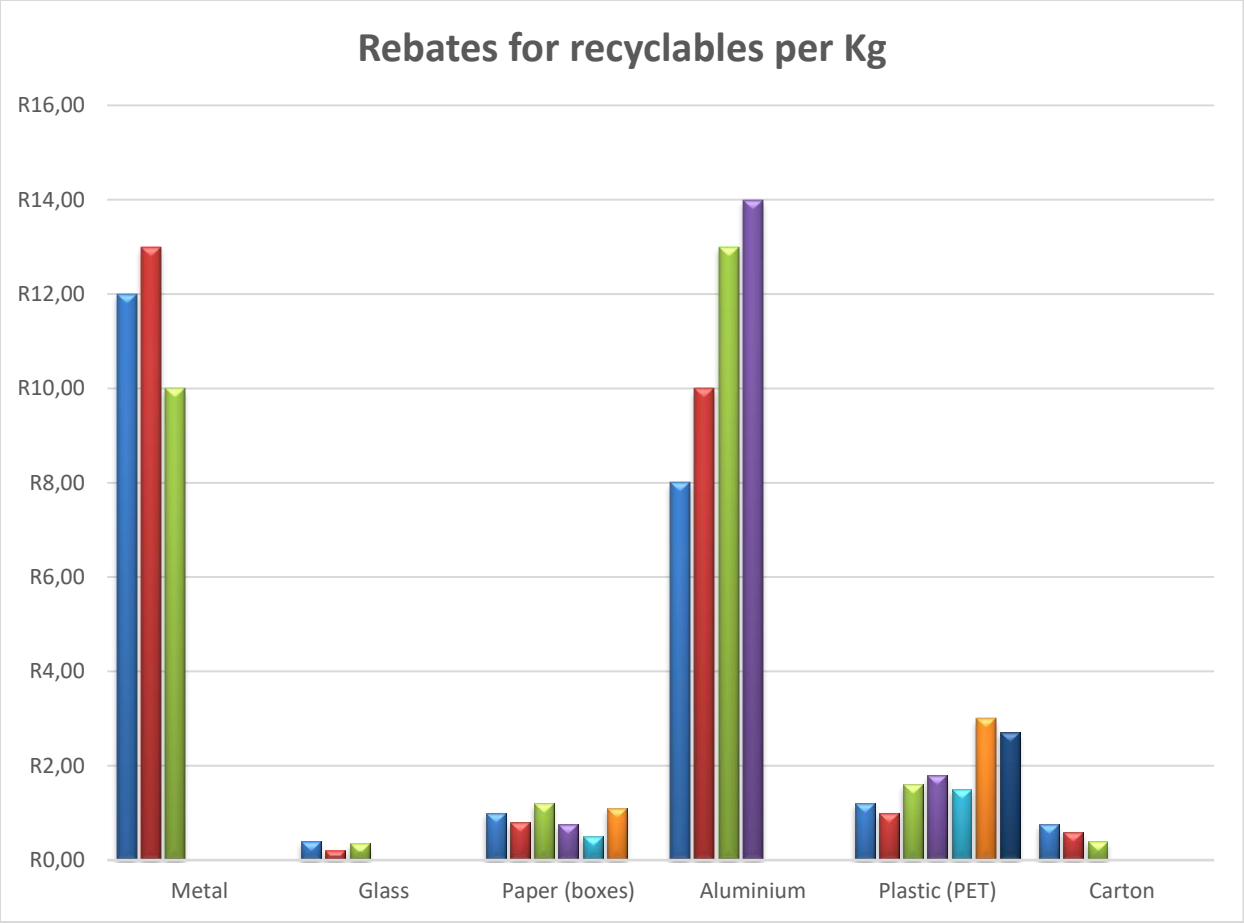


Figure 4.8: Different rebates for recyclables per Kg

4.2.3.5 Distance travelled to work, monthly expenditure and family support

Table 4.4 illustrates the distance respondents travel when going to work, their monthly expenditure with relations to their work, family members that assist with their work and how they assist them. As indicated in table 4.4, 29% of the respondents travel between 0-10 km, 64% travel between 11-20 km, and the remaining 7% travel between 21-30 km to work. The results further showed that 35% and 65% of the respondents have a monthly travel expenditure of between 0-R250 and R250-R500 respectively. These monthly expenditure covers transport and food only, it excludes costs they incur during transportation of recyclables to buy back centres, medical treatment costs and other operational costs.

As indicated in table 4.4, 56% of the respondents receive some form of assistance from their family members wherein in that 56%; 39% receive assistance from their kids, 4% receive assistance from their siblings and 13% receive assistance from their spouses. Furthermore, from the respondents that receive assistance from family members, 96% which is 53% of the overall participants receive assistance through waste picking, and 4% which is 3% of the overall participants receive it through financial support.

Table 4.4: Distance travelled to work, monthly expenditure and family support of the respondents

Characteristics	Frequency	Percentage
Distance travelled to work:		
0-10 km	23	29%
11-20 km	51	64%
21-30 km	6	7%
31 km and above	0	0%
Monthly work expenditure:		
0-R250	28	35%
R250-R500	52	65%
R500-R1000	0	0%
R1000 and above	0	0%
Family member support:		
Kids	31	39%
Siblings	3	4%
Spouse	10	13%
Form of support from family:		
Waste Picking	43	53%
Financial	2	3%
Other	0	0%

4.2.4 Operational challenges encountered by informal waste pickers within Vhembe District Municipality

Table 4.5 illustrates operational challenges encountered by the respondents while they are on duty. The results from this study revealed that all respondents encounter social stigma, exploitation, harassment, financial challenges and lack of resources. Furthermore, table 4.5 indicates that 1% of the respondents indicated that society shows them a positive attitude, while 45% indicated that society shows a negative attitude to them and their work, 53% indicated that society's attitude is neutral and the remaining 1% indicated that society is sickened. With consideration of the rebates informal waste pickers get from dealers and buyback centres, 89% of the respondents indicated that the rate per kg which dealers and buybacks use is fair, while 11% indicated that it is good.

Table 4.5: Operational challenges encountered by informal waste pickers

Characteristics	Frequency	Percentage
Challenges encountered while working:		
Social Stigma	80	100%
Exploitation	80	100%
Harassment	80	100%
Financial Challenges	80	100%
Lack of Resources	80	100%
Other	0	0%
Attitude from society and officials:		
Positive	1	1%
Negative	36	45%
Neutral	42	53%
Sicken	1	1%
Recycling rebate rate:		
Poor	0	0%
Fair	62	89%
Good	8	11%

Very Good	0	0%
Permission to work from municipality:		
Yes	80	100%
No	0	0%

4.2.5 Occupational health and safety challenges

The results from the study indicated that 87% of the respondents have knowledge of some occupational health and safety measures related to their work whereas 13% have none. Considering respondents 'access to water and sanitation, 78% indicated that they do not have access to clean water and sanitation while 22% have access to clean water and sanitation. Informal waste pickers deal with hazardous substances; therefore, it is important for them to wear proper protective clothing to minimizing the chances of harm. The results from this study indicated that 94% of the respondents have personal protective clothing (PPE), whereas 6% doesn't. Taking consideration their safety and security, 2% of the respondents indicated that their workstation is very secured and safe, 39% indicated that their workplace is slightly secured and safe and the remaining 59% indicated that their workplace is secured and safe. With the hours they work, only 1% of the respondents indicated that they work between 0-4 hours per day while the remaining 99% work between 5-9 hours per day.

Figure 4.9 presents injections mixed with general waste at Thulamela Landfill Site. This being in a black refuse back indicates that it was collected by the waste collection team either from residential area or business area as waste from self-medical treatment or treatment of a pet. However, these items have been in contact with body fluids and may be contagious and pass diseases from the primary owner to the informal waste pickers if informal waste pickers come into contact with them.

Figure 4.9: Medical injections mixed with general waste at Thulamela Landfill site

Figure 4.10 shows bottles that were identified mixed with general waste within Makhado Landfill site. As reclaiming valuable waste materials includes rummaging through waste broken bottles poses a threat to the informal waste pickers either by cutting their hands, legs or getting broken small pieces in their eyes. Other than injections and broken bottles, the results from his study indicated that the respondents encounter hazardous substances while working mixed with waste and some are part of the operation and maintenance of the site. These hazardous substances include moving machineries, fluorescent tubes, batteries, paint containers, cleaning chemicals, powders and dust particles, medical drips, syringes, rusted metals, razors and sharps. This reveals that informal waste pickers are at a risk of injury or infection from these hazardous substances while operating. The respondents indicated that from working, they are exposed to various injuries and illness which include cuts, backpains, wheezing, headaches, joint problems, respiratory problems, skin irritations, coughing, fatigue, sneezing, sinuses, nausea, body pains, stress etc. while practicing waste picking which reveals that waste picking is an activity associated with various illnesses and injuries of which left unattended

may result in serious illness or even death. This means that it is important that informal waste pickers approach their work in a manner that will reduce the chances of them getting sick or injured. Without any first aid kit, the respondents indicated that in case they are sick or injured on duty, they go to the clinic or nearest medical facility, while some ignore the matter until they knock off, some cover the injury with cloths or soil to stop the bleeding and continue to work and will only go to a medical facility or practitioner if the sickness or injury gets worse. This means that they stand a huge chance of getting an infection, sickness becoming worse or even death based on what injured them.

Figure 4.10: Broken bottles mixed with general waste in Makhado Landfill site

4.2.6 Support and integration of the informal waste sector into municipal solid waste management system

Figure 4.11 illustrates the form of support received by the respondents from their respective local municipalities. Six percent of the respondents indicated that they receive support from their municipalities in a form of Capacity building (C), 25% receive support in a form of Advice (A), another 25% receives support in a form of both Advice and

Capacity Building (A & C), and 44% receives support from their local municipality in a form of Advice, Capacity Building, State Incentives, and Facilities and Resources (A.C.S.F).

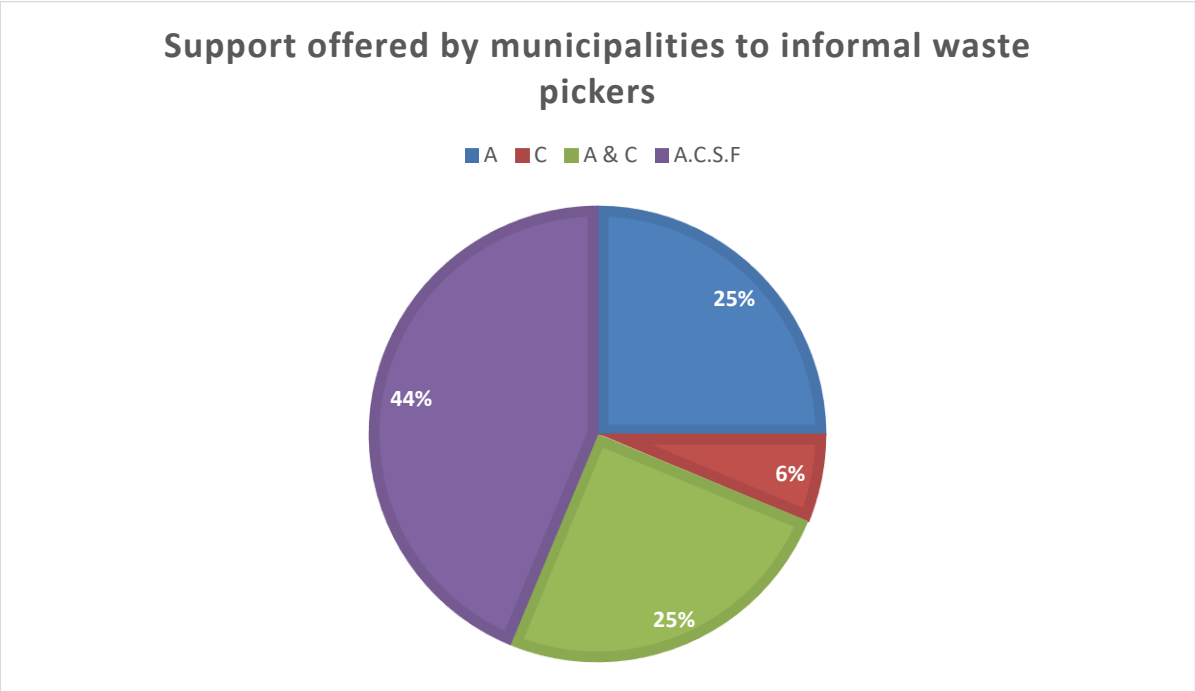


Figure 4.11: Form of support offered by local municipalities to informal waste sector

As illustrated in Table 4.6, the results from this study indicated that 65% of the respondents are aware that their local municipality has a forum for local recyclers while 35% are unaware or that their municipality has no forum for their local recyclers. Furthermore, 47% of the respondents indicated that they are members of the recycler's forums formed by their local municipality while 53% are not. Taking into considerations the funding options, the results revealed that 12% of the respondents indicated that they are aware of the options while the remaining 82% are not aware of any funding options. A small portion of the respondents indicated that they are aware of funding options.

Table 4.6: Support and integration of the informal waste sector into municipal solid waste management system

Characteristics	Frequency	Percentage
Local recyclers forum:		
Yes	52	65%
No	28	35%
Are you part of the forum?		
Yes	38	47%
No	42	53%
Funding options awareness:		
Yes	10	12%
No	70	82%
Access to municipal waste facilities:		
Yes	80	100%
No	0	0%
Involvement in municipal recycling related activities/events:		
Yes	80	100%
No	0	0%

Figure 4.12 is informal waste pickers together with their separated and sorted awaiting collection and trading for cash by dealers and buyback centre within Dzanani Transfer Station which is under Makhado Local Municipality. This supports the research question of “do you have access to municipal waste facilities for recovery of recyclables where in the results from this study illustrated that all respondents indicated that they do have access to municipal waste facilities to recover valuable waste materials as well as get invitations to events, functions and activities held by the municipality and other institutions that relates to informal waste sector activities.

Figure 4.12: Informal waste pickers with recovered and sorted valuable waste materials at Dzanani transfer station

4.2.7 Municipal solid waste management system within Vhembe District Municipality

The custodian of waste management belongs to local municipalities in South Africa by the Department of Forestry, Fisheries and the Environment (DFFE), and district municipalities can only assist municipalities with the smooth running of the competency through the provision of resources, technical support and advice (SAWIC, 2014). This responsibility includes provision of general waste collection services and managing waste disposal facilities including transfer stations within municipalities. Furthermore, municipalities are responsible for compilation and implementation of general waste management strategies and enforcement of appropriate waste minimisation and recycling initiatives (SAWIC, 2014). Therefore, the responsibility of waste management in Vhembe District Municipality belongs to four municipalities within the district, namely, Makhado, Thulamela, Musina and Collins Chabane local municipalities.

4.2.7.1 Waste management

The results from this study revealed that waste management in Makhado, Thulamela, Musina and Collins Chabane local municipalities is rendered in-house by a fully-fledged waste management section. All the four municipalities do not have a documented waste management strategy; however, they carry waste management practices in-line with the waste management hierarchy, Section 24, Chapter 2 of the Constitution of The Republic of South Africa Act (Act 108 of 1996), The National Environmental Management Waste Act (Act 59 of 2008), and all waste management related legislations including municipal bylaws. Makhado, Musina and Thulamela local municipalities have outsourced the operation and maintenance of the landfill site to an external service provider. Although Collins Chabane Local Municipality may have its own landfill site, it hasn't commenced with its operations and relies on Thulamela Landfill Site for waste disposal. Makhado and Thulamela local municipalities also have appointed a panel of service providers that will render waste recovery and recycling within their landfill sites. This minimises disorder and improper utilisation of the landfill as specific service providers will be allowed to access the landfill and recover waste; however, they do this through informal dumpsite waste pickers wherein they allow them to recover waste and then they come and trade cash for waste. These municipalities manage waste in the CBD, townships, suburbs, and rural areas.

4.2.7.2 Waste generation

The community of Vhembe District generates different types of waste ranging from industrial, commercial, and household waste. This includes general waste, garden waste, building rubbles, health care risk waste, e-waste, and hazardous waste. All the landfills in Vhembe District are general waste landfill site, therefore, management of waste is limited to general, garden and building rubbles. The results showed that the source waste in Vhembe District is industries, business premises, households, taxi ranks, schools, offices, and clinics. It was identified that the rapid increase in population, during month end CBD's gets congested by people and this results in waste generation booming increase over month end in towns. The results from this study as indicated in Table 4.7 indicate that as

per the landfill site records; Thulamela and Collins Chabane local municipalities generate the most waste with an average of 5 500 (54%) tons per month, followed by Makhado Local Municipality with an average of 2 696 (26%) tons per month and Musina Local Municipality with an average of 2023 (20%) tons per month. Thulamela and Collins Chabane local municipalities have been grouped together because they share the same landfill site for disposal. These results show that Vhembe District Municipality generates an average of 10 219 tons of waste per months.

Table 4.7: Monthly waste generated within Vhembe District Municipality in tons

Municipality	Quantity of waste per month	Percentage
Makhado	2 696 Tons	26%
Thulamela & Collins Chabane	5500 Tons	54%
Musina	2023 Tons	20%
Total	10 219 Tons	100%

4.2.7.3 Temporary waste storage

All service paying townships, commercial and industries temporarily store their waste in receptacles either provided by the municipality or by themselves and wait for the municipality waste collection team to come and collect the waste on a date stipulated by the municipality. Businesses that generate large amounts of waste rent out skip bins from the municipality and the skip is serviced regularly by the municipality. Municipalities also strategically distributed skip bins in and around towns, along rural areas roads and at designated areas for disposal of waste by citizens to minimise the chances of scattered waste and to reduce the backlog of waste collection in rural area thereby utilizing skip bins citizens can refer their waste whether in plastic bag or not to the skips, then the municipality will collect and refer them to the landfill site for final disposal. Table 4.8 illustrates transfer stations and drop-off points within Vhembe District. Makhado has 2 transfer stations of which only 1 of them is functional and 6 drop-off points all functional, Thulamela has 6 transfer stations and 5 drop-off points that are all non-functional, Collins

Chabane has 1 non-functional transfer station and 0 drop-off points, and Musina has neither a transfer station nor a drop-off point, however, it has designated areas that serves as central waste referral points for communities. In consideration of the above, Vhembe District has a total number of 9 transfer stations of which only 1 is functional and a total number of 11 drop-off points of which only 6 are functional.

Table 4. 8: Transfer stations and drop-off points within Vhembe District Municipality

Local municipality	Makhado LM	Collins Chabane LM	Musina LM		Vhembe LM
Transfer Station	2	6	1	0	9
Drop-off Point	6	5	0	0	11

Figure 4.13 is Dzanani Transfer Station falling under Makhado Local Municipality, which is the only completely developed functional transfer station within Vhembe District. Prior collection of waste from the transfer station and transportation to landfill site for final disposal, informal waste pickers recover and sort valuable waste materials from the transfer station, trade them for cash and make profit. Informal waste pickers are also sorting valuable waste in the 6 drop-off points within the Kutama-Sinthumule area under Makhado Local Municipality.

Figure 4.13: Dzanani Transfer Station

Other communities within Vhembe District have erected stands to use as waste temporary storage. These stands are erected in a manner that waste is stored in bags and placed on top at a height that stray animals such as dogs, goats and cattle cannot access the waste and scatter the waste along the road. They allow the waste to remain there until they are collected by the waste collection team.

4.2.7.4 Waste collection and transportation

Different methods of collection are followed within Vhembe District. To ensure effective waste collection, municipalities have waste collection schedules, route maps and plans that indicates days, time, location and frequency of waste collection. Results from this study revealed that households mainly townships and suburbs within Vhembe District that pay waste removal tariffs and receive house-to-house waste removal services. Municipal waste collection team roams around the streets of the suburbs or townships collecting waste that has been placed by households by their gates either in bins or refuse bags. Rural areas waste collection is mostly done along the road. This is because of the bad route network within rural area, therefore, citizens from rural areas refer their waste to the roadside on a stipulated day or nearby day. The CBD and Industrial areas also receive door-to-door waste collection on stipulated day and time. In case of uncertain circumstances that prevents the collection team from doing collection, the municipality immediately makes means of conveying the information to the public to avoid waste remaining at the gate or roadside for long and causing a nuisance. Within the district waste is collected by means of waste compactor trucks, skip loader trucks, tractors, half trucks and bakkies and transport waste to landfill site for final disposal following all waste transportation measures. Skip loader trucks and tractors collect full skip bins and transport them to landfill for final disposal. Because of their speed limits, tractors collect skip bins at a short distance while skip loaders collect both short and long distance.

4.2.7.5 Waste disposal

Local municipalities within Vhembe District, as custodians of waste management have moved from quarries and dumpsites to using sanitary landfill sites for disposal of waste. These landfill sites receive different types of waste which include industrial, commercial and household waste. As all the landfills in Vhembe are general waste landfills, the most dominant wastes they receive include general waste, garden waste as well as building rubbles. However, these landfills make an exception for some hazardous waste such as fluorescent tubes for temporary storage in skip bins of which they will acquire a competent and qualified service provider to collect and safely dispose them. Figure 4.14 illustrates fluorescent tubes stored in skip bins waiting for collection and disposal at Makhado Landfill Site. This skip has been allocated for fluorescent tubes only. These are fluorescents mainly discarded by municipal offices; however, it is meant for all fluorescent tubes discarded within the jurisdiction of the municipality

Figure 4.14: Skip bin allocated for fluorescent tubes disposal at Makhado Landfill Site

This study has taken 3 landfill sites from Vhembe District into consideration to form part of this evaluation which are Musina Landfill Site, Makhado Landfill Site, and Thulamela Landfill Site. Within all these landfill sites, there are informal waste pickers recovering valuable waste materials daily.

- **Makhado Landfill Site**

Makhado Landfill Site was established in 2011, however, began with operation in 2018 following the closure of the old Vondeling Landfill Site that was being utilised by the municipality. The landfill site is located at portion 1 of farm Reitvly No. 276-LS, Louis Trichardt, next to Tshikota Township with a size of approximately 20ha and an estimated life span of 20 years. The landfill site is classified as a G:M: B- landfill meaning that it is a general waste landfill Site (Makhado Local Municipality Integrated Waste Management plan, 2018). As per the records from the municipality, the landfill site receives an estimated 2 696 tons of waste per months. The site is fully fenced by concrete palisade, with a guard room, weighbridge, weighbridge operator room, ablution facilities, groundwater monitoring boreholes, leachate pond and a recycling facility on site. The landfill and recycling activities on site are operated by service providers appointed by the municipality.

Figure 4.15 shows the entrance to Makhado Landfill Site with notice boards indicating operation times, service provider responsible for operation and maintenance of the landfill site, License information, and Tariffs. At the landfill entrance, there is a spotter who identifies the types of waste being received and then directs the vehicle to the designated area for those types of waste and after that the vehicle then moves towards a weighbridge to be weighed and then it goes on forward to the cells to dump off the waste.

Figure 4.15: Entrance to Makhado Landfill Site

Figure 4.16 shows a recycling facility within Makhado Landfill Site where reclaimers store their waste while waiting for service providers to come and collect the valuable waste materials. The facility was originally developed to serve as a material recovery facility within the landfill where reclaimers will recover valuable waste material before final disposal, and only residue will be referred to landfill cell to be compacted and covered with soil. However, due to the rapid need to open a new landfill site and the large amounts of waste the site receives currently, the facility is not yet been used according to plan but rather as a temporary storage for recyclables.

Figure 4.16: Recycling facility within Makhado Landfill Site

- **Musina Landfill Site**

Musina Landfill Site was issued a permit of operating in December 2016 and has been declared a Class B landfill site. This means it does not meet the site selection and design standards outlined in the Centre for Advanced Engineering's Landfill Guidelines (2000) and is consented to accept general domestic and commercial waste. The site has an estimated life span of approximately 20 years. It is positioned on a portion of land situated North of Harper Road on Rem of the Farm Messina No. 4-MT which is far from the nearest residential area. The landfill site is still under construction; however, it is fully fenced with an access gate where there are security guards at the gate. There is no weighbridge, ablution facilities and a site office within the site, however, plans for their construction have been made and budgeted. The appointed service provider handling operation and maintenance of the landfill has provided its employees with a mobile site office to be using in the meantime. Although there is no weighbridge to record the amount of waste that the landfill site receives, it was estimated that the site receives an average of 2023 tons of waste per month.

- **Thulamela Landfill Site**

Figure 4.17 shows the entrance to Thulamela Landfill Site. The fence of the landfill site is damaged, and this allows anyone to access the site without having to use the entrance. This questions the safety and security of the landfill site as well as the type of waste being disposed within the site. With people accessing the site from the sides, they can bring in any items they want to discard without being prevented from discarding them into the landfill. Criminals can also enter the site and terrorise informal waste pickers as well as workers who are inside. Thulamela Landfill Site began operation as a dumping site without a license before 2004, however, in 2004, it was granted permit to operate officially as a license's landfill site. The license classified the landfill as a G:S: B+ landfill, meaning that it receives general waste for disposal. Thulamela Landfill Site is in Thohoyandou Block J, known as Tswinga. It is amid a residential area with an 80m buffer from the landfill to the residential area. The landfill has remaining life span estimation of 10 years. Thulamela Landfill Site receives waste from both Thulamela and Collins Chabane local

municipalities because Collins Chabane Local Municipality's landfill site is still under development and it is a newly formed municipality. Therefore, the municipality receives an estimated 5500 tons of general waste per month. Operation of the landfill is under an appointed service provider. The landfill is fully fenced with a guardroom, a leachate pond, and no weighbridge.

Figure 4.17: Entrance to Thulamela Landfill Site

Figure 4.18 shows notice boards at the entrance of Thulamela Landfill Site indicating the service provider who is responsible for the operation and maintenance of the landfill, the new name of the landfill site operation times and all the conditions of the landfill site in all local languages found around the municipality.

Figure 4.18: Notice Boards at Thulamela Landfill Site entrance

4.2.7.6 Vhembe District Municipality recycling

Vhembe District does not have formal recycling activities; however, private companies and individuals engage informally in recycling. Municipalities within the district encourage communities to get involved in recycling activities as a method of poverty alleviation which is a waste minimisation approach to the municipality. Makhado and Musina local municipalities hold quarterly recyclers' forums while Thulamela and Collins Chabane local municipalities hold monthly recyclers' forums to discuss matter relating to recycling. Table 4.7 presents average amount of waste diverted from landfills within Vhembe District. The data presented in table 4.9 was analysed from weighbridge records as per the municipality, it does not include data regarding recyclables that were recovered before they reached the landfill site for disposal. These results revealed that Makhado Local Municipality divert 73 tons (2.70%) of waste from the landfill site per months, Thulamela diverts 108 tons (1.96%) of waste from the landfill and Musina diverts 43 tons (2.1%) from the landfill site. In light of the above, as Collins Chabane Local Municipality does not have a functioning landfill, Vhembe District diverts a total of 224 tons per months from landfilling. This shows that the recycling rate for Vhembe District is 2.19% per month.

Table 4.9: Average amount of waste diverted from landfill within Vhembe District

Municipality	Quantity of Waste Diverted p/m	Quantity of Waste Received p/m	Percentage
Makhado	73 tons	2 696 tons	2.70%
Thulamela	108 tons	5 500	1.96%
Musina	43 tons	2 023	2.1%
Total	224 tons	10 219	2.19%

4.2.7.7 Environmental awareness and education

With the support from the provincial governments and other relevant stakeholders, all 4 municipalities within Vhembe District conduct regular environmental awareness and education programmes to promote sustainable environmental management, and this

includes promoting recycling as it is both environmental and economical beneficial. Information regarding environmental awareness and education was gathered through observation and document reviews.

Figure 4.19 illustrates an environmental education and awareness conducted at Tsianda Territorial Council within Makhado Local Municipality. Municipalities within Vhembe District liaise with territorial councils, ward councillors and relevant stakeholders to mobilise community members wherein the municipality environmental and waste management section capacitate community members. The community members are capacitated on proper waste management, waste disposal facilities and recycling initiatives. This is conducted to ensure a clean green environment within the community. During the activity, community members and stakeholders are given an opportunity to ask questions relating to the event and are provided with answers and advice of which some of these questions relate to recycling. On some occasions, the municipality invites specialist, and recyclers to come and capacitate and demonstrate to community members about the opportunities within the recycling industries.

Figure 4.19: Environmental awareness and education at Tsianda Territorial Council within Makhado Local Municipality

Figure 4.20 illustrates an environmental awareness and education conducted at Thohoyandou Botanical Garden. This activity was conducted by South African National

Biodiversity Institution in conjunction with Vhembe Biosphere Reserve, Department of Forestry Fisheries and the Environment, Limpopo Economic Development Environment and Tourism, Vhembe District Municipality, Thulamela, Makhado, Musina and Collins Chabane Local Municipality. The target audience for this event was primary school pupil. This reveals that municipalities within Vhembe District play their roles of capacitating citizens with relevant information relating to recycling through education and awareness for all age groups.

Figure 4.20: Environmental awareness and education at Thohoyandou Botanical Garden, Thulamela Local Municipality

4.2.7.8 Buyback centres information

Vhembe District Municipality has gained recognition of the informal waste sector and there has been developments and establishment of buyback centres within the district.

These buyback centres have been trading cash for waste, providing waste pickers with a means of living. Some of these buyback centres relies entirely on the workforce of informal waste pickers on the ground while others have employees who does waste recovery and sorting. Depending on its productivity and vision some of the buyback centres provide informal waste pickers with incentives such as personal protective clothing and trolleys to carry their waste material. Figure 4.21 is a demonstration of a trolley that is offered as incentives by one of the buyback centres within Vhembe. These trolleys ease the work for informal waste pickers as it reduces the heavy load they have to carry on their head, back or shoulders instead they push their loads. In light of the above informal, waste pickers can cover a large area than when carrying heavy loads on their own.

Figure 4.21: Trolley issued as an incentive by one of the buyback centres

Buyback centre 1 serves as both a waste picker and a buyback centre that has been in operation for the past 5 years operating within Collins Chabane Local Municipality. Table

4.10 indicates types of recyclables the organisation trades for cash, amount of recyclables in tons received per month, their percentage as well as rebates of each recyclable per kg. The results from this study indicated that the organisation is responsible for the recycling of Glass bottles and Aluminium Cans. As previously stipulated in Table 4.7 above, the buyback centre recycles 17 tons (41%) of aluminium cans per month and 18 tons (51%) of glass bottles per months. Furthermore, it is indicated that per kg aluminium is traded for cash at R13.00 and glass bottles is traded for cash at R0.40

Table 4.10: Recyclables buyback centre 1 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	17 tons	49%	R13.00
Glass Bottles	18 tons	51%	R00.40

Buyback centre 2 is amongst the buyback centres that were offered an opportunity to operate recycling services within the Thulamela Landfill Site by the municipality. It deals with plastic, papers, card box, bottles and aluminium cans. The buyback centre does not have employees of its own that handle recovery of waste, however, it has a mutual agreement with Thulamela Local Municipality as well as dumpsite waste pickers within Thulamela Landfill Site that it will come with a scale to measure the recovered waste from the waste pickers and then pay them according to its ratings. It does not only rely on dumpsite waste pickers only, but it has a firm of its own wherein waste pickers bring valuable waste and trade them for cash. Buyback centre 2 has employees who do waste recovery; however, they collect waste from business premises, and this alone does not generate much needed waste as business premises mostly produce packaging waste. The buyback centre has a mutual agreement with dumpsite waste pickers and the municipality that it will come with a scale to measure the recyclables recovered by waste pickers and buy the recyclables from the waste pickers as per the measure of their waste. Table 4.11 shows that the organisation is currently receiving monthly an average of 20 tons (15%) of plastic, 26 tons (20%) of papers, 24 tons (18%) of card boxes, 29 tons

(22%) of glass bottles as well as 32 tons (25%) of aluminium cans. This buyback centre also buys valuable waste from street waste pickers and anyone who takes their waste to their site for cash. This buyback centre offers a rebate of R1.50 per kg for plastic, R1.20 per Kg for paper, R1.20 per kg for card box, R0.35 per kg for glass bottles and R10.00 per kg for aluminium cans.

Table 4.11: Recyclables buyback centre 2 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	32 tons	25%	R10.00
Glass Bottles	29 tons	22%	R0.35
Card boxes	24 tons	18%	R1.20
Papers	26 tons	20%	R1.20
Plastic	20 tons	15%	R1.50

Buyback centre 3 is a recently established centre which has recently commenced with its operations. It is closely located to the Thulamela Landfill Site and has only been in operation for 6 months. The buyback centre trades cash for paper, card box, plastic and aluminium. Table 4.12 indicates that the establishment receives an estimated amount of 0.4 tons (21%) per month of aluminium, 0.4 tons (21%) per month of paper, 0.6 (32%) tons per month of card boxes, and 0.5 (26%) tons per month of plastic, however this does not imply that the establishment receives a lot of boxes, the percentage is based on the fact that card boxes are heavier that the other recyclables. The buyback centre only has employees to receive, sort and bail the recyclables and it fully relies on waste that has been brought in by informal waste pickers wherein they trade cash for the waste at a rate of R1.20 per kg for paper and card boxes, R3.00 per kg for plastic, and R13.00 per kg for aluminium.

Table 4.12: Recyclables buyback centre 3 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	0.4 tons	21%	R10.00
Card boxes	0.6 tons	32%	R1.20
Papers	0.4 tons	21%	R1.20
Plastic	0.5 tons	26%	R1.50

Buyback centre 4 has been in existence for 4 years and was primarily established as a scrap metal for cash facility, however, due to the business opportunities in the recycling sector it has opt to include trading cash for aluminium as well as plastic. Table 4.13 shows that the centre receives 20 tons (57%) of scrap metals per month, 5 tons (14%) of plastic per month and 10 tons (29%) of aluminium per month. The organisation trades cash for waste at a rate of R14.00 per kg for scrap metals, R13.00 per kg for aluminium and R1.80 per kg for plastics

Table 4.13: Recyclables buyback centre 4 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	10 tons	29%	R13.00
Glass Bottles	20 tons	57%	R14.00
Plastic	5 tons	14%	R1.20

Buyback centre 5 is also a recently established centre within the Makhado Local Municipality. It has been in existence and operating for 4 years and operating as waste pickers themselves. This centre deals with aluminium, glass, paper, card box and plastic (PET). This organisation recovers valuable wastes from landfill sites, transfer stations, business premises, schools, offices and streets on its own, however, it also trades cash for trash from informal waste pickers. Table 4.14 indicates that the organisation receives 5 tons (16%) of aluminium per months, 7 tons (22%) of card boxes per months, 10 tons (31%) of glass per month, 4 tons (12%) of paper per months and lastly 6 tons (19%) of

plastic per month. Buyback centre 5 did not disclose any information relating to the rebates rate it uses for trading.

Table 4.14: Recyclables buyback centre 5 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	5 tons	16%	-
Glass Bottles	10 tons	31%	-
Card boxes	7 tons	22%	-
Papers	4 tons	12%	-
Plastic	6 tons	19%	-

Buyback centre 6 was established by a woman who noticed an opportunity for women in recycling. It is an organisation that carries out its own waste recovery through community and school's clean-up campaigns. The organisation also has agreements with business premises that it will be the one that comes and collects recyclables provided they supply them with storage facilities. The organisation deals with card boxes, plastic, paper, aluminium, and glass bottles. Not only does the organisation relies on itself for waste recovery, but it also trades cash for waste as a buyback centre. Monthly, as indicated in table 4.15, the organisation receives 5 tons (43%) of card boxes, 0.2 tons (2%) of paper, 1.5 tons (13%) of plastic, 3 tons (25%) of aluminium and 2 tons (17%) of glass bottles. Furthermore, the results indicated that the organisation trades cash for waste at a rate of R8.00 per kg for aluminium, R0.40 per kg for glass bottles, R1.00 per kg for card boxes, R0.80 per kg for papers, and R1.20 per kg for plastic.

Table 4.15: Recyclables buyback centre 6 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	3 tons	25%	R8.00
Glass Bottles	2 tons	17%	R0.40
Card boxes	5 tons	43%	R1.00

Papers	0.2 tons	2%	R0.80
Plastic	1.5 tons	13%	R1.20

Buyback centre 7 operates within Makhado Landfill Site, relying on dumpsite waste pickers for recyclables. It forms part of the panel of service providers appointed to carry out recycling services within the landfill site by the municipality. This organisation trades cash for valuable waste that were recovered and sorted by dumpsite waste pickers. Table 4.17 illustrates that buyback centre 7 deals with plastic, card box, and paper and monthly it receives 10 tons (34%) of plastic, 8 tons (28%) of card boxes, 6 tons (21%) of papers and 5 tons (17%) of carton. Furthermore, the results indicated that buyback centre 7 trades cash for waste at a rate of R1.20 per kg for card boxes, R0.80 per kg for papers, R1.80 per kg for plastic, and R0.60 per kg for carton.

Table 4.16: Recyclables buyback centre 7 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Card boxes	8 tons	28%	R1.20
Papers	6 tons	21%	R0.80
Plastic	10 tons	34%	R1.80
Carton	5 tons	17%	R0.60

Buyback centre 8 is another organisation within Makhado Local Municipality recovering valuable waste materials from the municipality. The organisation collects and sorts waste from business premises, including hotels, pubs and restaurant, industries and schools. It extends its services to rural areas to expand productivity. The organisation deals with paper, plastic, card box, glass bottles, and aluminium. Table 4.17 indicates that buyback centre 7 per month receives 20 tons (16%) of aluminium, 18 tons (14%) of plastic, 15 tons (12%) of papers, 30 tons (25%) of card boxes, 10 tons (8%) of carton, and 30 tons (25%) of Glass bottles. Furthermore, the results from this study indicated that the organisation trades cash for waste at rebates of R14.00 per kg for aluminium, R0.40 per kg for glass

bottles, R1.20 per kg for card boxes, R0.75 per kg for papers and carton, R1.50 per kg for plastic.

Table 4.17: Recyclables buyback centre 8 deals with, Tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	20 tons	16%	R14.00
Glass Bottles	30 tons	25%	R0.40
Card boxes	30 tons	25%	R1.20
Papers	15 tons	12%	R0.75
Plastic	18 tons	14%	R1.50
Carton	10 tons	8%	R0.75

Buyback centre 9 is a new establishment which operates within the rural areas and townships of Collins Chabane Local Municipality. It gathers and recovers waste itself from households, business premises and schools. It also conducts community and school clean-up campaigns to enhance productivity. This organisation deals with paper, card boxes, plastic, aluminium, and glass bottles. As indicated in Table 4.18, buyback centre 9 on a monthly basis recycles 0.5 tons (10%) of paper, 1 ton (20%) of card boxes, 1 ton (20%) of plastic, 0.5 tons (10%) of aluminium, and 2 tons (40%) of glass bottles. This organisation also engages in trading cash for waste locally at a rebate rate of R8.00 per kg for aluminium, R0.20 per kg for glass bottles, R0.80 per kg for papers and card boxes, and R1.00 per kg for plastic.

Table 4.18: Recyclables buyback centre 9 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	0.5 tons	10%	R8.00
Glass Bottles	2 tons	40%	R0.20
Card boxes	1 ton	20%	R0.80

Papers	0.5 tons	10%	R0.80
Plastic	1 ton	20%	R1.00

Buyback centre 10 originally started conducting its own waste recovery and as time goes by it became a buyback centre. It operates within Musina Local Municipality dealing with plastic, papers, glass bottles, aluminium, and cartons. The result from this study as indicated in table 4.19 shows that on a monthly basis the organisation recycles 20 tons (16%) of plastic, 8 tons of paper, 30 tons (24%) of card boxes, 30 tons (24%) of glass bottles, 25 tons (20%) of aluminium and 10 tons (8%) of cartons. Buyback centre 10 did not disclose any information relating to its rebates for the recyclables.

Table 4.19: Recyclables buyback centre 10 deals with, tons received per month and their rebates per kg

Recyclables	Tons received per month	Percentage	Rebates per Kg
Aluminium	25 tons	20%	-
Glass Bottles	30 tons	24%	-
Card boxes	30 tons	24%	-
Papers	10 tons	8%	-
Plastic	20 tons	16%	-
Carton	10 tons	8%	-

4.2.7.9 Challenges identified within municipal solid waste management system

Findings from this study revealed that local municipalities within Vhembe District Municipality are faced with challenges relating to cultural and social aspects, financial, institutional as well as law enforcement. The researcher identified that although measures to educate and capacitate communities about the importance of proper waste management are in place, the mind-set of community members remains unchanged; few members of the community practice waste separation while others do not. Illegal dumping is still a major concern in Vhembe District that is growing rapidly extending from valleys and catchment to CBD's and roadsides. Figure 4 shows one of the major challenges that

municipalities within Vhembe District are facing which is illegal dumping. This situation was led villagers of Njakanjaka village to have no were to refer their waste and decided to dispose their waste at a nearby bush. However, this has resulted in anyone, even individuals who are not from the village, people driving by see an opportunity to refer all waste at this place which increases the illegal dumping

Figure 4.22: Illegal dumping at Njakanjaka village within Collins Chabane Local Municipality

The 4 municipalities within the district have strategically placed skip bins around rural areas as a method to try and reduce the backlog of waste collection within rural areas, however, as seen in figure 4.23 community members misuse the skip and no longer use it for their domestic waste, businesses also use the skips that were placed for residents which results in it getting full faster. Furthermore, it was identified that some community members send their kids to dispose the waste in the skips but because the kids cannot reach the top of the skip, they place the waste next to the skip attracting more waste from other users thinking that it is allowed. Stray animals access the waste and scatter it around and when the collection team collects the skips leaves the waste lying around.

Figure 4.23: Scattered waste around a municipal public skip bin

Political leaders as decision makers within municipalities still undermine the waste management section and give it less priority in terms of budget and infrastructure. The waste management section is provided with less budget as compared to other sections and planned projects within the waste section are delayed. In light of the above, it becomes difficult to effectively implement waste management and waste minimisation actions and procedures with the increasing rate of waste generation. Vhembe District is mainly rural, legislations, regulations and by-laws are put in place, however, they are not effective because it is difficult to enforce the law without proper measures in place. Citizens' practice illegal dumping because they are not aware of dangers associated with it, because there are no waste storage facilities nearby and because the municipality waste collection team cannot access their village. This reveals that the informal waste sector assists municipalities with accessing formal and informal settlement to gather valuable waste materials, thus reducing the amount of waste and reduce the cost of waste management for the municipality.

4.3 Discussions

4.3.1 Introduction

This chapter presents the discussion on the study results regarding the role of the informal waste sector within municipal solid waste management in Vhembe District. The results are also compared or related to previous literature. Discussions mainly focus on demographic characteristics of Informal waste pickers, socio-economic status of waste pickers, informal waste pickers activities, operational challenges encountered by informal waste pickers, occupational health and safety challenges, support, and integration of the informal waste sector into municipal solid waste management system.

4.3.2 Demographic characteristics of informal waste pickers

The result of the current study clearly shows that the informal waste sector within Vhembe District is dominated by the adult group. However, having a mixture of both youth and adults' respondents also shows that the informal waste sector has no age restriction, and it is open to anyone who feels that they can practice its activities. These results further indicate that Vhembe District is faced with unemployment as more of the respondents are at an age wherein, they are supposed to be employed and having a formal job with a regular salary, but they have resorted to rummaging waste materials to recover whatever valuables they can find to make a living. A study conducted in Abidjan, Cote d'Ivoire reported that within the country, there is a high number of individuals aged between 20-30 followed by individuals aged between 30-40 which partially support the current study (Andrianisa *et al.,* 2016). The study further reports that the reason for a high number of individuals aged under 40 being involved in informal waste activities is related to economic challenges and high unemployment rate (Andrianisa *et al.,* 2016). Similar trends were identified in a study conducted in Nigeria. The results of the study indicated that about 55.7% of informal waste pickers are amongst the age group of between 21 and 40 years old (Ogwueleka and Naveen, 2021). This supports the results of the current study that revealed that the informal waste sector is dominated by individuals under the age of 40. A study conducted in India; Ahmedabad opposed the results of this study. The

results of the study revealed that in an age range of 18-80 years, the most dominant age group was 45 years and above (Wittmer, 2021).

Considering gender, the results of the current study revealed that the informal waste sector within Vhembe District Municipality is dominated by females and this may be because they see potential of creating a living out of recovering and trading waste. Women see potential in informal waste picking and grabbed the opportunity in waste picking which is now serving as their employer. A study conducted in Mangolia revealed that informal waste picking is dominated by males due to the nature of its activities which involve bending, heavy lifting and walking long distances which appears to be stressful and hard for women to engage in (Uddin and Gutberlet, 2018). A study conducted is South Africa revealed that just like most industries, the informal waste sector is dominated by men (Department of Forestry, Fisheries and the Environment, 2020). These results oppose the results of the current study. Another study conducted in Brazil supports the current study as its results indicated that the informal waste sector is dominated by females because the sector allows women to develop personal growth and leadership as well as allowing them to value themselves (Gutberlet, 2021). Another study conducted in Brasilia; Brazil supported the results of the current study. The results of the study indicated that 67.9% of the informal waste pickers who participated in the study were female (Cruvinel, 2020).

Vhembe District municipality's informal waste sector is made up of individuals belonging to a family which reveals that they practice waste picking with the aim of providing for their families. It also means that they may have a lot of stress on their shoulders as it means that after work they must come home and carry out home duties such as taking care of their kids, spouse, parents or siblings. Furthermore, it also means that when they are on duty, they have to think about making money for the family. Moreover, most of these individuals belong to a household with a size of 3-4 family members. This is led to because most of the informal waste pickers were either married and divorced, had separated, or had lost their partners to death. Also, some have kids out of marriage, and some still lives with their parents. Supporting the results of this study are results from a

study conducted in Magnolia. They revealed that almost all the respondents that participated in the study were married and that the main reason for their involvement in informal waste picking is the need for a job to secure a livelihood as well as to support their families, more importantly their children (Uddin and Gutberlet, 2018). A study conducted in Brazil was against the current study. Its results indicated that 62% of the participants were single, however, it further indicated that 96% of the participants had children (Cruvinel *et al*., 2019). This supports the results of the current study that revealed that the majority of informal waste pickers are part of a household or family.

The result from the current study also shows that informal waste picking is a form of employment that does not require any form of qualification and can be done by anyone who feels the need to practice informal waste picking as the results show that it is being practiced by educated and uneducated people. Moreover, this also shows that unemployment is a major concern within the Vhembe District as the results show that there are individuals with education and qualifications who are resorting to waste picking as a form of employment. Similar trends were identified in a study conducted in Abuja, Nigeria. The results of the study revealed that 75.4% of participants (informal waste pickers) had a formal education although not all of them completed school (Ogwueleka and Naveen, 2021). This supports the results of the current study that indicated that the informal waste sector is dominated by individuals who have some form of a formal education. A study conducted in India opposes the current study with results that show that most informal waste pickers within the area don't have formal education (da Silva *et al.,* 2019). However, a study conducted in Cali, Canada indicated that only 48% of the participants had a formal education (Jaffe *et al*., 2018). This opposes the results of the current study that show that the informal waste sector is dominated by individuals with formal education.

4.3.3 Socio-economic status of informal waste pickers

The results from this study revealed that unemployed individuals are the most dominant respondents in the informal waste sector which clearly shows that informal waste picking and recycling is a form of employment for informal waste pickers in Vhembe District.

Considering the above, the informal waste sector is of significance to the Vhembe District socio-economic aspect as it is providing for the many poor families within the district. This shows that a lot of informal waste pickers within Vhembe District have been facing unemployment for a very long time and had identified an opportunity for employment and earn a living through informal waste picking and trading of recyclable valuable waste materials. Furthermore, the results indicated that after retirements, retrenchment, dismissal, or company closure some of the respondents opted to practice informal waste picking to continue taking care of their families and themselves. Similar results were identified in a study conducted in Cape Town.

The results of the study revealed that the majority of informal waste pickers that participated in the study were unemployed or have never been employed before, resorting to informal waste picking as a form of employment under the informal recycling economy (Bala *et al.,* 2021). Another study conducted in Sylhet City Corporation, Bangladesh supported the results of this study. The study revealed that the informal waste sector is full of unskilled labour, which means that chances of getting a formal employment are very low, therefore, it is full of people who are unemployed (Paul and Bhattacharjee, 2022). Furthermore, a study conducted in South Africa revealed that 86% of informal waste pickers that participated in the study claimed that they would like to have a full-time job or to be formally employed (Yu *et al.,* 2020). These results support the results of the current study as they indicate that many individuals resorted to informal waste picking due to unemployment. A study conducted in Koetmanshoop supported the results of the current study. The study revealed that 64.4% of the informal waste pickers that participated in the study were unemployed which on top of poverty is why they engage in informal waste activities (Nambuli *et al.,* 2021).

Furthermore, the current study revealed that most of the informal waste pickers in the district have an income of R2600.00 and above. A study conducted in Bantar Gebon revealed that most of the informal waste pickers make an income of between IDR 500.001 – IDR 1000 000 per month (Sasaki *et al.,* 2022). These figures amount to between R570.00 – R 1140 per month in South Africa, which is against the results of the current

study. A study conducted in Nigeria, Abuja, opposes the results of the current study. The study revealed that informal waste pickers in Abuja earn a monthly income of between $61.6 - $92.4 which is around R1060.00 – R1572.00 is South Africa (Ogwueleka and Naveen, 2021). A study conducted in Magnolia supports the results of the current study. The results of the study revealed that informal waste pickers within the country earn an income of between $180.00 - $210.00 which in South African Rands is above R2600.00 per month (Uddin and Gutberlet, 2018).

These results also revealed that although the respondents do make money monthly without involving informal waste picking and trading waste, they are unable to meet their needs for a satisfactory livelihood as 99% of the respondents showed that they are not satisfied with their monthly income. This implies that informal waste picking generates enough money for them to be able to sustain their livelihoods as they have families that needs financial support. Supporting the results of the current study are results from a study conducted in Brazil. The study revealed that most informal waste pickers had other domestic jobs that they do, however, because the money they were getting from those jobs was not satisfactory they made additional income through informal waste picking (Marques *et al.,* 2020). Another study conducted in Managua, Nicaragua, supports the results of the current study. The results of the study revealed that the majority of the informal waste pickers that formed part of the study complained that their monthly income, although is slightly above the national minimum wage is very low and cannot provide for basic household needs (Hartmann, 2018).

4.3.4 Informal waste pickers activities

The results of the current study revealed that Vhembe District informal waste sector is dominated by full-time waste pickers and part-time waste pickers because they have another form of employment or occupied by something else such self-employment and they practice informal waste picking to supplement their primary source of income. Opposing the current study are results identified in a study conducted in Kota Kinabala City, Sabah, Malaysia. The results from the study indicated that about 95% of the informal waste pickers that participated in the study indicated that they practice informal waste

picking as a part time job (Mapa, 2019). In a study conducted in South Africa, informal waste pickers indicated that they have been working for over 4 years and they work daily as full-time informal waste pickers (Yu *et al.,* 2020). Furthermore, another study conducted in Brazil supports the results of the current study. The study revealed that due to being underpaid, job loss and being unemployed most individuals have resorted to working as informal waste picker full-time to generate income and make a living (Conke, 2018).

The results of the current study also revealed that Vhembe District has a high number of dumpsite waste pickers than any other type of waste pickers. Supporting these results are results from a study conducted in Ndola, Zambia. The results of the study indicated that majority of informal waste pickers that participated in the study were dumpsite waste pickers because majority of citizens and stakeholders dispose of their waste at dumpsites (Mwanza *et al.,* 2019). Another study conducted in Koshe supports the results of the current study. The study revealed that in Koshe, hundreds of people live around the landfill with the aim of reducing the cost of transport and their livelihood highly depends on valuables from the landfill (Alemu, 2017). Furthermore, a study conducted in Indonesia, supports the results of the current study. A study conducted in Kenya also supported the results of the current study. The study results revealed that 96% of the informal waste pickers that formed part of the study recovered valuable waste materials exclusively from the landfill (Karuiki *et al.,* 2019). A study conducted in Gaza Strip, Palestine, opposes the results of the current study. The results of the study revealed that majority of the waste pickers that participated in the study prefer collecting recyclables from community bins along the streets (Al-Khatib *et al.,* 2020). Another study conducted in Kota Kinabalu City, Sabah, Malaysia also opposed the results of the current study. The results indicated that informal waste pickers are mostly concentrated at rubbish bins in major shopping centres in the town and in the residential area (Mapa, 2019).

Hundred percent of the respondents indicated that the main reason for their participation in informal waste picking is survival, meaning that informal waste pickers in Vhembe District rely in waste picking for income and socio-economic aspects such as buying food

and clothes. Results from a study conducted in Johannesburg indicated that the majority of informal waste pickers are involved in informal waste picking activities because of the need for employment and income generation (Simatele *et al.,* 2017). Similarly, a study conducted in Mangolia supports the current study. The results of the study revealed that more than half of the participants' primary reason for their involvement in informal waste picking activities is the need for a job and to secure a livelihood (Uddin and Gutberlet, 2018). A study conducted in Malaysia revealed that the informal waste pickers within the country do not primarily practice informal waste picking for rewards, income and incentives, rather they do it for charity and community-based programmes that help the poor (Tiew *et al.,* 2019).

Furthermore, the study revealed that informal waste picking is not a new thing in Vhembe District, waste pickers have been recovering valuable waste materials for over 16 years, diverting waste from the landfill saving municipality money and increasing landfill life span. Furthermore, this also indicates that informal waste picking is a continuous activity as the results revealed that there are also respondents with less than 5 years that has recently joined informal waste picking. A study conducted in Lagos State supports the results of the current study. The study revealed that majority of informal waste pickers spent between 6-10 years in the informal recycling industry which implies that they have vast experience in the field and are keen to making a living through informal waste activities (Salau *et al.,* 2017). A study conducted in Mangolia revealed that the majority of informal waste pickers have been working in the industry for a period of between 1 – 5 years followed by those who have been working for a period of between 6 – 10 years, then over 15 years and lastly 11 – 15 years (Uddin and Gutberlet, 2018). The results of this study support the results of the current study that informal waste picking is an activity that has been occurring for a long period and is continuing as there are individuals who are joining it recently.

The current study revealed that paper, aluminium and plastic are the most commonly recovered recyclables within Vhembe District, however, it also indicates that informal waste pickers within the district are not limited but can collect as many recyclables as

they require. A study conducted in Catalonia, Spain indicated that the majority of waste pickers that participated in the study recovered cardboard boxes and different types of metals (Rendon *et al.,* 2021). Furthermore, this study revealed that informal waste pickers in Catalonia gather any valuable waste material they can trade for profit. This supports the results of the current study as these results indicate that informal waste pickers are not limited to collecting specific or one type of recyclables. Opposing the current study is a study conducted in Zimbabwe, Pomona dumpsite. The study revealed that plastic is the most collected recyclable within the dumpsite, however, informal waste pickers are limited to collecting only one type of recyclable (Nemadire *et al.,* 2017). A study conducted in Gaza Strip, Palestine, supports the results of the current study. The study revealed that informal waste pickers in the Gaza Strip are not limited to one type of recyclable, however, the most collected recyclables are plastic, metals, paper, wood and cardboard boxes (Al-Khatib *et al.,* 2020).

Considering where the mostly trade their recyclables, the study revealed that informal waste pickers within Vhembe District prefer using both recycling dealers and buyback centres because informal waste pickers are most dominant in landfill sites and both dealers and buybacks visit landfill sites to buy waste. However, street waste pickers usually go for dealers because dealers come to them to buy so they do not incur transport costs, unlike having to transport their waste to buyback centres. In support of the results from the current study, a study conducted in Ndola, Zambia revealed that informal waste pickers prefer trading waste for cash with intermediate dealers (Mwanza *et al.,* 2019). Another study that supports the current study is a study conducted in China, that revealed that informal waste pickers trade their waste for cash with intermediate recycling dealers because of their nature of work and the aim of reducing the cost of transporting recyclables to recycling plants (Xue *et al.,* 2019). Furthermore, a study conducted in Bagerhat City of Bangladesh supports the results of the current study. The results of the study revealed that recycling dealers were identified to be secondary collector of recyclables within the city, collecting from informal waste pickers and paying them as per their measure of value (Das, 2018).

The results of the current study further showed that the majority of the respondents have to travel long distances to get to their workstations. This is basically because landfills are constructed far from residential area which will lead to respondents having to use lift or incur transportation costs. Similar results were identified in a study conducted in India. The study results revealed that the informal waste pickers must travel 8 – 10 km to work which is a long distance and becomes a burden when they have to travel carrying heavy objects (Wittmer, 2021). Another study supporting the results of the current study was conducted in South Africa. The study revealed that one of the reasons that leads informal waste pickers to suffer ergonomic conditions is because they must travel long distances to the landfill (Schenck *et al.,* 2019).

Vhembe District informal waste pickers receive assistance from family members which reduces the cost of having to pay someone outside the family as all of them will be working towards the same goal of putting food on the table at home. However, it also shows that there is involvement of child labour which brings in the challenge of not having enough time to have a social life and to do schoolwork as after school they have to join their parents in collecting recyclables and sorting them. A study conducted in Pakistan supports the results of the current study. The study revealed that informal waste pickers' children in Pakistan ended up working alongside the parents directly or indirectly, which is a serious child labour violation issue (Yousafzai *et al.,* 2020). Another study conducted in Santiago de Chile revealed that most waste pickers are usually accompanied by the children while going to work and the children ends up waste picking alongside their parents (Navarrete-Hernandez and Navarrete-Hernandez, 2018). A study conducted in Bantar Geban, Indonesia opposes the results of the current study. The study revealed that the inclusion of children in waste picking in Bantar Geban has been banned, therefore, getting assistance from children is against the law (Sassaki *et al.,* 2022).

4.3.5 Operational challenges encountered by informal waste pickers

The current study revealed that informal waste pickers within Vhembe District are discriminated or disapproved by society because people associate them with filth. The informal waste pickers also go through exploitation of their recyclables, they are

sometimes offered lower rates for their recyclables resulting in them making less profit from their hard work that deserves great value. Furthermore, the results indicated that informal waste pickers experience harassment from municipal officials who forcefully take their valuable waste materials such as metal and copper claiming that they can't recover these types of items it belongs to the municipality or tell them that whatever is within the landfill site belongs to the municipality, society and business owners shout and curse them associating them with any filth scattered in and around town blaming them and not wanting them next to their businesses claiming that they will chase away their customers.

As the informal waste sector is dominated by poor individuals, they also experience financial challenges and could not afford to buy resources and transport their recyclables which also leads to more exploitation. Furthermore, informal waste pickers in Vhembe District are facing different types of attitudes from society depending on where they are and the understanding of people around that area. Majority of respondents indicated that society's attitude towards them is neutral, which reveals that Vhembe District's Society is slowly accepting the existence of informal waste pickers and recognizing they role. Vhembe District trade cash for waste at a rate that does not meet informal waste pickers expectations however it is enough for them to meet their basic needs and to continue working. None of the respondents indicated having boundaries or being not permitted to working by the municipality which means that municipalities within the district recognises the role informal waste pickers play in waste management and waste minimisation .

A study conducted in the Global North was in support of the results of the current study. The results of the study indicated that due to the nature of the work conducted by informal waste pickers they are discriminated, excluded, and stigmatised from society (Bulla *et al.,* 2021). Another study conducted in Mangaung Metropolitan Municipality supported the results of the current study. The results revealed that informal waste pickers are often driven out of the landfills by municipal staff and officials construct high fences to prevent them from accessing the landfill site (Du Plesis, 2022). Another study in support of this study was conducted in South Africa. The study revealed that informal waste pickers are negatively impacted by formal recycling programmes as these programmes ignore their

existence and they intend to take over all the recycling without considering the already existing informal recycling systems (Department of Forestry, Fisheries and the Environment, 2020).

A study conducted in Sylhet City revealed that sexual harassment has is common challenge that female and young informal waste pickers experience at landfills (Paul and Bhattacharjee, 2022). This challenge was not identified in the current study, this may be because of the security and operation Vhembe District municipality landfill site have or because the participants did not want to reveal such information. A study conducted in Catalonia supports the results of the current study. The results of the study revealed that within the country informal waste pickers are viewed as a social problem and are mostly excluded, disempowered and unrecognised members of society (Rendon, *et al.,* 2021). Furthermore, the study revealed that informal waste pickers are often exploited by recycling dealers, and political leaders who do not appreciate their work nor defend their interest (Rendon *et al.,* 2021). Furthermore, a study conducted in South Africa supported the results of the current study. The study revealed that informal waste pickers are harassed, dehumanised and not viewed as part of the waste management and recycling systems (Department of Forestry, Fisheries and the Environment, 2020).

4.3.6 Occupational health and safety challenges

Majority of the participants that took part in the current study indicated that they are aware of occupational health and safety measures that are associated with their line of work which shows that informal waste sector in Vhembe has knowledge of how to tackle or approach hazardous areas and materials, however, none of the respondents indicated that they carry or have a first aid kit in place. This means that although they have knowledge of occupational health and safety measures, they have no means of first response to any injuries or harm that may occur while they are on duty. Similar results were identified in a study conducted in Himachal Padesh, India. The results of the study indicated that 90% of the informal waste pickers that participated in the study were aware of occupational health and safety measures and know how to apply them in case of emergencies (Thakur *et al*., 2018). A study conducted in Lagos, Nigeria also supports the

results of the current study. The study revealed that 54% of the informal waste pickers that participated in the study had knowledge of occupational health and safety measures as well as access to first aid kit (Isaac *et al.,* 2020).

Moreover, most informal waste pickers that participated in the current study indicated that they do not have access to drinking water and sanitation. This implies that informal waste pickers experience a challenge of accessing bathrooms and drinking water while on duty. It also means that if it happens that they have to use a bathroom, they have to go in the bushes which is a health hazard or ask at nearby households. Waste picking is draining and tiring and without enough drinking water, informal waste pickers get dehydrated. A study conducted in Brazil supports the results of the current study. The study revealed that informal waste pickers suffer from water borne diseases because of the lack of access to clean water and proper sanitation (Cruvinel *et al.,* 2019). A study was conducted in Paraguay that supports the results of the current study. The study revealed that informal waste pickers operate in workplaces without any sanitary services and proper sewage systems which makes the working conditions unbearable (Franco de Diana *et al.,* 2018).

Most informal waste pickers indicated that they have personal protective clothing PPE is a requirement of all landfill sites within Vhembe District, and majority of the respondents were in landfill sites. This also implies that informal waste pickers are in-line with safety measures related to their line of duty. A study conducted in Andralanitra opposes the results of the current study. The study revealed that informal waste pickers are exposed to various health risks because they use basic safety technologies and equipment and they rarely put on personal protective clothing (Andrianisa *et al.,* 2018). A study conducted in Brazil also opposed the results of the current study.

The study revealed that informal waste pickers claimed that personal protective clothing are heavy and slow productivity thus they do not wear any while operating (Zon *et al.,* 2020). A study also opposing the results of the current study was conducted in India. The results of the study indicated that the majority of informal waste pickers do not have adequate personal protective clothing made available for them and this exposes them to hazardous substances (Thakur *et al.,* 2018). The results of a study conducted in

Kathmandu revealed that 62% of the informal waste pickers that participated in the study indicated that they have used personal protective clothing and that they wear their own clothing as personal protective equipment, for example, they cover their hands with a cloth when picking hazardous substances such as broken bottles (Black *et al.,* 2019).

Vhembe District informal waste pickers work normal working hours as formal employees, however, based on the nature of their work which involves working in the sun, cold or rain, bending and flexing working long hours is a health risk that may show immediately or over a long period and the results from this study further indicated that none of the respondents indicated that they do go for regular medical inductions, which implies that they are not aware of any illnesses that may occur as a results of their work activities. A study conducted in Lagos, Nigeria, revealed similar results as the majority of informal waste pickers that formed part of the worked long hours as a means to maximise profit (Isaac *et al.,* 2020). A study conducted Ahmedabad supports the results of the current study. The results of the study revealed that informal waste pickers in Ahmedabad start to work as early as 4 am until 2:30 pm (Wittmer, 2021). This implies that they work for more than 10 hours which is more than normal working hours. A study conducted in Brazil supports the results of the current study. The study indicated that most of the informal waste pickers within the country resort to working long hours because the recycling rate is very low so in order to have good profit they need to work longer (Pincelli *et al.,* 2021).

The current study revealed that informal waste pickers within Vhembe District suffer from various injuries and illnesses brought by their work. In support of the current study, a study conducted in Kathmandu revealed that informal waste pickers mainly suffer from respiratory problems, fatigue, backache, and headache (Black *et al.,* 2019). Whereas a study conducted in Magnolia revealed that informal waste pickers suffer from Tuberculosis, stomach diseases, skin diseases, kidney problems, backaches, cuts, burns, broken bones, headaches, eye problems, heart, and liver problems (Uddin and Gutberlet, 2018).

Furthermore, a study conducted in Himachal Padesh revealed that informal waste pickers suffer from respiratory problems, injuries, muscle pains and headaches (Thakur *et al.,* 2018). Similar results were also identified in a study conducted in Antananarivo, Madagascar. The study revealed that informal waste pickers are affected by headaches, fever, backaches, skin wounds, food poisoning, fatigue and coughing (Andrianisa *et al.,* 2017). Another study conducted in Lusaka supported the results of the current study. The study revealed that chest pains and coughing were common in dumpsite waste pickers as a result of dust and smoke followed by body pains from working long hours and lifting heavy objects (Chileshe and Moonga, 2017).

4.3.7 Support and integration of informal waste sector into municipal solid waste management system

Vhembe District municipalities recognise the role informal waste pickers play in their solid waste management system and want to equip them and engage them in a manner that is both beneficial for both the informal waste pickers and the municipality. Results from the current study revealed that local municipalities have ways to support the informal waste sector either through advising them on opportunities, offering them training, handing out incentives such as picking tools, PPE and bags, and offering them their facilities and resources to sort and store waste. Considering the above, these are the current methods municipalities are using to involve informal waste pickers into their solid waste management system in Vhembe District. However, not all respondents indicated that they receive state incentives and facilities and resources. This reveals that there is a certain portion of informal waste pickers that are recognised by the municipality, either through a forum or a database wherein the municipality registers all the recyclers within its jurisdiction. This also implies that for the duration of the research the municipality did not have enough incentives for all informal waste recyclers. Furthermore, it is possible that there are funding options in Vhembe District. However, a lot of informal waste pickers are not aware. This reveals that information about funding was not dispersed in a way that informal recyclers can have access to.

A study conducted in Brazil supports the results of the current study. The results of the study indicated that Brazilian policies recognise the informal waste sector and their government further implemented various programmes and national policies that advocate for the inclusion of informal waste pickers in municipal solid waste management system (Noble, 2019). A study conducted in China revealed that the Chinese government has realised that it is impossible to prevent informal waste pickers from conducting recycling activities as households prefer waste collection from informal waste pickers rather than the municipality due to high prices of waste collection resulting in the government supporting the informal waste sector (Chen and Gao, 2021). A study conducted in Russia supports the results of the current study. The results of the study revealed that the Russian government has recognise the major role of informal waste pickers that saves costs and resources while also cleaning the town and has implanted formalisation of the sector programmes (Luiz da Silva *et al.,* 2019).

Another study conducted in Malaysia supports the results of the current study. The study indicates that the government recognises informal waste pickers and has dedicated a National Recycling Day to recyclers wherein they exhibit their products and some of them are awarded for the marvellous work they do (Guibrunet, 2019). Results from a study conducted in India, Dheli revealed that waste management and recycling has been privatised and denied from informal waste pickers which opposes the results of the current study (Hartmann, 2018). A study conducted in Brazil supports the results of the current study. The study revealed that informal waste pickers within the country have been included in the Brazilian occupational code by the Ministry of Labour (Bonini-Rocha *et al.,* 2021). A study conducted in The Bengaluru municipality revealed that authorities have involved informal waste pickers in the door to door collection of solid waste and operations of solid waste collection centres (Nalini and Arora, 2021).

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

This chapter presents conclusions drawn from the current study and recommendations to address the problem identified in the study area. Conclusion and recommendations are drawn from the findings based on the specific objectives of the study which were; (1) to identify challenges and opportunities associated with the involvement of the informal waste sector in municipal solid waste management, (2) to identify the occupational health and safety challenges the informal waste sector encounter on their day-to-day operations, (3) to evaluate the support provided by the national, provincial and local government to the informal waste sector, and (4) to evaluate municipality strategies of integrating the informal waste sector into municipal solid waste management system

5.2. Conclusions

The study was conducted in Vhembe District Municipality, which is composed of four local municipalities namely, Makhado, Thulamela, Collins Chabane and Musina. The study focused on Thohoyandou, Malamulele, Makhado and Musina town and Thulamela, Musina and Makhado landfill sites. The informal waste sector in Vhembe District is a female dominated sector with most of them being adults. As the sector is welcoming, it is composed of a mixture of individuals including youth, educated, uneducated, employed, unemployed and breadwinners. Authorities and policy makers worldwide realised that the solution to the global waste management problem can be achieved through following the circular economy model (Gall *et al.,* 2020; Marquez and Rutkowski, 2020; Fuss *et al.,* 2021).

It was identified that informal waste pickers within Vhembe District play a critical role of diverting waste from landfill at a recycling rate of 2.19%. Hundreds of informal waste pickers within Vhembe District roam around the towns and streets as well as within the landfill sites searching and recovering valuable waste materials with the aim of trading them to make profit. Informal waste pickers implement the first stage of the circular

economy, thus reducing environmental impacts and creating local economies for poor individuals (Ferronato *et al.,* 2020). Although their primary goal for their involvement in informal waste activities is survival, form of employment and income securing, informal waste pickers within Vhembe District play a crucial role of saving municipalities on waste management costs, reduce waste impacts on the environment as well as create a local economy for themselves through recovering and selling waste. Unintendedly, informal waste pickers implement their activities as per the waste management hierarchy, which is meant to guide all waste managers for an effective waste management system, meaning to say the informal waste sector ensures that municipalities implement the best waste management practices (Mwanza and Mbohwa, 2017).

With the world moving towards a circular economy, as the base of the circular economy, informal waste pickers have an opportunity to improve their working conditions as well as their standard of living through recycling (Araya-Cordova *et al.,* 2021; Valanzuela-Levi, 2021). Despite the importance in municipal solid waste management, recycling and local economy, the informal waste sector is still not recognised and stigmatised by society (Tong *et al.,* 2021; Cetrulo *et al.,* 2018). This study found that informal waste pickers in Vhembe District are stigmatised, rejected, harassed, exploited, and do not have enough funds and resources to carry out their activities effectively. Nonetheless, part of Vhembe District society does not view them as a nuisance, and they have gained recognition from the municipalities.

The municipalities grant them access to operate around the towns and in their landfills, which grants them the opportunity to increase their profits. Due to the nature of the work, informal waste pickers practice which unregistered and unregulated authorities and policy makers do not protect informal waste pickers or intervene in making their workplace safer (Carenbauer, 2021). This study found that Vhembe District's landfill sites are fully fenced with one entrance and security for the safety of staff and municipal resources and asserts. This also keeps the informal waste pickers in landfill safe, however, it was also found that in Thulamela Landfill Site the fence is partially damaged and in Musina Landfill Site the security grants anyone access to the landfill. This could impact the safety of the area as

criminals can easily access the landfill. Municipal officials exploit informal waste pickers of valuable materials such as copper and steel for their own benefits within Vhembe District landfill sites. The 4 municipalities within the district in conjunction with government departments, recycling companies and other stakeholders bring in opportunities for training and incentives as a token of appreciation for the great work that is done by informal waste pickers. They offer them incentives such as trolleys and personal protective equipment to ensure that they work effectively with ease.

Informal waste pickers work in environments that are unhygienic, exposed to dust and smoke, working long hours, lifting heavy objects, and walking long distances recovering waste. This exposes them to various occupational health and safety risks daily (Abdel-Shafy and Mansour*.,* 2018; Black *et al.*, 2019; Zolnikov *et al.,* 2021). In Vhembe District, informal waste pickers are aware of occupational health and safety measures, however, they do not carry any first-aid kit although their work is associated with hazardous substances. Their work exposes them to hazardous substances that leads to short-term and long-term injuries and illnesses, and this is worsened as they do not go for any medical inductions or regular check-ups.

Maintaining a good health is a great aspect for effectiveness at work, however, informal waste pickers encounter health risks that range from biological, chemical, ergonomic, physical, mechanical, and social in nature (Zolnikov *et al.,* 2021). It was found that the lack of clean drinking water and sanitation is a major issue within Vhembe District which compels informal waste pickers to drink unhealthy waters from streams and nearby rivers of which some of these water sources are contaminated by pollutants from the landfill. Landfills are full of mosquitoes, rodents and flies which are vector-borne diseases transmitters and informal waste pickers come into contact with them daily (Cruvinel *et al.,* 2020). Chances of infection from various diseases are high for informal waste pickers within Vhembe District as it was identified that they have to rummage within the mixed waste which composes of both general and hazardous waste such as medical waste and broken bottles.

Informal waste pickers are part of the solution towards a global goal of zero waste to landfill and the circular economy as they provide sustainable waste management services that are outlined in waste management hierarchy (Guibrunet, 2019). Municipalities are pushed to restructure their solid waste management system to a circular economy; therefore, it is important that they involve and support the informal waste sector as this sector is fully determined to meet the requirements of the circular economy (Navarrete-Hernandez and Navarrete-Hernandez, 2018; Fuss *et al*., 2021).

This study confirmed that all the 4 municipalities, including the district municipality, provincial and national government supports the work conducted by the informal waste sector. They offer them advice, incentives, workshops, and they allow informal waste pickers to access and use their facilities for waste recovery, sorting and storage. There are forums formed around Vhembe district that are in support of informal recyclers that share all information related to recycling including funding options with informal waste pickers. A strategy to how municipalities in Vhembe District can integrate informal waste pickers has not yet been developed, however, a database registering all informal waste pickers exist which allows municipalities to know them and include them in all factors that affects them.

5.3. Recommendations

5.3.1. Recommendations for the integration of the informal waste sector in municipal solid waste management system

Current polices in Vhembe District cater for the inclusion of informal waste pickers for statistics. However, these policies do not protect informal waste pickers from being harassed and exploited which makes it difficult for them to enjoy their work. The researcher recommends development of improved policies that cater for the inclusion and protection of informal waste pickers in solid waste management. These policies will entitle informal waste pickers to rights and legal protections while working. Exploitation has been one of the greatest challenges that negatively affect informal waste pickers. Dealers and intermediaries pay little money to waste pickers while they are making more money from

major recycling companies. The researcher recommends that the municipality develops a system that determines and monitors recycling rebates with existing and upcoming buyback centres and intermediaries. This system will determine the rebates and set a fixed price for trading recyclables that will be made known to the public and all buyback centres and intermediaries to avoid exploitation.

The informal waste sector is largely dominated by poor individuals who are trying to earn a living through recovering and trading waste. Because of their economic status, they lack resources to effectively execute their work, therefore, this study recommends that municipalities develop material recovery facilities within landfill that will maximise the recycling rate and allow informal waste pickers to use their resources for waste recovery and recycling. Rummaging through the waste within landfill cells is also a risk due to smoke, dust and moving machinery. Plant operators within landfill site often do not give informal waste pickers enough time to go through all the waste to recover whatever they can, however, with a material recovery facility they will be able to recover all recyclables and only residue will be referred to cells for landfilling.

It was identified that there are no recycling plants in Vhembe District. This means that both informal waste pickers, dealers and buyback centres have to incur transportation costs while transporting recyclables. This also compels informal waste pickers to largely rely on dealers and buybacks for trading as most of them cannot afford it. In light of the above, the researcher recommends developing of recycling plants within the district and provide necessary training to informal waste pickers for the utilisation of the plant. Having a recycling plant will provide informal waste pickers with employment and will enable them to always take their recyclables to the plant without having to wait. Moreover, within Vhembe District, informal waste pickers do not have storage facilities to temporarily store their waste before trading them. They either leave them at the landfill which puts them at risk of getting stolen or loss due to other unforeseen circumstances such as fire, for street waste pickers to store waste in their yards, and this poses a health hazard to them and their neighbours. With consideration to the above, the researcher recommends that

municipalities provide land for temporary use as storage for recyclables and assist in financing transportation of recovered recyclables.

This study recommends that municipalities should generate a database of all their informal waste pickers and arrange for them free regular medical inductions and tests as well as involve a selected few in training such as first aider trainings and occupational health and safety. This will help waste pickers to keep track of their health and get necessary help if needs be and the training will enable them to know how to react in case of injuries and other occupational health and safety issues that may occur while operating.

5.3.2. Recommendations for further research

This study focused on the role that informal waste sector plays in municipal solid waste management, their challenges and inclusion in municipal solid waste management systems. Little research has been conducted within Vhembe District that addresses the preference of communities regarding who they prefer regarding waste collection between informal waste pickers and municipality. More research is required on this aspect. This study identified gaps on the informal waste sector's ability to create a local economy of its own. Further research is needed to identify methods on how the informal waste sector can create an economy of its own locally. Current studies on the informal waste sector identify occupational health and safety conditions and challenges, however gaps were identified regarding solutions to the harsh conditions that the informal waste sector encounters. There is a need for further research to be conducted regarding technologies and methods municipalities and informal waste pickers can follow to help improve working conditions of informal waste pickers.

It was found that informal waste pickers receive assistance from their kids to reduce workload and costs which affect the children's education and social life. Further research should be conducted on methods that could be used to assist informal waste pickers' children to get a proper education and social aspects as well as to know where the children's futures end up. Society's view of informal waste pickers is still a challenge. Further research should be conducted to identify needed education and awareness to

enable society view informal waste pickers as one of their own. This will enable them to be close to their premises.

REFERENCES

Abdel-Shafy, H.I. and Mansour, M.S.M. (2018). Solid Waste Issue: Sources, Composition, Disposal, Recycling and Valorization. *Egyptian Journal of Petroleum*, 27: 1275-1290.

Agovino, M. Ferrara, M. and Garofalo, A. (2018). An exploratory analysis on waste management in Italy: a focus on waste disposal in landfill. *Land Use Policy,* 57: 669-681.

Ajwani-Ramchandani, R., Figueira, S., Torres de Oliveira, R., Jha, S., Ramchandani, A., & Schuricht, L. (2021). Towards a circular economy for packaging waste by using new technologies: The case of large multinationals in emerging economies. *Journal of Cleaner Production*, 281.

Alderete, N.M. Joseph, A.M. Van den Heede, P. Matthys, S. and De Belie, N. (2021). Effective and sustainable use of municipal solid waste incineration bottom ash in concrete regarding strength and durability*. Resources, conservation & Recycling*, 167: 105356.

Alemu, K.T. (2017). Recognise Informal Waste Pickers to Avoid Future Disters like Koshe. https://www.ids.ac.uk/opinions/recognise-informal-waste-pickers-to-avoid-future-disasters-like-koshe/ Accessed 21 August 2022.

Ali, M. Geng, Y. Robins, D. Cooper, D. Roberts, W. and Vogtlander, J. (2019). Improvement of waste management practices in a fast-expanding sub-megacity in Pakistan, on the basis of qualitative and quantitative indicators. *Waste Management*, 85: 253-263.

Al-Khatib, I.A. Al-Sari, M.I. and Kontogianni, S. (2020). Scavengers' Contribution in Solid Waste Management Section in Gaza Strip, Palestine. *Environmental Monitoring and Assessment,* 192:354.

Andrianisa, H.A Brou, Y.O.K. and Sehibi, A. (2016). Role and importance of informal collector in the municipal waste pre-collection system in Abidjan, Cote d'ivoire, *Habitat International,* 53:265-273.

Anshassi, M. Laux, J.S. and Townsend, G.T. (2019). Approaches to integrate sustainable materials management into waste management planning and policy, *Resource, Conservation and Recycling*, 148:55-66.

Aparcana, s. (2017). Approaches to Formalization of the Informal Waste Sector into Municipal Solid Waste Management System in Low and Middle-Income Countries: Review of Barriers and Success Factors. *Waste Management*, 61: 593-607.

Appasamy, P. and Nelliyat, P. (2007). Financing Solid Waste Management: Issues and Options. *Proceedings of the International Conference on Sustainable Solid Waste Management, Chennai, India,* 615*:* 537-542.

Araya-Cardova, P.J. Davila, S. Vallenzuela-Levi, N. and Vasquez, O.C. (2021). Income inequality and efficient resources allocation policy for the adoption of a recycling program by municipalities in developing countries: The case of Chile. *Journal of Cleaner Production*, 309: 127305.

Awasthi, A.K. Wang, M. Awasthi, M.K. Wang, Z. and Li, J. (2018). environmental pollution and human body burden from improper recycling of e-waste in China: a short review. *Environmental Pollution,* 243:1310-1316.

Awjani-Ramchadani, R. Figueira, S. Torres de Oliveira, R. Jha, S. Ramchadani, A. and Schuricht, L. (2021). Towards a circular economy for packaging waste by using new technologies: The case of large multinationals in emerging economies. *Journal of a Cleaner Production.* 281: 125139.

Ayodele, T.R. Alao, M.A. and Ogunjuyigbe, A.S.O. (2018). Recyclable resources from municipal solid waste: assessment of its energy, economic and environmental benefits in Nigeria. *Resource, Conservation & Recycling*, 134: 165-173.

Azam, M. Jahromy, S.S. Raza, W. Raza, N. Lee, S.S. Kim, K. and Winter, F. (2020). Status, characterization, and potential utilization of municipal solid waste as renewable energy source: Lahore case study in Pakistan. *Environment International,* 134: 105291.

Azevedo, B.D. Scavarda, L.F. Caiado, R.G.G. and Fuss, M. (2021). Improving urban household solid waste management in developing countries based on the German experience. *Waste Management*, 120: 772-783.

Baker, M. Mamela, S. Rampete, N. (2016). Empowerment of Waste Pickers in the City of Johannesburg, creating an Enabling Environment for the Informal Waste Sector to Participate in Municipal Waste Service Delivery. *Institute of Waste Management of Southern Africa*, 171-177.

Bala, S. Blaauw, P.F. Christian, C.S. and Yu, D. (2021). Identifying the prospects of decent job creation along the value chain of plastic recycling. Development Southern Africa. https://doi.org/10.1080/0376835x.2021.2018290. (Accessed 23 September 2022).

Barrett, A. (2021). Justice for Waste Pickers in Kenya. https://bioplasticsnews.com/2021/12/01/justice-waste-pickers-kenya/ (Accessed 20 October 2022).

Bissmont, M. (2020). The practice of household waste minimisation. *Environmental Sociology,* 6(4), 355–363.

Bulla, J.P. Rendon, M. and Trenc, J.E. (2021). Policing the stigma in our waste: what we know about informal waste pickers in the global north. *Local Environment,* 26:10, 1299-1312.

Black, M. Karki, J. Lee, A.C.K. Makai, P. Barai, Y.R. Kritsotakis, E.I. Berner, A. and Fossier Heckman, A. (2019). The Health Risk of Informal Waste Workers in the Kathmandu Valley: A Cross-sectional survey. *Public Health*, 166: 10-18.

Blomsma, F. and Brennan, G. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. *Journal of Industrial Ecology,* 23(3): 603-614.

Bonini-Rocha, A.C Costa de Oliveira, R.A. Bashash, M. Machado, G. and Cruvinel, V.R.N. (2021). Prevalence of musculoskeletal disorders and risk factors in recyclable material waste pickers from the dump and structural city in Brasilia, Brazil. *Waste management*, 125:98-102.

Botello-Alvarez, J.E. Rivas-Garcia, P. Fausto-Castro, L. Estrada-Baltazar, A., Gomez-Gonzalez, R. (2018). Informal Collection, Recycling and Export of Valuable Waste as Transcendent Factor in the Municipal Solid Waste Management: A Latin-American Reality. *Journal of Cleaner Production*, 182: 485-495.

Botti, L. Battini, D. Sgarbossa, F. and Mora, C. (2020). Door-to-door waste collection: analysis and recommendations for improving ergonomics in an Italian case study. *Waste Management*, 109: 149-163.

Bowen, G.N. (2009). Document Analysis as a Qualitative Research Method https://www.researchgate.net/publication/240807798 (Accessed 04 November 2021)

Campbell, S. Greenwood, M. Prior, S. Shearer, T. Walkem, K. Young, S. Bywaters, D. and Walker. (2020). Purposive sampling: Complex or simple? Research Case Examples. https://doi.org/10.1177/1744987120927206 Accessed 17 March 2023

Carenbauer, M.G. (2021). Essential or dismissible? Exploring the challenges of waste pickers in relation to COVID-19. *Geoforum,* 120: 79-81.

Cervantes, T.D.E. Martinez,A.L. Hernandez, M.C. and Garcia de Cortaza, A.L.(2018). Using indicators as a tool to evaluate municipal solid waste management: A critical review, *Waste Management,* 80:51-63.

Cetrulo, T.B. Marques, R.C. Cetrulo, N.M. Pinto, F.S. Moreira, R.M. Mendizabal-Cortes, A.D. Malheiros, T.F. (2018). Effectiveness of solid waste policies in developing countries: a case study in Brazil, *Journal of Cleaner Production*, 2015, 179-187.

Chadha, K. (2020). Informal waste workers: The issue of formalisation. https://sprf.in/wp-content/uploads/2021/02/24.07.2020_Informal-Waste-Workers_-The-Issue-of-Formalisation.pdf Accessed 17 March 2023

Chen, L. and Gao, M. (2021). Formal or informal recycling sectors? Household solid waste recycling behavior based on multi-agent simulation. *Journal of Environmental Management*, 294: 113006.

Chien, C. Aviso, K. Tseng, M. Fujii, M. and Lim, M.K. (2021). Solid waste management in emerging economies: Opportunities and challenges for reuse and recycling. *Resources, Conservation & Recycling*, 172: 105677.

Chileshe, B. and Moonga, M.S. (2017). Alternatives for Dumpsite Scavenging: The Case of Waste Pickers at Lusaka's Chunga Landfill. *International Journal of Humanities, Social Sciences and Education*, 4(6):40-51.

Choudhary, K. Sangwan, K.S. and Goyal, D. (2019). Environment and economic impacts assessment of PET waste recycling with conventional and renewable sources of energy. *Procedia CIRP*, 80: 422-427.

Christensen, T.B. (2021). Towards a circular economy in cities: Exploring local modes of governance in the transition towards a circular economy in construction and recycling. *Journal of Cleaner Production*, 305: 127058.

Cities Alliance. (2021). Liberia: Waste Pickers Fighting Plastic Pollution. https://www.citiesalliance.org/resources/multimedia/videos/liberia-waste-pickers-fighting-plastic-pollution (Accessed 20 October 2022).

Collins Chabane Local Municipality Report (2021). Reviewed Integrated Development Plan, 2021.

Combs, J.P. (2011). Data Analysis in Mixed Research: A Primer [ONLINE] Available at https://www.researchgate.net/publication/267387779 (Accessed 04 November 2021).

Conke, S.L. (2018). Barriers to waste recycling development: Evidence from Brazil, *Resources, Conservation and Recycling*, 134: 129-135.

Creswell, J.W. (2006). Qualitative inquiry and research design: Choosing among five approaches. London. Sage Publications. ISBN 13: 9781412916073

Creswell, J.W. (2014). Research design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed). https://doi.org/10.5539/elt.v12n5p40 (Accessed 15 October 2021).

Crowe, S. Cresswell, K. Robertson, A. Huby, G. Avery, A. And Sheikh, A. (2011). The Case Study Approach. *BMC Medical Research Methodology,* 11:100

Cruvinel V.R.N Zolnikov, T.R. Obara, M.T. Lopes de Oliveira V.T. Vienna, E-N. Ganem do Santos, F.S Cristina de Oliveira, K. and Scott J.A. (2020). Vector-borne diseases in waste pickers in Brasilia. Brazil. *Waste management*, 105:223-232.

Cruvinel, V.R.N. Zolnikov, T.R. Bashash, M. Marques, C.P.asld scoh, J.A. (2019). Waterborne diseases in waste pickers of Estructural, Brazil, the second largest open –air dumpsite in the world. *Waste management*, 99:71-78.

Danese, G. (2021). One person's trash is another person's treasure: In search of an efficient property regime for waste in the Global South. *Waste Management*, 128: 251-260.

Das, S. (2018). Recycling Practices of Solid Waste in Bagerhat City of Bangladesh. https://www.researchgate.net/publication/327463808 Accessed 30 July 2022.

Das, S. Lee, S.H Kumar, P. Kim, K. Lee, S.S. and Bhattacharya, S.S. (2019). Solid waste management: scope and the challenges of sustainability*, Journal of Cleaner Production*, 228:658-678.

Dawn. (2011). How to formalise the informal sector. https://www.dawn.com/news/681607/how-to-formalise-informal-sector Accessed 17 March 2023

De Vos, A.S. and Schulze, S. (2002). The Science and the Professions. *Research at the Grass Roots for the Social Sciences and Human Service Professions*, 2:340-341.

Demuth, C. and Mey, G. (2015). Qualitative Methodology in Developmental Psychology. http://dx.doi.org/10.1016/B978-0-08-097086-8.23156-5 Accessed 17 March 2023

Deus, R.M. Mele, F.D. Bezerra, B.S. and Battistelle, R.A.G. (2020). A municipal solid waste indicator for environmental impact: Assessment and identification of best management practices, *Journal of Cleaner Production*, 242: 118433.

Department of Forestry, Fisheries and the Environment and Department of Science and Innovation (2020). Waste picker integration guideline for South Africa: Building the

Recycling Economy and Improving Livelihoods through Integration of the Informal Sector. https://wasteroadmap.co.za/wp-content/uploads/2021/02/Waste-Picker-Integration-Guidelines.pdf Accessed 17 March 2023

Department of Planning, Monitoring and Evaluation. (2014) https://www.dpme.gov.za/keyfocusareas/outcomesSite/MTSF%201/Outcome%2010%20Environment%20MTSF%20Chapter.pdf Accessed 17 March 2023

Du Plesis, A. (2022). Uncovering the Nexus between the Informal Waste Economy and Municipal Solid Waste Management in the Mangaung Metropolitan Municipality. https://www.researchgate.net/publication/360080990 Accessed 30 July 2022 .

Dutra, R.M. Yamane, L.H. and Siman, R.R. (2018). Influence of the expansion of the selective collection in sorting infrastructure of waste pickers' organizations: A case study of 16 Brazilian cities. *Waste Management,* 77: 50-58.

Elmusharaf, K. (2012). Qualitative Sampling Techniques. http://www.gfmer.ch/SRH-Course-2012/research-methodology/Qualitative-sampling-techniques-Elmusharaf-2012.h Accessed 16 October 2021

Eriksen, M.K. Christiansen, J.D. Daugaard, A.E. and Astrup, T.F. (2019). Closing the loop for PET, PE and PP waste from households: influence of material properties and product design for plastic recycling, *Waste Management*, 96:75-85.

Fattor, M.V. Vieira, M.H.A. (2019). Application of Human HAZOP Technique adapted to identify risks in Brazillian waste pickers cooperatives, *Journal of Environmental Management*, 246:247-258.

Fedilis, R. Colmenero, J.C. (2018). Evaluating the performance of recycling cooperatives in their operational activities in the recycling chain. resource, *Conservation and Recycling*, 130: 152-163.

Ferdous, W. Manalo, A. Saddique, R. Mendis, P. Zhuge, Y. Wong, H.S Lokuge, W. Aravinthem, T and Schubel,P. (2021). Recycling of landfill wastes (tyres, plastic, and glass) in construction – A review on global waste generation, performances, application and future opportunities. *Resource, conservation and recycling*, 173:105745.

Ferronato, N. Moresco, L. Lizarazu, G.E.G. Portillo, M.A.G. Conti, F. and Torretta, V. (2021). Sensitivity analysis and improvements of the recycling rate in municipal solid waste life cycle assessment: Focus on a Latin American developing context. *Waste Management*, 128: 1-15.

Fiksel, J. and Lal, R. (2018). Transforming waste into resources for the Indian economy. *Environmental Development,* 26: 123-128.

Franco de Diana, D. Abreu, J.S. Serafini, D.C. Ortiz, J.F. Samaniego, M.J. Aranda, A.C. Zamorano-Ponce, E. (2018). Increased genetic damage found in waste picker women in a landfill in Paraguay measured by comet assay and the micronucleus test. *Mutation Research Genetics Toxicology and Environmental Mutagenesis,* 836: 19-23.

Fulwani, D. Banda, D. Shah, H. and Chandel, D. (2020). Women rag pickers at a dump in Ahmedabad: Genotoxicity and Oxidative stress. *Mutation Research-Genetic Toxicology and Environmental Mutagenesis*, 503254: 858-860.

Fuss, M. Barros, R.T.V. and Poganietz, W. (2021). The Role of Socio-integrated recyclingsystems in implementing a circular economy- the case of Belo Horizonte, Brazil. *Waste Management*, 121: 215-225.

Gall, M. Weiner, M. Chagas de Oliveira, C. Lang, R.W. and Hansen, E.G. (2020). Building a circular plastic economy with informal waste pickers: Recyclate quality, business model, and societal impacts*. Resource, Conservation & Recycling*, 156: 104685.

Ganem dos Santos, F.S. Zolnikov, T.R. Ribas, I.B. Casabona, J. Monteiro, E. Martins, E. Franca, D. Navegantes de Araujo, W. and Cruvinel, V.R.N. sysphilis and other sexually transmitted infections among waste pickers in Brasilia, Brazil. *Waste Management*, 118: 122-130.

Godfrey, L. and Oelofse, S. (2017). Historical Review of Waste Management and Recycling in South Africa. *MDPI Resources*, 6:57.

Golzar, J. Noor, S. and Tajik, O. (2022). Convenience Sampling. http://dx.doi.org/10.22034/ijels.2022.162981 Accessed 17 March 2023

Guibrunet, L. (2019). What is “informal” in Informal Waste Managemnt? Insights from the case of waste collection in Tepito Neighborhood, Mexico City. *Waste Management*, 86: 13-22.

Gutberlet, J. (2015). Cooperative Urban Mining in Brazil: Collective Practices in Selective Household Waste Collection and Recycling. *Waste Management*, 45: 22-32.

Gutberlet, J. (2021). Grassroots Waste Pickers Organisation Addressing the UN Sustainable Development Goals. *World Development,* 138: 105195.

Hartmann, C. (2018). Waste Picker Livelihoods and Inclusive Neoliberal Municipal Solid Waste Management Policies: The Case of La Chureca Garbage Dump Site in Managua, Nicaragua. *Waste Management,* 71: 565-577.

Heidari, R. Yazdanparast, R. and Jabbarzadeh, A. (2019). Sustainable Design of a Municipal Solid Waste Management System Considering Waste Separators: A Real-World Application, *Sustainable Cities and Society,* 47: 101457.

Hesran, C.L. Ladier, A. Botta-Genoulaz, V. and Laforest, V. (2019). Operations scheduling for waste minimization: A review. *Journal of Cleaner Production*, 206: 211-226.

Hou, C. and Sarigollu, E. (2021). Waste prevention by consumers' product redistribution: Perceived value, waste minimization attitude and redistribution behavior. *Waste Management,* 132: 12-22.

Hull, C.E. Millette, S. and Williams, E. (2021). Challenges and opportunities in building circular-economy incubators: Stakeholder perspectives in Trinidad and Tobago. *Journal of Cleaner Production*, 296: 126412.

Ibanez-Fores, V. Coutinho-Nobrega, C. Bovea, M.D. De Mello-Silva, C. and Lessa-Feitosa-Virgolino, J. (2018). Influence of implementing selective collection on municipal waste management systems in developing countries: a Brazilian case study. *Resource, Conservation and Recycling.* 134: 100 – 111.

Issock, P.B.I. Mpinganjira, M. and Roberts-Lombard, M. (2021). Trying to recycle domestic waste and feelings of guilt: a moderated mediation model applied to South African households. *Sustainable Production and Consumption*, 27: 1286-1296.

Iyamu, H.O. Anda, M. and Ho, G. (2020). A review of Municipal solid waste management in the BRIC and high-income countries: A thematic framework for low-income countries. *Habitat International,* 95: 102097.

Jaffe, K. Dong, H. Godefroy, A. Boutang, D. Hayashi, K. Milloy, M.J.S. Kerr, T. and Richardson, L. (2018). Informal recycling, income generation and risk: health and social harms among people who use drugs. *International Journal of Drug Policy,* 60: 40-46.

Jaligot, R. Wilson, D.C. Cheeseman, C.R. Shaker, B. and Stretz, J. (2016). Applying value chain analysis to informal sector recycling: A case study of the Zabaleen. *Resource, Conservation and Recycling*, 114: 80-89.

Janani, R. and Lalithambigai, N. (2021). A critical literature review on minimizing of material wastes in construction projects. *Materials Today: Proceedings*, 37: 3061-3065.

Kamdar, I. Ali, S. Bennui, A. Techato, K. and Jutidamrongphan, W. (2019). Municipal Solid Waste Landfill Siting Using an Integrated GIS-AHP approach: A Case Study From Songkhla, Thailand. *Resource, Conservation and Recycling*, 149: 220-235.

Karuiki, J.M. Bates, M. Magana, A. (2019). Characteristics of waste pickers in Nakuru and Thika municipal dumpsites in Kenya. Current Journal of Applied Science and Technology, 37(1): 1-11.

Kasinga, C. and Tilley, E. (2018). Formalizatopn of informal waste pickers cooperatives in Blantyre, Malawi: a feasibility assessment. https://doi.org/10.3390/SU10041149 Accessed 17 March 2023

Katusiimeh, M.W. Burger, K. and Mol, A.P.J. (2013). Informal waste collection and its co-existence with the formal sector: The case of Kampala, Uganda. *Habitat International*, 38: 1-9.

Kaza, S. Yao, L. Bhada-Tata, P. and Van Woerden, F. (2018). What a waste 2.0: A global snapshot of solid waste management to 2050. Washington DC: The World Bank.

Kirchherr, J. reike, D. and Hekkert, M. (2017). Conceptualizing the circular economy an analysis of 114 definitions. *Resources, Conservation & Recycling,* 127: 221-232.

Koerber, A. and McMichael, L. (2008). Qualitative Sampling Methods: A Premer for Technical Communicators. https://doi.org/10.1177/1050651908320362 Accessed 17 March 2023.

Kumar, A. Samadder, S.R. Kumar, N. and Singh, C. (2018). Estimation of the generation rate of different types of plastic wastes and possible revenue recovery from informal recycling. *Waste Management*, 79: 781-790.

Lalitha, R. Fernando, S. (2019). Solid waste management of local government in the western province pf Sri Lanka: An implementation analysis, *Waste Management*, 84:194-203.

Lindisfarne Press (2001). Evaluate the Comparative usefulness of Formal and Informal Interviews.

Lishan, X. Sha, H. Zhilong, Y. Ouwen, W. and Tao, L. (2021). Identifying multiple stakeholders' roles and network in urban waste separation management – a case study in Xiamen, China. *Journal of Cleaner Production*, 278: 123569.

Luiz da Silva, C. Weins, N. and Pontinkara, M. (2019). Formalizing the informal? a perspective on informal waste management in the brics through the lens of institutional economics. *Waste Management*, 99: 79-89.

Ma, B. Li, X. Jiang, Z. and Jiang, J. (2019). Recycle More, Waste More? When Recycling Efforts Increase Resource Consumption. *Journal of Cleaner Production*, 206: 870-877.

Mabadahanye, V. (2017). The study of Waste Management practices within households in Khakhanwa Village, Thulamela Municipality. University of Venda.

Mahmood, K. (2013). Mixed Methods Research [Online] Available at https://cirt.gcu.edu/research/developmentresources/research_ready/mixed_methods/overview Accessed 30 September 2021.

Makhado Local Municipality Report (2021). Final Integrated Development Plan 2021/22.

Makhado Local Municipality Report (2018). Integrated Waste Management Plan 2018 – 2023.

Maluleke, P. (2017). An assessment of the challenges faced by Thulamela Local Municipality and local residents in their pursuit of sustainable household/domestic waste management practices in Bolmat village, Limpopo Province. University of Venda.

Mannie, N.M. and Viviers, H. (2016). Just imagine. *Institute of Waste Management South Africa,* 161-170.

Mapa, M.T. Powel, J.C. Asis, A.H.B. Sakke, N. and Gulusan, A. (2019). Waste Scavenging and its Contribution for Survival and Urban Recycling in Kota Kinabalu City, Sabah, Malaysia. *Indonesia Journal of Geography*, 51(2): 183-189.

Marquez, A.J.C. and Rutkowski, E.W. (2020). Waste management drivers towards a circular economy in the global south – The Colombian case. *Waste Management*, 110: 53-65.

Mascarenhas, L.C. Ness, B. Oloko, M. and Awour, F.O. (2021). Multi-criteria analysis of Municipal Solid Waste Treatment Technology to Support Descision Making in Kisumu, Kenya. *Environmental Challenges,* 4: 100189.

Mathakho, K. (2019). Investigation of municipal solid waste management: a case study of Vhembe District Municipality, South Africa. University of Venda.

Mcleod, S. (2023). Qualitative Vs Quantitative Research: Differences, Examples and Methods. https://simplypsychology.org/qualitative-quantitative.html Accessed 17 March 2023

Melare, A.V. Gonzalez, S.M. Faceli, K. and Casadei, V. (2017). Technologies and Decision Support Systems to aid Solid-Waste Management, a System Review. *Waste Management*, 59: 567-584.

Minelgaite, A. and Liobikiene, G. (2019). Waste Problem in European Union and its Influence on Waste Management Behaviours, *Science of the Total Environment*, 667: 86-93.

Moh, Y. and Manaf L.A. (2017). Solid Waste Management Transformation and Future Challenges of Source Separation and Recycling Practice in Malaysia, *Resource, Conservation and Recycling,* 116: 1-14.

Mohr-Swart, M. and Godschalk, S. (2016). Waste Reclamation – a Framework for the Roles and Resposibilities of the Stakeholders involved, *Institute of Waste Management of Southern Africa,* 178 – 183.

Muheirwe, F., Kombe, W., & Kihila, J. M. (2022). The paradox of solid waste management: A regulatory discourse from Sub-Saharan Africa. *Habitat International*, 119: 102491.

Munyai, O. and Nunu, W.N. (2020). Health Effects associated with Proximity to Waste Collection Points in Beitbridge Municipality, Zimbabwe. *Waste Management*, 105: 501-510.

Musina Local Municipality Report (2021) Reviewed Integrated Development Plan, 2021/22.

Muswema, A. and Oelofse, S. H. (2016). Implementing Small, and Medium Enterprises (SME) Waste and Recycling Programmes. *Institute of Waste Management of Southern Africa*, 497-502.

Mwanza, B.G. and Mhohwa, C. (2017). Drivers to Sustainable Plastic Solid Waste Recycling A Review. *Procedia Manufacturing*, 8: 649-656.

Mwanza, B.G. Mbohwa, C. Telukdarie, A. and Medoh, C. (2019). Value Addition to Plastic Solid Wastes: Informal Waste Collectors' Perspective, *Procedia Manufacturing*, 33: 391-397.

Nackerdien, F. and Yu, D. (2019). A Panel data analysis of the Formal-Informal sector Labour Market linkages in South Africa. *Development Southern Africa*, 36(3): 329-350.

Nahman, A., Godfrey, L. (2010). Economic Instruments for Solid Waste Management in South Africa: Opportunities and Constraints, *Resource, Conservation and Recycling,* 54, 521-531.

Nalini, S. and Arora, k. (2021). Waste Pickers and workers in the informal waste industry: The pillars of Extended Producers Responsibility. https://globalrec.org/2021/03/24/waste-pickers-and-workers-in-the-informal-waste-industry-the-pillars-of-extended-producers-responsibility/ (Accessed 20 October 2022).

Nambuli, F. Togarepi, C. and Shikongo, A. (2021). Waste Scavenging a problem or an opportunity for Integrated Waste Management in Namibia: A case of Keetmanshoop Municipality, Namibia. *Environment and Pollution*, 10(2).

Nandy, B. Sharma, G. Garg, S. Kumari, S. George, T. Sunanda, Y. and Sinha, B. (2015). Recovery of Consumer Waste in India – A Mass Flow Analysis for Paper, Plastic and Glass and the Contribution of Households and the Informal Sector, *Resource, Conservation and Recycling*, 101: 167-181.

Navarrete-Hernandez, P. Navarrete-Hernandez, N. (2018). Unleashing Waste-Pickers' Potential: Supporting Recycling Cooperatives in Santiago de Chile. *World Development,* 101: 293-310.

Nefale, A. (2018). An Evaluation of Strategic Management of Landfill Sites: A Case Study of Thohoyandou Block J Landfill Site, Vhembe District Municipality, Limpopo Province. University of Venda.

Nemadire, S. Mupurazi, S. and Nyamadzawo, G. (2017). Formalising Informal Solid Waste Recycling at the Pomona Dumpsitein Harare, Zimbabwe. *Natural Resource Forum*, 41: 167-178.

Nguyen, T.H. Nguyen, H. Nguyen, T.T. Le T.T.T. and Nguyen T.H.Y. (2021). Recyclable waste collection by informal sector in Vietnam: Dataset from Vinh, Nha Trang, Buon Ma Thout, Da Nang, Ho Chi Minh and Hanoi Cities. *Data in Brief*, 36: 106979.

Ogwueleka, T.C. and Naveen, B.P. (2021). Activities of informal recycling sector in North-Central, Nigeria. *Energy Nexus,* 1: 100003.

Ojovan, M.I. Lee, W.E. and Kalmykov, S.N. (2019). An Introduction to Nuclear Waste Immobilisation, Third Edition. ISBN: 978-0-08-102702-8.

Olatayo, K.I. Mativenga, P.T. and Marnewick, A.Z. (2021). Comprehensive Evaluationn of Plastic Flows and Stocks in South Africa. *Resource, Conservation and Recycling*, 170:105567.

Omosimua, I.J. Oluranti, O.I. Obindah, G. and Busayo, A. (2020). Working Conditions and Career Aspirations of Waste Pickers in Lagos State. *Recycling*, 6:1.

Ouda, O.K.M. Rehan, M. Nader, N. and Nazim, A. (2017). Environmental and Economic Benefits of Recovered Paper: A Case Study of Saudi Arabia. *Energy Procedia*, 142: 3753-3758.

Paul, K. and Bhattacharjee, P. (2022). Livelihood Status and Health Condition of Waste Pickers in Sylhet City Corporation: A Study. *Space and Culture, India,* 9:4.

Petkovic, B. Agdas, A.S. Zandi, Y. Nikolic, I. Denic, N. Radenkovic, S.D. Almojil, S.F. Roco-Videla, A. Kojic, N. Zlatkovic, D. and Stojanovic, J. (2021). Neuro fuzzy evaluation of circular economy based on waste generation, recycling, renewable energy, biomass and soil pollution. *Rhizosphere*, 19: 100418.

Phonchi-Tshekiso, N.D. Mmopelwa, G. and Chanda, R. (2020). From public to private solid waste management: Stakeholders perspectives on private-public solid waste management in Lobatse, Botswana. *Chines Journal of Population, Resources and Environment*, 18: 42-48.

Pincelli, I.P. Borges de Castilhos Junior, A. Matias, M.S. and Rutkowski, E.W. (2021). Post-consumer plastic packaging waste flow analysis for Brazil: The challenges moving towards a circular economy. *Waste Management*, 126: 781-790.

Pupping de Oleveira, J.A. (2019). Intergovernmental relations for environmental governance: Cases of solid waste management and climate change in two Malaysian States. *Journal of Environmentall Management,* 233: 481-488.

Rahi, S. (2017). Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development. *International Journal of Economics & Management Sciences,* 6: 403

Ramukhwatho, F.R. du Plesis, R. and Oelofse, S. (2016). Household food wastage by income level: A case study of five areas in the city of Tshwane Metropolitan Municipality, Gauteng Province, South Africa. *Proceedings of the 23rd WasteCon Conference:* 57-67.

Rendon, M. Espluga-Trenc, J. and Verd, J. (2021). Assessing the functional relationship between the formal and informal waste systems: A case-study in Catalonia (Spain). *Waste Management,* 131: 483-490.

Report: Vhembe District Municipality (2021). Integrated Development Plan review for 2021/2022.

Romano, G. Rapposelli, A. and Marrucci, L. (2019). Improving waste production and recycling through zero-waste strategy and privatization: An empirical investigation, *Resources, Conservation and Recycling*, 146: 256-263.

Salau, O. Osho, S. Pizarro, R. Sen, L. Adejonwo-Osho, O. and Osho, G. (2017). The impacts of the Informal Sector on the Economics of the Municipal Waste Management System in Lagos State: An overview of its Income Generation Potentials for the Vulnerable Urban Poor in Developing Countries. *Journal of Global Ecology and Environment*, 6(1): 35-44.

Samson, M. (2019). Whose frontier is it anyways? Reclaimer “integration” and the battle over Johannesburg’s waste-based commodity frontier. *Capitalism Nature Socialism,* 31:4, 60-75.

Sandhu, K. Burton, P. and Dedekorkut-Howes, A. (2017). Between Hype and Veracity: Privatization of Municipal Solid Waste Management and it’s on the Informal Waste Sector. *Waste Management*, 59: 545-556.

Sapkota, S. Lee, A. Karki, J. Makai, P. Adhikari, S. Chaudhuri, N. and Fossier-Heckmann, A. (2020). Risk and risk mitigation in waste-work: A qualitative study of informal waste workers in Nepal. *Public Health in Practice,* 1: 100028.

Sasaki, S. and Akari, T. (2013). Employer-Employee and Buyer-Seller Relationships among Waste Pickers at Final Disposal Site in Informal Recycling: The Case of Banter Gebang in Indonesia. *Habitat International*, 40: 51-57.

Sasaki. S. Choi, Y. and Watanabe, K. (2022). Economic Status of Waste Pickers in Bantar Geban compared to other Workers in Indonesia. *Habitat International,* 119: 102501.

Schenck, C.J. Blaauw, P.F. Viljoen, J.M.M. and Swart, E.C. (2019). Exploring the Potential Health Risk Faced by Waste Pickers on Landfills in South Africa: A Socio-Ecological Perspective. *International Journal of Environmental Research and Public Health,* 16(11): 2059.

Schmitz, A. (2012). Online Surveys: Gathering Data. [Online] Available at https://saylordotorg.github.io/text_emarketing-the-essential-guide-to-online-marketing/s21-04-online-surveys-gathering-data.html Accessed 04 October 2021.

Schoonenboom, J. and Johnson, R.B. (2017). How to construct a mixed methods research design. *Kolner Zeitschriftfur Soziologic und Sozialpsychologie.* 69: 107-131

Schurink, W.J. 2005. Lecture thirteen: Evaluating qualitative research. Johannesburg: Department of Human Resource Management, University of Johannesburg.

Shah, A.V. Srivastava, V.K. Mohanty, S.S. and Varjani, S. (2021). Municipal solid waste as a sustainable resource for energy production: State-of-the-art review. *Journal of Environmental Chemical Engineering*, 9: 105717.

Shi, Y. Wang, Y. Yue, Y. Zhao, J. Maraseni, T. and Qian, G. (2021). Unbalanced Status and Multidimensional Influences of Municipal Solid Waste Management in Africa. *Chemosphere*. 281: 130884.

Siman, R.R. Yamane, L.H. Baldam, R. Tackla, J.P. Lessa, S.F. and Mendonca de Britto, P. (2020). Governance Tools: Improving the Circular Economy through the Promotion of the Economic Sustainability of Waste Picker Organizations. *Waste Management*, 105: 148-169.

Simatele, D.M. Dlamini, S. and Kubanza, N.S. (2017). From Informality to Formality: Perspectives on the Challenges of Integrating Solid Waste Management into the Urban Development and Planning Policy in Johannesburg, South Africa. *Habitat International*, 63: 122-130.

Simatele, D.M. and Etambakonga, C.L. (2015). Scavenging for solid waste in Kinshasa: A livelihood strategy for the urban poor in the Democratic Republic of Congo. *Habitat International.* https://www.researchgate.net/publication/278333020 Accessed 23 October 2022.

Singh, A. (2019). Managing the Uncertainty Problems of Municipal Solid Waste Disposal, *Journal of Environmental Management*, 240: 259-265.

Sotamenou, J. De Jaeger, S. and Rousseau, S. (2019). Drivers of Legal and Illegal Solid Waste Disposal in the Global South- The Case of Households in Yaounde (Cameroon), *Journal of Environmental Management*, 240: 321-330.

Stafford, W.H.L. (2020). Municipal solid waste energy conversion in developing countries. *Technologies, Best Practices, Challenges and Policy*, 1: 185-217.

Steuer, B. Ramusch, R. Part, F. and Salhofer, S. (2017). Analysis of the Value Chain and Network Structure of Informal Waste Recycling in Beijing, China. *Resource, Conservation and Recycling*, 117: 137-150.

Suthar, G. and Babu, P. (2017). Municipal solid waste management: Current approaches, gaps and solutions. *Open Access International Journal of Science & Engineering*, 2 (10): 111-115.

Suthar, S. Rayal, P. Ahada, C.P.S. (2016). Role of Different Stakeholders in Trading of Reusable/Recyclable Solid Waste Materials: A Case Study, *Sustainable Cities and Society,* 22: 104-115.

Taiwo, O.E. Venter, C. Oso, K.A. (2016). Treating Waste as a Resource in the Cities of Lagos and Johannesburg, *Institute of Waste Management of Southern Africa,* 466-475.

Taleb, M.A. and Farooque, O.A. (2021). Towards a circular economy for sustainable development: An application of full cost accounting to municipal waste recyclables. *Journal of Cleaner Production*, 280: 124047.

Taylor, L. (2020). Case Studies. *International Encyclopaedia of Human Geography*, 2: 95-100.

Thakur, P. Ganguly, R. and Dhulia, A. (2018). Occupational Health Hazard Exposure among Municipal Solid Waste Workers in Himachal Pradesh, India, *Waste Management*, 78: 483-489.

Thulamela Local Municipality Report (2021). Reviewed Integrated Development Plan, 2021/22.

Tiew, K. Basri, N.E.A Watanabe, K. Zain, S.M and Wang, S. (2019). Comparative study on recycling behaviors between regular recyclers and non-regular recyclers in Malaysia, *Journal of Environmental Management*, 237: 255-263.

Timm, S. Chidzungu, T. Dladla, N. Kadyamadare, G. Maema, K. Mahlase, M. Mokobane, A. Molefe, K., Ndlovu, L., Ntuli, Z. Phakoe, K. Pholoto, L., Sekhwela, M. And Shogole, M.

and Samson, M. (2020). Final Technical Report: Johannesburg Case Study Lessons from Waste Picker Integration Initiatives. https://www.researchgate.net/publication/342976454_Final_Technical_Report_Johannesburg_Case_Study_Lessons_from_Waste_Picker_Integration_Initiatives Accessed 17 March 2023.

Tong, Y.D. Huynh, T.D.X. and Khong, T.D. (2021). Understanding the role of informal sector for sustainable development of municipal solid waste management system: A case study in Vietnam. *Waste Management*, 124: 118-127.

Turner, D.P. (2020). Sampling methods in research design [ONLINE] Available at https://doi.org/10.1111/head.13707 (Accessed 10 November 2021).

Uddin, S.M.N. and Gutberlet, J. (2018). Livelihoods and Health status of informal recyclers in Mongolia, *Resources, Conservation and Recycling*, 134: 1-9.

Valanzuela-Levi, N. (2021). Poor performance in municipal recycling: The case of Chile. *Waste Management,* 133: 49-58.

Van der Werff, E. Vrieling, L. Van Zuijlen, B and Worrell, E. (20219). Waste minimization by household – A unique informational strategy in the Netherlands. *Resource, Conservation & Recycling*, 144: 256-266.

Vassanadumrongdee, S. and Kittipongvises, S. (2018). Factors influencing Source Separation Intention and Willingness to Pay for Improving Waste Management in Bangkok, Thailand. *Sustainable Environmental Research*, 28: 90-99.

Vhembe District Municipality Report (2021). Final Integrated Development Plan, 2021/2022.

Vosloo, J. (2014). Research Design and Methodology. https://dspace.nwu.ac.za/bitstream/handle/10394/12269/Vosloo_JJ_Chapter_5.pdf?sequence=6 Accessed 16 October 2021

Wang, Y. Shi, Y. Zhou, J. Maraseni, T. and Qian, G. (2021). Implementation effect of municipal solid waste mandatory sorting policy. *Journal of Environmental Management*, 298: 113512.

Wei, F. Zhu, Q. Pourhejazy, P. and Liu, C. (2021). Contract vs recruitment: integrating an informal waste merchant to a formal collector for collection of municipal solid waste. *Journal of Cleaner Production,* 287: 125004.

Wilson, C. (2014). Semi-structured Interviews [ONLINE] Available at https://doi.org/10.1016/B978-0-12-410393-1.00002-8 (Accessed 01 November 2021)

Wittmer, J. (2021). “We live and we do this work”: Women Waste Pickers’ experiences of wellbeing in Ahmedabad, India. World Development, 140: 105253.

WSP. (2018). Informal Economy – What is it and how can we formalise the sector? https://www.wsp.com/en-gb/insights/informal-economy-what-is-it-and-how-can-we-formalise-the-sector Accessed 17 March 2023

Wynne, L.A. Nieves, P.M. Vulava, V.M. Qirko, H.N. and Callahan, T.J. (2018). A community-based approach to solid waste management for riverine and coastal resource sustainability in the Philippines. *Ocean and Coastal Management*, 151: 36-44.

Xiao, J.X. Lou, M.J. and Li, W. (2021). Evaluation of models for household recycling behaviour in high-rise buildings: A Chinese case study in urban Guangzhou. *Waste Management*, 131: 125-135.

Xue, Y. Wen, Z. Bressers, H. and Ai, N. (2019). Can Intelligent Collection Integrate Informal Sector for Urban Resource Recycling in China? *Journal of Cleaner Production*, 208: 307-315.

Yildiz-Geyhan, E. Altun-Ciftcioglu, G.A. and Kadirgan, M.A.N. (2017). Social life cycle assessment of different packaging waste collection system. *Resource, Conservation & Recycling*, 124: 1-12.

Yoo, S.H Rhim, H. and Park, M. (2019). Sustainable waste and cost strategies in a strategic buyer-supplier relationship, *Journal of Cleaner Production,* 237: 117786.

Yousafzai, M.T. Nawaz, M. Xin, C. Tsai, S. and Lee, C. (2020). Sustainability of Waste Pickers Sustainoprenuers in Pakistan's Informal Solid Waste Management System for Cleaner Production. *Journal of Cleaner Production*. 267: 121913.

Yu, D. Blaauw, D. and Schenck, R. (2020). Waste Pickers in Informal Self-employment: Over-worked and the Breadline. *Development Southern Africa*, 37(6): 971-996.

Zaman, A.U. and Swapan M.S.H. (2016). Performance Evaluation and Benchmarking of Global Waste Management Systems. *Resource, Conservation and Recycling*, 114: 32-41.

Zolnikov, T.R. Costa da Silva, R. Tuesta, A.A. Marques, C.P. and Cruvinel V.R.N. (2018). Ineffective waste site closures in Brazil: A systemetic review on continuing health conditions and occupational hazards of waste collectors. *Waste Management,* 80: 26-39.

Zon, J.L.N. Leopoldino, C.J. Yamane, L.H. and Siman R.R. (2020). Waste pickers organizations and municipal selective waste collection: Sustainability indicators. *Waste Management*, 118: 219-231.

APPENDIX A

QUESTIONNAIRE DIRECTED TO INFORMAL WASTE PICKERS OPERATING WITHIN LUOIS TRICHARDT, THOHOYANDOU, MALAMULELE AND MUSINA TOWNS AS WELL AS WASTE PICKERS OPERATING IN MUSINA, MAKHADO AND THULAMELA LANDFILL SITES

The main purpose of this questionnaire is to gain knowledge on the role the informal waste sector play in municipal solid waste management system within the four local municipalities in Vhembe District. Furthermore, the questionnaire will try to collect data from pickers regarding their knowledge of recycling rates and the recycling processes, as well as demographic and social profile of respondents; educational levels of the respondents, respondent's employment status, and attitude waste pickers receive from the public, the activities carried out by informal waste pickers and challenges the waste pickers experience as well as the type of support the formal sector provides to the informal waste sector

Respondent No: _____

Date: _____

Mark applicable options with an (X) within the provided box next to the options

SECTION A: DEMOGRAPHIC AND SOCIAL PROFILE OF THE RESPONDENTS												
1. Age	10-19 Years		20-29 Years		30-39 Years		40 Years and above					
2. Gender	Male		Female									
3. Marital Status	Single		Married		Divorced		Widowed		Separated			
4. Size of Family	None		1-2		3-4		5 and above					
SECTION B: EDUCATION												
5. Have you attended any formal school?	Yes		No									
6. Highest grade passed (provide grade in Space provided e.g. 12)	Grade 1-5		Grade 6-9		Grade 10-12							
7. Tertiary Education	Certificate		Diploma		Degree/ BTech		Other (specify)					
SECTION C: EMPLOYMENT STATUS												
8. What do you do for a living?	Self-employed		Formally employed		Informally employed		Unemployed					
9. Have you ever been involved in……?	Hawking		Professional		Catering		Piece Jobs					
10. How long have you been involved in the activities mentioned in question 9?	1 year and below		2-5 years		6-9 years		10 years and above					
11. Previous employment	Never employed		Sales Person		Driver		Other (Specify)					
12. Reason for leaving previous employment	Retired		Working Conditions		Business Closure		Other (Specify)					
13. What is your Monthly level of income?	R50-R400		R500-R1200		R1300-R2500		R2600 and above					
14. Are you satisfied with the money you get?	Yes		No									
SECTION D: WASTE PICKER ACTIVITIES												

15. Are you a full-time or part-time waste picker?	Full-time		Part-time									
16. What type of waste picker are you?	Itinerant waste-Buyer		Street Waste-Picker		Reclaimer / dumpsite waste picker		Other (specify)					
17. What is the reason for your involvement in waste picking?	Survival (source of income)		Environmental protection		Other (Specify)	_____ _____ _____ _____						
18. How long have you been practicing waste picking?	0-5 years		6-10 years		11-15 years		16 years and above					
19. Where is your preferred area of work?	CBD		Landfill site		Rural		Urban		Transfer station			
20. What is the type of waste/ recyclable materials do you collect?	Glass		Paper (Inc. Card box)		Aluminium		PET / Plastic					
	Metal		Compost		Carton		Bricks					
21. How much in KG do you collect per day (If there is no scale, estimate)												
22. Where do you take your recyclables after collection?	Major Recycling Companies		Buy-Back Centres		Recycling Dealers		Own a Re-use / and Recycle business					
23. How much is the recycling rate within your area of work?												
24. How many KM do you have to travel to get to work?	0-10 km		11-20 km		21-30 km		31 km and above					
25. How much do you spend per month at work	0 - R250		R250 - R500		R500-R1000		Above R1000					
26. Are any of you family members involved in your work (Tick the applicable member)	Kids		Siblings		Spouse							

27. In what form are your family members involved in your work	Waste Picking		Financial support		Other (Specify)	_____ _____ _____ _____

SECTION E: OPRATIONAL CHALLENGES

28. Which of the following can you say are the challenges u experience when working? (you can choose more than 1)	Social Stigma		Exploitation		Harassment		Financial Challenges		Lack of resources
	Other (specify)	_____ _____ _____ _____ _____ _____							
29. What attitude does society and officials show towards you and your work?	Positive		Negative		Neutral		Sicken		
30. How would you rate the recycling rate from recycling dealer you are currently using?	Poor		Fair		Good		Very Good		
31. Does your local municipality allow your work? (elaborate)	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____								

SECTION F: OCCUPATIONAL HEALTH AND SAFETY CHALLENGES

32. Are you familiar with any Occupational Health and Safety measures?	Yes		No
33. Do you carry a fist aid kit?	Yes		No
34. What form of illness or injuries do you incur from your line of duty?	_____ _____ _____ _____ _____ _____ _____		

35. What hazardous substances do you encounter?	_____ _____ _____ _____ _____											
36. Do you have any access to clean drinkable water and sanitation?	Yes						No					
37. Do you have proper PPE related to your work?	Yes						No					
38. How secure and safe is your workplace	Not secured and safe		Slightly secured and safe		Secured and safe		Very secured and safe					
39. Do you go for any medical inductions on regular basis?	Yes						No					
40. How many hours do you work per day?	0-4 hrs		5-9 hrs		Above 10 hrs							
SECTION G: SUPPORT AND IMTEGRATION OF THE INFORMAL INTO THE MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM												
41. How does your local municipality support your work?	Funding		Advice		Capacity Building/ Training		State Incentives / initiatives		Facilities and Resources			
	Other (specify)											
42. Does your local municipality have a recycler's forum that you know of?	Yes						No					
43. If your answer is yes above, are you part of the forum?	Yes						No					
44. Are you aware of funding options within your area of work?	Yes						No					
45. Do you have access to municipal waste facilities for recovery of recyclables?	Yes						No					

46. Does your local municipality hold any activities/ event that involves you? Elaborate	_____ _____ _____ _____ _____ _____

Thank you for your co-operation

APPENDIX B

INTERVIEW SCHEDULE DIRECTED TO THE RESPONSIBLE ORGANISATION (LOCAL GOVERNMENT WITH REGARD TO WASTE MANAGEMENT WITHIN VHEMBE DISTRICT MUNICIPALITY)

The main purpose of this interview is to provide information on policies and strategies that governs waste management in Makhado, Thulamela, Musina and Collins Chabane Local Municipalities. This information will help in determining the support provided by the local government to the informal waste sector and to identify whether the municipality is aware of the informal waste activities that are occurring within its jurisdiction. It will also assist with the evaluation of the municipality strategies to integrate the informal waste sector into its municipal solid waste management system. The interview will also try to identify whether there is a need/ opportunity for improvement or whether the existing strategies are efficient.

Municipality: _____

Date of Interview: _____

Mark applicable options with an (X) within the provided box next to the options

1. Does your municipality's legal framework include informal waste pickers?

   _____

   _____

   _____

   _____

2. Does your municipality have any strategies or planned strategies to integrate the informal waste sector into their municipal solid waste management system? Elaborate

   _____

   _____

   _____

   _____

   _____

3. How effective is / are the strategies in conducting waste management services within your municipality?

Highly effective		Moderately effective		Ineffective	

4. Is the municipality aware of any informal waste pickers/ recyclers within its Jurisdiction?

Yes		No	

5. If above in 4 your option was yes,

   i. Do you find their existence within your municipality beneficial?

Yes		No	

   ii. In what ways does the informal waste sector benefit the municipality

Waste collection costs		Waste reduction		Other (specify)	

   _____

   _____

   _____

6. In your opinion, is informal waste picking a solution to the global waste management problem?

Yes		No	

7. Does the municipality support informal waste activities? If yes how?

8. Does the municipality have any facilities that supports informal waste activities?

Yes		No	

9. Was the information about the support and facilities conveyed to the public? If yes how?

10. Is there any form of compensation provided by the municipality to the informal waste pickers used as a strategy to promote recycling activities? If yes Illustrate.

Thank you for your co-operation

APPENDIX C

INTERVIEW SCHEDULE DIRECTED TO RECYCLING BUYBACK CENTRES WITHIN VHEMBE DISTRICT MUNICIPALITY

The main purpose of this interview is to provide insight on the most dominant type of recyclable Vhembe District Recycles, recycling rates, level of exploitation, and major suppliers of valuable wastes within the district. The interview will also provide information on whether the municipalities support buyback centers as well as how buyback centers conduct their business with informal waste pickers and the type of support buyback centers offers to informal waste pickers

Buyback Centre No: _____

Date of Interview: _____

Mark applicable options with an (X) within the provided box next to the options

1. How long has your organization been in operation?

   _____

2. Does your local municipality know of your operation?

Yes		No	

3. If you answered yes above does your organization report monthly/weekly of its activities?

Yes		No	

4. What are the types of waste/recyclables does your organization deal with?

Paper Inc. card boxes		Plastic		Metals Inc. aluminum cans		Glass		Other (Please Specify	

_____

_____

_____

5. What is your recycling rate per kilogram?

Type of Waste	Rate/Kg (R)
Paper	
Plastic	
Metals	
Glass	

6. Are the local informal waste pickers happy with your organization's recycling rates?

Yes		No	

7. Does your organization conduct waste recovery activities?

Yes		No	

8. If your answer was yes above
   i. Where do you conduct waste recovery?

   _____

   _____

   ii. Between your organization and informal waste picker who would you say is the major supplier of recovered waste material (recyclables)?

The Organization		Informal Waste Pickers	

9. How many tons or kilograms of recyclables does your organization receive per month?

Type of Waste	**Tons/kg per month**
Paper	
Plastic	
Metals	
Glass	

10. In what form does your organization support local informal waste pickers?

_____

_____

_____

Thank you for your co-operation

APPENDIX D

FIELD OBSERVATION CHECKLIST

Y = Yes N= No P= Partially

No.		Y	N	P	Comment
1.	Does waste picking contribute to the local economy (poverty alleviation and income generation) for informal waste pickers?				
2.	Does informal waste pickers within Vhembe District Municipality have access to valuable waste materials?				
3.	Does the informal waste sector play a role in municipal solid waste and the circular economy?				
4.	Does the public accept and value the work conducted by the informal waste pickers?				
5.	Is the existence of the informal waste pickers beneficial for both the municipal and the environment?				
6.	Does the informal waste pickers wear any form of Personal Protective Clothing?				
7.	Are there any harmful objects found amongst the workplace of the informal waste pickers?				
8.	Do informal waste pickers carry a medical first aid kit or have access				

	to medical services in case of an emergency?				
9.	Are the working conditions of informal waste pickers acceptable or good for their health?				
10.	Does the municipality allow waste pickers activities?				
11.	Is there any form of working relationship between the informal waste pickers and the municipal solid waste management team?				
12.	Is there room for improvement to better the informal waste sector?				

APPENDIX E

Ethical Clearance from the Health Research Ethics Committee of the College of Agriculture and Environmental Sciences, University of South Africa

UNISA university of south africa

UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 05/10/2020

Dear Mr Mathivha

NHREC Registration # : REC-170616-051
REC Reference # : 2020/CAES_HREC/126
Name : Mr FKS Mathivha
Student #: 49998218

Decision: Referred back
Submission deadline for next meeting: 29/10/2020

Researcher(s): Mr FKS Mathivha
49998218@mylife.unisa.ac.za

Supervisor (s): Mr ND Baloyi
baloynd@unisa.ac.za; 011-471-2689

Ms T Tshimbana
tshimtp@unisa.ac.za; 011-471-2410

Working title of research:

Evaluating the role of the informal waste sector in municipal solid waste management: A case study of Vhembe district municipality, South Africa

Qualification: MSc Environmental Management

Thank you for the application for research ethics clearance by the UNISA-CAES Health Research Ethics Committee for the above mentioned research.

The **medium risk application** was reviewed in compliance with the UNISA Policy on Research Ethics and the UNISA Standard Operating Procedure on Research Ethics Risk Assessment on 01 October 2020. (Please note that the risk level will be downgraded once the required clarification has been received.) **The application is referred back for revisions and clarifications.** Please provide the committee with a **cover letter** explaining how you have addressed the below mentioned aspects **by 29 October 2020**. Additionally, all application documentation should be amended to indicate the recommended changes. **Highlight all changes** made on the application documents to streamline the review process. The ethics clearance number, **2020/CAES_HREC/126**, must be used in all correspondence.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The following comments, emanating from the reviews, are tabled for your attention, clarification and/or amendment:

1. The researcher indicates that data will be collected from waste pickers through an online method – is this realistic? Do waste pickers have access to online facilities?
2. The researcher indicates that field observations will be done – will these include video or photos of people? If so, the researcher must ensure that people will not be identifiable in such images.
3. The sampling methodology needs to be clarified. How will respondents be selected, as both random and convenient sampling methods are described? What informs the sample size of 15 participants per municipality?
4. The risk section does not address the possibility of xenophobic attacks, which should be considered as many of the waste pickers are from other countries. How will the researcher ensure that participants will not be identified and possibly targeted as a result? Could it influence the interaction among the waste pickers? Although the research is intended to be beneficial to the waste pickers, the findings may lead to the formalisation of their work environment which not all may be in favour of.
5. The committee recommends that the aim and objectives be refined. One of the objectives are the same as the aim, and there is also overlap between the objectives. The researcher should align the questions in the questionnaire with the objectives, and indicate how the data for each objective will be collected and analysed. The data analysis should include the model that will be applied, and the variables for each model identified.

The revised application and the supporting documents must be submitted to the Research Ethics Administrator Ms M Van Wyk for review by the committee.

Data collection activities, as indicated in the application documents, may not commence until final approval has been granted by the UNISA-CAES Health REC.

It is your responsibility to ensure that the proposed research adheres to the values and principles expressed in the UNISA Research Ethics Policy.

Please note:
If your re-submission does not adhere to the procedure set out above it will not be tabled for ethics review and will be returned to you within 48 hours.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone +27 12 429 3111 Facsimile +27 12 429 4150
www.unisa.ac.za

Yours sincerely,

Prof MA Antwi
Chair of UNISA-CAES Health REC
E-mail: antwima@unisa.ac.za
Tel: (011) 670-9391

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone +27 12 429 3111 Facsimile +27 12 429 4150
www.unisa.ac.za

APPENDIX F

Letters Requesting Permission to conduct Research sent to Municipalities

UNISA

MEMORUNDUM

To : The Municipal Manager
Collins Chabane Local Municipality

Date: 12 February 2020

PERMISSION REQUEST FOR STUDENT TO CONDUCT A RESEARCH STUDY

This letter serves as confirmation that **Mr. Mathivha Funanani Khangale Sampson** is a student of University of South Africa with a student number of **49998218** who is registered for MSc in Environmental Management under my supervision.

The aim of his research project is to evaluate the role of the informal waste sector in municipal solid waste management in Vhembe District Municipality, South Africa. To achieve this, the following would be the objectives: to evaluate the role played by the informal sector in municipal solid waste management in Vhembe District Municipality, to identify challenges and opportunities associated with the involvement of the informal waste sector in municipal solid waste management, to identify the Occupational health and safety challenges the informal waste sector encounter on their day-to-day operations and identify alternatives and measures that could reduce or prevent the risks the informal waste sector faces, to assess possible strategies that can be adopted to improve the informal waste sector, and to recommend alternative measures to ensure improvement of the informal waste sector.

In execution the following research methods would be employed; interviews, records and document analysis, site inspection and observation, and questionnaires

Thanking you in advance
Mr Ntsako D Baloyi

Lecturer (School of Ecological and Human Sustainability)
Department of Environmental Sciences
Office B1-41 | Calabash Building
Tel: 011 471 2689
E-mail: baloynd@unisa.ac.za

UNISA

MEMORUNDUM

To : The Municipal Manager
Makhado Local Municipality
83 Krogh Street, Civic Centre
Makhado
0920

Date: 12 February 2020

PERMISSION REQUEST FOR STUDENT TO CONDUCT A RESEARCH STUDY

This letter serves as confirmation that **Mr. Mathivha Funanani Khangale Sampson** is a student of University of South Africa with a student number of **49998218** who is registered for MSc in Environmental Management under my supervision.

The aim of his research project is to evaluate the role of the informal waste sector in municipal solid waste management in Vhembe District Municipality, South Africa. To achieve this, the following would be the objectives: to evaluate the role played by the informal sector in municipal solid waste management in Vhembe District Municipality, to identify challenges and opportunities associated with the involvement of the informal waste sector in municipal solid waste management, to identify the Occupational health and safety challenges the informal waste sector encounter on their day-to-day operations and identify alternatives and measures that could reduce or prevent the risks the informal waste sector faces, to assess possible strategies that can be adopted to improve the informal waste sector, and to recommend alternative measures to ensure improvement of the informal waste sector.

In execution the following research methods would be employed; interviews, records and document analysis, site inspection and observation, and questionnaires

Thanking you in advance
Mr Ntsako D Baloyi

Lecturer (School of Ecological and Human Sustainability)
Department of Environmental Sciences
Office B1-41 | Calabash Building
Tel: 011 471 2689
E-mail: baloynd@unisa.ac.za

UNISA

MEMORUNDUM

To : The Municipal Manager
Musina Local Municipality

Date: 12 February 2020

PERMISSION REQUEST FOR STUDENT TO CONDUCT A RESEARCH STUDY

This letter serves as confirmation that **Mr. Mathivha Funanani Khangale Sampson** is a student of University of South Africa with a student number of **49998218** who is registered for MSc in Environmental Management under my supervision.

The aim of his research project is to evaluate the role of the informal waste sector in municipal solid waste management in Vhembe District Municipality, South Africa. To achieve this, the following would be the objectives: to evaluate the role played by the informal sector in municipal solid waste management in Vhembe District Municipality, to identify challenges and opportunities associated with the involvement of the informal waste sector in municipal solid waste management, to identify the Occupational health and safety challenges the informal waste sector encounter on their day-to-day operations and identify alternatives and measures that could reduce or prevent the risks the informal waste sector faces, to assess possible strategies that can be adopted to improve the informal waste sector, and to recommend alternative measures to ensure improvement of the informal waste sector.

In execution the following research methods would be employed; interviews, records and document analysis, site inspection and observation, and questionnaires

Thanking you in advance
Mr Ntsako D Baloyi

Lecturer (School of Ecological and Human Sustainability)
Department of Environmental Sciences
Office B1-41 | Calabash Building
Tel: 011 471 2689
E-mail: baloynd@unisa.ac.za

UNISA

MEMORUNDUM

To : The Municipal Manager
Thulamela Local Municipality

Date: 12 February 2020

PERMISSION REQUEST FOR STUDENT TO CONDUCT A RESEARCH STUDY

This letter serves as confirmation that **Mr. Mathivha Funanani Khangale Sampson** is a student of University of South Africa with a student number of **49998218** who is registered for MSc in Environmental Management under my supervision.

The aim of his research project is to evaluate the role of the informal waste sector in municipal solid waste management in Vhembe District Municipality, South Africa. To achieve this, the following would be the objectives: to evaluate the role played by the informal sector in municipal solid waste management in Vhembe District Municipality, to identify challenges and opportunities associated with the involvement of the informal waste sector in municipal solid waste management, to identify the Occupational health and safety challenges the informal waste sector encounter on their day-to-day operations and identify alternatives and measures that could reduce or prevent the risks the informal waste sector faces, to assess possible strategies that can be adopted to improve the informal waste sector, and to recommend alternative measures to ensure improvement of the informal waste sector.

In execution the following research methods would be employed; interviews, records and document analysis, site inspection and observation, and questionnaires

Thanking you in advance
Mr Ntsako D Baloyi

Lecturer (School of Ecological and Human Sustainability)
Department of Environmental Sciences
Office **B1-41** | Calabash Building
Tel: 011 471 2689
E-mail: baloynd@unisa.ac.za

APPENDIX G

Permission to Conduct Research Letters from Municipalities

Old DCO Building
Hospital Roads
Malamulele
0982

Private Bag X9271
Malamulele
0982
Tel (015) 851 0110
Fax (015) 851 0097

COLLINS CHABANE LOCAL MUNICIPALITY

Enq : Makhasa V.E
Contact no : 072 196 6531

To whom it may concern

PERMISSION TO CONDUCT A RESEARCH STUDY

I write in my capacity as the Acting Municipal Manager of the Collins Chabane Local Municipality (LIM345) in Malamulele – Limpopo.

I hereby confirm that permission is granted for Mathivha Funanani Khangale ,A student in the University of South Africa currently doing MSC in the environmental Management.

With this writing, I hereby confirm that Mathivha Funanani Khangale has been granted approval/permission to conduct his research in our municipality in order for him to improve the informal waste sector.

I hope the above is in order.

Yours sincerely.

R.R SHILENGE
ACTING MUNICIPAL MANAGER

04/03/2020
DATE

MAKHADO MUNICIPALITY

Vision: A dynamic hub for socio-economic development by 2030
Mission: To ensure effective utilization of economic resources to address socio-economic imperatives through mining, agriculture and tourism

24 FEB 2020

Reference : 16/4/1/1
Enquiries : Director Community Services
Date : 19 February 2020

To : : Mr Ntsako D Baloyi
Lecturer (School of Ecological and Human Sustainability)
Department of Environmental Sciences
Contact: 011 471 2689
Email : rcmaguga@gmail.com

Dear Sir

SUBJECT: REQUEST FOR PERMISSION FOR STUDENT TO CONDUCT A RESEARCH STUDY IN MAKHADO MUNICIPALITY WASTE MANAGEMENT FACILITIES.

1. The above matter refers to your letter dated 12th of February 2020 which was received on the 13th of February 2020 regarding permission for student to conduct a research in Makhado Municipality waste management facilities.
2. The permission is hereby granted and the Municipality will assist with required information with regard to your research study request. Attached hereby is the indemnity when utilising waste facilities.
3. After receiving this letter, you are requested to visit the municipality (Department of Community Services) to formally plan on how the study will be executed.

Yours truly,

MR NETSHIVHENGWA
MUNICIPAL MANAGER

24/02/2020
DATE

Tel: 015 519 3000 | Fax: 015 519 1195 | E-mail: municipal.manager@makhado.gov.za |
Address: Civic Centre, 83 Krogh Street, Private Bag X2596, Makhado, 0920
| www.makhado.gov.za | Call Centre: 015 519 3900/ 3904/ 3906

MUSINA

Postal Address:
Musina Local Municipality
Private Bag X611
Musina
0900

Physical Address:
21 Irwin Street
Musina
0900

Information Center
(015) 534 6100
info@musina.gov.za
www.musina.gov.za

ENQUIRIES SPEAK TO
RIKA LE ROUX

REFERENCE NO
9/4/A

18 February 2020

UNISA
School of Ecological and Human Sustainability
Office B1-41-Calabash Building

Attention: Mr ND Baloyi

RESEARCH PROJECT: EVALUATE THE ROLE OF THE INFORMAL WASTE SECTOR IN MUNICIPAL SOLID WASTE MANAGEMENT IN MUSINA LOCAL MUNICIPALITY

Permission is herewith granted to Mr Mathivha Funanani Khangali Sampson (Student number 49998218) to evaluate the role of the informal waste sector in municipal solid waste management in Musina Local Municipality

TN TSHIWANAMMBI
MUNICIPAL MANAGER

EXTERNAL MEMO

Private Bag X5066
Thohoyandou
0950
Limpopo Province
Tel: 015 962 7500
Fax: 015 962 4020

THULAMELA MUNICIPALITY

Ref	: 4/3/4/1
Enquiries	: Mabasa N.H
Tel	: 015 962 7514
Fax	: 015 962 4020
To	: .Mr. Mathivha F
From	: THULAMELA MUNICIPALITY
Date	: 24 FEBRUARY 2020
Subject	: PERMISSION TO CONDUCT RESEARCH AT THULAMELA MUNICIPALITY

1. The above matter refers.
2. Kindly note that permission to conduct research has been granted.
3. Contact Human Resources Section for more information.
4. Hoping that this will meet your favourable considerations.

MUNICIPAL MANAGER: MALULEKE H.E

APPENDIX H

Participant Consent Form

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____(participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

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

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the <insert specific data collection method>.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname…… (please print)

Participant Signature……..Date……

Researcher's Name & Surname……(please print)

Researcher's signature……..Date……

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za