THE AWARENESS AND PERCEPTION OF SORTING MUNICIPAL SOLID WASTE:
A CASE STUDY OF LEBOWAKGOMO ZONE A AND F, LEPELLE-NKUMPI LOCAL
MUNICIPALITY, LIMPOPO PROVINCE.

BY

JULIA RAPHAHLE MOLABA

DISSERTATION SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE IN GEOGRAPHY

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES, SCHOOL
OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES, FACULTY OF SCIENCE
AND AGRICULTURE, UNIVERSITY OF LIMPOPO, SOUTH AFRICA.

SUPERVISOR: DR J.M LETSOALO

CO-SUPERVISOR: PROF M.H.N MOLLEL

2023

DECLARATION:

I hereby declare that the work presented in this dissertation has never been submitted in any form, to any institution. This work represents my original work, where I have made use of the information of other authors, acknowledgements are made.

Ms Julia Raphahle Molaba

Signature: _____

Date: _____

DEDICATION:

I would like to dedicate my dissertation to my late grandmother and my family. They have supported me throughout this journey of furthering my studies. I would like to thank God for giving me the strength and guidance in this journey.

ACKNOWLEDGEMENTS

ABSTRACT

Sorting of waste at source is a process where the user is involved in the waste management system that contributes to waste separation. The Municipal Solid Waste (MSW) generated in households need to be sorted to improve sustainable waste management. This study addresses the awareness and perception of sorting municipal waste in Lebowakgomo Zone A and F, Lepelle-Nkumpi Local Municipality.

The objectives of the study were to: assess the willingness of householders in sorting Municipal Solid Waste at households' level before collection services in Lebowakgomo Zone A and F; investigate the socio-economic and environmental impacts of sorting solid waste at source in Lebowakgomo Zone A and F; ascertain the challenges faced during recycling of unseparated solid waste in Lebowakgomo Zone A and F and examine the strategies of Lepelle-Nkumpi Local Municipality on encouraging source separation at Lebowakgomo Zone A and F.

The study used a mixed method research approach. The sample size for Lebowakgomo Zone A was 280 and for Lebowakgomo Zone F was 192. The data was collected using open and closed-ended questionnaires, key informant interviews and field observation. The data was analysed using the Statistical Package for the Social Sciences (SPSS) Software version 27. The analysed data was presented in the form of tables, pie charts, bar graphs, and thematic paragraphs.

The findings of this research show that the households are willing to sort waste before collection services. There are, however, challenges of waste collection in the two sections. The socio-economic and environmental impacts in Lebowakgomo Zone A and F are creation of jobs, and community participation while there is littering and pollution from waste that is not collected properly. The storage of waste is lacking especially when waste is to be sorted firstly before recycling. Lepelle -Nkumpi Local Municipality is working with the communities to separate their waste. The environmental campaigns need to be established in communities to empower people with knowledge. Environmental education and awareness should be introduced in communities by Lepelle-Nkumpi Local Municipality.

Keywords: Municipal Solid Waste (MSW), source sorting, environmental awareness, willingness, perception

TABLE OF CONTENTS……………………………………………………………………**Page**

ACRONYMS

MSW-   Municipal Solid Waste

EPR-   Extended Producer Responsibility

RSA-   Republic of South Africa

USA-   United State of America

ISWM-   Integrated Solid Waste Management

SWM-   Solid Waste Management

DEA-   Department of Environmental Affairs

MRF-   Material Recovery Facility

NWMS-   National Waste Management Strategy

IPWP -   Integrated Pollution and Waste Management Policy

GDP-   Gross Domestic Product

NEMA-   National Environmental Management Act

NEMWA-   National Environmental Management Waste Act

DEAT-   Department of Environmental Affairs and Tourism

TREC -   Turfloop Research Ethics Committee

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Background

This chapter introduces sorting waste, recycling, and solid waste management as the background to the study. It further discusses the rationale, aim, objectives, research questions, scientific contributions, ethical considerations, limitations of the study, study area, definition of terms, and summary of the study.

1.1.1 Waste

According to the National Environmental Management Waste Act (NEMWA) (Government Gazette, 2014), waste is any material that is discarded, abandoned, and rejected. The study focused on MSW although there are other types of waste listed as agricultural waste, hazardous waste, garden waste, construction waste, mining waste, commercial waste, industrial waste, medical waste, etc.

1.1.2 Municipal Solid Waste

Municipal Solid Waste (MSW) is waste such as paper, aluminium, glass, plastic etc. generated in households. Municipalities collects waste once a week from households. Waste management hierarchy incorporates the processes that promotes sustainability and sorting waste is focused on reaching the goal of sustainability (DEA, 2018). Municipal Solid Waste (MSW) is the most generated type of waste which need to be managed properly to contribute towards sustainable environment and enhancing the processes of managing waste which in this regard is focused on sorting waste.

1.1.3. Waste Management

Waste management is defined as: the different methods and measures designed and implemented to identify, control, and handle the various types of waste from generation and until disposal. Full implementation of waste management processes, including waste prevention and reuse, and recycling wherever possible, has and can further help avoid considerable environmental impacts (Mubaslat, 2021). Waste management processes are generation, sorting, storage, collection, treatment, recovery, and disposal. The integrated sustainable waste management hierarchy focuses on the following processes which are waste minimization, reuse, reduction,

recycling, recovery, and waste disposal. Integrated Solid Waste Management (ISWM) governs the processes of waste management, which promotes the environmental, economic, and social livelihood. There are various methods key to the functioning of ISWM incorporating the sorting and collection and treatment of waste (DEA, 2009).

1.1.3.1 Waste Generation

Municipal Solid Waste (MSW) is generated in households and needs to be sustainably managed through the processes of waste management implemented from the household or at any point source. South Africa consumers has been increasing the amount of waste generation due to the elevated lifestyle demands and other factors such as the increasing population. The waste generated in 2011 was recorded as 108 million tons (DEA, 2011) and in 2017 about 121 million tons was recorded (DEA, 2018). The substantial expansion in the extent of waste produced is drawn from the pattern of population growth and economic development.

1.1.3.2 Waste classification

Waste classification is the process where waste is categorised into types of wet and dry waste and thereafter into recyclable and non-recyclable waste. Waste classification and separation also improve the recycling process. Czajkowskia et al. (2014) stated that most communities when awarded an opportunity to sort waste they prefeed to sort in households by themselves. Furthermore, household waste sorting contributes the most towards recyclable materials in respective countries such as Australia and Europe. The waste classification strategy add value to waste disposal process, especially in developing countries (Wen et al., 2014).

1.1.3.3 Waste Sorting at Source

Waste sorting refers to a process were waste is parted into diverse portions. The process can happen by hand at the source. Waste sorting is supported by several collection schemes for produce of recyclable material. The first strategy identified was through using hand to sort waste. Source separation at households is necessary to maximize the yield of recyclable resources. Waste separation increases the number of waste materials that are recovered. Sorting of waste is incorporated into the process to enhance the quality and quantity of waste as a resource. The study will evaluate the awareness of sorting waste and perceptions of contributing towards waste

management. The level of engagement will determine the sustainability of waste management through waste sorting in households.

1.1.4 Recycling

Recycling promotes environmental sustainability by substituting raw materials that are to be used by redirecting generated waste outputs. Recycling is an excellent practice when the environmental benefits surpass the degradation and pollution that could be caused on the environment. The benefits of recycling include substitution of not using raw materials (EPA, 2007). The process promotes contribution toward sustainable environment as useful resources are converted to be reused and saving natural resources (Zaman, 2010; Chen et al., 2010).

1.1.5 Education and awareness

Through awareness and community participation in environmental campaigns, there will be more recovered waste, less pollution, and a clean environment. The intention of communities to engage is source sorting of waste enhances the waste management sector and that outcomes in positive impacts on economic, environmental, and social factors (DEA, 2018). It calls for willingness to participate in source sorting to combat these challenges with the benefit of all stakeholders. The waste management sector administrations encourage contribution toward prevention of waste generation, reuse, reduce, waste sorting etc., through the National Waste Management Strategy (NMWS). The households need to participate in waste sorting, cleaning campaigns, environmental awareness meetings, etc. (Dlamini et al., 2019).

1.1.6 Sustainable Waste Management

Sustainability practices can be attained through practicing effective recycling by preparatory at separating waste at source to recycle more valuable materials. One of the goals to prevent pollution on the environment is through minimizing the amount of waste generated and encouraging reduction of pollution methods (Basic Facts, 2006). The source sorting of waste is a good initiative for sustainable waste management as the recyclable material will be selected. The municipality collection services, or service providers of waste collection will drop off the recyclable materials at a recycling centre The source sorting needs community participation through awareness which will yield more benefits. The service providers will be required to collect waste in the

community. It will be vital for the community to be aware of the waste collection day to be facilitated properly. Sustainable waste management is important to reduce pollution and increase the number of resources that will be recycled.

1.2 Problem Statement

Waste management includes the recycling process, which is one of the practices of sustainable management of waste. The MSW generated in households can be separated at household level in categories of glass, paper, aluminium, and plastic. The separated waste has high value of being recycled and contributes to social, environmental, and economic sustainability of communities (Basic Facts, 2006).

Sorting at source is the process where the producer is involved in portioning the materials that are produced and neglected before collection. Therefore, it is important to understand the significance of this process both from households and municipal perspective when coming to the amenities that need to be provided (Rousta et al., 2013). Furthermore, for waste separation to be implemented effectively the involvement of households' contribution is vital component (DEA, 2018). Community involvement is taken as a support system to yield positive results towards the goal of source sorting.

The separation, storing and collection of recyclable materials in South Africa are supported by a recycling infrastructure were waste turns into recyclable material. The recyclable waste collection system is linked to existing waste disposal site as part of waste management. Waste that could no longer be recovered is transferred to landfill site. In most municipalities is well known that material recycling facilities and buy back centres requires space to store waste that will be recyclable (Wikipedia, 2021).

Lack of environmental awareness is regarded as one of the waste management challenges amongst many faced challenges. The problem of not separating waste leads to high amounts of waste, which will end up in landfill areas while it can be recycled to strive for zero waste principle. Waste sorting at source helps in ensuring that the materials that will be recycled will be of good quality and more materials can be released from separated solid waste (Zaman, 2010).

Waste sorting is still a challenge in many local municipalities of South Africa. The challenges encountered are lack of infrastructure, lack of environmental campaigns,

lack of municipal budget to accommodate waste management and the increasing population that generate high quantities of waste (Troschinetz et al., 2009). Lepelle-Nkumpi Local Municipality is no exception to these challenges when coming to sorting of Municipal Solid Waste at household level. This study would therefore like to find out if people in Lebowakgomo Zone A and F are aware and willing to sort MSW before recycling.

1.3. Rationale

The assessment of MSW recycling practices aids the advancement of sustainable waste management practices. Waste is generated daily, and the rate of its replenishment is high (Guita, 2019). The increase in population and human activities expansion on the environment, consume more natural resources that take time to be produced and more virgin material to create waste that is discarded. The same waste can be used to save the resources and to encourage waste management sustainability (Zaman, 2010). Recycling is one of the processes that conserve virgin materials and promote a clean environment. The awareness and increase in sorted recyclable materials empower the economy and benefits people to be financially independent. It promotes a strong currency as it contributes to the revenue of a country (Glushkov et al., 2019).

The National Waste Management Strategy (NWMS) of 2000 is a legislative obligation of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) that governs that the municipalities are obliged to comply with it. The waste management in South Africa, encounter several backlogs and the NWMS presented a strategy to meet the requirements. The challenges relating to MSW management include, among others, the lack of recycling facilities which will allow source sorting of waste and change of waste channels to and buy-back facility (DEA, 2009).

South African governance include the education and environmental awareness through conventional Integrated Pollution and Waste Management Policy (IPWM) of 2000 to reduce and manage waste (DEAT, 2000). The policy of NWMS of 2000 has drawn goals to be achieved and concentrate on diverse crucial fundamentals of waste management plan including waste minimization, municipal collection services, recycling, waste recovery, capacity building, waste information system, education, and awareness etc. (Chimuka et al., 2011). The Municipal System Act 7 of 2011 states

that municipalities are obligated to supply communities with collection equipment for waste collection service to provide social and clean environment conditions (DEAT, 2000).

The Human Environment Theory by Hammond et al. (1995) ground this study, who state that human beings depend on the environment for the provision of resources. Human beings generate waste, which if not managed properly through processes such as recycling, will impact negatively on the environment.

Related to the above theory is the Behavioural Model, the model intrigues the connection directly to the study, which state that with the certainty that if human beings had knowledge, their perception and alertness of the environmental issues subsequently they would act in a manner that promotes environmental sustainability. The Model is connected to knowledge, attitudes, and behaviour. When people are better informed, they take better decisions since they will be aware and have a willing attitude to sorting of solid waste. The vast knowledge of environmental variables may entail good sustainable environmental behaviour. Education and awareness are necessary to engage communities on the benefits of waste sorting and their behaviour to take care of the environment (Elijah, 2017)

The USA has the uppermost Gross Domestic Product (GDP) across the globe and produce high quantities of waste associated to regular generation of waste in other developed countries (World Bank, 2012). USA implemented legislation and procedures to decrease the amount of waste produced at household level. Source separation make it possible to have compostable and recycled material. According to the findings is indicated that in 2011, 35% of waste is recycled and recovered and used for compost since source separation has been implemented (Australia, 2014).

A study conducted in the Western Cape revealed that source separation had been implemented although it is not practised in all municipalities. The study outcomes indicate that Overstrand is the solitary municipality that exercise separation of waste at household level among western cape municipalities that participated in the study. Many municipalities do not practice source separation as there is lack of infrastructure (Western Cape Government, 2019). There is, therefore, a need to find out if Lepelle-Nkumpi Local Municipality faces the same challenges as above. The intention of this

study was to find out if people in Lebowakgomo Zone A and F of Lepelle-Nkumpi Local Municipality are aware and willing to sort Municipal Solid Waste at household level.

1.3.1 Aim

The aim of the study was to enhance the awareness and perception of sorting municipal solid waste in Lebowakgomo Zone A and F, Lepelle-Nkumpi Local Municipality, Limpopo Province.

1.3.2 Objectives

The objectives of the study were to:

i. assess the willingness of households in sorting Municipal Solid Waste at households' level before collection services in Lebowakgomo Zone A and F.

ii. investigate the socio-economic and environmental impacts of sorting solid waste at source in Lebowakgomo Zone A and F.

iii. ascertain the challenges faced during recycling of unseparated solid waste in Lebowakgomo Zone A and F.

iv. examine the strategies of Lepelle-Nkumpi Local Municipality on encouraging source separation at Lebowakgomo Zone A and F.

1.3.3 Research Questions

i. Does lack of awareness and perception of sorting municipal solid waste at source lead to socio-economic and environmental impacts in Lebowakgomo zone A and F?

ii. Are there challenges of recycling of unseparated solid waste in Lebowakgomo Zone A and F?

1.4 Scientific contribution

Waste management sector will benefit from the study through increase in the amount of waste that will be recycled. The waste sorting of MSW at source is among the processes that ensures high value of waste. The households will be aware of the type of waste they utilize if it will be recyclable waste or not before they consume it and whether that will also contribute to minimisation of waste or not. The environmental issues such as pollution will be decreased as waste will be managed properly by

practising sorting of waste at source. The recyclers in Lepelle-Nkumpi Local Municipality will receive more of waste that is recyclable from municipal collection point services.

The study will improve the lives of Lebowakgomo community economically, environmentally, and socially. There will be environmental campaigns that will take place to guarantee that communities are knowledgeable about waste management. There will be cleaner material produced out of the waste that will be separated from the source. The community in Lebowakgomo will be aware and participate in waste management pyramid whereby they help to drop amount of waste that end up being disposed of.

1.5 Ethical considerations

Turfloop Research Ethics Committee (TREC) has provided ethical clearance for the study. In Lebowakgomo Township the consideration was given by the Lepelle-Nkumpi Local Municipality Ward Councillors. The recycling business owners gave permission for the officials that are working in their recycling businesses to be interviewed. The respondents that were designated to partake in the research study participated willingly. The information that was collected was confidential and the participants were anonymous**.**

1.6 Limitations of the study

A major limitation to any questionnaire-based survey is experienced where people are asked to provide details of their perception and their experiences on sorting waste, and this was a limitation during data collection. The perception of householders is based on their experience and how they perceive sorting waste. The respondents were able to share their perceptions knowing that they are free to share their experiences. Through explaining to them that is for research purpose they shared their experience willingly. Financial resources were a limitation for data collection budget, but the funds were eventually saved to guarantee that the data is gathered. Time management was a challenge as the time that was stipulated was exceeded but it yielded good results since the respondents were ultimately willing to express their perceptions. The respondents were given adequate time to complete the questionnaire.

1.7 Study area

Lebowakgomo was the capital of the formerly known Bantustan Lebowa and located in the Lepelle-Nkumpi Local Municipality . The study area is situated 45 km from Polokwane City, which is the capital of Limpopo Province in South Africa. The geographical location of Lebowakgomo is 23º 18' 39'' S and 29º 28' 31''E. The population of Lebowakgomo is 35 087 with 10 144 households (Census, 2011).

The study was conducted in Lebowakgomo Zone A and F since they are sections where waste collection services are available. They are also close to the recycling facilities, and it was considered a great benefit if the households are aware of sorting of waste at source before recycling. The households at Lebowakgomo Zone A and F are close to the complex and the mall which therefore makes their generation of domestic waste higher than other neighbouring areas (IDP, 2020/21). The employment sectors include government community social services, wholesale and trade, construction as well as mining and quarrying. The least employment sector is agriculture and transportation (IDP, 2020/21).
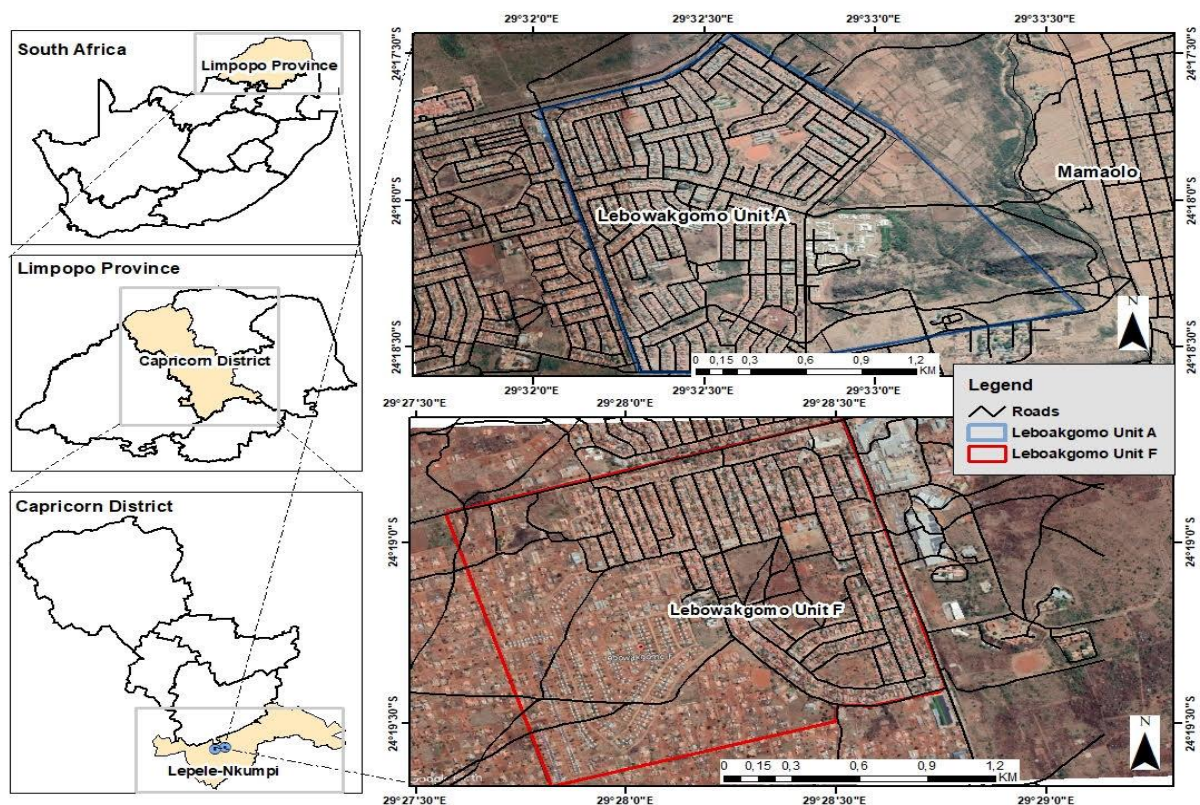
Figure 1.1: Map showing the study area in Lepelle-Nkumpi Local Municipality (ESRI, 2021)
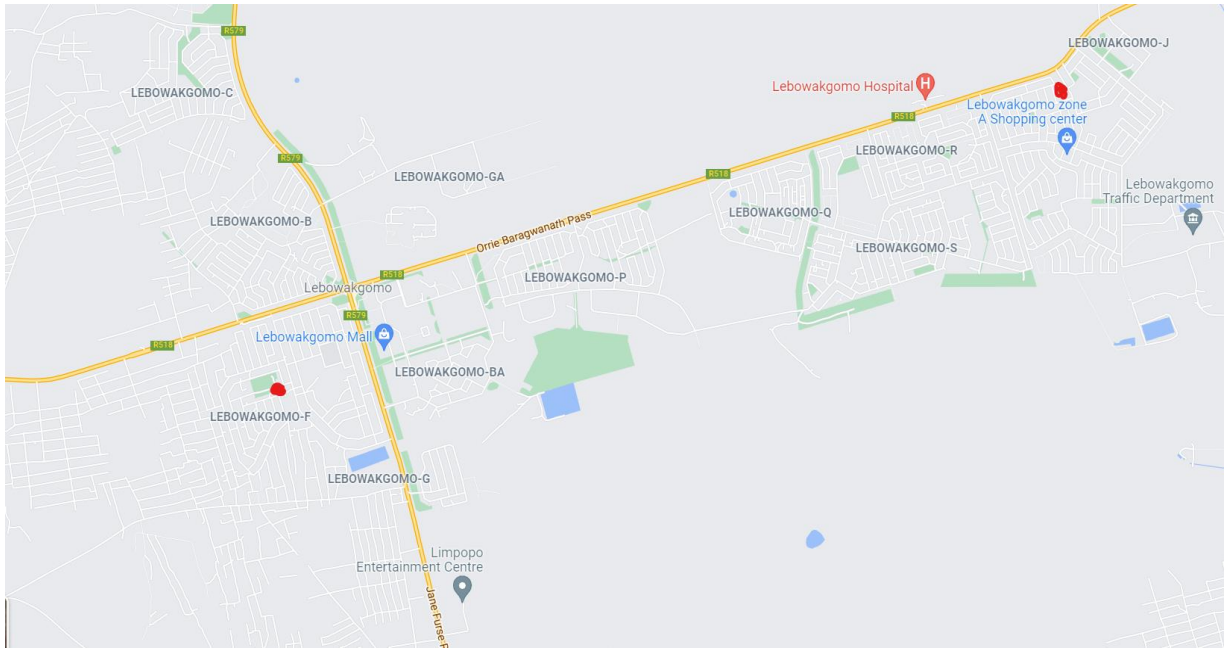
Figure 1.2: Lebowakgomo Zone A and Lebowakgomo Zone with surrounding Zones (Google earth, 2021).

Figure 1.3: Google map showing Lebowakgomo Zone A (Google earth, 2021)
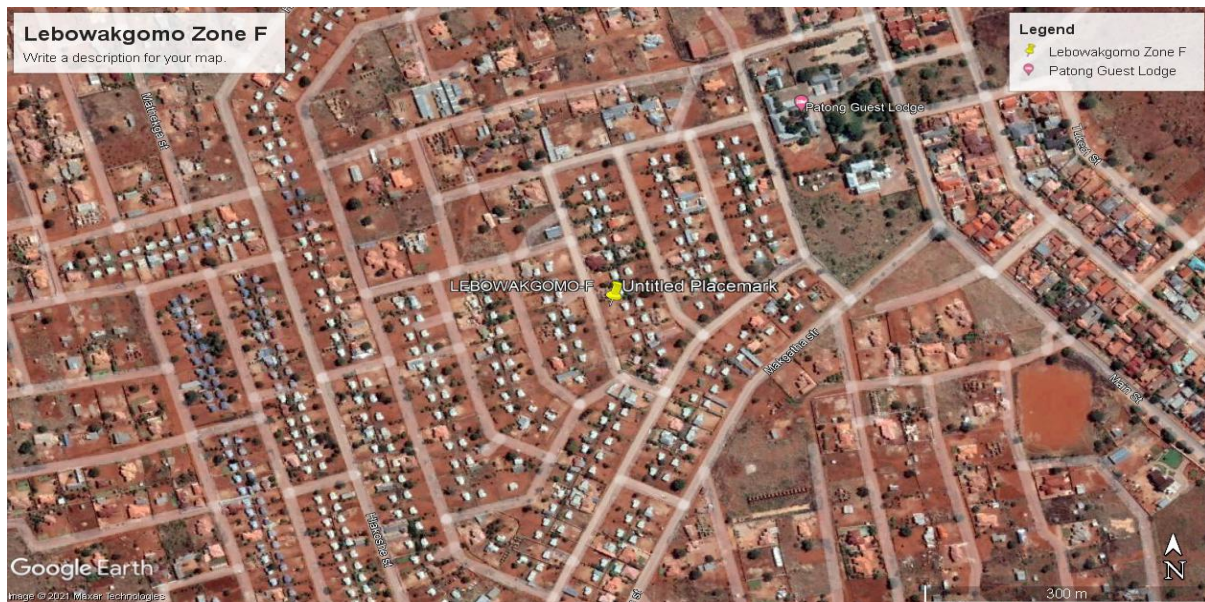
Figure 1.4: Google map showing Lebowakgomo Zone F(Google earth, 2021)

1.8 Definition of terms

Community participation is a social process in which certain social groups that share needs and exist in a predetermined geographic space actively pursue the identification of those needs, make decisions, and create methods to address those needs (Claridge, 2004).

Environmental campaigns are activities that relate to conservation, preservation, and sustainability to raise awareness among people and encourage more ecologically responsible behaviour (Climate Action, 2016).

Material Recovery Facility is a plant that splits waste and makes single-stream recycling materials to be traded to end purchasers (Meredith, 2019).

Municipal Solid waste is waste produced in households such as paper, plastics, etc. (Government Gazette, 2014).

Non-recyclable materials refer to material that can be separated from a waste stream, and not be reprocessed through recycling (EPA, 2021).

Perception refers to the way in which something is regarded, understood, or interpreted (Wikepedia, 2019).

Recyclable materials refer to raw or processed substance that can be separated from a waste stream, reused, and repurposed into additional element through recycling (EPA,2021).

Recycling is the process of adapting waste materials into innovative resources and substances (Rousta, 2020).

Source separation is the segregation of diverse categories of various types of waste material at the place of generation (Teresa, 2021).

Sustainability refers to meeting our own needs short of the adjusting resources for future generations to reach their wants (Mead, 2017).

Waste refers to any generated material used and regarded as a reject and be abandoned ready to be discarded (Government Gazette, 2014)

Waste Management is the process of the generation, waste minimisation, storage, collection, recovery, recycling and disposal of waste materials (Ebikapade, 2016).

1.9 Organization of the study

There are five consecutive chapters which are organised under the following order: Chapter 1 is addressing the background of study, the problem statement, the aim and objectives, rationale, scientific contribution, ethical considerations, outlining the layout of the dissertation.

Chapter 2 is addressing the literature review, which consists of waste definition, waste management hierarchical processes, challenges and impacts of waste separation, attitudes, and perceptions of separation of waste, policies and legislations related to waste separation at source. Furthermore, the study discusses the relevant case studies at local, regional, and global level.

Chapter 3 is entailing the research methodology which outlines the research design, sampling, data collection methods and data analysis.

Chapter 4 addresses the results and discussion of the analysed data. The findings are presented in graphs, tables, figures, and thematically as per the objectives.

Chapter 5 consists of the summary, conclusions, and recommendations of the study. The recommendations are based on what need improvement drawn from the findings of the study.

1.10 Summary of the chapter

Chapter 1 has provided the background, the problem statement, the aim, and objectives of the study. This chapter has illustrated the awareness and willingness of sorting waste in households. The chapter has further explained the definitions associated to integrated waste management and given background on waste separation in households. The next chapter will review the relevant literature of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Municipal Solid Waste (MSW) is waste that is generated in households such as paper, glass, plastic, metal, etc. The municipal system collects waste on a weekly basis as part of the waste management process. Waste management incorporates the processes in a hierarchy that promotes sustainability and, in this case, the process that will be focused on is sorting waste. Waste management processes are generation, sorting, storage, collection, treatment and recovery and disposal. The integrated sustainable waste management hierarchy focuses on the following processes such as waste minimization, reuse, reduction, recycling, recovery, and disposal as the last resort (DEA, 2018).

Municipal Solid Waste (MSW) is generated in households and needs to be sustainably managed through the processes of waste management. Sorting of waste is combined into the process to improve the quality and quantity of waste. The trend in waste generation in South Africa has been increasing due to the high consumer demands, the rise in population and the growing economy.

The separation of waste will improve the waste classification to account for waste statistics properly (Fakoya, 2018). The challenges related to improper waste management incorporate deficiency of infrastructure, lack of funds, lack of education and awareness to minimize waste generation, etc. It is indicated by Mannie and Bowers (2014) that 95% of the waste produced is disposed in landfill sites, and 87% of municipalities do not have necessary infrastructure to efficiently manage waste and follow reduction initiatives. South Africa lags behind compared to developed countries such as Europe by two to three decades arising from several issues (Godfrey and Oelofse, 2017). The key challenges that are experienced are illegal dumping, unauthorised Solid Waste Management (SWM), inadequate collection services and lack of enforcement of current waste legislation (Abdel-Shafy and Mansour, 2018).

Sustainable waste management is a way to combat the challenges related to waste management and willingness to sort waste will come in handy to alleviate some of the challenge. Through the National Waste Management Strategy (NMWS), the national and municipal governments promote a path toward waste minimization, reuse, and

recycling. The households need to participate in waste sorting, cleaning campaigns, environmental awareness meetings, etc. (Dlamini et al., 2019).

This chapter addresses the willingness to sort waste at the household level. The education and awareness of sorting waste enhances the recyclable material of waste and helps in proper sustainable waste management. Moreover, it outlines the importance of source separation in the waste management hierarchy. There will be an understanding of the objectives and research questions of the study.

Waste separation increase the quantity of waste materials that are recovered. Through awareness and community participation in environmental campaigns, there will be more recovered waste, less pollution, and a clean environment. The willingness of communities to partake in the sorting of waste advances the waste management sector and that results in positive impacts on economic, environmental, and social factors (DEA, 2018).

2.2 Waste

Municipal Solid Waste (MSW) can be sorted into wet and dry waste. The wet waste comprises of food leftovers that can be composted and used as fertiliser for gardening in a household. The dry waste consists of bottles, paper, plastic, etc. that can be sorted into recyclable and non-recyclable objects before storage. The dry waste will be sorted and stored in categorised storage bins (Waite, 2000).

Municipal Solid Waste (MSW) is managed through the facilitation of a municipal waste strategy where waste is collected from the household by municipal collection vehicles. Waste sorting is one of the processes that will efficiently contribute to waste as a resource that is managed from the source. Households consume products which, after they have been utilised become waste. When waste is not managed properly environmental impacts such as pollution, nuisance, and health hazards can result. However, if it is managed properly, it can have positive environmental, social, and economic impacts. When waste is managed properly it saves natural resources and improves people's lives. Economically waste creates jobs and benefits communities due to alleviating unemployment and community's livelihood (Waite, 2000).

2.3 Waste Management

Waste management includes the processes required to manage waste from when it is generated to its final disposal point. The National Waste Management Strategy (NWMS) as of 1999 implemented the waste management governance. The processes of waste management hierarchy are in a sequence of avoiding generation of waste and are as follows, waste minimization, waste generation, sorting, storage, collection, recycling, recovery, and disposal of waste. Sorting waste into dry and wet waste is regarded as waste. There will be reduction of the material that is disposed in landfill sites. The main aim of segregation is to have material that is in a good condition to be recycled. Sorting waste is necessary to be practiced in households. Separation of waste is vital to waste management process as different materials of generated waste are stored in various portions at the place where waste is generated (Rousta, 2018).

A sustainable integrated waste management system involves reducing environmental impacts, good public health, proper infrastructure, and efficient policies and regulations. The most preferred option of waste management is to minimize the quantity of waste generated while the least option is landfilling. All the processes in the waste management hierarchy play an important function (Rousta, 2018). The estimates indicate that about (20%) of waste is recycled yearly however the remaining 80% is disposed of in landfill sites. Zero waste policy was implemented to reduce the recorded amount of waste that are disposed and to prevent pollution. The awareness about the implementation of the 3R's was to reduce the amount of waste and be send to the landfills. The processes include Reduce, Reuse, Recycle. The 3R's play a vital role in reducing the issues that can ascend out of wrong waste management habits (Balwan et al., 2022)

Improper waste management causes negative issues on the environment and disturbs the natural systems. Disposing of waste in landfill sites have environmental impacts. Protecting the environment, the public's health, and safety is the main goal of effective waste management. It's crucial to realize that waste management and segregation are essential to reducing the environmental impacts (Balwan et al., 2022).

In South Africa, there are challenges faced by municipalities including lack of financial resources, operational challenges, enforcement of legislations, and poor planning and management. Many municipalities are currently having difficulty providing basic waste

management services as a result (DEA, 2018). In South Africa, 12.2 million homes received refuse removal in 2018, whereas 323 478 households did not (Stats SA, 2018). According to estimates, South African households produce 12.7 million tonnes of domestic waste annually, of this amount, 3.67 million tonnes are not properly collected and treated by waste collection systems, which results in significant amounts of waste being dumped illegally (Rodseth et al., 2020).

The pace of urbanization across the world especially the developing countries is witnessing an unprecedented increase with rural to urban migration, one of contributing factors putting tremendous strain on cities. Currently, about 55% of the world population reside in the cities which are projected to rise to 68% by the year 2050 as per estimates (World bank, 2018). Every year, the globe produces 2.01 billion tonnes of MSW, of which at least 33% are not handled responsibly for the environment. Global production of municipal solid garbage is anticipated to increase to 3.4 billion tonnes by 2050. With an average of 808 kg produced annually per person, the United States produces the most waste per person in the world. Although they tend to have better waste management programmes, richer countries tend to produce more waste than poorer countries (Balwan et al., 2022).

Waste management is one of the most critical areas that everyone in the world should address. In Europe the separate collection system was introduced, separate collections of waste types, such as paper and plastics, were already in place. Slovakia has had the separate collecting requirement in place since 2010. Paper, plastics, metals, glass, and mixed municipal waste are just a few of the main categories for separate collection from the public that were first established (Rozsa, 2021).

In Sweden the implementation of waste management hierarchy focuses on source reduction, recycling, waste recovery and landfilling. Source separation is crucial before the other steps that track in a hierarchy i.e., recycle, reuse, and reduce. After source separation it is suitable to store the remains of waste and the waste that is collected thereafter will be thoroughly sorted and has to be the waste that cannot be used any longer in a household (DEA, 2018).

2.3.1 Waste Generation

Minimal waste generation and avoiding generating waste at all costs supports waste management hierarchy. The designs and trends of the products keep on improving and human beings keep on generating waste. Waste is generated by human activities in households, commercial and construction sectors etc. Waste was regarded as a nuisance and material that after generation it becomes useless in historic times. However, currently the narrative changed as there are strategies to manage generated waste. Due to the small growth pattern of population the management of waste was better compared to when the population increase at an alarming rate, the lack of space for infrastructure to manage waste properly also is in shortage as there are new developments in most areas (Balwan et al., 2022).

2.3.2 Waste Separation

Municipal Solid Waste (MSW) is sorted into two categories, dry and wet waste. The wet waste comprises of food leftovers and garden refuse. Municipal Solid Waste (MSW) can be separated at household level into different bins before collection service. The households must be willing to sort their waste into categories to enhance the methods of recycling. In most communities, the waste materials are separated at the Materials Recovery Facility (MRF) after waste is collected. The worth of materials recycled is less than expected when it is separated in households. The contaminated materials cannot be recycled as they cannot be reprocessed and could have financial and environmental costs. From these materials that cannot be recycled, it provides source of renewable energy. Energy such as biogas could be produced from non-recycled waste and be used efficiently to supplement non-renewable energy resources (Waite, 2000).

The main end goal is to save as many resources from waste before it can be disposed into landfill sites as possible. Households need to be aware of sorting waste and the difference it can make in conserving the environment. "Waste sorting manages to inspire a globular model in which waste can be reused and be recycled for as many cycles as possible, it can be recovered to be used in energy source. Producers in the European Union are stimulated to implement a global approach and launch goals for their products that span from production, throughout life cycle, to its waste management (Hellwig et al., 2019).

The feasibility of recycling supports the socio-economic of measures in communities. It is vital that enough resources be dedicated to sorting of waste since it encourages clean recyclables. The cost of transportation and collection services must be planned thoroughly to ensure that there is no fruitless expenditure. The increase in the quantity of separated waste increases the number of materials that are recyclable. There are waste collectors that collect waste from waste bins and take it to recycling companies for income generation thus making the waste management sector to subsidise to the GDP (DEA, 2018).

2.3.3 Waste Storage

Waste is stored in waste bins after waste generation. The process take place after generation of waste. Daily waste in generated in different spheres it be household, manufacture etc. The waste is stored in waste bins before collection. Waste can be separated into different categories at source depending on recyclables and non-recyclables before it is stored in closed waste bins. Ideally, the waste should be stored in separated waste containers according to the colour codes of the sorted bins with labels of plastic, paper etc. (Government Gazette, 2011).

It is critical to preserve recyclables from be transferred to landfill sites and recovering as much resources as possible to save the environment. Recycling is a good practice as it creates jobs and save the environment through the waste that is recovered. This will conserve raw materials and reduce the expenses and labour involved in getting rid of waste. To achieve this, make it a habit to keep recyclable waste from leftovers waste in separate waste bin or container at the source of generation. The rubbish collectors (rag pickers) can receive this recyclable waste at the doorstep. To prevent environmental and health impacts that can be caused by waste not properly stored, the waste storage bin must have a lid and be closed properly to avoid the odours and breeding of vectors that can cause diseases (Government Gazette, 2011).

2.3.4 Waste Collection

Municipalities provide support in the waste collection service. Waste collection methods need to be improved where waste is separated and collected in various bins. The waste collected from household is separated in various bins as per their recyclable materials. The National Waste Strategy improves the collection services and enhance

the methods to sustainably manage waste. The sorting of waste at households will help in determining recyclable materials. Waste collection occurs weekly in most urban areas and fortnightly in rural areas. The households take their bins outside of the household for accessibility of waste collectors to collect waste through the kerbside system. In South Africa, Waste collection is still an issue in majority of municipalities, where there are sometimes delays and postponements on the day of collection due to vehicle breakdowns and other forms of disturbance (Waite, 2000).

In rural areas there are historical challenges when coming to waste management than in urban areas. About 61% of South African household in 2007 have access to the waste collection services delivery. The remaining percentages are still without the basic right, and it remains as a challenge. The access is biased as it favours the metropolitan cities in urban areas. The lack of collection services contributes to visual pollution on the environment. The results shows that 95% of urban household have access to waste collection service and 75% of rural households have sufficient service levels (NWMS, 2011).

2.3.5 Waste Treatment

Waste is treated through recycling and reprocessing where materials are recovered. The waste material can be utilized to produce energy and produce new materials. The Material Recovery Facility (MRF) is the most common waste treatment facility in South Africa. Sorted waste is recovered in high quantities. The sorted waste that is categorized as organic waste can be taken to the farms to be used as compost. Integrated Solid Waste Management (ISWM) offers a comprehensive method that are economically viable, socially and ecologically successful.

An Integrated solid waste management system employs a variety of various treatment processes. Waste sorting and collection are fundamental to the function of IWMS. It is critical to understand that different initiative and programmes need to be established and work hand in hand as there is no single method that can be implemented to manage waste in an environmentally friendly manner. As a result, all available treatment alternatives must be weighed equally, and the optimum combination of available options can be selected to the community based on the assessment of their needs. The community environmental, economic, and social needs are at the forefront

to be met by the government initiative schemes that support waste management (SSWPU, 2000).

2.3.6 Waste Disposal

Disposal is the process where waste is buried in a landfill site as the destination. There are landfill sites that receive MSW which is non-hazardous waste and there are landfill sites that receive hazardous waste, such as medical waste and other chemicals. Adaptation of the sorting channel waste in proper hierarchy. Landfill sites are designed in a way to minimize environmental pollution to water, air, and visual pollution. Disposal of waste in landfill sites remain the most practiced process according to the 2017 statistics. The information presented stated that disposal of MSW accounted for 61.4% of general waste while hazardous waste is 93.7% (DEA, 2018).

2.4 Waste separation aspects

Waste separation is the procedure in which waste is parted in fractions at the household. Waste is separated before collection to not contaminate the other materials before processing. The materials that cannot be reused from households are separated accordingly to waste classification sorting codes. The separated waste will be collected by the kerbside system to the Material Recycling Facility (MRF). The separation of MSW is practiced mostly in cities (Waite, 2017).

2.4.1 Challenges of waste separation

Waste separation is mandatory to be incorporated in sustainable waste management although there are continuous backlogs associated to the separation of waste. Sorting waste in households encounters the challenge of space to store separated waste in storage bins. The income, size of the family, and level of education are hindering factors when coming to the sorting of waste. The location of the areas is also a challenge as waste takes long haulage to be transported to MRF. The collection cost is one of the factors that discourage households to sort their waste as it is not collected regularly (Fadhullah et al., 2022).

Studies identified that management of waste was not effective in one of the rural areas in Kelantan, due to the lack of awareness to separating waste properly. The process of handling waste in households was inefficient especially since proper waste handling

start at the households. Most households are having challenges of time management to be able to sort waste as most time they spend it at work and hardly at home. However, they are knowledgeable about sorting waste and other related processes of waste management. Moreover, educational and awareness campaigns should be implemented and educate people about the impacts of sorting waste. The increase in rate of behaviour change in sorting waste will be evident as there would have implemented procedures need to be followed to successfully handle waste properly. (Fadhullah et al., 2022).

According to Babazadeh et al. (2018) the households in Tabriz, Northwest of Iran, believed that they lost motivation after mixing the separated MSW by the waste collectors. The perception of households on the effectiveness of their efforts in separating waste was changed by the way the waste they have sorted gets mixed up and some will no longer be willing to sort the MSW. The lack of refusal bags, bins, proper infrastructure, awareness etc. was among the challenges. Another cause for households to ignore responsibilities of waste management was because of renting in flats and modest residences such as apartments. The lack of space in their residences is a challenge as they could not use separate waste containers for wet and dry waste. According to the respondents, the major barrier to participation in the initiative was insufficient knowledge and education regarding the separation of MSW.

Waste management becomes more efficient when there is proper governing of waste from the household. The separation of waste will be a success through proper waste management processes which are effective at household level, these are reuse, composting organic waste and recycling. However, separation at source initiatives, on the other hand, are typically non-existent in rural communities due to inadequate infrastructure. South Africa aims to accomplish a 50% household separation rate by 2023 and plans to establish MRF, specialized compartment vehicles for waste collection, marketing recyclable material and to increase plastic recycling materials. There is still a challenge of waste management as the waste separation is regarded as the duty of the municipality and households need to engage in source sorting (Viljoen et al., 2010).

2.4.2 Impacts of waste separation

There are impacts of waste separation which include environmental, economic, and social impacts. Below is the elaboration of the mentioned impacts of waste separation.

2.4.2.1 Environmental impacts

Waste that is not separated properly in households poses a health hazard and leads to the spread of infectious diseases and attracts flies, rats, and other creatures that in turn spread diseases. There is an increase in the generation of waste and the main aspect of concern is pollution that impacts land, air, water, etc. With the increase in the global population and the ascending demand for food and other essentials, there has been a rise in the amount of waste generated daily in households. The plague outbreak in Surat is an embodiment of a city suffering due to the cruel attitude of the local body in maintaining cleanliness in the city. This calls for the excessive solid waste that is generated to be controlled by taking specific preventative measures such as sorting waste and recycling (Rozsa, 2021).

When waste is not separated it tends to be smelly and more contaminated than the separated waste. The waste affects communities where there are no proper waste disposal methods. The people who are most affected are the pre-school children, waste workers, workers in Material Recovery Facilities, etc. Other high-risk groups include the population living close to a waste dump and those, whose water supply has become contaminated either due to waste dumping or leakage from landfill sites. Solid waste that is not properly managed increases the risk of injury and infection (Rozsa, 2021).

The separation of waste increases the recyclable material and hence reduces the amount of waste that requires disposal which consequently avoid the environmental damage that occurs during disposal. The disposal of waste in landfills can create groundwater contamination through the leakage of leachate. The impact of air pollution through the generation of methane gas by the anaerobic degradation of the organic material within the landfill is also a cause for concern. Furthermore, the incineration of waste produces carbon dioxide and other airborne emissions. Recycling high quantities of waste rather than opting for the disposal option reduces the amount of pollution and prolong the longevity of the landfill (Waite, 2017).

In some of the areas the weather conditions are not as favourable for the correct storage of waste. The efficiency of the amenities to sort waste is important to produce the quality of the sorted waste. The results of proper separation of waste at households and having recycling facilities produce sufficient recyclable material that is not contaminated. The lack of storage and amenities impacts the environment with visual pollution and littering when waste is not properly stored in households. Waste must be separated in colour codes of the waste bins to avoid the waste that is wet because of rain or littering of the streets by dry waste when it is windy (Rozsa, 2021).

The sorting of waste encourages recycling as it increases the amount of waste that will be converted to other products. The benefits of recycling help to reduce energy usage, reduce the consumption of fresh raw resources, reduce air pollution and water pollution that will be caused by leachate I produced in landfills. As waste is reduced from disposal by sorting more materials, greenhouse gas emissions from landfill sites are also reduced. The greenhouse gases are contributing to climate change. The products that can be recycled are paper, cardboard, glass, aluminium, tin, and plastic containers. The sorted organic waste can be used in farms to produce manure for agricultural benefits. Recycling of organic matter leads to the generation of valuable compost, which serves as plant fertilizer (Balwan et al., 2022).

The separation of waste improves the sustainability of waste management. Waste disposal contributes to climate change that causes air pollution and eutrophication. There is a decrease in the life expectancy of people in developed and developing countries as the conditions are no longer as habitable. The amount of waste disposed must be managed through reuse, recycling, storage, treatment, and disposal. Most municipal solid wastes and hazardous wastes are managed in land disposal units. The separated waste will be diverted in more of the waste management process before it can be disposed into landfill sites (Balwan et al., 2022).

2.4.2.2 Economic Impacts

One of the benefits of separation of waste is that as the number of separated elements of municipal waste rises, waste collection and disposal costs should also decrease. Separation of waste is one step in the waste hierarchy that helps to decrease landfill quantities. Therefore, it is necessary to have a collection system for other types of

waste. The sophisticated key is to be proximity to places, where residents can take sorted waste such as waste drop-off centres and civic facility sites, where residents can transfer the waste not collected from households (Rozsa, 2021).

Recycling waste plays a significant role from an economic point of view since it provides additional resources for the waste management sector, reduces the environmental impact related to waste management, and promotes job creation and investment in the recycling sector (Exposito, 2018). Recycling helps in better waste management and better economically stable communities.

Recycling projects mainly steered by social needs and demand for some resources are on the rise. In South Africa, the privately owned Buy Back Centres (BBC) in Bloemfontein and Pretoria cities, have been used to improve recycling of cans, glass, plastics, and paper, which has generated job opportunities for more than 300 people (Hettiarachchi et al., 2018). According to Godfrey and Oelofse (2017), development of organizations as an approach to integrate the informal SWM sector has accelerated enterprise development and job creation, but these have proven to be mostly unsustainable.

There are several recycling companies that contributes towards recycling. Examples of the recycling companies in South Africa that are Mama-She recyclers, Pikitup, Mondi paper and Nampak packaging companies. Consequently, paper recycling has risen from 41% to 57% between 2007 and 2015 (Godfrey and Oelofse, 2017). Through the bottle-2-bottle recycling plant, PET recycling company (PETCO), city of Johannesburg and Coca Cola company have directed 22,000 tonnes of plastic waste for recycling to produce bioplastics (DST, 2014; Infrastructure News, 2015; Bell and Russell, 2018).

2.4.2.3 Social Impacts

Recycling is done by private companies, manufacturers, and volunteers, with the demand for particular recyclable materials and social requirements driving the process (Godfrey and Oelofse, 2017). Collect-a-can and Steelrec are one of the mentioned recycling companies that recycle aluminium cans. Collaboration initiatives by the Republic of South Africa (RSA) government and organisations donating funds, such as the DANCED5, are encouraging sustainable waste management (Godfrey and

Oelofse, 2017). The establishment of recycling objectives in the 2001 Polokwane Declaration further demonstrates government support for recycling. According to Sentime (2014), the declaration's objectives were never legalised to form part of the policy as there were controversial. In 2017, the RSA was able to transfer 11% of MSW and 7% of hazardous waste to MRF (DEA, 2018). There is a need for intervention in upgrading the recycling in different areas to boost the economy and creating jobs in waste sector according to Godfrey and Oelofse (2017).

The amount of recycled waste will also be determined by the processes followed before recycling. Furthermore, each approach may influence a whole community's attitude toward recycling as well as the amount to which producers participate in the recycling process. The cost of recycled waste that was separated will have a high cost in terms of the value and empower people 's livelihood. Collection of separated waste is one step closer to achieving sustainable waste management, but it may be seen as an impartial sub-system and hence evaluated on its own terms and circumstances (Gallardo et al., 2011).

2.5 Community Participation in solid waste separation

Community participation is the pillar of waste sorting. Households need to participate in campaigns to support the sorting of waste. The campaigns on awareness and education will equip the households to be knowledgeable in their actions and attitudes towards waste management.

2. 5.1 Education and Awareness

The environmental campaigns play a vital role in imparting knowledge of how to take care of the environment through education and making people aware. When the society is knowledgeable, they tend to behave in a manner that they are aware of in terms of behaviour and attitude. The Conceptual Behavioural Model emphasis in making the communities aware of how to take care of the environment through waste sorting and change in behaviour to think positively. Since the concept of waste minimization is still a struggle in most communities, then the sorting of waste will improve the waste management sector. The households can adopt sorting of waste at the source level as part of conserving the resources that will rather be discarded. Waste will always be generated and what can be a better option than ensuring that

the waste value is better saved through sorting. It will be a habit of the community to adopt the new ways of conserving the environment (Waite, 2000).

According to Wate (2000) the communities that are educated and knowledgeable tend to be interested in environmental preservation and sustainable waste management. The packaging of the products keeps on improving and it states on the labels if the product is recyclable or non-recyclable so that it can be better sorted accordingly. This will encourage households to act in a good manner to pay attention to the design, whether it is paper or plastic.

There are ways that can persuade the households to sort waste, during collection service by making them aware that they can be fined for not sorting waste. The municipalities must encourage environmental education to communities. Households need to learn ways in which they can manage waste and sorting waste is forming part of the process. The more aware they become of the need and opportunities for waste sorting, minimization, and recycling to mention a few, the more they are motivated to separate waste at source (Waite, 2000).

Implementation of sorting waste in household is dependent on education as the key to ensure that people are aware and educated. When people are practicing source separation the yielding results will be visible as there will be well sorted and clean materials separated from the other. The use of natural resources will be substituted with the recycled material. The promotion of clean and safe environment, economy development and good health to the communities are the objectives that we strive to achieve holistically with intervention of education and awareness. About 80% of municipalities are implementing local awareness campaigns. Eighty percent (80%) of schools are engaged in waste awareness programmes (DEA, 2018).

2.5.2 Attitudes and perceptions

Sorting recyclables can be performed at the point of origin (i.e., within the home or workplace) for selected collection by the municipality or to be dropped off at a recycling center by the waste generator. Pre-sorting at the source necessitates public engagement, which may not be forthcoming if no advantages are to be obtained. The municipality's sorting offers the benefit of eliminating the requirement for members of the community and guaranteeing that recycling transpires. The negative is that the

value of the recyclable materials will decrease because of being mixed in with and compacted with other waste might have adverse impacts on the quality of the materials that are recyclable (UNEP, 2018).

The United Nations recognizes that how individuals spend their lives, and consequently their vocational decisions and patterns, have an influence on environmental, and socioeconomic long-term viability This suggests that individuals are either not having enough knowledge about sustainable growth or that the awareness derived from that knowledge does not result in better-suited behaviour choices and habits. Lack of education and awareness contributes to people not participating in environmental campaigns (Coraile, 2019). Recycling makes the consumer aware of their consumption and the need for resource conservation and it stimulates and encourages change in consumption behaviour. The sorting of waste will encourage the willingness to save more materials that will already be consumed and that will be a change in behaviour to sort waste before is stored in bins (Wate, 2000).

The government can also discover the recycling opportunities to reduce waste and prevent landfill disposal. The awareness to separate waste will work well for manufacturers as they will be able to reuse the recyclable materials and give the households coupons as a reward. The communities need to participate in environmental campaigns to be educated about how to take care of the environment which includes managing waste properly. The communities will then make better decisions and live in communities that are clean and feel empowered (DEA,2018).

2.6 Case studies on solid waste separation

Municipal Solid Waste separation is practiced in some parts of the world and there are studies conducted globally, regionally, and nationally. The studies show the importance and challenges other continents, countries, and municipalities encounter.

2.6.1 Global

In Worthing Borough, a seaside town in West Sussex, England, the recyclables are separated by the households using blue /green containers. The waste is sorted at household levels into recyclables and non-recyclables. The vehicle operators sort waste into two-wheeled bins to the vehicle in its compartment to avoid mixing. The

materials will be sent to a landfill for disposal. The collection of source-separated waste is successful and effective when done properly in households (Waite, 2000).

In Malaysia, Southeast country in Asia, consumes over 30,000 tonnes of waste every day, with a 3% annual increase. Malaysians accumulated 33,000 tonnes of solid waste per day in 2012, above the 30,000 tonnes expected in 2020 (Shay-Wei et al., 2017).

According to Alexis and Ames (2009), the following aspects contribute to municipal solid waste recycling in developing countries: Malaysia government policy and finances; waste characterisation, collection, and segregation; household education and the economy; the handling of municipal solid waste; organizing, and employees training; local recycled-material marketplaces; technological and managerial capabilities; and the availability of land. The study also discovered that throughout the collection and segregation, the municipal solid waste management plan and the local recycled-material market need the most collaboration with the rest of the components. Rafia and Muhammad (2011) discovered that a lot of households were unaware of the positive impacts of recycling, whereas Shay-Wei et al. (2017) expressed concern about garbage separation in China. Even though expanding civilisations found previously unknown minerals to the biosphere, the spectrum of their negative effects on environment was quite restricted (Andrzej and Arkadiusz, 2012). Human civilisation may now obtain a wide range of non-biodegradable chemical substances. Rather than being discarded, these should be returned to the economy and used again in the manufacturing process.

According to Emery et al. (2003), the socio-economic position and housing patterns of China influence not just the amount of solid waste produced but also how it is managed. As a result, understanding the unique features and demands of various communities is critical in developing an appropriate waste management strategy. There is no single resolution that can be implemented to address all waste management conditions in the varied globe of different types of waste on the environment. Waste management services and waste management amenities are respectively there to ensure that households receive proper services to satisfaction.

About 40% of inhabitants with a primary/secondary education level segregate their daily food waste, but only about 25% of individuals with a bachelor's degree or above do so. Even at the 10% significant level, the hypothesis that inequalities in food waste

segregation are connected to variation in gender, age, income, and type of residence have no basis in evidence (Shay-Wei et al., 2017).

Waste sorting is an important step in ensuring that waste produced is repurposed and, as a result, reduces the quantity of waste that will end up in landfills. In their quality of life, most respondents do not segregate their household waste. There is a strong link between waste sorting behaviours and gender. Women are more likely than males to be active in sorting duties. The end outcome is waste reduction. According to Shay-Wei et al. (2017), barely 30% of households segregate their food waste.

The causes for not sorting food waste in Malaysia are mainly "do not have time" and "lazy to change". However, approximately half of the respondents do not know how to practise sorting waste. A structured waste sorting education programme is strongly needed for the country. The study found that there is a significant association between education and waste sorting for both household waste and food waste. It is interesting to note that people with lower education are involved in waste sorting more actively as compared to those with higher education. The reasons behind this might be due to time–cost and lifestyle. Most of the time, waste sorting tasks tend to be conducted by older people or the maid living with the family (Shay-Wei et al., 2017).

However, most of the residents in Malaysia do not perform their sorting duties and thus dispose of mixed waste, which is problematic. Based on the study, environmental conservation is one of the main reasons why respondents sort their household waste in their daily life. The results show that age and education have a positive relation with reuse and recycling behaviour. This means that older people and higher educated people are more active in reuse and recycling. Highly educated people tend to be less active in waste sorting but more active in recycling. Higher time cost is one of the factors in waste sorting. Highly educated working adults prefer sending all the waste to recycling centres. If a person perceives that the time used in waste separation is a constraint, they have a high opportunity cost of time. Thus, they are less likely to sort the waste (Shay-Wei et al., 2017).

According to Ziakhinis et al. (2017), 53% of the households in Indonesia primarily burned their waste. Most households had good knowledge of waste management with 93.7%, and 85.7% of households showing that they cared about the environment. The households had good knowledge meaning that they know that burning waste can

pollute the air, and that they should separate the waste, and use organic waste as compost. However, only few households in Indonesia, approximately 9% have sorted their waste. Approximately 39% stated their reason for not sorting their waste was that they were too lazy. Based on this research, households in Indonesia which are knowledgeable of managing waste are dominant in household waste sorting. It shows that households in Indonesia have knowledge about how to sort and recycle waste and are willing to sort their waste. The households which have knowledge of managing waste have more environmental concerns because of the awareness of sustainable waste management. Households tend to be willing to sort their waste when they are aware of the importance of waste management and conserving the environment.

Due to an increase of waste in China, more and more greenhouse gases are being emitted through the disposal process, hindering the growth of a sustainable ecological society. Among the key tasks in the expansion of an ecological civilization, waste sorting and treatment play important roles in reducing disposal volume, cost, and land resource consumption, among other elements. Thus, improvements in waste sorting and treatment are crucial for China's carbon emission reduction strategies (Lian ,2021). Considering the importance of waste sorting and treatment in the development of an ecological civilization, empirically evaluating the environmental impact of such programs is particularly important. According to Han et al. (2017) the educational level of rural households in China has a significantly more positive effect on their recycling behaviour. Similarly, people in China with higher education levels were willing to participate in environmental campaigns and with change of behaviour.

France has strict regulations concerning landfills, resulting in 244 sanitary landfills in 2010 (BIPRO/CRI, 2015). In the last ten years, 150 landfills were closed, which shows that the country is clearly improving its waste management. These sanitary landfills received 19.6 million tonnes of waste in 2010, the first year that less than 20 million tonnes of waste were sent to landfills. According to the DEA (2018), collection schemes in France are shared between municipal services and private contractors in variable systems. Source separation is amongst the incentives that contributes to the reduction of waste materials that are disposed, collect a glass, and bring at collection point initiatives.

2.6.2 Regional

According to Owusu et al. (2013) Accra, the capital city of Ghana, and Kumasi, the second largest city have a combined population of about 4 million and a floating population of about 2.5 million and generate over 3000 tonnes of solid waste daily. Kumasi has a well-functioning waste management system from an African perspective, since an estimated 70% of the waste is collected and transported to landfill sites. However, financing waste management is a challenge, and that waste is not recovered and reprocessed as waste is collected to landfill site. They are not practicing the sorting of waste which is the reason why the landfill span is less than ten years. The environmental impacts are an issue such as water pollution, air pollution, littering etc.

 The success of household participation in waste management, especially source separation there are factors that support the household to be willing to participate in the process which includes socio-economic factors, health, and environmental benefits. The challenges are the infrastructure, such as the availability of waste bins close to the households, household space, etc. The willingness of households to participate in source separation is practiced in first-class residential areas and less interest in the third-class level of residences. The willingness of sorting waste also involves the status in residential zoning (Owusu et al., 2013).

Evidence regarding the link between education and separation behaviour differs. Levels of education have a negative impact on separation behaviour in Kampala, Uganda. People with higher education are assumed to hold higher-paying jobs earning enough income to be able to pay for their refuse removal. Paying for their refuse removal makes them feel that it is not their responsibility to participate in waste separation programs. Conversely, results in Nigeria show that higher educational levels led to higher participation rates in waste separation programs (Wang et al., 2018).

In Guinea, the municipal waste sorting initiative is the project that is developed regarding the waste constituent, the project feeds in the decentralisation procedure and provisions municipalities with the group of the waste pre-collection. It provides for the construction of 30 transportation and sorting stations in Conakry and supporting activities aimed at building stakeholder engagement, managerial and institutional dimensions. Routes for waste recovery (compost, plastic) are also to be developed. In

parallel, the project also delivers support to the national waste agency which has taken up a new role. Special attention is given to elaborate a master plan for waste management in the Conakry area (eight municipalities) that will pave the way for the entry into service of new structures (landfill, transfer stations). All this responds to the strategy adopted by the Government to enhance waste service levels during the 2018-2022 period (Enabel, 2020).

Source separation of Municipal Solid Waste (MSW) is an essential part of sustainable and integrated MSW management. In Zimbabwe, the national solid waste management plan of 2014 provides for source separation under goal 2 and public education for awareness raising on the importance of source separation under goal 7. This provides the necessary commitment and necessity for source separation at national level. This study reviewed the accessible opportunities and limitations for MSW source separation in Harare. Such opportunities for source separation that exists include the convenience of a national plan, MSW composition which affluences source separation of organics to either anaerobic digestion or composting, recyclables, and non-recyclables of a low heating value agreeable to incineration with energy recovery (Nnhubu et al., 2019).

In Algeria, the management of urban solid waste is still undeveloped, in a technical and organizational point of view. The lack of sorting at source, encourages disposing waste to the landfill. Packaging waste including paper and cardboard, and plastic characterise a significant portion of municipal solid waste (between 20% and 30%). These percentage approximations accounts for more than 1.2 million tonnes of plastic and almost as many papers and cardboard. During the past five years, the country has practiced innovation in recovery. Several companies function in the recycling of paper, plastics, and some metals, but they are insufficient. The amount of waste from recycled paper and cardboard has not exceeded 100 000 tonnes in 2012 with a projection of 120 000 tonnes for 2013. According to the forecast of the MATE, by 2022, 50% of waste paper and cardboard will be collected, this is about 450 000 tonnes (Kehila, 2014)

2.6.3 National

West Rand District Municipality (WRDM) is found in the southwest region of Gauteng Province and covers an area of 4 095km^2. The area is segmented into four municipalities namely Westonaria, Merafong city, Mogale city and Randfontein (Ginindza and Muzenda, 2016). About 98% of produced waste is disposed at 4 landfills: Lebanon, Uitvaalfontein, Raipoort and Luipaardsvlei facilities while only 2% is directed to recycling (Ginindza and Muzenda, 2016). Informal waste picking spreads SWM in the municipality, though it is unregulated and characterized by informal settling at areas adjacent landfills. Illegal dumping due to the small size and insufficient number of waste bins and skips is a common phenomenon. About 20% of the population is not enclosed by municipal waste services and in areas where it is done, residents have to struggle with odours and spillages due to deprived infrastructure, an overwhelmed transport system, vehicle breakdowns and spare parts non-availability (Ginindza and Muzenda, 2016).

In recognition of these failures, the municipality in collaboration with the West Rand Development Agency has plans to build two buyback centers and a recycling plant in Westonaria to recover disposed waste. In addition, the municipality is conducting trials for methane monitoring at Luipaardsvlei landfill in an educational program with the residents using street clean-up campaigns to minimize generation, illegal dumping and promote alternative waste treatment methods (Ginindza and Muzenda, 2016). These opportunities can be improved to successes if integrated waste management planning is incorporated.

High income earners in Tshwane Metropolitan Municipality of South Africa are more likely to separate their waste than the medium and lower income earning group. The pattern is repetitive in most municipalities where households have higher incomes than those who are not willing to participate in waste separation programs. Household income directly and significantly impacted disposal behaviour and even more so in rural and remote areas. Borland et al. (2020) stated that, in a low-income area, recycling of waste takes place if there are financial reimbursements devoted to it.

In Hantam Municipality in Northern Cape, there was a study conducted in 2019 based on the willingness of the households to participate in separation at source program. The households in informal settlements are willing to separate waste than the

households in formal settlement. The findings indicated that 90.6% are willing to separate waste and 9.4% are not willing to separate waste in informal settlements. The households in formal settlements that are willing to separate waste are about 90.2% and the households who are not willing to separate are 9.8%. The households are not composting their waste except for one household which shows lack of knowledge about separation of waste (Viljoen et al., 2021)

In Western Cape province, 76% of municipalities practice source separation and they already have a system in place while 24% municipalities do not. Witzernberg and Matzikama are among the municipalities that are not participating in source separation. Municipalities that are participating in the source separation, to name a few, are Cederberg, Knysna and Overstrand. Municipalities indicated that a variety of Source Separation systems are being implemented, from two bags and split bag systems to drop-offs and buy-back centres. The waste managers advised that the municipalities should not run the initiatives but rather appoint the well qualified contractors to manage the source separation initiative and others (EADP, 2019).

The municipalities participate in waste management initiatives and take charge when they are knowledgeable. The community benefits by receiving a waste management service with the associated hygiene improvement. Poverty amongst residents is also alleviated. Several municipalities have similar initiatives, for example, Thulamela Municipality in Limpopo Province who funds the initiative from the Expanded Public Works Programme budget and Msunduzi and Emnambithi municipalities in Kwazulu - Natal Province (CSIR, 2011).

The Siyazenzela initiative was started by the Local Economic Development department in 2007. The word siyazenzela means we do it ourselves. People living in informal settlements in Hibiscus Coast Municipality in Kwazulu-Natal Province participate to collect waste from households and to preserve the area clean. All waste collectors obtain protective clothing. The municipality removes the collected waste from central collection points once a week. The waste collectors are not paid in cash, but fortnightly they receive basic household provisions and fresh harvest as a form of compensation (CSIR, 2011).

2.7 Environmental Legislations

2.7.1 The Constitution of South Africa, 1996

The Constitution is the supreme law of South Africa, and it stipulates for establishment of various Acts. It assigns coexisting legislative capability to the national and provincial government with admiration to the environment and pollution control (section 146 of the Constitution). It assigns exclusive provincial legislative competence to the local government matters of cleansing and refuse removal, refuse dumps and solid waste disposal. The Constitution allows national legislation to set national norms and standards relating to these issues in cases where national consistency is required to deal effectively with the matter (Constitution of South Africa,1996).

2.7.2 The National Environmental Management: Waste Act (Act No. 59 of 2008)

The National Environmental Management: Waste Act (Act No. 59 of 2008) specifies that standards are required to give result to the right to an environment that is not detrimental to health and well-being, and that these rights must be applied uniformly throughout the Republic. It is recognized that South Africa is a developing country and the determination of the setting of standards is to certify a service to all while complying with health and safety regulations without unreasonably changing current creative collection processes as long as they function well and deliver a service of acceptable standard to all households. These National Domestic Waste Collection Standards are therefore applicable to all domestic waste collection services throughout the country (DEA, 2018).

The National Environmental Management Waste Act No. 59 of 2008 as amended (NEMWA) places a duty on government to place even measures that seek to reduce the quantity of waste that is produced and, where waste is generated to ensure that waste is re-used and recovered in an environmentally sound manner. It is estimated that 20.7million tonnes of 54.2 million tonnes made of general waste was recycled in 2017, which results in overall recycling rate of 38.3% and overall landfill or treated rate of 61.7% which proves that most waste is disposed (DEA, 2018).

2.7.3 Environment conservation Act (Act No.73 of 1989)

The Act protects ecological processes, natural systems, and the natural beauty as well as the preservation of biotic diversity in the natural environment. It also promotes sustainable utilisation of species and ecosystems and the operative application and re-use of natural resources. The act protects the environment against disturbances, deterioration, defacement, poisoning, pollution, or destruction because of man-made constructions, installations, and human activities (DFFE, 2014).

2.7.4 The National Water Act (Act No 36 of 1998)

The National Water Act (Act No 36 of 1998) is the legislation that indorses prevention of pollution, protection, conservation, and advance of water resources in South Africa. The ultimate principle is that water resources be protected to achieve sustainable use of water for future generations. Chapter 3 (Section 19) of the National Water Act states that there should be measures to prevent the pollution of water resources and measures to remedy effects. It is the responsibility of every user to guarantee that they manage waste properly to not affect the water bodies as a result of pollution. It is the responsibility of every waste producer to manage waste properly and not pollute water bodies. Reduction in the amount of waste that is disposed of minimize water pollution (DWAF, 2017).

2.7.5 National Health Act 2003

The National Health Act, 2003 describes municipal health services to include water quality monitoring; food control waste management; health surveillance of premises; surveillance and prevention of communicable diseases, excluding immunizations; vector control; environmental pollution control; disposal of the dead; and chemical safety, but excludes port health, malaria control and control of hazardous substances. Section 32 of the Act requires that the municipal health services including waste management must be effectively and impartially provided. Furthermore, national, and provincial government must enter into a service level agreement as planned in section 156 (4) of the Constitution, assigning the administration of the listed matters to the municipality (NHA, 2019).

2.7.6 The National Waste Management Strategy (NWMS) of 2000

Legislation related to SWM is usually disjointed in several laws that include clauses on rules/regulations regarding SWM, for example, in the Public Health Act, Local Government Act and the Environmental Protection Act (Srivastava et al., 2005; Minciardi et al., 2007). The rules and regulations are enforced by the diverse agencies. However, there are often repetition of responsibilities of the agencies involved and missing elements in the regulatory provisions for the development of effective SWM systems.

An integrated MSW management system reflects an approach to sustainable waste management. Such method is environmentally effective and includes an optimized waste collection system, efficient sorting accompanied by one or more processes like recycling or composting of organic segments, and finally landfilling of the residual waste. Towards this direction, Waste Framework Directive launches the concept of waste hierarchy and sets the principles for the protection of the environment through the implementation of more efficient MSW management systems. Accordingly, the European Union member states gradually incorporate the waste regulation into their national regulatory framework and accept waste treatment methods that lead to energy and material recovery from the various MSW streams (Batsioula, 2018).

The National Waste Management Strategy (NWMS) is part of a plan to absorb generated waste despite the growing challenges of population increase, urbanization, and consumer trends. The plan highlights the national plan towards sustainable development through environmental resource protection (Dlamini et al., 2019). Such an initiative demands effective use of raw materials, waste prevention, efficient use of resources and sustainable material designing (DEA, 2018). South Africa hopes to achieve these action plans through the descending waste management hierarchy. The eight goals of NWMS plays a role in achieving a sustainable waste management.

Although the motive of the NWMS outlined by its goals was to improve waste services, most of these targets have not been met such as 100% of collection services in South Africa (Dlamini et al., 2019). Only 61% of households had access to waste services and the number covers most of the urban areas (Zhakata et al., 2016; Gutberlet, 2018). Budgetary allocations for waste management at local levels were insufficient to meet

the demand. The plan overloads the local municipalities to steer up its goals despite the lack of corporative governance with provincial and national governments. As such, municipalities are overwhelmed as evident from the high quantity and diversity of wastes, and thus their inability to serve its residents leading to the rise of illegal dumping (Zhakata et al., 2016). These defects need attention from the initial phase on how the waste management sector will engage the integrated legislations the SWM systems in South Africa. The legislative institute is currently revisiting the NWMS to initiate the achievable goals and action plans towards sustainable SWM (SAWIC, 2018).

2.7.7 Municipal Systems Act (Act No 32 of 2000)

The Municipal Systems Act (Act No 32 of 2000) defines the alternate methods that may be employed in delivering municipal services and the procedures to be followed when such replacements are considered. The Act further orders communities to be encouraged to participate in strategic decision-making concerning to service delivery. Municipalities ensure proper budgeting to deliver on their Constitutional mandate with regards to the provision of waste services. To have successful implementation of IWMP there is a need to implement accessible resources such as finance, human resources, and operational skills to deliver on the goals and targets of the municipality. The plan includes the goals and targets such as the development of laws and funding for operational and maintenance costs for equipment for the effective delivery of waste services and establishment of waste disposal facilities (CoJ IWMP, 2011).

2.7.8 Extended Product Responsibility Policy (EPR) (2020)

The Extended Product Responsibility (EPR) is introduced as a pollution prevention policy that focuses on whole product systems rather than individual production facilities. The product ends up in households as waste. The source separation helps the households to be familiar with the products that are consumed and how they will be sorted once regarded as waste. The key goals of EPR are sustainable development through environmentally responsible product development and product recovery, which are attained hand in hand through cleaner production and waste prevention. Producer accountabilities include liability, ownership, economic, physical and information responsibilities. It is the responsibility of the household to ensure that

waste is managed properly with the provision of resources from the municipalities. There are three classes of policy instruments that can be started by the government to encourage EPR, i.e., regulatory, economic, and informative instruments (DEAT, 2014).

The EPR (2020) regulates the amount of waste that is recycled, sorted, and recovered. The packaging of the product is the responsibility of the manufacturer. The development and maintenance of a system to collect EPR fees and compensate the reclaimers and pickers into the post-consumer value chain. The increase in job creation and the recycling companies will increase. The South African Information Centre (SAWIC) is accessible for information to the public about the materials that need to be reclaimed as the responsibility of the consumer. The EPR Scheme is to increase the recovery of identified products from municipal waste (EPR, 2020).

2.8 Challenges of Sorting Waste

Municipalities often perceive the collection of recyclables sorted from general waste as a load to their managerial skills and their operational costs. Historically, municipalities did not take waste minimization and recycling as their order, and it was thus not involved in their collection strategies. The section of the municipality enabling and funding the operation can agree with community members to collect waste from all households within their area and handover it to fundamental collection points where the municipal waste collection vehicles can collect the waste for disposal. This will have the added advantage of job creation (CSIR, 2011).

Participation in source separation of recyclables without any significant financial benefit can be challenging as it is considered as time consuming. A cost saving on the monthly disposal charges would inspire a business to participate in source separation. Buy-back centres are more viable in low-income areas, where participating community members are rewarded for collecting and bringing in recyclables. Separation at source and the need to collect the recyclables separately has only recently become a requirement with the promulgation of the Waste Act. There is a challenge when coming to including the separate collection of recyclables into implemented collection strategies (CSIR, 2011).

Although the Republic of South Africa (RSA) has made great strides in developing legislative frameworks to support SWM, there is a lot that needs to be achieved to enforce these regulations, improve waste management services through the improvement in recycling considering that landfilling remains the last resort (Godfrey, 2019). There is quite some backlog that South Africa faces in SWM such as planning, financial management, interpretation of existent SWM legislation and delivery of waste services (DEA, 2016a). According to Gutberlet (2018), municipalities having a responsibility of providing waste services do not have baseline data and decision-making tools to assist them in making informed decisions on SWM. There are 524 landfills of the known 1,203 facilities registered but the challenge is that they are not managed properly. Recyclers encounter challenges as they receive contaminated waste that needs to be clean before it can be recovered to meet waste management standards (Niekerk and Weghmann, 2019). The provision of waste services to the community should be responsive such as recycling campaigns, cleaning campaigns and so forth. The community can also be responsive to sorting waste when they are aware and knowledgeable (Dlamini et al., 2019).

Poor financial management characterized by inadequate funding, embezzlement of funds and poor waste service recovery deter effective SWM by interfering with institutional behaviour (in planning and management), equipment, infrastructure, and labour management (Mannie and Bowers, 2014). Poor waste tariff distribution and financial constraints in SWM sectors of many municipalities of the country confirm the challenge as serious (Niekerk and Weghmann, 2019). The challenges have made operational expenses such as capital expenditure, employee remuneration, maintenance, and fuel unrealistic to meet. Poor financial accounting of allocated funds mulled by corruption leads to poor management of the waste cycle by non-investment based on service demand. At the institutional level, SWM is challenged by inconsistent waste collection schedules, unreliable services, inadequate organizational capacity, ineffective sanitation laws and an ambiguous authority line (Gutberlet, 2018).

The national government affirms that provision of waste services is a right though its treatment to the local governments that are financially constrained by rising populations and ever-increasing waste quantities is insufficient (Tsheleza et al., 2019). Poor waste services are predominant in rural areas and residents have turned to

alternatives such as burning and illegal dumping that have negative environmental effects. Additionally, these flaws have resulted in unpleasant and unhealthy environments. Even in urban areas such as Johannesburg, waste services are hampered by a complex waste flow due to increased middle-class citizens and informal settlements that pressure local authorities with increased generation (Dlamini et al., 2019). This challenge depicts a failure by the government to plan effectively and apply cost effective approaches to bridge the SWM gaps (Simelane, 2016). To these waste service and cost recovery challenges, improved governance and planning incorporating all stakeholders including informal waste pickers is essential (Godfrey, 2019).

Waste vehicles are the main economic cost contributors as landfills are located distances away from households. There is a shortage of vehicles and equipment used in waste collection processes in municipalities. According to Fakoya (2014), most of this equipment and vehicles are imported and their maintenance costs are very high. The complex and various nature of waste generated intensifies the current situation and create separation and sorting challenges. According to Thornhill (2012), the purchase of large and high number of waste vehicles, their ineffective use and overdo has resulted in misuse of funds at the municipality level, which portrays institutional inadequacy.

Solid Waste Management (SWM) in RSA faces a challenge in labour management due to inadequate or appropriate skills to manage the involved activities (DST, 2016). Although the waste sector is known to have created more than 60 000 jobs by 2016 through informal waste picking, recovery, and recycling, it is appealing unskilled labour, which is not sustainable when compared to the increasing SWM demands. Inadequate human volume to handle technical issues such as maximum space use, environmental compliance and compaction ratios at municipality level affect the country's waste sector. Although common of unskilled labours are required due to the labour-intensive nature of SWM activities, training them with essential skills would improve the management of its worth chain (Godfrey et al., 2016).

Although the waste classification and management (R634) regulations have streamlined the quantities of landfilled waste streams, they have led to prohibitions of others. Consequently, more streams are being prohibited at landfills though production

is on the rise. These procedures protect both the environment and the quantities engaged in the landfill disposal. However, they come with enlarged costs of waste treatment and the essential to re-plan the management of such wastes sustainably. South African industries must adapt and adopt to greener products and a circular economy that changes the concentration from landfilling (Stubbs ,2019).

2.9 Waste separation and Sustainability

Sustainability is a concept that came into prominence in 1992 in Rio earth summit. It is the approach that uses and consumes earth resources in a way that does not disadvantage future generations. Sustainability is striving to use waste as a resource effectively and minimizing the impacts on the environment. The waste management processes such as sorting waste and waste recovery increase recyclable materials. Recycling waste to recover useful materials reduces the need for virgin raw materials. These reimbursements of reserving raw materials and harvesting of resources being extracted are reduced and have less destruction to the environment. The reprocessing of waste material generates significant energy savings compared to the creation of virgin materials (Waite, 2000).

Managing waste properly is crucial for building sustainable and liveable cities, but it remains a challenge for many developing countries and cities. Operative waste management is exclusive, often including 20%–50% of municipal budgets. Operating this essential municipal service necessitates integrated systems that are competent, sustainable, and socially supported (Argus and Carl, 2001; Gerke and Pretz, 2004).

Denison (1996), states that natural resources are being exhausted and landfills are being occupied at a cumulative rate. Human being can all make a change by protecting the environment, conserving natural resources, and sustaining the planet for future generations. Developed countries on the other hand accord great importance to the carbon dioxide emission reduction which is mainly released by MSW (Arafat et al., 2015). For that reason, most of the countries already had long-term experience with separate collection for certain materials found in MSW especially glass and paper for recycling (Argus and Carl, 2001; Gerke and Pretz, 2004).

Zero-waste aims to decrease the environmental impact of waste disposable norm and to address climate change issues concurrently. The principle is grounded on the idea

of handling materials in ways that preserve value, reduce environmental impact, and conserve natural resources. It seeks to guarantee that products can be restored, reused, and recycled. Executing zero waste needs converting from waste management through incinerators and landfills to an impactful resource recovery system. Additionally, leachate from landfills enters groundwater and pollutes farmland and drinking water. At current waste generation levels, the recycling industry cannot hope to keep up with demand, and while recycling is highly important to the zero-waste movement, it must not be so heavily relied on. To address the negative impact of climate change then zero waste and a rounder economy are truly most sensible and sustainable choices (Argus and Carl, 2001; Gerke and Pretz, 2004).

2.10 Conceptual framework

The conceptual framework is discussed in the context of awareness and perception of households towards waste separation. The literature summarised the categories of willingness to separate waste which are education and awareness, community participation and availability of resources. The separation of waste improves the social, environmental, and social impacts. The impacts that are improved are job creation, reduction in pollution, composting etc. The environmental campaigns are helping the community to be educated and engage in community activities such as sorting waste, removing the litter etc. The availability of resources such as waste bins, refuse bags, buy-back centres, etc. will help in the separation of waste process. The separation of waste contributes towards sustainable waste management. The concept of awareness and perception of sorting waste in households is based on community participation.

```
                    ┌─────────────────┐
                    │ Sorting MSW in  │
                    │ Household       │
                    └─────────────────┘
                      ╱             ╲
                     ╱               ╲
        ┌─────────────────┐       ┌─────────────────┐
        │ Education and   │       │ Availability  of│
        │ awareness &     │       │ resources       │
        │ community       │       └─────────────────┘
        └─────────────────┘                │
          ╱          ╲                      │
         ╱            ╲                     │
┌─────────────────┐ ┌─────────────────┐ ┌─────────────────┐
│ Composting, job │ │ Environmental   │ │ Waste   bins,   refuse│
│ creations, red. │ │ campaigns,      │ │ bags,     buy     back│
│ in pollution.   │ │ legislation     │ │ centres,     recycling│
└─────────────────┘ └─────────────────┘ └─────────────────┘
          ╲                │                  ╱
           ╲               │                 ╱
            ┌─────────────────────┐
            │ Sustainable Waste   │
            │ Management          │
            └─────────────────────┘
```
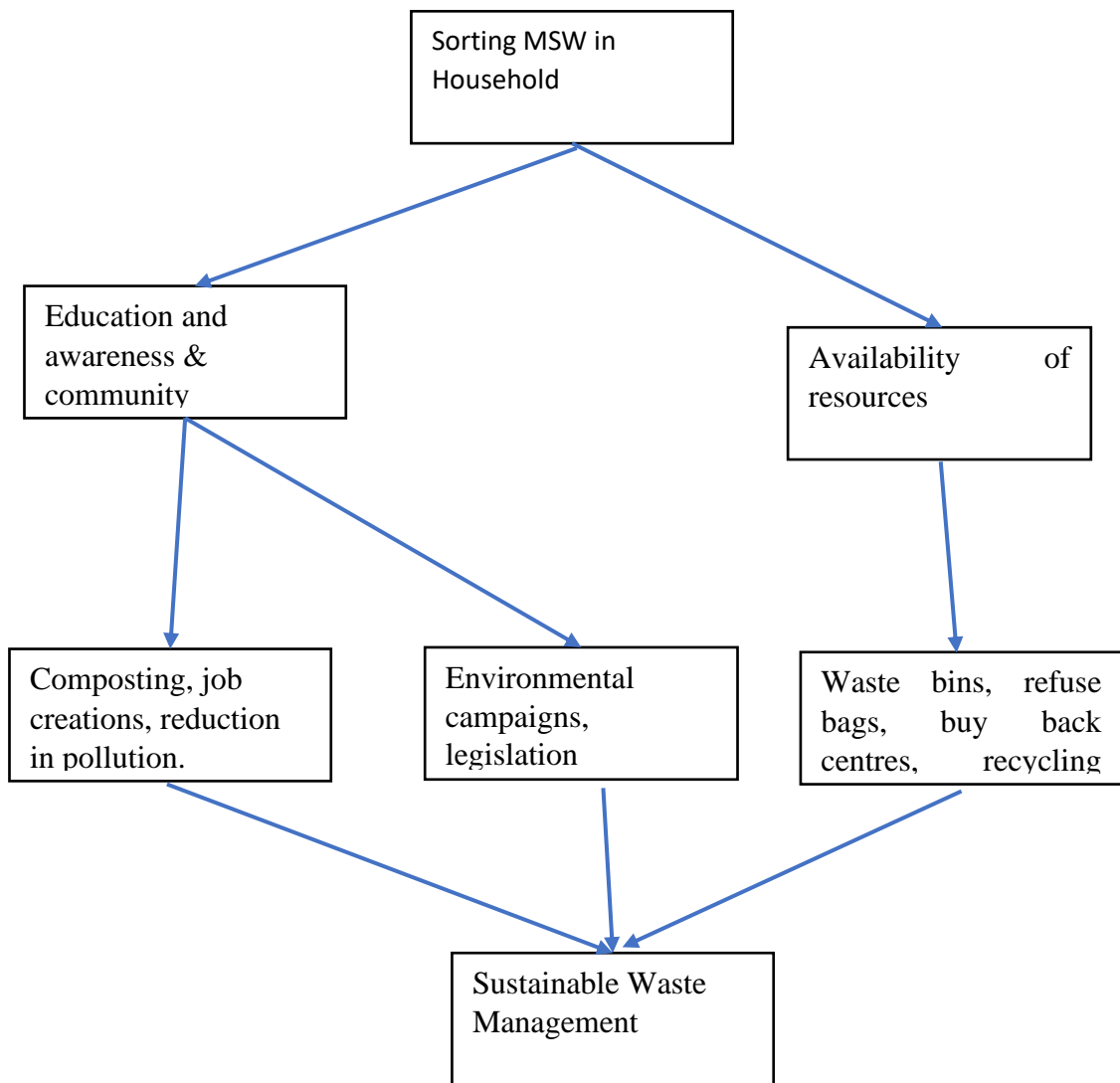
Figure 2.1: Conceptual framework of awareness and perception of sorting MSW.

2.11 Summary of the chapter

The sorting of waste is an important process of sustainable waste management. Households have challenges when coming to sorting waste as there are challenges related to Municipal Solid Waste. Education and environmental awareness are the main concern to improving waste management services. Waste, when not properly managed impacts on the environment. However, when managed properly communities can benefit from the very same waste generated. Community participation remains the pillar in sorting waste. The Municipalities' legislations and by-laws must be enforced, and the financial allocations fund the campaigns to enable communities to participate. The provision of waste management infrastructure and

amenities must be improved to enable householders to sort waste. The following chapter discusses the research methodology.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

Chapter 3 addresses the research design and data collection methods. The data collection instruments that were used and the data analysis tools that analysed the raw data are outlined.

3.2 Research design

The research adopted a mixed method research approach. Quantitative research collects data in numerical form and can be measured and categorised and used in statistics. Qualitative research collects data in descriptive form especially description of behavior and motivation variables. Quantitative research can tell when, where, and how often things happen while qualitative research looks at the why and how things happen the way they do (McLeod, 2008). The study collected data on the type of waste recycled and recycling facilities as well as the number of people that are aware and willing to sorting waste. The data collection instruments that were used are questionnaires, key informant interviews and field observation.

3.3 Sampling

3.3.1 Sampling frame

The sampling frame was the total number of households in Lebowakgomo Zone A and F residential areas. Lebowakgomo Zone A consists of 2801 households and Lebowakgomo Zone F consists of 1924 households (Census, 2011).

3.3.2 Sample size

The sample size for the study was 10% of the total number of households in Lebowakgomo Zone A and F because it produces a reasonable maximum sample size and a survey that involves 5-10% of the target population which is representative of the whole population (Gans et al., 2018).

$$\text{Sample size (n)} = \frac{N \times 10}{100}$$

Where, n= households sample size

N= total number of households

The Sample size for Lebowakgomo Zone A:

Sample size (n) $= \frac{2801 \times 10}{100}$

Therefore, the sample size for Lebowakgomo Zone A was 280

The Sample size for Lebowakgomo Zone F:

Sample size (n) $= \frac{1924 \times 10}{100}$

Therefore, the sample size for Lebowakgomo Zone F was 192.

3. 3.3 Sampling method

Systematic random sampling was used to select the households because they are arranged in a grid plan pattern. The periodic interval / skip was calculated using the formula:

$$k^{th} = \frac{N}{n}$$

Where, k^{th} = the periodic interval / skip

N= the population size, and

n = the sample size

Zone A: k^{th} = 2801 /280= 10

Zone F: k^{th} = 1924 /192=10

The first house was randomly picked, and thereafter every 10th house in Zone A and F, respectively, were selected.

3.4 Data collection method

3.4.1 Secondary data

Secondary data was compiled from data produced by other users such as internet articles, books, journal articles and satellite images.

3.4.2 Primary data

Primary data was collected using questionnaires, key informant interviews, and field observations.

3.4. 2.1 Questionnaires

A total of 280 questionnaires were distributed in Lebowakgomo Zone A and 192 in Lebowakgomo Zone F. The questionnaire had open and close-ended questions and was self-administered. The questionnaires were distributed to people from the age of 18 and above that are residing in the household. They were distributed to households to assess the willingness in sorting municipal solid waste at household level before collection services (Objective i). The questionnaires further assisted to investigate the environmental impacts of sorting waste at source (Objective ii). This tool also examined the strategies of Lepelle-Nkumpi Local Municipality on sorting Municipal Solid Waste at Lebowakgomo Zone A and F (Objective iv). The researcher conducted a pilot survey at Lebowakgomo Zone A and F to validate the validity and reliability of the questionnaire. Ten (10) questionnaires, five (5) per zone were used to test the research instrument. These questionnaires (The pilot study questionnaires) were not included in data analysis.

3.4.2.2 Key Informant Interviews

The interviews were held with business recyclers to ascertain the challenges faced during recycling of unseparated waste in Lebowakgomo Zone A and F (Objective iii). Furthermore, the interviews were also held with Waste Management Officials to examine the strategies of Lepelle-Nkumpi Local Municipality on encouraging source separation   at Lebowakgomo Zone A and F (Objective iv).

3.4.2.3 Field Observations

 Field observations were conducted to investigate the environmental impacts of sorting waste at source in Lebowakgomo Zone A and F (Objective ii). This tool was also conducted at recycling facilities to ascertain the challenges faced during recycling of unseparated waste in Lebowakgomo Zone A and F (Objective iii). Furthermore, field observation was conducted at municipal collection services to examine the strategies of Lepelle-Nkumpi Local Municipality on encouraging source separation at Lebowakgomo Zone A and F (Objective iv).

Table 3.1: Summary of data collection methods.

Objectives	Type of Instrument	Data collected
i. Assess the willingness of householders in sorting Municipal Solid Waste at household level before collection services in Lebowakgomo Zone A and F	• Questionnaires	Environmental awareness, willingness, community knowledge and behaviour on sorting waste.
ii. Investigate the impacts of sorting waste at source in Lebowakgomo Zone A and F.	• Questionnaires • Field Observation	Availability of resources (refuse bags and waste bins), collection services, recycling centre and infrastructure
iii. Ascertain the challenges of recycling unseparated waste in Lebowakgomo Zone A and F.	• Key Informant Interviews • Field Observation	Budget and cost, complexity of different waste and landfill disposal, recycling facilities.
iv. Examine the strategies of Lepelle-Nkumpi Municipality on sorting Municipal Solid Waste at Lebowakgomo Zone A and F	• Questionnaires • Key informant Interviews. • Field Observation	Environmental campaigns, by-laws, implementation of IWMP, recycling, and job creation.

3.5 Data analysis

The Statistical Package for the Social Sciences (SPSS) Software version 27 was used for data capturing and data analysis. The analyzed data was presented in the form of tables, pie charts and bar graphs, and thematic paragraphs.

Table 3. 2: Summary of data analysis methods and presentation.

Objectives	Data Collection Instrument	Data Analysis Method	Data Presentation
i. Assess the willingness of householders in sorting Municipal Solid Waste at household level before collection services in Lebowakgomo Zone A and F	• Questionnaires	Descriptive statistics and Pearson Chi Square test.	Tables, pie charts and bar graphs; Thematic paragraphs
ii. Investigate the impacts of sorting waste at source in Lebowakgomo Zone A and F.	• Questionnaires • Key Informant Interviews	Descriptive statistics and narrative analysis	Tables, pie charts and bar graphs. Thematic paragraphs
iii. Ascertain the challenges of recycling unseparated waste in Lebowakgomo Zone A and F.	• Questionnaires • Key Informant Interviews • Field Observation	Descriptive statistics and narrative analysis	Tables, pie charts and bar graphs Photos and thematic paragraphs

iv. Examine the strategies of Lepelle-Nkumpi Municipality on sorting Municipal Solid Waste at Lebowakgomo Zone A and F	• Questionnaires • Key Informant Interviews • Field Observation	Descriptive statistics and narrative analysis	Tables, pie chart, bar graphs and photos Thematic paragraphs

3.6 Summary of the Chapter

Chapter three addressed the research methodology. The subtopics that were discussed were research design, sampling, data collection and data analysis methods. The study used mixed method approach and the data collection tools that were used are questionnaires, key informant interviews and field observations. The next chapter will focus on results and discussion of analysed data.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

The research study is on evaluating the awareness and perceptions of sorting municipal solid waste: a case study of Lebowakgomo Zone A and F, Lepelle-Nkumpi Local Municipality, Limpopo Province. The chapter presents the socio-economic characteristics, waste management practices, willingness of householders to participate in waste sorting of MSW, impacts of unseparated waste, and challenges of sorting and recycling MSW. The roles of the municipality incorporate the legislations that encourage source sorting as part of sustainable waste management.

4.2 Socio-economic characteristics

The socio-economic characteristics that are included in the study are the demographics of the population such as age, gender, marital status, education, income, and occupation etc.

4.2.1 Age

Age is the period someone has been alive, or something has existed (Cambridge Dictionary, 2020). This is the time one has lived from birth until the date when the person has participated as a respondent for the study. The age limit for a respondent to participate in this study was 18 years and older. The age interval of 18-28 years is the youngest and 49 and above is the oldest.

Figure 4.1 shows age distribution of the respondents. Respondents in Lebowakgomo Zone A aged 49 years and above made up 33% which is the highest, followed by 29-38 years with 25%. On the other hand, 39-48 year olds contributed 25% while the lowest is 18-28 years which consists of 17% of the respondents. Respondents in Lebowakgomo Zone F aged 29-38 year old were the highest at 39%, followed by 49 years and above at 28%. Furthermore, 39-48 year olds contributed 22% and the lowest was 18-28 years which consisted of 11% of respondents (Figure 4.1). The pensioners were accessible as they stay at home while the working class was only accessible in the afternoon after work.
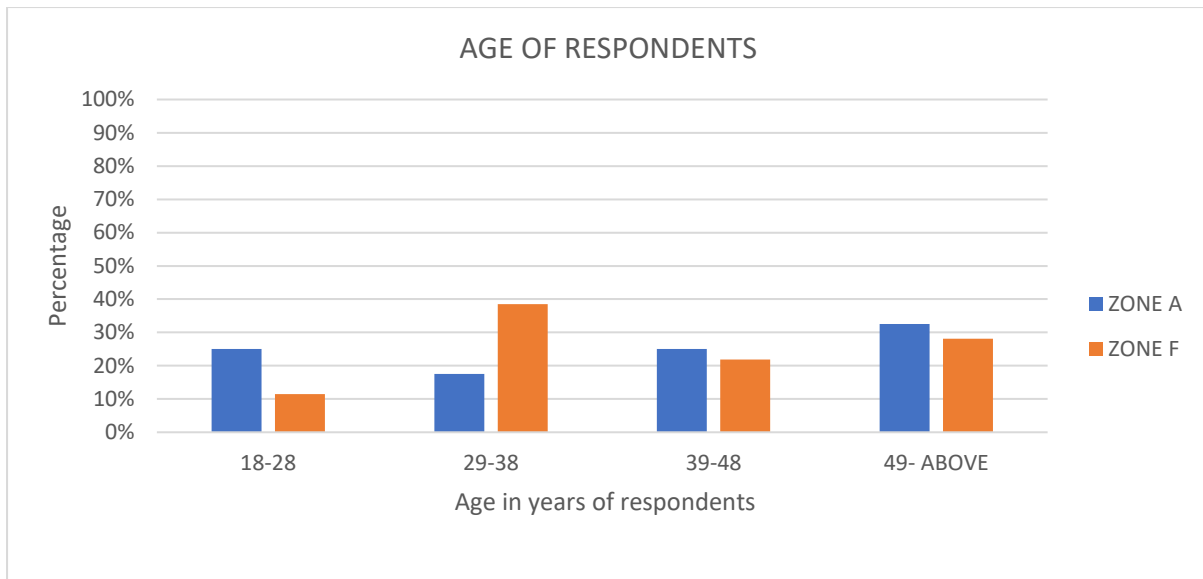
Figure 4.1: Age structure of respondents (years).

According to Setiawan (2020), in a study conducted in Indonesia, the age of the participants was included from 17 to 94 years old, with the middle group at 35 to 60 years old accounting for 68.8% of the participants. Figure 4.1 supports Setiawan (2020) which shows that most of the respondents are in the 49 years and above age group in Lebowakgomo Zone A. In contrast, in Lebowakgomo Zone F the highest number of respondents are at the age of 29-38 years of age and are followed by those at 49 years and above.

This study further supports the one that was conducted by Mpinganjira et al. (2020), where 66% of respondents were accounting for 18 to 35 years. The City of Johannesburg is a metropolitan area which is a hub for job opportunities and most youth will be found in these types of areas contrary to Lebowakgomo where the highest number of respondents are at the age of 49 and above.

4.2.2 Gender

Gender is defined as the same social character or physic build in women, men, girls, and boys. This includes norms, behaviours and roles associated with being a woman, man, girl, or boy, as well as the interactions amongst themselves. Gender is also referring to the range of characteristics related to sexuality where females and males are two categories that differentiate between the gender (WBO, 2022).

The findings displayed in Figure 4.2 indicated that 60% of the respondents were female while 40% were male for Lebowakgomo Zone A. In Lebowakgomo Zone F, 80% of the respondents were female and 20% were male (Figure 4.2). The females are the highest in both areas. The reason for the above could be that most men are at work during the day and that women are usually the ones that deal with household waste and therefore store and separate it.
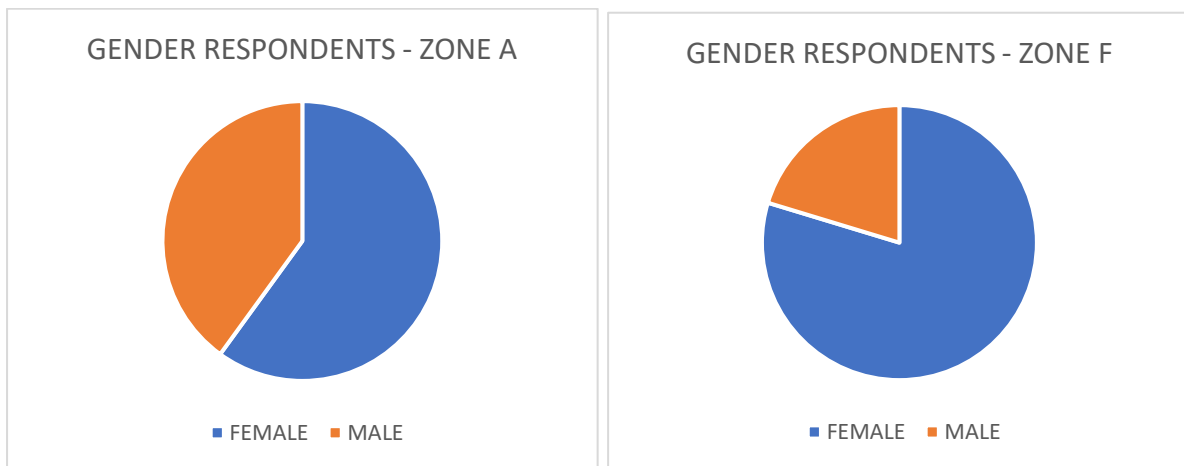
Figure 4.2: Gender of respondents.

The above results concur with the Indonesian study in Surabaya which purported that 33.4% of males and 66.6% of females participated Setiawan (2020). In addition, according to Mpinganjira et al. (2020), 27.7% of respondents were male and 62.3% were female. The study was conducted in Johannesburg, South Africa. It shows that females are interested to engage in studies than men and that shows the willingness to participate.

This study further supports the one that was conducted in Ghana (Kumasi Metropolis) where 66.9% of participants were female and 33.1% of participants were male (Asase et al., 2008). The study further indicates that the females tend to be the ones mostly interested in adding value to SWM in comparison to the opposite gender. In Ghana, Kumasi Metropolis, the mothers, and helpers who are female contribute 97.9% and males contribute 2.9% (Songsore and Megranahan, 2000).

4.2.3 Marital Status

This is the state used in government offices to declare the status of being married or not married, to identify a person is married, single, divorced or widowed (Merriam Webster dictionary, 2022). Most respondents in this study are single, followed by married respondents. The number of respondents that are single is 53%, followed by married respondents at 40%. Those who are widowed constituted 3%, divorced 2% and other made 2% respectively in Lebowakgomo Zone A (Figure 4.3). In Lebowakgomo Zone F, 58% of the respondents are single, followed by married respondents at 26%, widowed 10%, divorced 5%, and other 1% (Figure 4.3). The marital structure of Lebowakgomo Zone A and F are similar as the singles are the highest and other are the lowest.
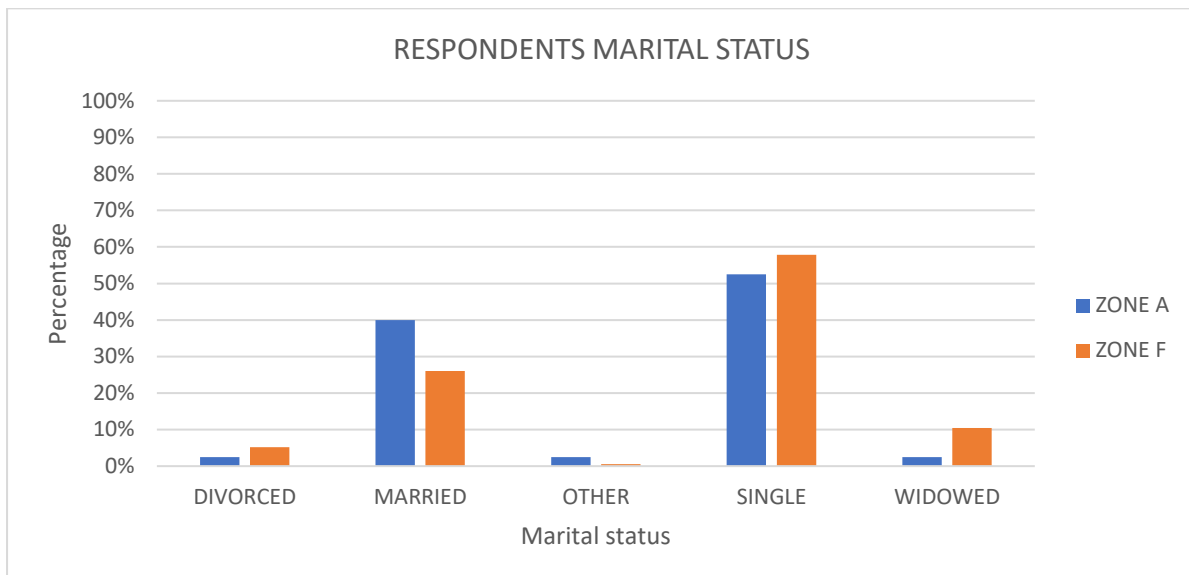
Figure 4.3: Marital Status of respondents

Most respondents are single as shown in figure 4.3 above. The study in Ghana had 66% of respondents as single (Asase et al., 2000). Most people are remaining single as the countries are developing. In Johannesburg, South Africa Mpinganjira et al. (2020) stated that 43.4% of participants were single, while 32.6% were married or stayed together with a partner and 24% were divorced.

4.2.4 Education

According to Naziev (2017), education is a process that incorporates systems and regulations of involves transferring knowledge and expertise from a certain group in a society to another. The lowest education level is no formal education whereas the highest level is tertiary.

Findings in figure 4.4 show percentages of respondents' education level. Fifty-three percent (53%) of respondents went to tertiary level, 43% to secondary level, 2% to primary level, and 2% have no formal education in Lebowakgomo Zone A. The results structure is similar compared to Lebowakgomo Zone F, where 73% of respondents went up to tertiary level, 16% to secondary level, 10% had no formal education, and 1% primary level. Most respondents have attended colleges and universities and others are working while others are pensioners. It shows that the literacy level is high.
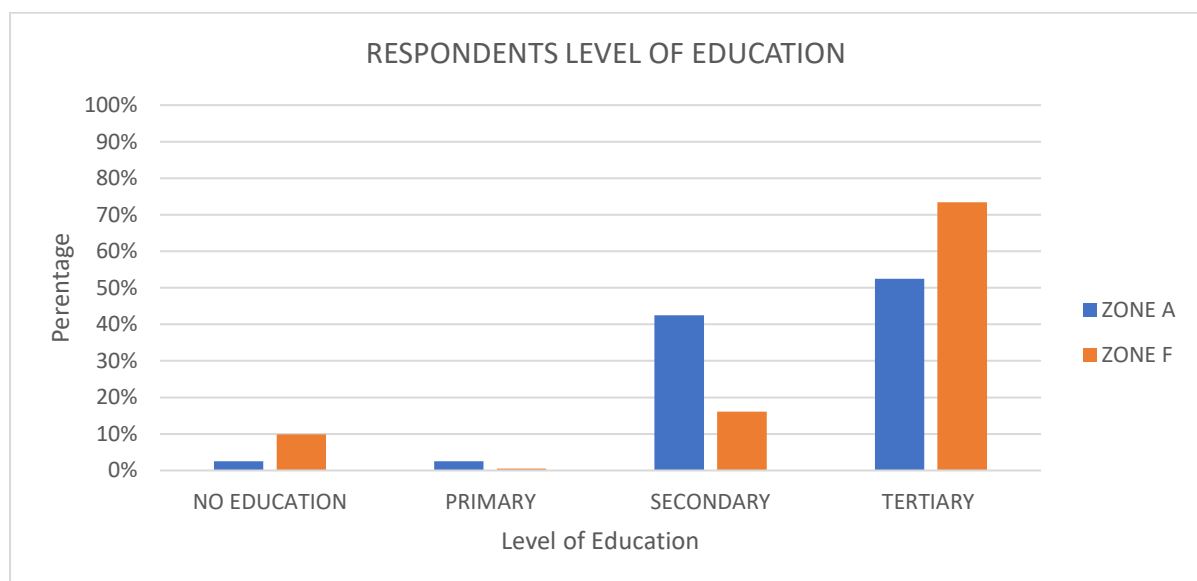
Figure 4.4: Highest level of education

This study supports the one conducted in Surabaya, Indonesia by Setiawan (2020) where it is indicated that 50% of the household participants have finished their secondary school level of education.

According to Mpinganjira et al. (2020), more respondents in the study were also young and educated as about 61% had tertiary education, which was conducted in Johannesburg, South Africa.

4.2.5 Occupation

Occupation is defined as the way in which a person earns a means of living through the work initially paid for or through business. (Collins dictionary, 2022). People work in different sectors as a way of making a living such as community services, construction, government, etc. to sustain their lives financially. Society has different occupations and more will still emerge as there is development.

The highest percentage (60%) of respondents' occupations fall under "other", which includes pensioners, unemployed, and working in other sectors. Twenty- five percent (25%) of respondents are government officials, 5% work for community services while wholesale, and trade accounts for 5%, mining sector contributes 3% and construction sector also accounts for 2% in Lebowakgomo Zone A as displayed in Figure 4.5. In Lebowakgomo Zone F the highest percentage (65%) of respondents' occupation fall under "other", 26% of respondents are government officials, 6% work for community services and wholesale, and trade accounts for 2%, mining sector contributes 1% and construction sector does not account for any employment (Figure 4.5). Other occupations and government official occupation sectors are dominant in both Lebowakgomo zone A and F.
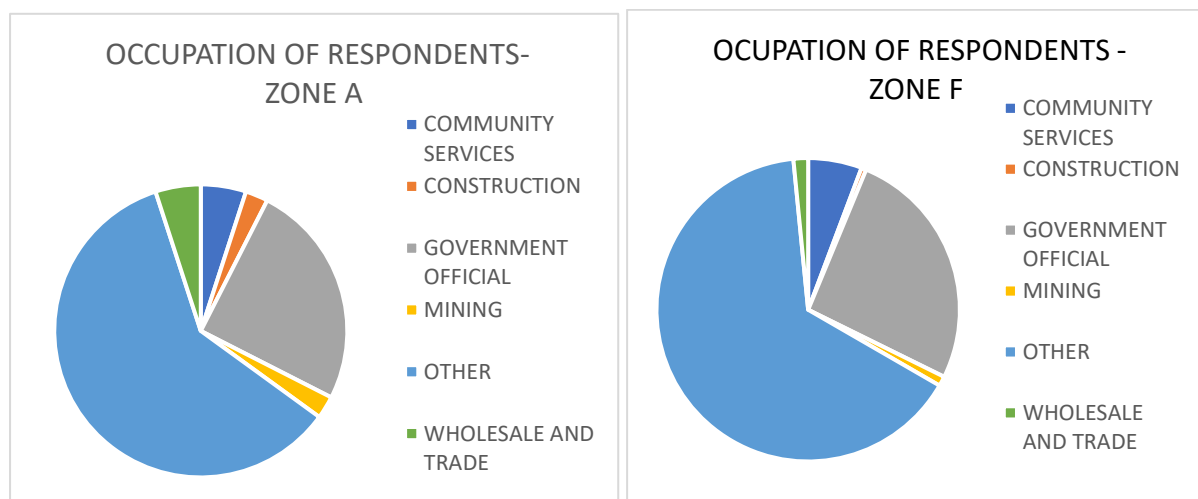
Figure 4.5: Occupation of respondents

The occupations of the respondents in this study are not in agreement with the study conducted in Indonesia by Setiawan (2020) where private sector occupations employed most of the respondents at 41.2%. According to Mpinganjira (2020), study

conducted in Johannesburg, South Africa, 17.4% of the respondents were self-employed and 34.3% were employed. The dynamics are evolving as most people are working for themselves and not working for other organisations. It shows that the highest percentage is comprised of different occupations that respondents are partaking in.

4.2.6 Income

Income is money received consistently for the work paid for or through investments (Oxford dictionary, 2020). Individuals receive their income from different sources but mostly from their occupations.

The lowest interval of income in this study is from R 0- R5000 and the highest interval is R15001 and above. Most respondents in Lebowakgomo Zone A and F are pensioners. Figure 4.6 represents findings showing that 55% of respondents earn less than R5000.00. Fifteen percent (15%) of the respondents earn between R5001-R10 000, 7% of the respondents earn R1001-R15000 and lastly 23% of the respondents earn between R15 000 and above in Lebowakgomo Zone A. Figure 4.6 represents findings showing that 39% of respondents earn less than R5000.00. Twenty percent (20%) of the respondents earn between R5001-R10 000, 6% of the respondents earn R1001-R15000 and lastly 35% of the respondents earn between R15 000 and above in Lebowakgomo Zone F. The results imply that because many respondents earn less than R5 000, they won't have money to buy adequate resources such as waste bins and refuse bags to separate waste.
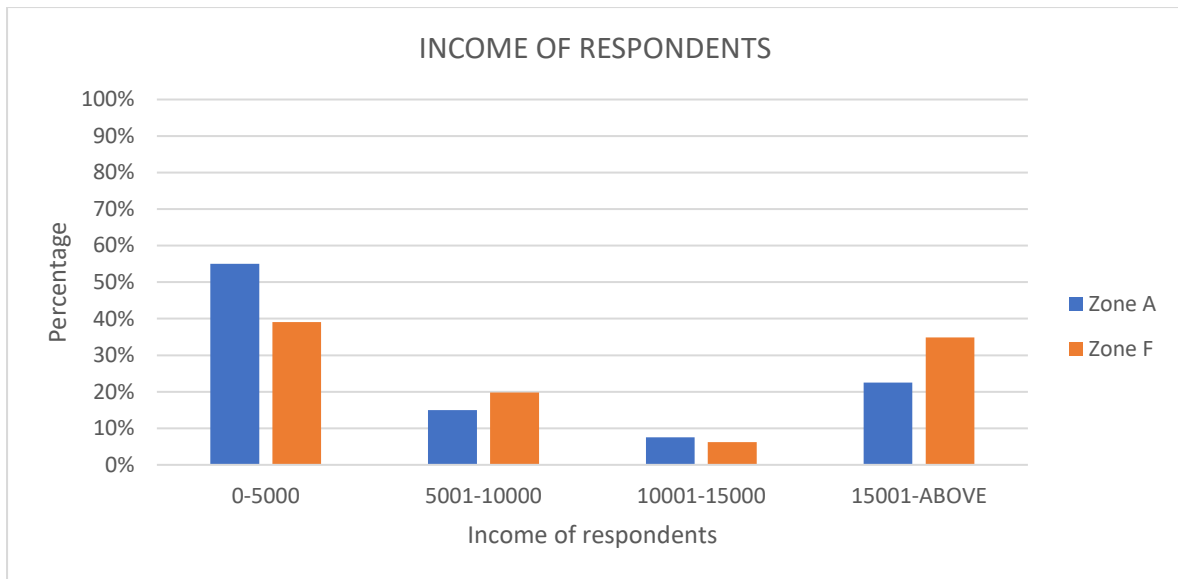
Figure 4.6: Income of respondents

There is a high percentage of respondents that are earning a low income of R5000 and less. For lower-income areas source separation can create jobs by establishing recycling facilities. The formalisation of waste pickers needs the implementation of strategies to be liased formally and train the stakeholders that will be involved. (Beer, 2015).

This study supports the study conducted in Johannesburg, South Africa which shows that the results of an average household comprised of 4 people with monthly income of between R10 000.00 and R40 000.00 (Mpinganjira et al., 2020).

4.2.7 Household size

A household is house that consist of more than one person living in the same home. It may be of a single family or another type of person group. The household is the key factor in determining the analysis in many social, micro economic, and institutions models, and is important to the factors that involves investments in economy and the benefits that will be gained in a long term. (Wikipedia, 2022). The people living in a household are counted as the ones that are currently living in the household for the study and not counting the visitors who came temporarily for a day or two.

Figure 4.7 shows that 1 to 3 people who reside together in a household account for 27%, 4 to 6 people accounted for 60%, 7 to 9 household members account for 10%,

and 3% of the respondents reported that 10 and above of household members live in the same house in Lebowakgomo Zone A. Figure 4.7 shows that 1 to 3 people who reside together in a household account for 31%, 4 to 6 people account for 52%, 7 to 9 household members account for 16%, and 1% of the respondents reported that 10 and more household members live in the same house in Lebowakgomo Zone F. This shows that most households in both Lebowakgomo Zone F and A have an average of 4 to 6 members. This gives an implication of the amount of waste generated that can be separated before collection.
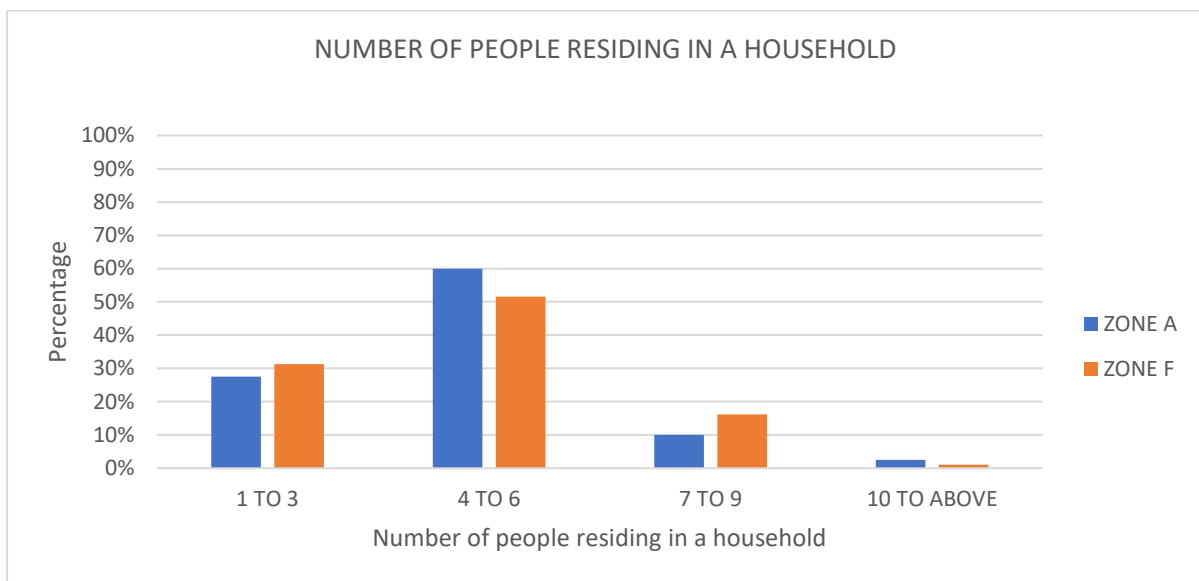
Figure 4.7: Number of people in a household

In figure 4.7, the results still support the study conducted in Indonesia where respondents that have family members of not more than 4 people accounted for 77.2% of the participants. Most people are not staying with many members in their families (Setiawan, 2020).

4.2.8 House ownership

House ownership is the state of having a title deed on a house or flat in the name of the owner, whereby the payment will be made on it (Collins Dictionary, 2022). The ownership status of respondents is based on whether they own or rent the house they live in.

Most people in Lebowakgomo Zone A and F own their houses. Figure 4.8 shows that 73% of respondents own their houses, in Lebowakgomo Zone A and 62% for Lebowakgomo Zone F while 15% rented in Lebowakgomo Zone A and 10% in Lebowakgomo Zone F and 12% were not specific in Lebowakgomo Zone A and 28% were also not specific in Lebowakgomo Zone F. The results also show that some of the respondents are residing in Lebowakgomo Zone A and F with the other respondents because of work as they are renting the houses.
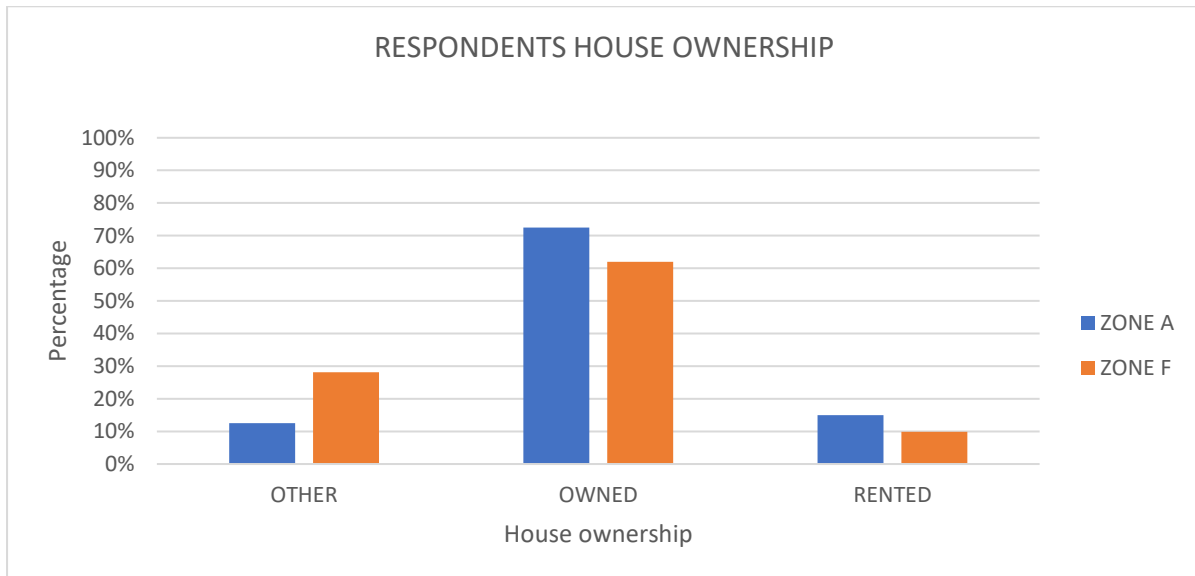
Figure 4.8: Number of responds household ownership

There are more than 60% of household members who have been residing in the zone for over 20 years in Surabaya City, Indonesia (Setiawan, 2020).

Household members that have tenants are not interested in waste separation due to space constraints and are crowded even if bins are provided. The households with space are more willing and even participating in recycling and composting (Bennagen et al., 2002).

4.2.9 Respondents and Householder relationship

The relationship between the respondents and the householder is either that they are family members, or they are the householder. It is a matter of responsibility that one will take in a household that will differentiate if one owns a title deed of a house or they are residing in the house without owning it (Wikipedia, 2021). There is also a caretaker

who has occupied a house for rental purposes, but the title deed belongs to the householder who is not currently staying in the house. In some instances, tenants have rented in household where they are either staying with caretakers or household owners.

Figure 4.9 displays that most of the respondents (50%) are house owners followed by 25% of relatives to the house owner. Tenants and others make up 12% and 8% respectively and the least of the respondents are caretakers (5%) for Lebowakgomo Zone A. The results are similar for Lebowakgomo Zone F as most of the respondents (52%) are house owners followed by 25% of relatives to the house owner, others (14%), tenants (7%), and caretakers (2%) are the least of the respondents as indicated in the figure below.
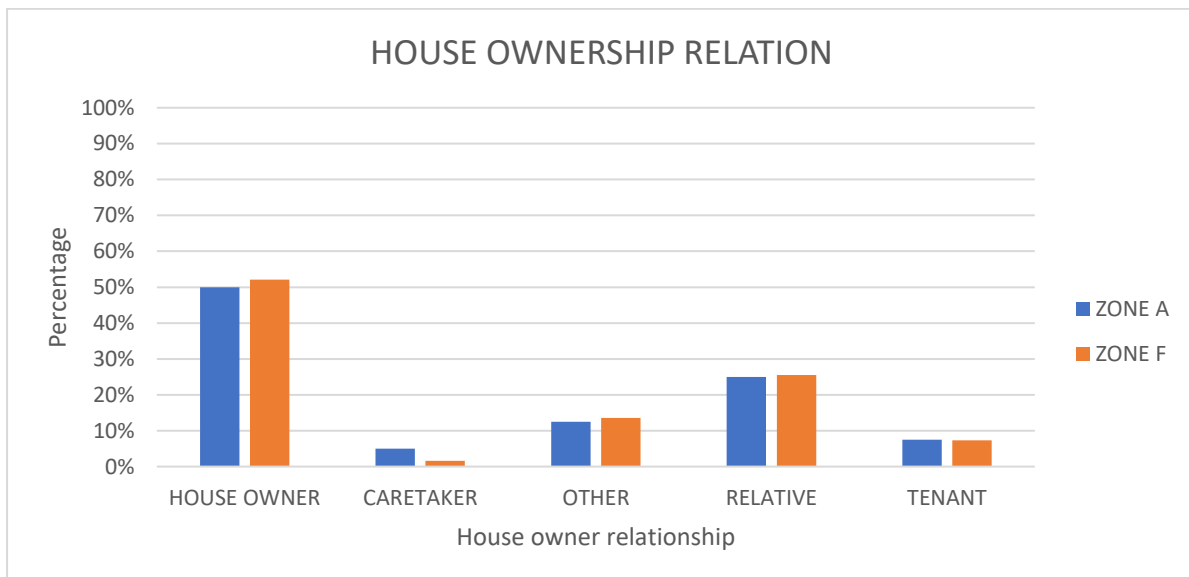
Figure 4.9: Respondents and House owner relationship

Most respondents are house owners as they have been residing in the area for over a period of years. The relatives are next in number since they are related to the house owner either as a daughter, son, etc. The Indonesian case study also has the highest house owner percentage (Setiawan, 2020).

4.3 Household waste management practices

Householders are supposed to participate in waste management practices such as waste generation, waste separation and waste storage.

4.3.1 Waste generation

Municipal Solid Waste (MSW) is generated in households and needs to be sustainably accomplished through the processes of waste management.

Waste that is generated mostly is paper (38%), followed by plastic (33%), organic waste (17%), garden waste (5%), aluminium (5%), and the lowest is glass (3%) in Lebowakgomo Zone A (Figure 4.10). Waste generated mostly in Lebowakgomo Zone F is paper (35%), followed by plastic (37%), garden waste (11%), organic waste (10%), glass (6%), and the lowest is aluminium (1%) in Lebowakgomo Zone F (Figure 4.10). Paper is the highest generated waste in both Lebowakgomo Zone A and F.
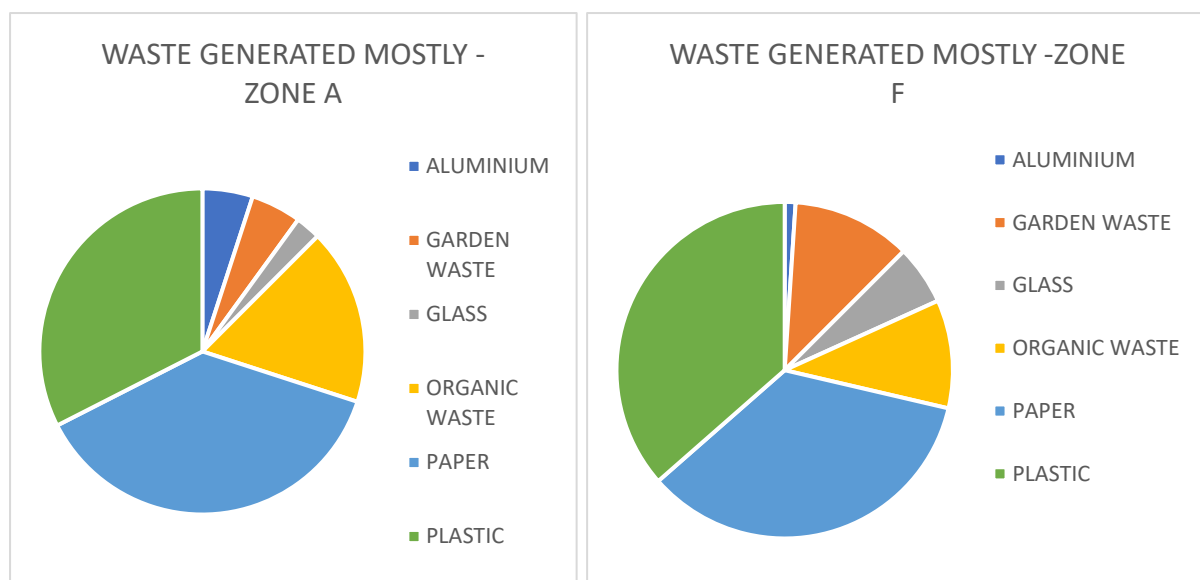
Figure 4.10: Waste generated mostly

The illustration from Figure 4.10 shows that paper and plastic quantities are generated mostly. It is ideal that they are sorted in separate bins rather than classified in one bin as recyclables. The study revealed that paper, plastic, and organic waste are among the top three types of waste generated although, organic waste is the highest in studies conducted around the African continent (UNEP, 2018).

It is projected that 57% of waste that is produced in households is organic, 13% is plastic, 9% is paper or cardboard, 4% glass, 4% metal, and the remaining 13% is other materials. However, the altered manufacturing patterns and the intake of consumers changes it is slowly shown in the contents and variable in waste. The percentages of

organic waste have drastically declined in the previous years, whereas the percentage of plastic and paper increased. This pattern is predicted to continue as is expected to increase income standards. The estimates of about 13% of MSW in Africa is accounted as plastic. Waste avoidance is the exceptional way to deal with generation plastic waste. Some African countries have implemented the processes and measures in place of reducing the plastic waste (UNEP, 2018).

Pearson Chi-Square test was conducted to ascertain if age of respondents influences the sorting of municipal waste in Lebowakgomo Zone A (Table 4.1). There is a significant relationship between age and the sorting of household waste because P is <.001 which is less than the significance level (P=0.05).

Table 4.1: Pearson-Chi Square for influence of age and sorting of household waste in Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	105.030[a]	5	<.001
Likelihood Ratio	130.703	5	<.001
N of Valid Cases	280		

a. 3 cells (25.0%) have an expected count of less than 5. The minimum expected count is 1.93.
b. 0.05 significance level

Pearson Chi-Square test was conducted to ascertain if age influences households to sort waste in Lebowakgomo Zone F. There is no significant relationship between age and the sorting of household waste as displayed in Table 4.2 because P> .312 is greater than the significance level (P=0.05).

Table 4.2: Pearson Chi- Square for age and sorting of household waste in Zone F.

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.943ᵃ	5	.312
Likelihood Ratio	8.136	5	.149
N of Valid Cases	192		

a. The minimum expected count is .45.
b. 0.05 significance level

4.3.2 Separation and Storage

Separation of waste is the segregation of diverse sorts of solid waste at the place where it is produced (a household or business) (Teresa, 2021). After separation, it is stored in labeled bins. Figure 4.11 shows the extent of sorting as follows: 42% of paper is the highest, followed by 18% of plastic, 17% not sorted, 12% glass, 10% aluminium, and 1% organic waste as the lowest for Lebowakgomo Zone A. For Lebowakgomo Zone F, 31% of paper, followed by 19% of plastic, 17% of aluminium,15% not sorted, 13% of glass and 5% of organic waste is sorted (Figure 4.11). The waste that is sorted in Lebowakgomo Zone A and F differs in composition. However, paper is the highest type of waste that is mostly sorted. Respondents sort waste for recycling purpose and so that hawkers can collect waste easily and keep the environment clean. The respondents are sorting organic waste to produce manure for gardening.
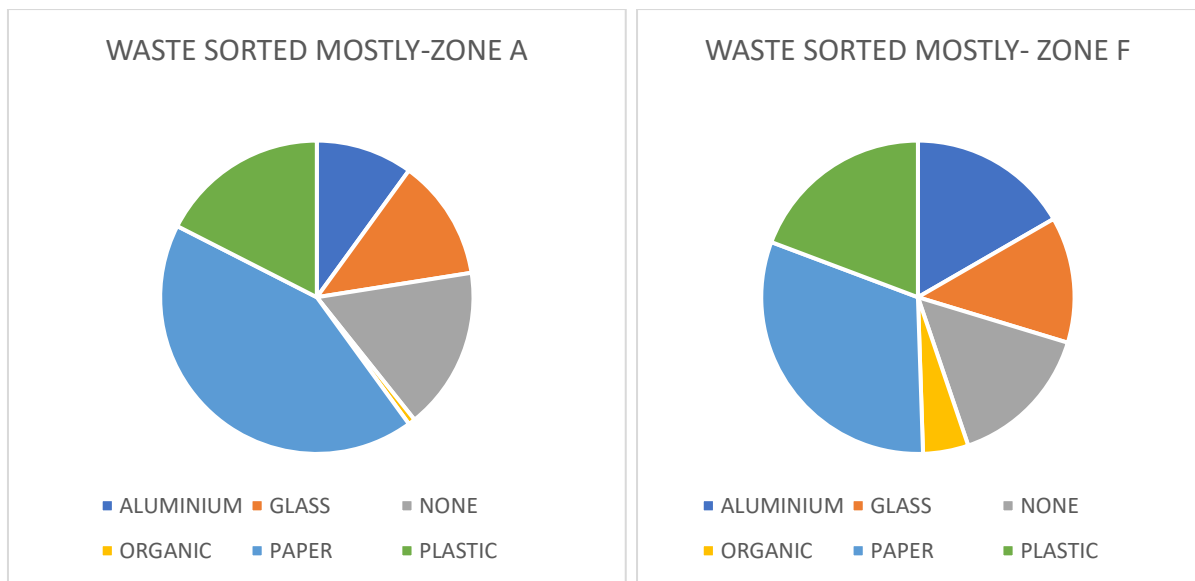
Figure 4.11: Municipal Solid Waste sorted composition

Figure 4.11 shows that the highest percentage of waste sorted is paper while the lowest is organic waste. Sixteen percent (16%) of the respondents are not participating in sorting waste. Over 58% of the households have been engaging in the process of waste separation before disposal in Surabaya in Indonesia (Setiawan, 2020).

According to Asase et al. (2008), household waste sorting was not practised by urban households in Ghana (Kumasi Metropolis). Interest to sort waste was shown after a reduction in collection fees. The trained government officials shared the information on participation while cash incentives were also introduced to encourage households to separate waste.

In Sweden, the highest quantities of sorted and recycled waste are recovered from packaging materials. The manufacturing companies are inventing some new designs and ideas that can improve the packaging materials to increase recycled materials and decreasing the environmental impact. The consumers will identify easily the materials that need to be recycled through the designed packaging and how they should be sorted in designated sorting categories. (Rousta, 2018).

Some households store waste in two bins while others store in one bin (Figures 4.12 a and b). The separation system is not introduced yet, but some households have at least two waste bins. The labeled bins are used to store waste properly for sustainable waste management that encourages source separation and recycling.

Figure 4.12 a and b: Two waste bins to store waste: One waste bin to store waste

A Chinese initiative for household waste separation requested residents to separate food waste, dry waste, and hazardous waste into labeled designated bins. The Xiamen initiative required households to sort MSW into recyclable and non-recyclable waste over the years from 2015. The department of housing and rural development categorized them as national household waste separation classification recycling surveys which was mainly paper, metal, plastic, and fabric (Fei et al., 2016). The sorted waste needs to be stored in labeled containers per category to increase the quality of recyclable materials.

Waste bins are used to store waste in households after waste generation and before waste collection. Figure 4.13 indicates that 2% of households have no bin, 78% have one bin, 15% have two bins while 5% have three bins in Lebowakgomo Zone A. Figure 4.13 indicates that 1% of the households have no bin, 47% of households have one bin, 42% have two bins and 10% have three bins in Lebowakgomo Zone F. The households who do not have waste bins to store waste, store them in refuse bags because their bins were broken or stolen. Most households have one bin and the ones who have more than one bin have bought them because of the amount of waste they produce.
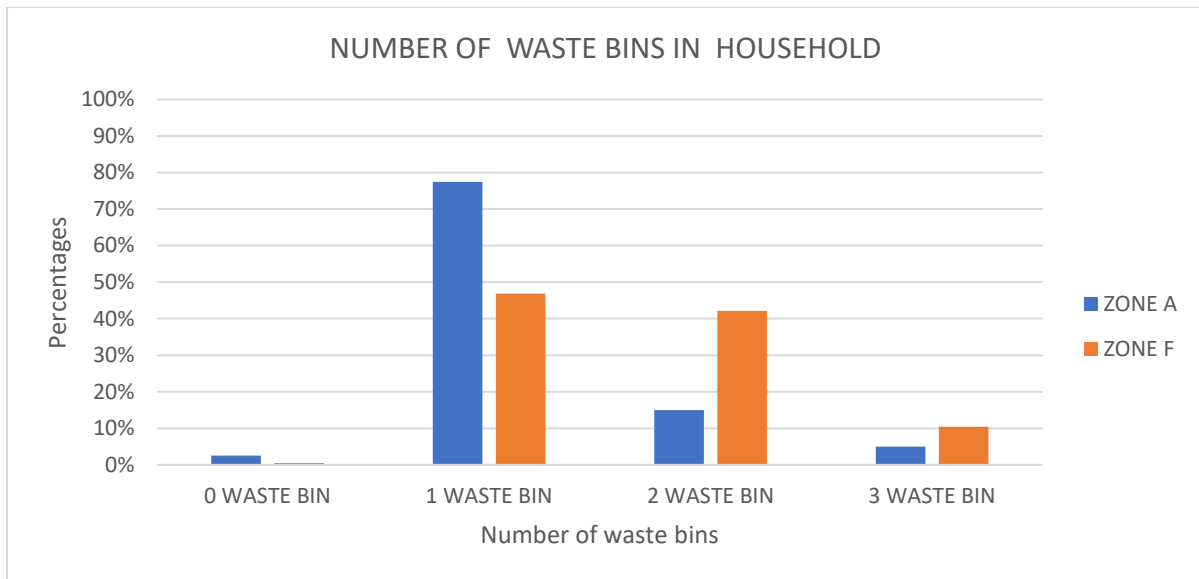
Figure 4.13: Number of waste bins in a household

The respondents in Lebowakgomo Zone A and F have the highest number of respondents who have one waste bin and is followed by two and three waste bins in Lebowakgomo Zone A as it is displayed in Figure 4.13. Most respondents are still using one bin to store waste as there is inadequate provision of resources from municipality and government. The Lepelle-Nkumpi Local Municipality is in the process of implementing the source separation process. The labeled bins are normally found in public spaces like malls and other official government offices.

Pearson-Chi Square test was conducted to ascertain if the number of waste bins contribute to sorting of waste in Lebowakgomo Zone A (Table 4.3). There is a significant relationship between the number of waste bins in a household and waste sorting because P<.001 is less than the significance level (P=0.05).

Table 4.3: Pearson-Chi Square for the number of waste bins in a household to sort waste in Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	19.509ᵃ	3	<.001
Likelihood Ratio	19.917	3	<.001
N of Valid Cases	280		

The minimum expected count is 1.93.

0.05 significance level

Table 4.4 shows Pearson-Chi Square test conducted to ascertain if the number of waste bins contributes to waste sorting in Lebowakgomo Zone F. There is no significant relationship between the number of waste bins in a household and waste sorting because P>.30 is greater than the significance (P=0.05).

Table 4.4: Pearson-Chi Square for the number of waste bins in a household to sort waste in Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.922ᵃ	3	.030
Likelihood Ratio	10.122	3	.018
N of Valid Cases	192		

a. 3 cells (37.5%) have expected count less than 5.

   The minimum expected count is .22.

b. 0.05 significance level

4.3.3 Municipal Solid Waste Collection

In 2016 around 59% of houses had their refuse collected by the management of waste government collection service (3rd baseline report, 2012). This study supports the baseline report conducted as 100% of respondents stated that their waste is minimally transferred once every week if there is no delay, strike, or broken-down collection vehicle. Waste collection service in South Africa is implemented mostly in suburbs and cities although recently it is practiced in some of the rural villages (DEA, 2012).

The study is not in alignment with solid waste collection in Ghana where waste management is provided under service contract and is paid for by the residents. One of the reasons the residents are paying is because of lack of funds for the service (Asase et al., 2008). The waste collection services in South Africa are paid for through the municipal rates per household. However, the service is not paid immediately during collection.

 According to DEA (2018), in France, there is a door-to-door collection of sorted waste, paper, glass, metal, and plastic and there are also drop-off amenities sites to receive sorted waste. Sorted waste gets recycled and recovered and thus encouraging householders to sort waste. The Gaborone City Council was initially encouraged to contract waste collection services from the private companies as there is shortage of resource. There is shortage of waste collection vehicles that empowers human resources that help in collection services (Bolaane, 2015).

Some cities have achieved very high collection rates, while others have low rates. For example, in Sousse, Tunisia and Lagos, Nigeria, waste collection is about 90% whereas in Jimma Ethiopia the collection rate is lower at 25%. The countries with higher population generate more waste than the ones with lower population rate. There is a vast difference in countries depending on the factors that contribute to integrated waste management. Ghana is also having the lowest collection rate as in

the City of Wa 28% of waste is collected, which is well under the continental average of 55%, while in the capital of Accra coverage is over 80%. These variances normally result from different admission that local communities have to infrastructure, capacity, and financing (UNEP, 2018).

4.3.4 Recycling

Recycling is the procedure of recovering waste into substances that can be recovered and assigned to create different products (Rousta, 2022). Figure 4.14 displays that 58% of respondents recycle waste and 42% do not recycle waste in Lebowakgomo Zone A. In addition, Figure 4.14 displays that 54% of respondents recycle waste and 46% do not recycle waste in Lebowakgomo Zone F. There are respondents who are aware of the benefits of recycling which are to generate income and to keep the environment clean.
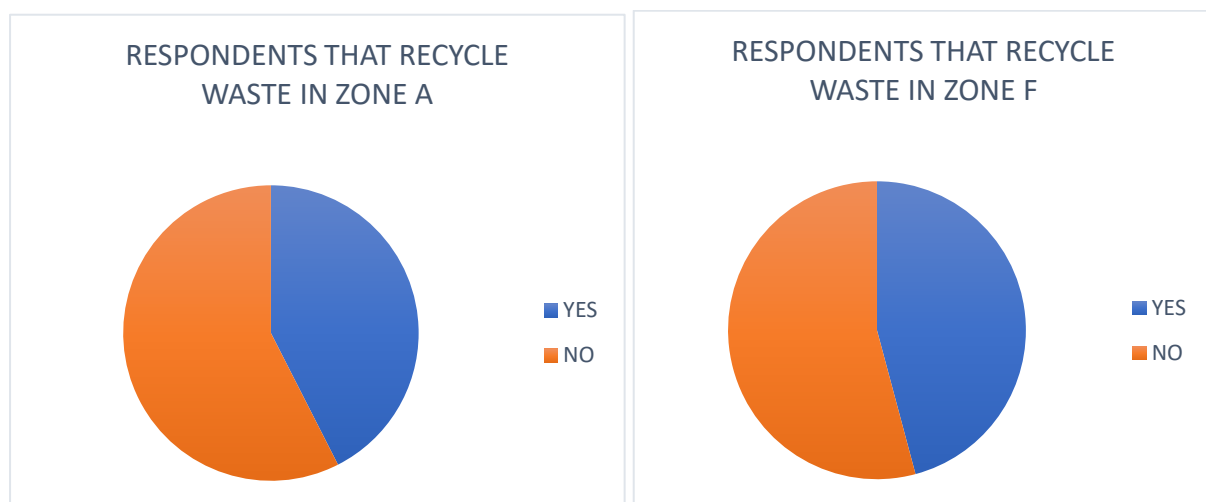
Figure 4.14: Respondents recycling waste

There are more respondents willing to recycle waste. Recycling is important and improves the benefits of source sorting which includes unspoiled materials that will be recycled, easier collection of sorted wate and the MRF are having less chance of rejecting the materials. The sorted waste is cleaner and thus has great value. The recycling of waste materials creates job opportunities, better economy, and sustenance in natural resource (Ndlangamandla, 2017). There are various opportunities that are created in waste sector including business opportunities. Even in developed countries, not all people recycle their waste. Studies show that in

Australia, 63% of people recycle their waste, followed by Germany with 62%. In the USA, 40% of the population sort and recycle their waste (McGlade, 2013).

Over the period 2010 – 2015, the proportion of households contributing in recycling augmented for all four recyclable constituents (plastic, paper, glass, and metal) (CSIR, 2016). Recycling plastics presented the major growth in the proportion of households recycling (6.1% – 10.0%), followed by glass (4.7% – 8.1%) and metal (2.8% – 6.2%).

Figure 4.15 shows the recyclable aluminium cans that are separated in households to be recycled. The organic waste is also separated and used to produce compost that is used in gardening to grow plants. The households need labeled bins to store their separated waste in categories. There are some households that are aware and willing to separate waste.

Figure 4.15: Separated cans for recycling

Recycling was most common in provinces with the largest urban populations and least common in the most rural provinces. The Western Cape had the highest percentage (20.3%) of urban households that sorted waste for recycling, followed by Gauteng at 12.7%. With only 1.2% of urban households recycling waste, Limpopo is the lowest in the country (DEA, 2012).

Pearson-Chi Square test was conducted to ascertain if recycling encourages benefits to sorting waste in Lebowakgomo Zone A (Table 4.5). There is a significant relationship between recycling waste and benefits of sorting waste because P<.001 is less than the significance level (P=0.05).

Table 4.5: Pearson-Chi Square for recycling and benefits of sorting waste in Zone A.

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	236.351[a]	28	<.001
Likelihood Ratio	314.914	28	<.001
N of Valid Cases	280		

a. 50 cells (86.2%) have expected count less than 5. The minimum expected count is 2.98.

b. 0.05 significance level

Pearson-Chi Square test was conducted to ascertain if recycling encourages the benefits of sorting waste in Lebowakgomo Zone F (Table 6). There is a significant relationship between recycling waste and the benefits of sorting waste because P<.001 is less than the significance level (P=0.05).

Table 4.6: Pearson-Chi Square for recycling and benefits of sorting waste in Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	129.813[a]	37	<.001

Likelihood Ratio	174.690	37	<.001
N of Valid Cases	192		

a. 70 cells (92.1%) have expected count less than 5. The minimum expected count is .46.

b. 0.05 significance level

The significant relationship between recycling and the benefits of waste sorting shows that there is an awareness that when waste is recycled there is benefit for the environment. This is derived from respondents' perception of sorting waste and that it is beneficial. Lebowakgomo Zone A and F both have the highest number of respondents who recycle waste than the respondents who do not recycle waste.

4.4 Willingness of households to participate in Municipal Solid Waste separation
4.4.1 Willingness to sort waste

Willingness is the quality or state of being prepared to do something or readiness to do something (Oxford dictionary, 2020). In this context, it is the state of respondents on whether they need to participate in sorting waste or not. Seventy- two percent (72%) of respondents are willing to sort waste and 28% are not willing to sort waste in Lebowakgomo Zone A (Figure 4.16). Seventy- eight percent (78%) of respondents are willing to sort waste and 22% are not willing to sort waste in Lebowakgomo Zone F (Figure 4.16). The results show that most of the respondents are willing to sort waste, while some are already sorting waste for recycling purposes and others are doing it to help the waste pickers to easily collect the recyclable waste from the bins. The respondents who are not willing to sort waste mentioned that they do not have time to sort waste and others say that they do not have to do the work that others are paid to do.

RESPONDENTS WILLING TO SORT WASTE IN HOUSEHOLDS- ZONE A

RESPONDENTS WILLING TO SORT WASTE IN HOUSEHOLDS - ZONE F

YES
NO
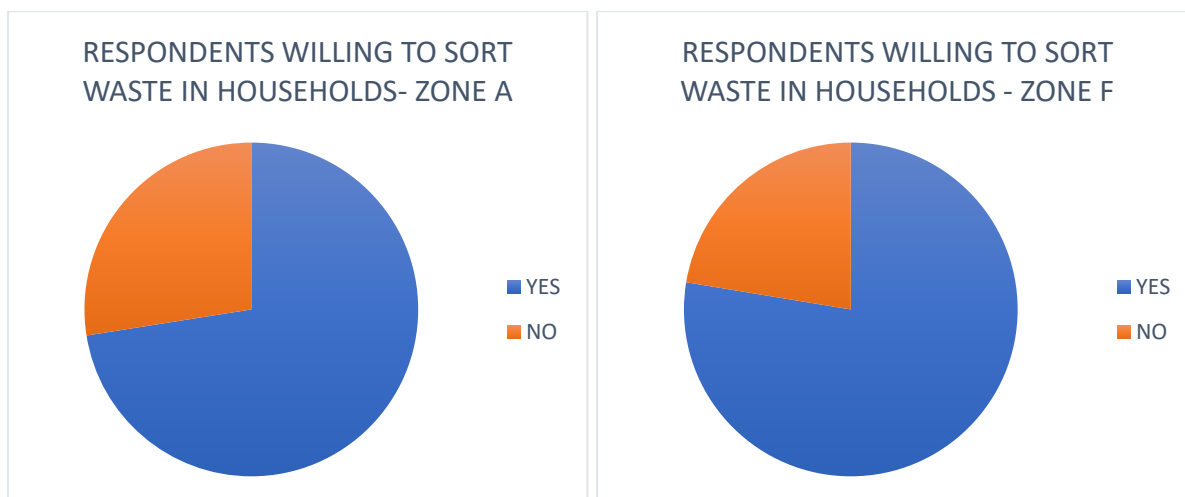
Figure 4.16: Respondents willingness to sort waste in households

This study supports the one conducted in Ghana where 80% of the respondents were willing to participate in separation of waste and 20% were not willing to participate (Asase et al., 2008). According to DEA (2019), in Western Cape, 76% of municipalities practice source separation while 24% of municipalities do not. It is an indication that most people are willing to sort waste, which this study supports.

One respondent said that t*hey are "willing to sort waste because, when it is re-used and recycled it is beneficial"*

Another respondent indicated: "*The reason is to help other people who come and collect separated waste for generating income*".

Table 4.7 below shows Pearson-Chi Square test conducted to ascertain if the platforms where respondents have heard about sorting waste influence the willingness to sort waste in Zone A. There is a significant relationship between willingness to sort and platforms where respondents have heard about sorting waste because P<.001 is less than the significance level (P=0.05).

Table 4.7: Pearson-Chi Square for willingness to sort waste and the platforms where respondents have heard about sorting waste in Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	42.382^a	4	<.001
Likelihood Ratio	39.603	4	<.001
N of Valid Cases	280		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.70.

b. 0.05 significance level

Pearson-Chi Square test was conducted to ascertain if the platforms where respondents have heard about sorting waste influence the willingness to sort waste in Zone F (Table 4.8). There is a significant relationship between willingness to sort and platforms where respondents have heard about sorting waste because P<.001 is less than the significance level (P=0.05).

Table 4.8: Pearson Chi-Square for willingness to sort waste and the platforms where respondents have heard about sorting waste in Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	132.232^a	37	<.001
Likelihood Ratio	142.089	37	<.001
N of Valid Cases	192		

a. 63 cells (82.9%) have an expected count of less than 5. The minimum expected count is .22.

b. 0.05 significance level

There are households who are participating in source separation with the minimal resources that they have but are encouraged to separate waste for socio-economic and environmental impacts as indicated in Figure 4.17.

Figure 4.17: Separated waste in bags

The households separate some of the waste that can be recycled from the other waste in the waste bin. Figure 4.17 above shows that households are willing to separate waste but do not have adequate resources such as bins and refuse bags. According to Asase et al. (2008) respondents that were willing to participate in solid waste source separation were given free solid waste collection services as an incentive to motivate.

Sixty-five percent (65%) of respondents have not sorted and recycled waste before and 35% of respondents in Lebowakgomo Zone A have sorted and recycled waste before as illustrated in figure 4.18. Sixty-one percent (61%) of respondents have not sorted and recycled waste before and 39% of respondents in Lebowakgomo Zone F have sorted and recycled waste before as illustrated in figure 4.18. There are respondents who are interested in sorting waste for recycling purposes, and it shows that there are some of the respondents who sort waste for other related benefits such as a clean environment and to improve waste management services.
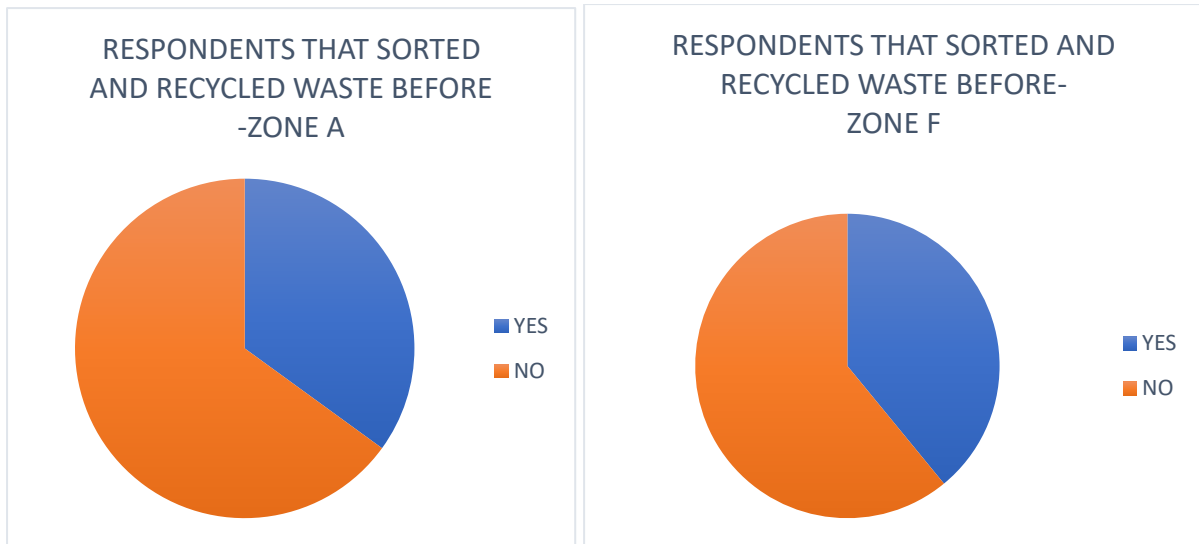
Figure 4.18: Respondents who have sorted and recycled their waste before

It is estimated that 80 – 90% of post-consumer paper and packaging is recovered by informal waste pickers, feeding into a growing local recycling economy that diverts 52.6% of the 3.39 million tonnes of packaging consumed in South Africa (in 2014), from landfill sites (CSIR, 2018).

Pearson Chi-Square test was conducted to ascertain if education influence willingness to sort waste in Lebowakgomo Zone A (Table 4.9). There is a significant relationship between education and willingness to sort because P<.001 is less than the significance level (P=0.05).

Table 4.9 Pearson-Chi Square test for relationship between education and willingness to sort waste in Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	810.196ᵃ	105	<.001
Likelihood Ratio	457.562	105	<.001
N of Valid Cases	280		

a.138 cells (95.8%) have an expected count of less than 5. The minimum expected count is .18.

b.0.05 significance level

Pearson Chi-Square test was conducted to ascertain if education influences willingness to sort waste. In Lebowakgomo Zone F. There is a significant relationship between education and willingness to sort because P<.001 is less than the significance level (P=0.05) as displayed in Table 4.10.

Table 4.10: Pearson Chi-Square test for relationship between education and willingness to sort waste in Lebowakgomo Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.280[a]	3	<.001
Likelihood Ratio	24.854	3	<.001
N of Valid Cases	192		

a. 2 cells (25.0%) have an expected count of less than 5. The minimum expected count is .46.

b. 0.05 significance level

4.4.2 Reasons for willingness to separate at source

Perception is an opinion of how people know about certain information and the standard that is held at (Cambridge dictionary, 2020). In this context it is the respondent's opinion towards waste sorting in households and if in the future they will be interested in sorting waste. Figure 4.19 indicates that there are 77% of respondents that will be sorting waste going forward and 23% would not be sorting waste in future in Lebowakgomo Zone A. Furthermore, Figure 4.19 indicates that there are 83% of respondents that will be sorting waste going forward and 17% would not be sorting waste in future in Lebowakgomo Zone F. There are some of the respondents that do

not know about waste sorting and some who do not have resources to sort waste such as bins and refuse bags. There is an indication that there is still a lack of environmental awareness in Lebowakgomo Zone A and F. However, most people are willing to sort waste going forward.
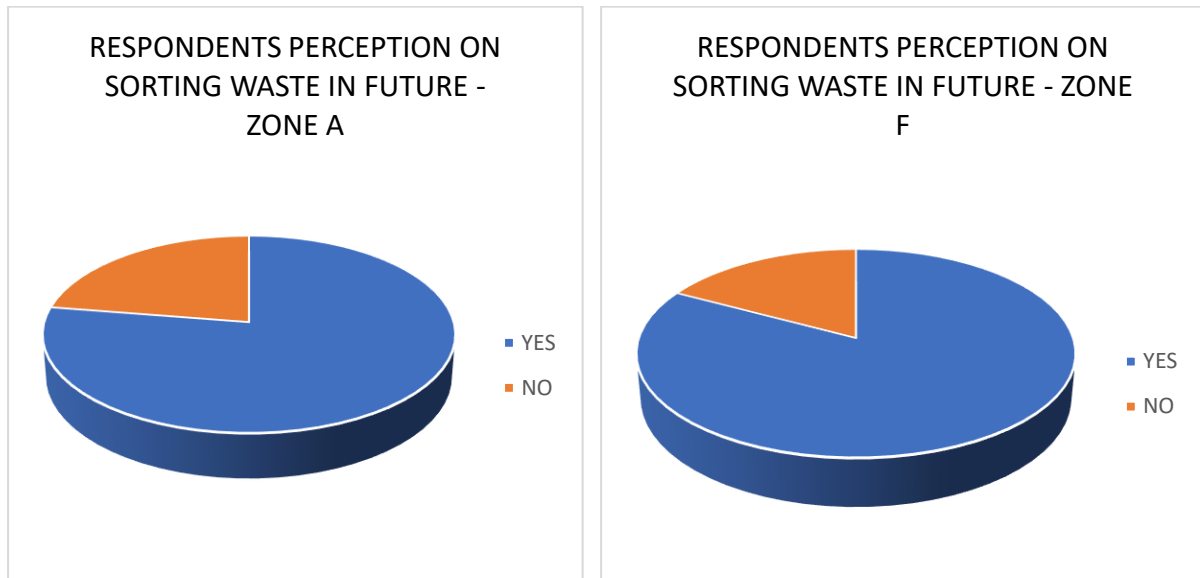
Figure 4.19: Respondents' perceptions toward waste sorting in the future

According to Setiawan (2020), more than 90% of the respondents participate in waste sorting in Indonesia who perceive waste sorting as good while 10% of the respondents did not perceive sorting of waste as good. These results indicate that waste sorting programs are mostly encouraged in households

Pearson Chi-Square test was conducted to establish if there is a relation between perception towards sorting waste in the future and willingness to participate in community environmental campaigns in Zone A (Table 4.11). There is a significant relationship between perception towards sorting waste in the future and willingness to participate in community environmental campaigns because P<.001 is less than the significance level (P=0.05).

Table 4.11: Pearson Chi-Square for perception towards sorting waste in the future and willingness to participate in community environmental campaigns in Lebowakgomo Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.358[a]	1	<.001
Likelihood Ratio	26.777	1	<.001
N of Valid Cases	280		

Pearson Chi-Square test was conducted to establish if there is any relation between perception towards sorting waste in the future and willingness to participate in community environmental campaigns in Lebowakgomo Zone F (Table 4.12). There is no significant relationship between perception towards sorting waste in the future and willingness to participate in community environmental campaigns because P>.143 is greater than the significance level (P=0.05).

Table 4.12: Pearson-Chi Square for perception towards sorting waste in the future and willingness to participate in community environmental campaigns in Lebowakgomo Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.147[a]	1	.143
Likelihood Ratio	1.902	1	.168
N of Valid Cases	192		

Figure 4.20 shows that 70% of respondents regard sorting waste as their responsibility whereas 30% do not regard that as their responsibility in Lebowakgomo Zone A. Figure 4.20 shows that 77% of respondents regard sorting waste as their responsibility whereas 23% do not regard that as their responsibility in Lebowakgomo Zone F. The older age groups are the ones that mostly say it is their responsibility and the younger groups are not regarding it as their responsibility.
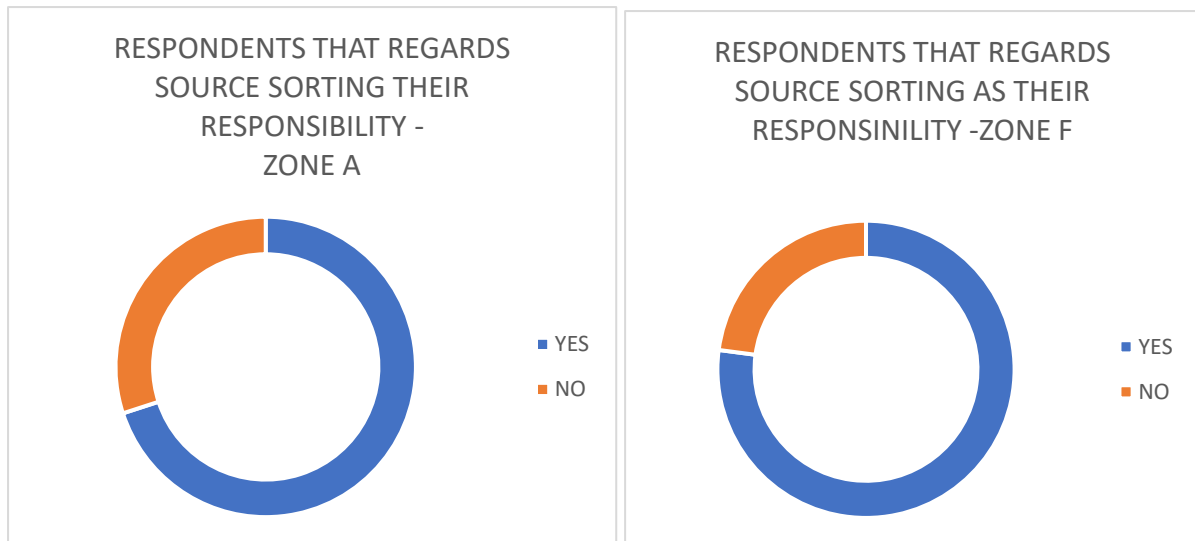
Figure 4.20: Respondents that take source sorting as their responsibility

 In Norwegian municipalities (Norway) it is not obvious that everyone perceives sorting as a burden. The survey that was conducted there shows that 38% of the respondents who sort waste, entirely or partly agreed that sorting is a pleasant activity. Those who agreed with this do sort waste somewhat more than others, and this applies to all waste types. More than half of the respondents who entirely agreed that sorting is a pleasant activity would prefer to sort it themselves even if a firm could take over this activity for them at no extra cost. The respondents who entirely disagreed that sorting is a pleasant activity, only 14% replied that they would prefer to sort waste themselves (Nyborg, 2000).

The framework of exploring the willingness of households to participate in source separation was proposed by Hanmann et al. (1991). However, in this regard exploration of cash incentives and provision of resources for waste sorting such as bins was the motive.

In Ghana future integrated waste management systems and source separation are facilitating for waste recovery through recycling and composting of waste materials. There is extra effort required from householders. The householders can be compensated through free collection services (Asase et al., 2008).

4.4.3 Provision of additional resources

Seventy-five percent (75%) of respondents in Lebowakgomo Zone A are willing to participate in waste separation if the municipality provides resources such as waste bins and refuse bags. Twenty-five percent (25%) of the respondents are willing to buy resources to separate waste In Lebowakgomo Zone F, 54% of the respondents are willing to sort waste if the municipality provides resources such as waste bins and refuse bags. Forty-six percent (46%) of the respondents are willing to buy resources to separate waste. Figure 4.21 displays the respondents who are willing to buy resources such as waste bins and refuse bags and are aware of sorting waste. When the respondents are working, they will be able to afford other resources for waste sorting.
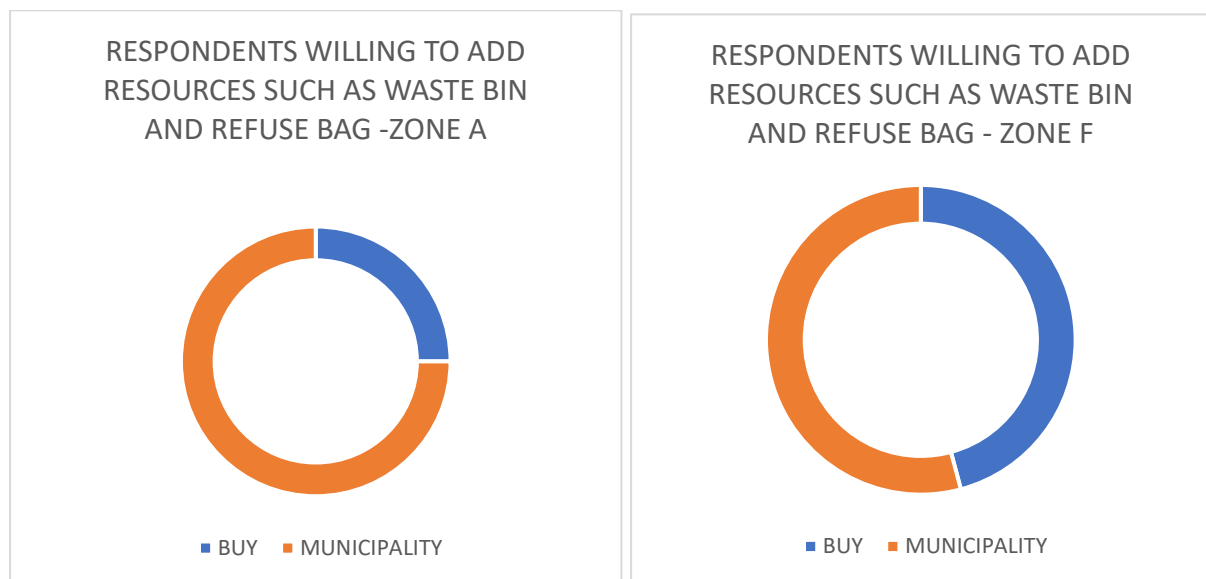
Figure 4.21: Respondents willing to buy resources

Figure 4.22 indicates that 87% of respondents are willing to buy their own refuse bags and 13% prefer the municipality to provide for them in Lebowakgomo Zone A. On the other hand, in Lebowakgomo Zone F 97% of respondents are willing to buy their own refuse bags and 3% prefer the municipality to provide for them. Figure 4.22 shows that

there is a lack of resources for enhancing the source separation. The willingness of respondents to separate waste rely on provision of adequate waste bins and refuse bags.
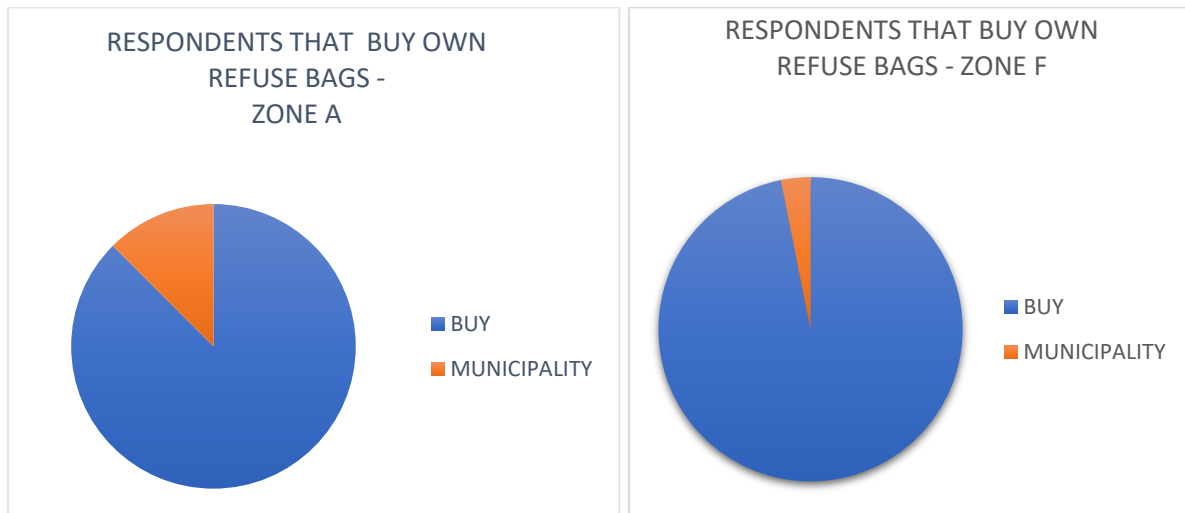
Figure 4.22: Respondents that buy refuse bags or provided by municipality

Most municipalities do not have the necessary resources for waste separation and infrastructure for waste collection for promotion of recyclable materials (CSIR, 2018). The study conducted in most South African municipalities is in alignment with that most municipalities are not providing communities with the resources for waste management such as refuse bags and waste bins as most respondents are buying their own refuse bags. Municipality is only providing 9% of respondents with refuse bags.

Eighty-five percent (85%) of respondents will separate waste if they are equipped with resources and 15% are not willing to separate waste in Lebowakgomo Zone A if they are not supplied with relevant resources. On the other hand, 95% of respondents will separate waste if they are equipped with resources while 5% are not willing to separate waste in Lebowakgomo Zone F. Figure 4.23 below displays the respondents that need resources such as refuse bags, bins, and knowledge on how to sort waste.
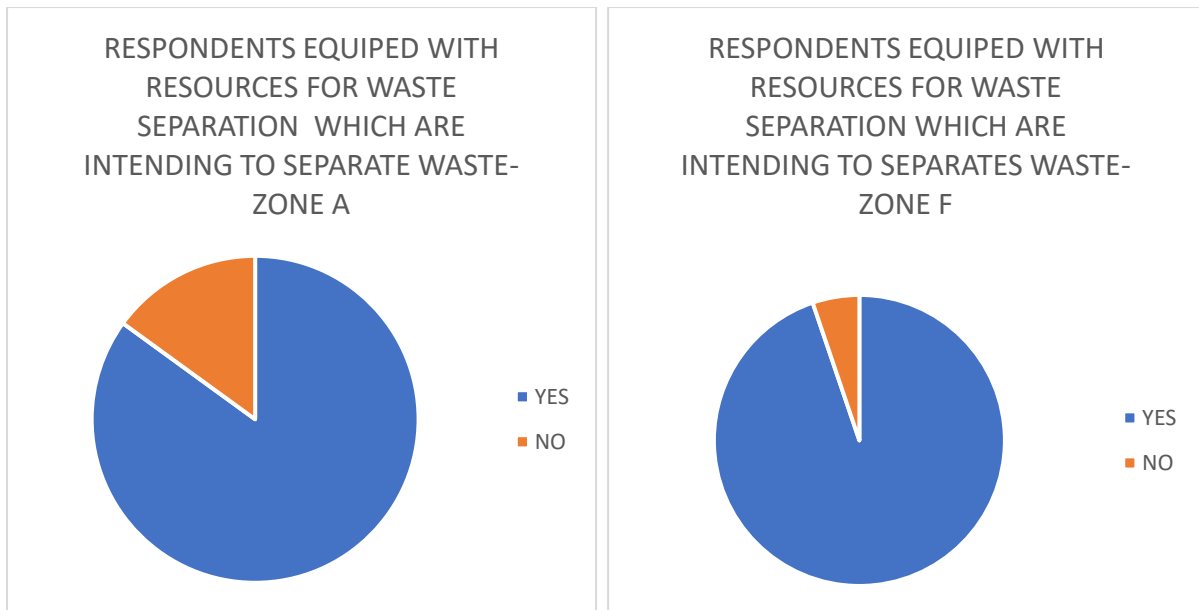
Figure 4.23: Respondents equipped with resources to separate waste.

The study indicated that most respondents are interested in sorting waste if they are equipped with resources. The waste sorting initiative will be a success if the government provides communities with resources.

4.4.4 Resources required for separation of waste

Figure 4.24 below indicates the resources required by the respondents to separate waste where 37% of respondents need refuse bags and bins, 30% need bins, 20% need only refuse bags, 10% need refuse bags, bins, and PPE, and 3% need refuse bags and PPE in Lebowakgomo Zone A. Fifty-five percent (55%) of respondents need refuse bags and bins, 18% need bins, 13% need only refuse bags, 13% need refuse bags, bins, and PPE, and 1% need refuse bags and PPE in Lebowakgomo Zone F(Figure 4.24). Most respondents require refuse bags and bins as they are not currently provided with refuse bags but provided with one bin.
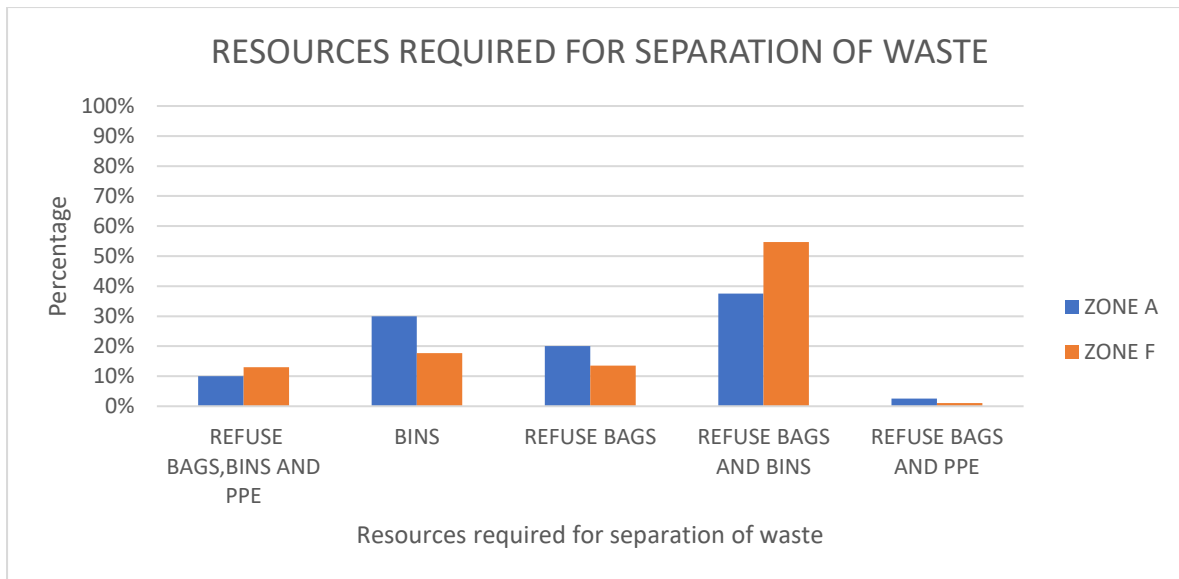
Figure 4.24: Resources that will be required for the separation of waste.

The resources that are required to separate waste are mainly refuse bags and labeled bins. Respondents are willing to separate waste however, there is only minimal resources.

4.4.5 Community Participation

Community participation refers to community projects that assist to people being involved in local initiatives to address local issues. Making decisions that assist the environment rather than harm it is referred to as environmental awareness (Study.com, 2022).

Figure 4.25 below shows that 35% of respondents have heard about sorting municipal waste from schools, 20% heard about it from environmental campaigns,18% from work, 17% have not heard about sorting, and 10% heard about it from other related platforms in Lebowakgomo Zone A. On the other hand, in Lebowakgomo Zone F as shown in Figure 4.25 below, 38% of the respondent have not heard about sorting, 29% of respondents have heard about sorting municipal waste from schools, 20% heard from environmental campaigns, 10% from work, and 3% heard about it from other related platforms. The others include social media, TV, radio, newspaper etc. The schools are playing an important part in the awareness although the percentage of respondents who have not heard about sorting waste is high.
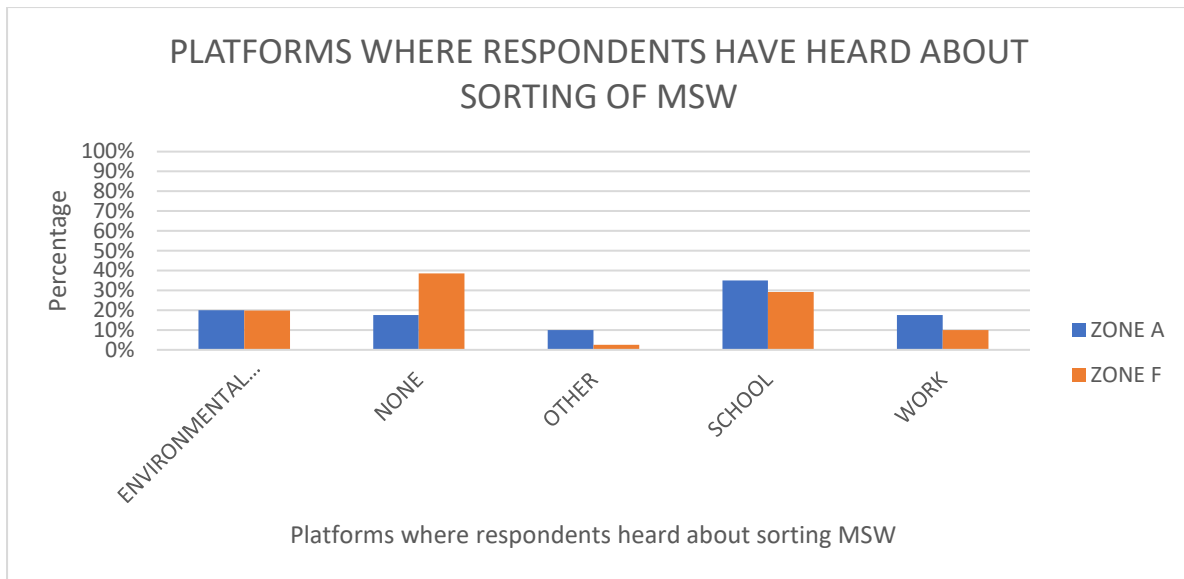
Figure 4.25: Platforms where respondents have heard about sorting MSW

In Lebowakgomo Zone A the highest platform where respondents have heard about sorting waste is schools whereas in Lebowakgomo Zone F the highest, number have not heard about sorting waste. The platforms vary from area to area as their level of knowledge and perception also varies.

Pearson Chi-Square test was conducted to ascertain if education influences willingness to sort waste in Lebowakgomo Zone A. There is a significant relationship between education and willingness to sort because P<.001 is less than the significance level (P=0.05) as displayed in Table 4.13 below.

Table 4.13: Pearson Chi-Square test for education and willingness to sort waste in Lebowakgomo Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	40.297ᵃ	3	<.001
Likelihood Ratio	40.694	3	<.001

Linear-by-Linear Association	22.246	1	<.001
N of Valid Cases	472		

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.07.

0.05 significance level

Table 4.14 shows Pearson Chi-Square test conducted to ascertain if education influences willingness to sort waste in Lebowakgomo Zone F. There is a significant relationship between education and willingness to sort because P<.001 is less than the significance level (P=0.05.)

Table 4.14: Pearson-Chi Square test for education and willingness to sort waste in Lebowakgomo Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	38.427[a]	12	<.001
Likelihood Ratio	45.149	12	<.001
N of Valid Cases	192		

a. 11 cells (55.0%) have expected count less than 5. The minimum expected count is .03.

b. 0.05 significance level

There are 57% of respondents that have encouraged other people about source sorting and 43% who have not encouraged other people about source sorting as shown in Figure 4.26 below for Lebowakgomo Zone A. There are 65% of respondents that have encouraged other people about source sorting and 35% who have not

encouraged other people about source sorting in Lebowakgomo Zone F (Figure 4.26). In most cases it is easier to advise people about something one will be practicing.
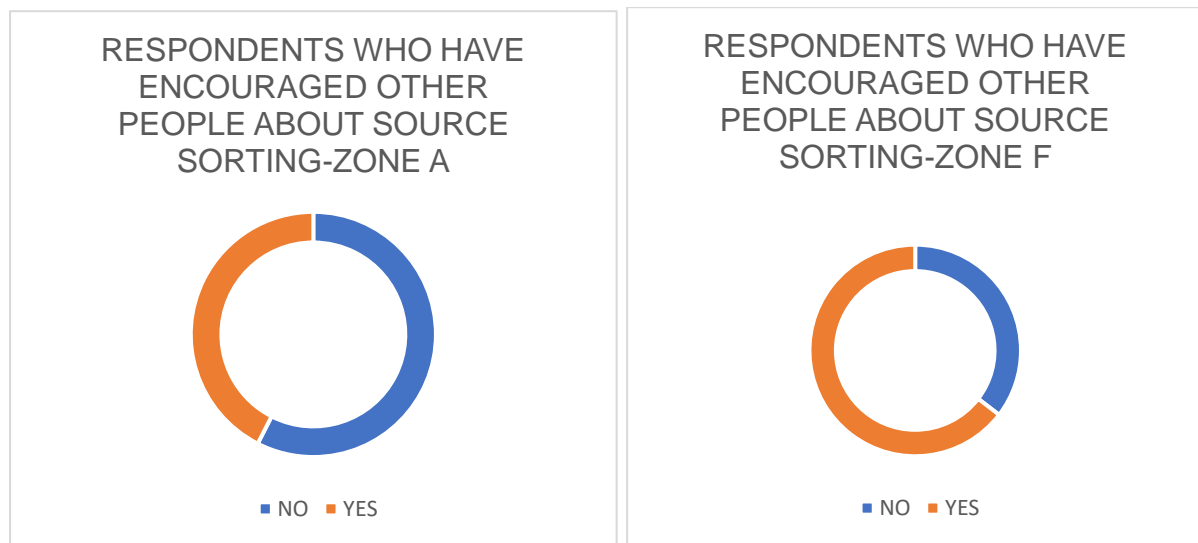
Figure 4.26: Respondents that encouraged source sorting

Key participants involved in establishing source sorting involved various stakeholders such as recycling centres, municipalities, households, and businesses about the importance of waste sorting. The environmental campaigns to educate people about the sorting of waste is achieved through involvement of different spheres of media such as newspaper, hand books, social media and posters to the community (Zhuang et al., 2008).

4.4.6 Willingness to participate in environmental campaigns

Environmental campaigns are activities that relate to conservation, preservation, and sustainability, raise awareness among people and encourage more ecologically responsible behaviour (Climate Action, 2016). This includes the environmental campaigns that take place in a community such as cleaning campaigns, collection of cans, cleaning the schools etc. There are 80% of respondents who are willing to partake in environmental campaigns and 20% not willing to partake in environmental campaigns in Lebowakgomo Zone A (Figure 4.27). There are 89% of respondents who are willing to participate in environmental campaigns and 11% not willing to participate in environmental campaigns in Lebowakgomo Zone F (Figure 4.27). If people are aware and have resources, they tend to participate in campaigns to take

care of the environment. Most of the environmental campaigns that respondents are interested in participating in are recycling projects and cleaning the environment.
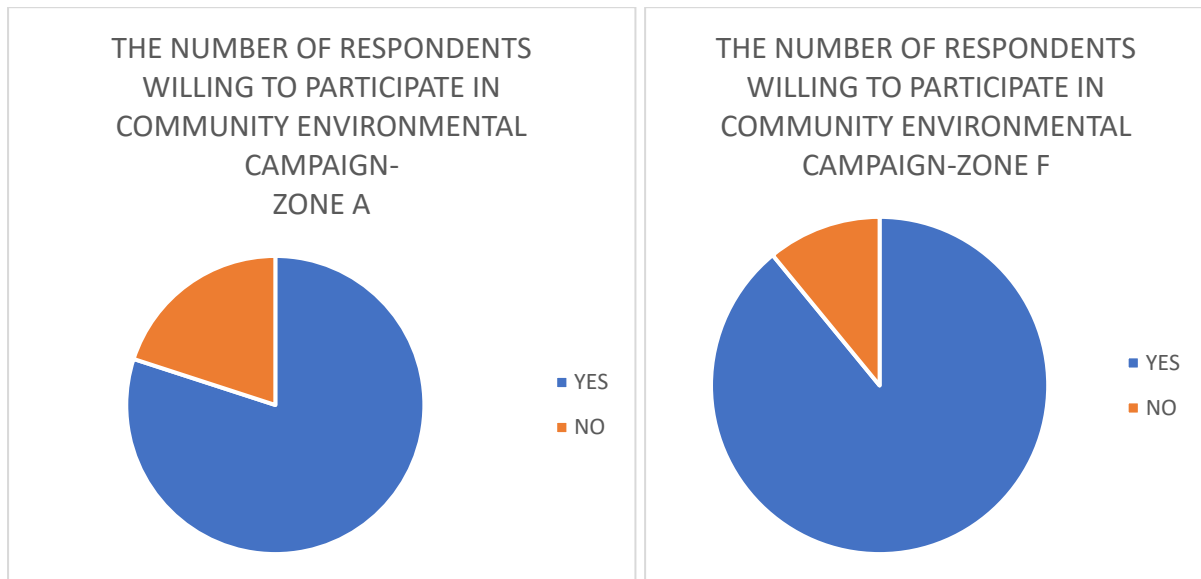
Figure 4.27 The respondents willing to participate in environmental campaigns.

According to DEA (2018), to ensure that householders participate in environmental campaigns the government must also conduct environmental awareness activities regularly. Guidelines of raising awareness should be communicated more often to guarantee that households receive feedback and have the relevant information.

According to Andreoni (1990), the motivation behind people's charitable deeds may be their desire to experience the "warm glow of giving". Even when the impacts of one's own work may be as little the fulfilment of doing a great thing for other will be worthwhile. It will be advantageous for someone who is simply seeking the joy of giving if the government has plans to extend home sorting arrangements, provided that is voluntary.

Pearson Chi-Square test was conducted to ascertain if participating in environmental campaigns influence willingness to sort waste in Lebowakgomo Zone A (Table 4.15). There is a significant relationship between participating in environmental campaigns and willingness to sort waste in Lebowakgomo Zone A because P<.001 is less than the significance level (P=0.05).

Table 4.15: Pearson Chi-Square test for participating in environmental campaigns and willing to sort waste Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	112.226ᵃ	17	<.001
Likelihood Ratio	130.381	17	<.001
N of Valid Cases	280		

a. 14 cells (38.9%) have an expected count of less than 5. The minimum expected count is 1.93.
b. 0.05 significance level

Pearson Chi-Square test was conducted to ascertain if participating in environmental campaigns influence willingness to sort waste in Lebowakgomo Zone F (Table 4.16). There is a significant relationship between participating in environmental campaigns and willingness to sort waste in Lebowakgomo Zone F because P<.001 is less than the significance level (P=0.05) as displayed in Table 4.16.

Table 4.16: Pearson-Chi Square test for participating in environmental campaigns and willingness to sort waste in Lebowakgomo Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	112.636ᵃ	24	<.001
Likelihood Ratio	118.366	24	<.001

N of Valid Cases	192		

a. 37 cells (74.0%) have an expected count of less than 5. The minimum expected count is .22.

b. 0.05 significance level.

4.4.7 Awareness

Awareness is the situation where the person perceives or knows about certain information regarding the matter (Oxford dictionary, 2020). In this study, respondents are either aware of sorting waste or they are not aware. Seventy- three percent (73%) of respondents are aware of sorting waste and 27% are not aware of sorting waste in Lebowakgomo Zone A. Seventy-three percent (73%) of respondents are aware of sorting waste and 27% are not aware of sorting waste in Lebowakgomo Zone F. Figure 4.28 shows that most respondents have knowledge about sorting waste in households. The number of respondents aware of sorting waste are equal in both Lebowakgomo Zone A and Lebowakgomo Zone F.
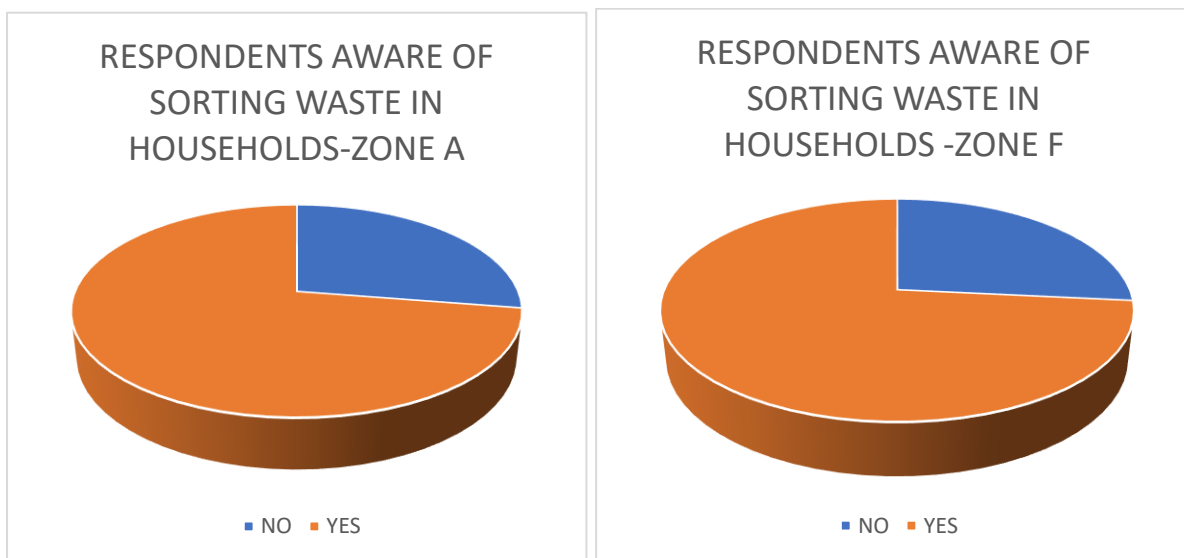
Figure 4.28: Awareness of sorting waste in households

In an Indonesian study by Setiawan (2020), Less than 40% of respondents knew that they were required by the waste management law to sort their garbage at the source, according to their answers to the question about their comprehension of this responsibility. Although the law's implementation began in 2008, it implies that the

requirement to sort garbage is not yet generally understood. Most respondents are not aware of sorting waste in households.

The study conducted in Kumasi metropolis, Ghana reported that 75.2% of representatives are aware of sorting waste and 24.8% are not aware (Asase et al., 2008). Most people are aware of sorting waste and its benefits, the implementation process is the one that is a challenge, however, there are more countries that are intending to sort waste as part of waste management.

Table 4.17 shows Pearson Chi-Square test conducted to discover if education affect awareness to sort waste in Lebowakgomo Zone A. There is no significant relationship between education and awareness to sort because P>.019 is greater than the significance level (P=0.05.)

Table 4.17: Pearson Chi- Square test for education influence in awareness to sort waste in Lebowakgomo Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.940ª	3	.019
Likelihood Ratio	13.484	3	.004
N of Valid Cases	280		

a. 2 cells (25.0%) have an expected count of less than 5. The minimum expected count is 1.93.

0.05 significance level.

Pearson Chi-Square test was conducted to discover if education affect awareness to sort waste in Lebowakgomo Zone F. There is a significant relationship between education and awareness to sort waste because P<.001 is less than the significance level (P=0.05) as displayed in Table 4.18.

Table 4.18: Pearson Chi-Square test for influence of education on awareness to sort waste in Lebowakgomo Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.120[a]	3	.001
Likelihood Ratio	15.330	3	.002
N of Valid Cases	192		

a. 2 cells (25.0%) have expected count less than
   5. The minimum expected count is .27.
b. 0.05 significance level.

The respondents' perception of knowledge about the value of sorting waste is evident, however, there is lack of resources to implement the process of waste sorting. The knowledge respondents have about the value/importance of sorting waste will be beneficial in future as it will promote sustainable waste management and the support from municipalities to ensure that people are equipped with knowledge. Seventy-five percent (75%) of respondents know the value of sorting and 25% don't know the value of sorting waste in Lebowakgomo Zone A (Figure 4.29). Eighty-seven percent (87%) of respondents know the value of sorting and 13% don't know the value of sorting waste in Lebowakgomo Zone F (Figure 4.29).
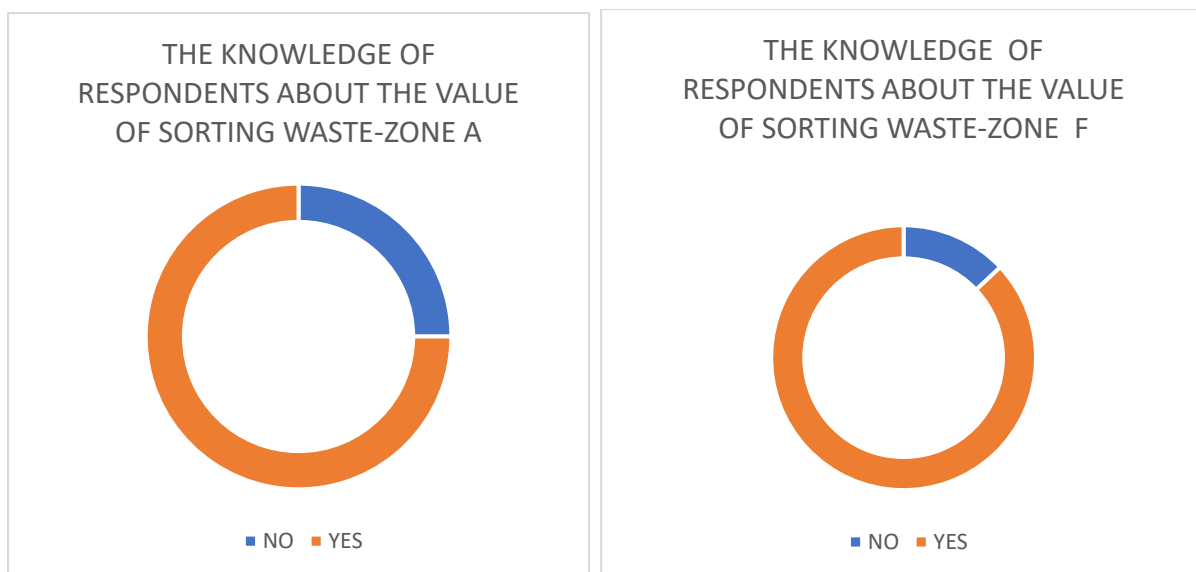
Figure 4.29: The knowledge of respondents about the value of sorting waste

As indicated in Figure 4.29 respondents know about the value of sorting waste. The respondents indicated that mostly, sorting waste is for the benefit of clean environment. Respondents know about the value of sorting waste and recycling.

One respondent said*: "The value of sorting waste is to have a clean environment and keep communities in a good environmental state."*

Another respondent said: "*The value of sorting waste that I know about is for recycling and for a clean environment.*"

Another respondent said: "*I don't have knowledge about why and how I should sort waste".*

4.5 Socio-economic and environmental impacts of sorting solid waste at source
4.5.1 Benefits of source sorting

The benefits of source sorting promote sustainable waste management and enhances the positive environmental and socio-economic impacts. The pillars that will encourage respondents to sort MSW are environmental awareness (35%) followed by saving recyclable materials (28%), income from recyclable materials (18%), better waste management (17%) and lastly 2% of the respondents for garden waste in Lebowakgomo Zone A (Figure 4.30). Benefits to sort MSW in Lebowakgomo Zone F are environmental awareness (53%) followed by saving recyclable material (23%),

income from recyclable materials with 14%, better waste management 10% (Figure 4.30). Figure 4.30 shows that participants know about the positive impacts of sorting MSW that encourages them to sort their waste. The environmental awareness is needed to encourage more householders about sorting waste.
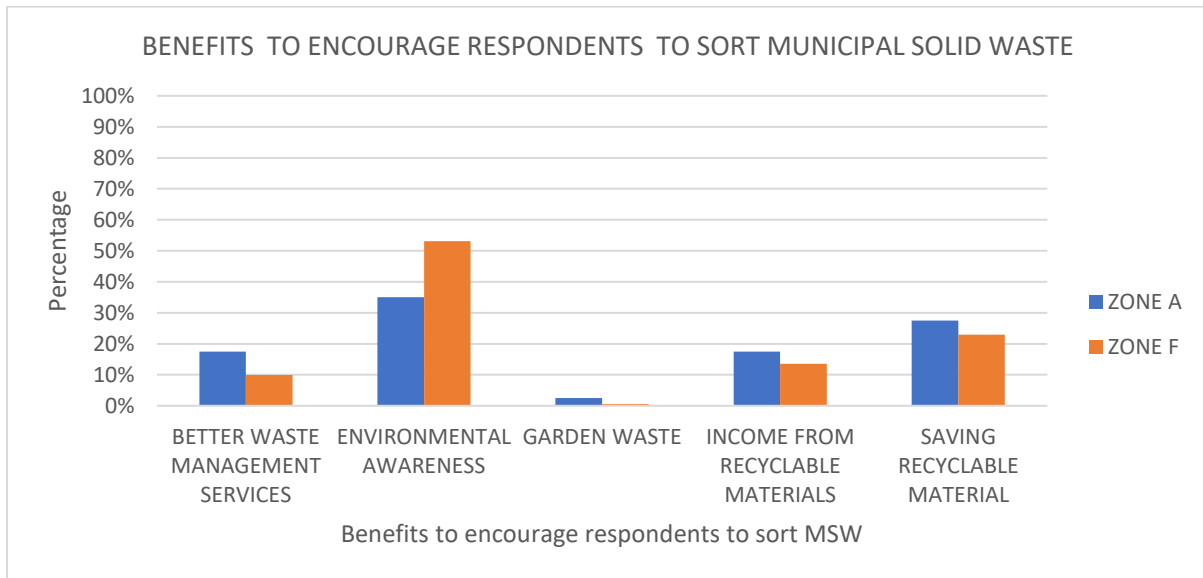
Figure 4.30: Benefits to encourage respondents to sort MSW.

Sorting waste contributes a significant impact on waste management procedures efficacy, resulting in significant alterations towards the amount of recyclable waste materials (Pitchayanin Sukholhaman, 2016). MSW over the past years emphasised on the importance of sorting waste and recycling for sustainable waste management (Center for Sustainable Systems, 2013). From an economic standpoint, recycling and sorting waste are very important because they give the industry more resources, lessen the environmental impact of waste management, and encourage investment and job growth in the recycling industry (Exposito, 2018). Waste sorting at source guarantees diverse advantages such as increase in the number of materials in MRF, compost from organic waste, better harvest yields for farmers, improvement in service delivery in municipalities and promoting sustainable waste management (Bennagen et al., 2002).

Figure 4.31 shows that for Lebowakgomo Zone A, 80% of respondents are sorting waste for the benefit of a clean environment, 15% of respondents for community participation and 5% for income generation. In Lebowakgomo Zone F 85% of

respondents are sorting waste for the benefit of a clean environment, 9% of respondents for community participation and 6% for income generation (Figure 4.31). Most respondents sort waste to benefit from clean environment and eradicate the pollution impact in communities. The benefit of income generation is the lowest as it comes secondary to the main reason of benefits. People are striving to reside in clean and healthy environments.
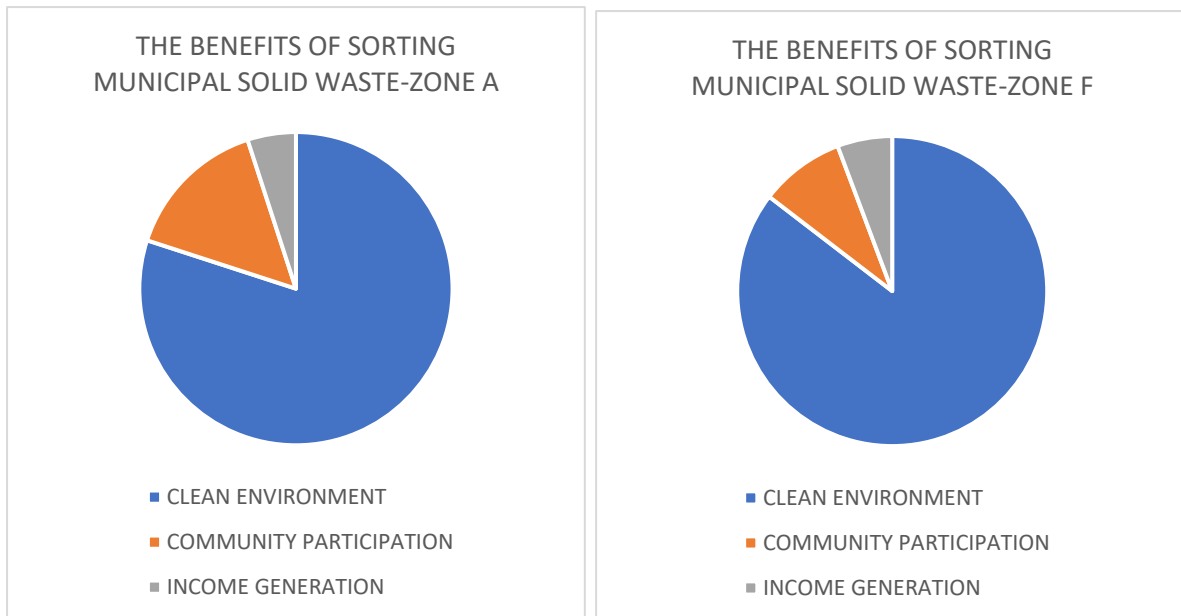
Figure 4.31: The benefits of sorting MSW

Environmental considerations correspond to the clearest justification for sorting at the household level. According to Nyborg (2000), 97% of participants completely sort waste at the source or some parts. The enthusiasm to sort driven from that they want to contribute towards a habitable surrounding. Communities desire to live in a clean environment as a way of to be responsible or for a person conscience (Nyborg, 2000).

There are socio-economic benefits such as getting free waste bins and incentives for cash in return for persuading respondents to be more willing to separate waste. The benefit of health encourages sorting of waste. The attitude and perception of respondents was positive and expressed in a way of willingness to participate in source sorting (Asase et al., 2008). The respondents are more interested in sorting waste for environmental and health benefits rather than for socio-economic benefits as most respondents refused cash incentives for source separation (Asase et al., 2008).

Figure 4.32 shows the respondents' motivation to sort waste in Lebowakgomo Zone A and F. Ninety percent (90%) of respondents are motivated because of benefits of sorting waste and 10% are not motivated in Lebowakgomo Zone A. Ninety-seven percent (97%) of respondents are motivated because of benefits of sorting waste and 3% are not motivated in Lebowakgomo Zone F. The motivated respondents are aware of the positive impacts of sorting waste in a household such as using organic waste for manure and generating income from recyclable waste.

THE BENEFIT OF SORTING AT SOURCE MOTIVATION-ZONE A

■ YES ■ NO

THE BENEFIT OF SORTING AT SOURCE MOTIVATION -ZONE F

■ YES ■ NO
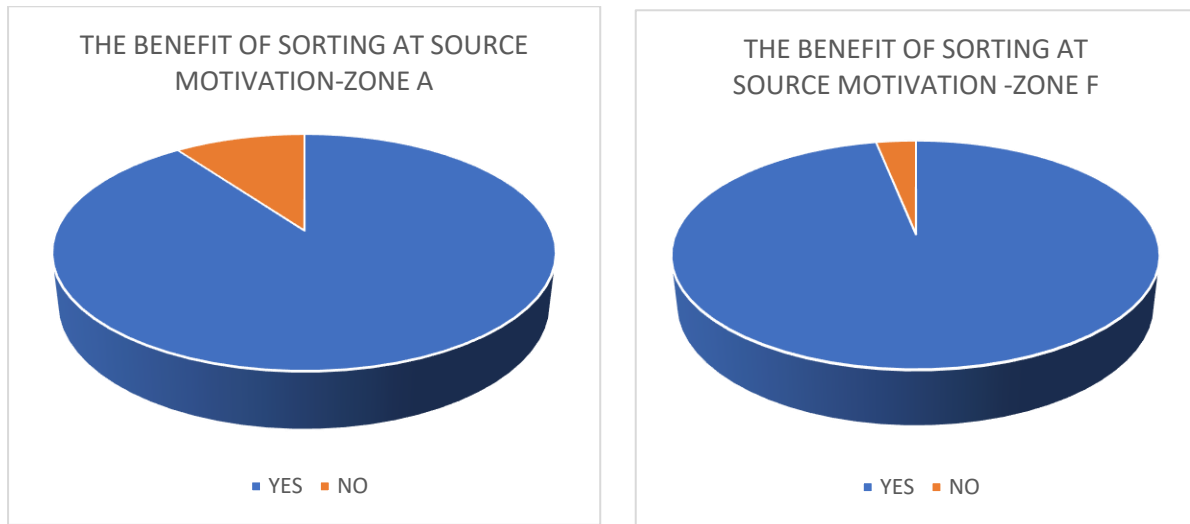
Figure 4.32: Benefits of sorting at source motivation

There are some respondents who are motivated to sort waste because there are benefits connected to it. The benefits of source sorting include clean recyclables, job creation and clean environment. The benefits should be a motivation to respondents to want to sort waste in future and the enhancement of business prospects in the waste industry (Ndlangamandla, 2017).

The respondents in Ghana indicated that they are not sorting waste because it is time consuming. Health benefits show positive significance as per the perception of respondents that they will benefit from a clean environment (Sterner and Bartelings, 1999).

One respondent said: *"The benefits that I am aware of is sorting the cans and recycling them"*

Several waste reduction approaches were tried in most cities and countries to bring change in the IWMS. The separation at source is regarded as the fundamental step towards sustainable waste management. It is further certified that waste reduction is efficient to improving recycling. Willingness to so separate waste encourages good practices in communities. The benefits that could be proposed to the stakeholders such as incentives to both businesses and households will contribute enormous change in the implementation of source sorting (NWMS, 2020).

There are households that grow and take care of their gardens by using the organic waste than disposing it in one bin. They are sorting their waste which does not cause other waste to lose its recyclable value. Figure 4.33 shows the organic waste that is used to produce compost.

Figure 4.33: Separated dry waste to produce compost

The organic waste that is separated can be used to produce compost. Householders are encouraged to participate in environmental campaigns from municipalities, to equip them with knowledge on benefits of sorting waste such as producing compost. There is a need for adequate resources to sort waste in households such as to have adequate composting and have recycling collectors for both at households' gates and in outdoor spaces such as community skips (Barros et al., 2013).

4.5.2 Negative impacts of unseparated waste

Negative impacts of unseparated waste have a strong effect on the environment and surrounding. Pollution can cause harm that takes time to be remedied on the environment. Figure 4.34 shows the number of participants who said that they were negatively impacted by unseparated waste on the environment, where 48% accounts for pollution (air ,water etc.), 20% for visual aesthetics (littering), 20% for none, 10% for health impact and 2% for injury in Lebowakgomo Zone A. Figure 4.34 give an illustration of the number of respondents that were negatively impacted by unseparated waste on the environment where 54% accounts for pollution, 18% for visual aesthetics, 11% for none, 10% for injury and 7% for health impact in Lebowakgomo Zone A .
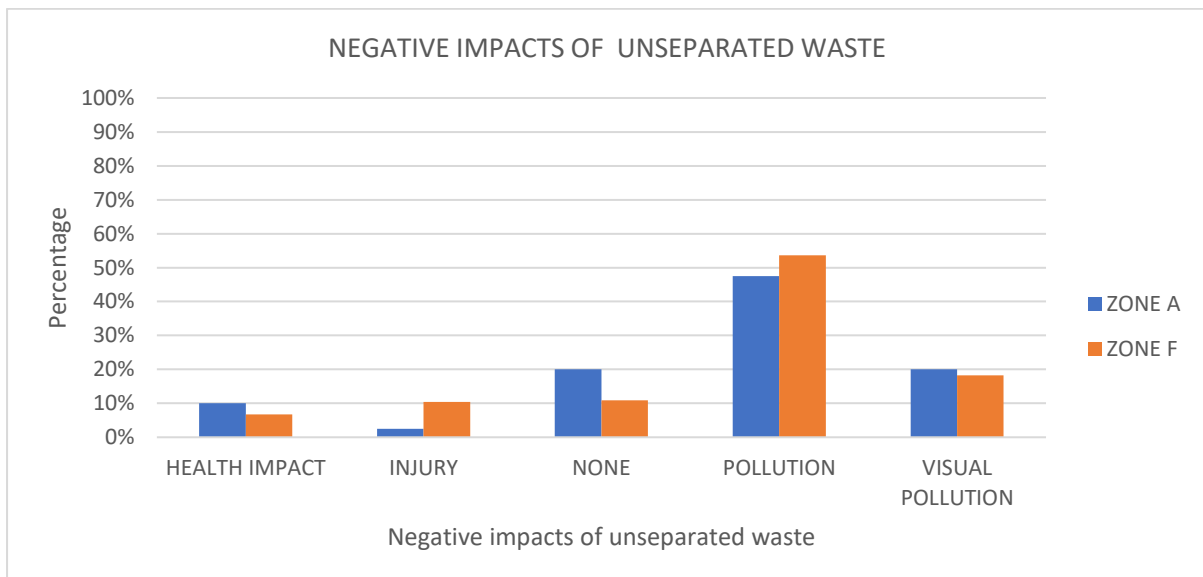
Figure 4.34: Negative impacts of unseparated waste on the environment.

Figure 4.34 illustrates the highest negative impacts of pollution in Lebowakgomo Zone A and F that have been experienced by the respondents. The inappropriate behaviour of managing waste have negative impact on the environment as waste that is not properly disposed it attracts rats and squirrel and other animals. Mosquitoes can impact the surroundings when breeding in MSW and will spread diseases such as malaria, Zika virus etc.

One respondent said*: "Unseparated waste affects me badly because of smell and causes worms especially if not collected on time".*

Figure 4.35 and 4.36 below shows the visual pollution that occurred near the road and the shrubs in Lebowakgomo Zone F. Waste that is not managed properly ends up causing pollution. The impact of pollution contributes to climate change and health impacts such as outbreak of infectious diseases.

Figure 4.35: Littering in the bush Figure 4.36: Littering near the road

Visual pollution is a result of lack SWM practices and impacts to the water pollution with is a world-wide issue. Conducted studies indicates that 80% water pollution is caused by litter from the land (ISWA, 2015). There should be vast data on main culprits of pollution and approaches to reduce visual pollution in the environment. Figures 4.35 and 4.36 are showing visual pollution whereby if it rains the very same waste will be deposited into the water bodies.

Figure 4.37 and figure 4.38 below indicates that there is still a challenge when coming to environmental awareness toward waste management. There is visual pollution that is taking place in some of the areas. The skips are not maintained properly as can be seen in the photo overflowing with waste (Figure 4. 38). When households are aware of taking care of their environment and the importance of sorting waste to be recycled there would be less littering and illegal dumping of waste.

Figure 4.37: Waste dumped near the road Figure 4.38: Overflowing waste skips

The observed negative impacts on the environment in Figures 4.37 and 4.38 support the study on mishandled solid waste and open dumpsites indicated that pollution of ground water is common in areas that are experiencing waste pollution on the environment. The burning of waste causes air pollution as it releases emissions that are toxic and impact human health (ISWA, 2015). The carbon dioxide that is released from burning of non-collected waste contribute to climate change.

Pearson Chi-Square test was conducted to find out if sorting waste influences the impact on the environment in Lebowakgomo Zone A (Table 4.19). There is a significant relationship between sorting waste and the impacts on the environment because P<.001 is less than the significance level (P=0.05).

Table 4.19: Pearson-Chi Square test for impacts on the environment and sorting of waste in Lebowakgomo Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	108.352[a]	21	<.001
Likelihood Ratio	135.883	21	<.001

N of Valid Cases	280		

a. 18 cells (40.9%) have an expected count of less than 5. The minimum expected count is 1.93.

b. 0.05 significance level

Pearson Chi-Square test was conducted to find out if sorting waste influences the impact on the environment in Lebowakgomo Zone F (Table 4.20). There is a significant relationship between sorting waste and impacts on the environment because P<.001 is less than the significance level (P=0.05).

Table 4.20: Pearson Chi-Square test for impacts on the environment and sorting waste in Lebowakgomo Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	76.320[a]	28	<.001
Likelihood Ratio	87.053	28	<.001
N of Valid Cases	192		

a. 46 cells (79.3%) have expected count less than 5. The minimum expected count is .22.

b. 0.05 significance level

4.6 Challenges faced during recycling of unseparated solid waste

4.6.1 Challenges provided by respondents

The challenges that hinder source separation of MSW are absence of environmental awareness, inadequate infrastructure, and shortage of storage etc. (Oelofse, 2018).

According to the respondents the challenges that hinder separation at source are lack of environmental awareness (42%), lack of storage in households (33%), non-collection services (13%) and lack of infrastructure (12%) as illustrated in Figure 4.39 for Lebowakgomo Zone A .The challenges that hinder separation at source for Lebowakgomo Zone F are lack of environmental awareness(51%), lack of storage in households (24%), lack of infrastructure (13%) and non-collection services (12%) for Lebowakgomo Zone F (Figure 4.39) . Lack of environmental awareness is the main challenge when coming to separation of waste in households in both Lebowakgomo Zone A and F.
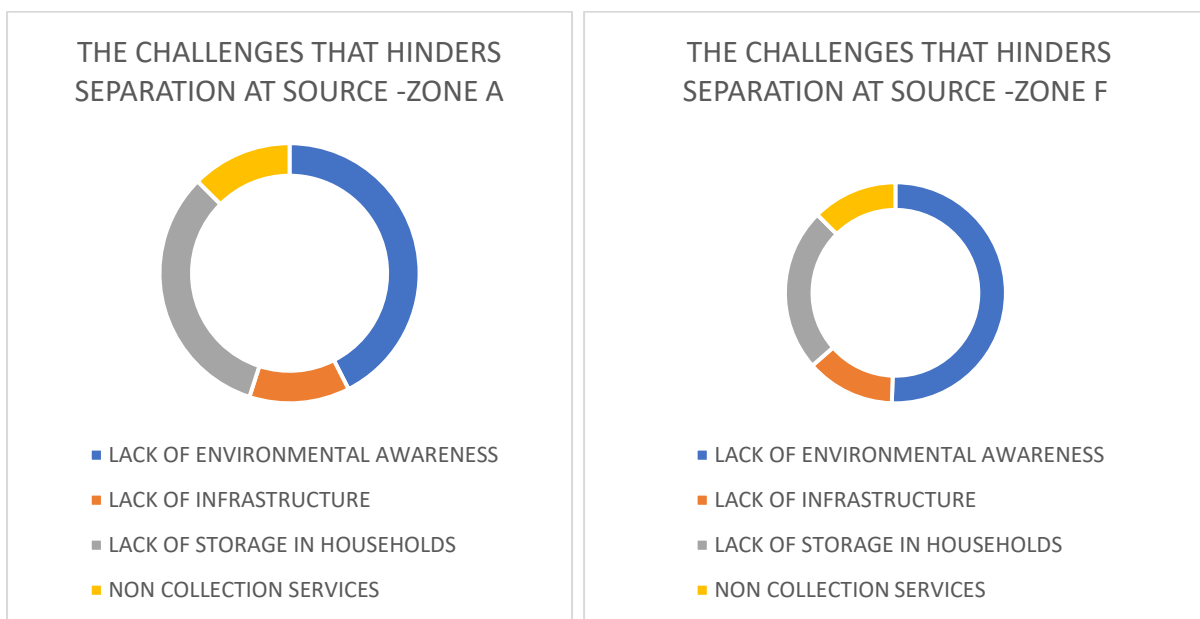
Figure 4.39: Challenges that hinder separation at source

These challenges were also found in the Western Cape study by Oelofse (2018), where lack of environmental awareness was the major challenge. It was advocated that if waste sorting is to be introduced in municipalities, the implementation strategy supposed to prioritise the wants of the households. The effective way is engagement in awareness campaigns, service delivery to the people and administering the challenges already identified in communities.

Some of the respondent's reasons for not sorting waste in households in Indonesia are that participants have not experienced source sorting in communities. The showed the results that collection and transport accounts for (26%), shortage of sorting

facilities (23%), and inefficient time management skills (22%) (Setiawan, 2020). McDonald and Oates (2003) emphasised on deprivation of allocation of time to sort waste as one of the challenges that contribute to none contribution in solid waste household separation.

One respondent said: *"The challenges can be overcome through awareness and engaging the community."*

Another respondent said*: "The challenges can be resolved through government intervention to improve waste management."*

The respondents said that to overcome the challenge there should be environmental awareness and government intervention.

Pearson Chi-Square test was conducted to find out if some of the challenges that hinder source sorting. There is a significant relationship between challenges that hinder source sorting in Lebowakgomo Zone A because P<.001 is less than the significance level (P=0.05) as displays in Table 4.21.

Table 4.21: Pearson Chi-Square test for challenges that hinder source sorting in Lebowakgomo Zone A.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	34.391^a	3	<.001
Likelihood Ratio	35.416	3	<.001
N of Valid Cases	280		

   a. 0 cells (0.0%) have expected count of less than 5. The minimum expected count is 9.63.

   b. 0.05 significance level

Pearson Chi Square test was conducted to find out if some of the challenges that hinder source sorting in Lebowakgomo Zone F (Table 4.22). There is no significant

relationship between the challenges that hinders source sorting in Lebowakgomo Zone F because P>.033 is greater than the significance level (P=0.05).

Table 4.22: Pearson-Chi Square test for challenges that hinder source sorting in Zone F.

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.760ᵃ	3	.033
Likelihood Ratio	7.998	3	.046
N of Valid Cases	192		

a. 0 cells (0.0%) have an expected count of less than 5. The minimum expected count is 5.38.

b. 0.05 significance level

4.6.2 Challenges of the recycling company

According to the manager of the recycling company that was interviewed, the company does not have many challenges when coming to unseparated waste. The centre receives different types of waste categories but is mainly interested in aluminium. The Material Recycling Facility (MRF) centre in Lebowakgomo (Figure 4.40) receives different types of waste categories of MSW from households but is mainly interested in aluminium. ferrous and non- ferrous steel. The centre profit margins are good since they have operated for over 20 years in Lebowakgomo. The centre receives waste, and they sort it themselves manually into two categories of ferrous and non-ferrous.

There is a weigh bridge where waste is measured before it will be separated and there is a scale that measures the waste that the centre will buy from the customer. Waste that will be recycled is stored in bags inside the MRF (Figure 4.41). The forklift helps in carrying some of the bags since they will be heavy. The recycling company buy in the aluminium from householders which is what they will weigh on a scale (Figure 4.42

and Figure 4.43) to determine the value of the aluminium material and give the household the valued money. The waste is measured in kilograms (kg) to know the buy-back amount that the customer will receive in return for the material that will be weighed. The waste that is not aluminium such as plastic and paper is stored in bins, and they will dispose it to the Lenting landfill since they are not recycling plastic and paper. The centre is equipping their consumers who bring in waste with knowledge to separate waste to ensure that their waste is still in a more recyclable state. There are still customers who bring in unseparated waste but before they scale their waste, they must separate it first.

It is easier to work with waste that is separated rather than unseparated waste and the centre continues to work with new customers on how to separate their waste in categories. Since aluminium doesn't get rusty, it is received in a more recyclable state than the other metal products. The MRF engages with customers as they come to the facility and consequently the centre receives more of the waste from the households who are interested in recycling. The system that is in place helps them to separate waste since they have enough space.

The separated waste will make the recycling process easier, and the consumers will have enough buy back measures when they bring the separated waste to the facility. The separated waste from households will lower strive to zero waste to landfill policy to improve the socio-economic effects in communities. The separated quantities yield more recyclable materials than unseparated waste.

Figure 4.40: The MRF in Lebowakgomo

Figure 4.41: The bags storing recyclable material

Figure 4.42: The weighbridge at MRF
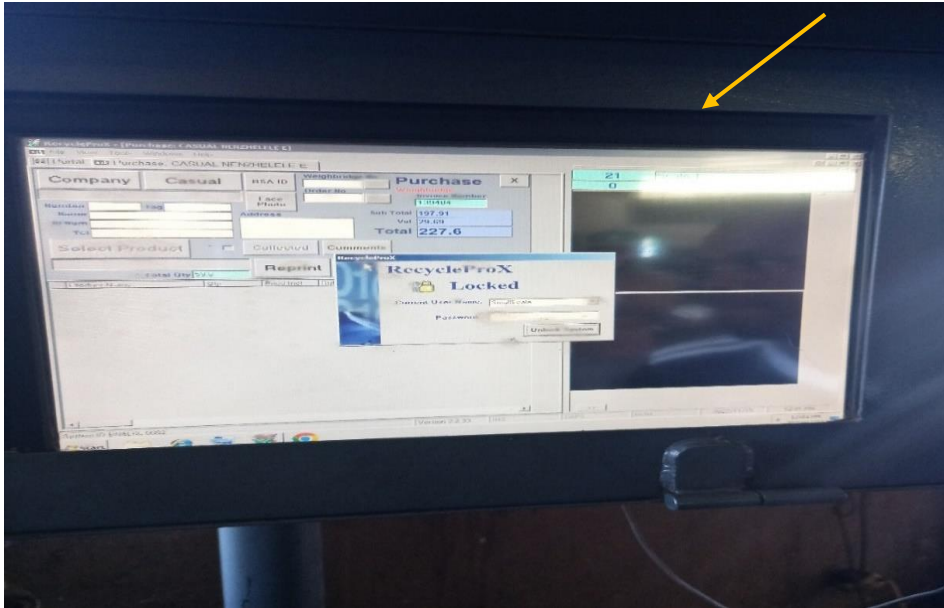
Figure 4.43: Material Recycling Facility scale recorder

4. 7 Role of the Municipality on encouraging source separation

Lepelle-Nkumpi Local Municipality collects waste once a week. They have provided households with one bin and the other additional bin the households buy for themselves.

The interview was conducted with waste management official, the end goal of the interview was to examine the strategies established in relation to sorting waste in Lepelle-Nkumpi Local Municipality. The outcome of source sorting in Lepelle-Nkumpi Local Municipality is in implementation stage. They are in the process of checking with the community through public participation and informing them about the source sorting plan/initiative.

The interviewed municipal representative said that collection service is practiced, and waste collection services collects every week on the chosen day per collection schedule. He further mentioned that the implementation plan for source separation will benefit in recycling of materials. They will separate waste and the recycling waste collectors will organize waste trucks to collect the recyclable waste and the waste collection trucks will collect the other non-recyclables. The waste collection trucks dispose waste at the Lenting waste disposal site. They currently know about four recycling companies that collect recyclable waste casually and they will engage them further to ensure the success of the source separation to encourage recycling.

They have at least one environmental campaign from the municipality per year. The environmental campaign that the community mostly engages in is cleaning litter campaigns. The community also initiates some of the campaigns and the Municipality support the initiative with the resources such as refuse bags and PPE.

The Municipality provides the communities with the refuse bags at least once in a week and supports the reclaimers. The Municipality has provided the households with one bin, and they are planning on giving them recyclable refuse bags to separate waste. The municipal representative was asked about the enforcement of the law and waste management strategies in place and mentioned they are complying with waste management by-laws for Lepelle-Nkumpi Local Municipality and NEMWA Act (103) 1998. They are enforcing the by-laws to govern waste management sector and to protect the environment.

4.8 Summary of the chapter

The findings show that the households are aware of sorting waste, and they are willing to separate waste in future. The municipality is engaging in initiatives that will also encourage waste sorting. Community participation in environmental campaigns is important to ensure sustainable waste management. Environmental awareness and provision of resources are a necessity for sorting waste.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the results and findings on evaluating the awareness and perception of sorting municipal solid waste in Lebowakgomo Zone A and Zone F. The summary covers the willingness and perception, socio-economic and environmental impacts of solid waste, environmental awareness, challenges of sorting, and the strategies of municipality in separation of waste. The chapter also covers the conclusions of the study and provides recommendations towards sustainable source sorting of municipal solid waste by householders.

5.2 Summary

5.2.1 Willingness of households to participate in MSW separation

The respondents in Lebowakgomo Zone A and Zone F are aware of sorting MSW and willing to participate in sorting waste. There are respondents who regard sorting waste as their responsibility and are keen to sort waste in their households. The households are interested in participation of sorting provided that, there are resources such as waste bins and refuse bags that will be provided by the municipality. There are, however, households that are willing to buy their own resources.

Respondents are willing to sort waste in the future. They are knowledgeable about environmental, economic, and social benefits of sorting waste with the aid of proper provision of environmental awareness initiatives. There will be improvement of citizens that take care of the environment by themselves and not depending on government to manage waste generated in households. The willingness to sort waste is a sustainable approach as the respondents are willing to sort waste with the understanding that this is to benefit the environment and surroundings.

Respondents in Lebowakgomo Zone A and Zone F are willing to participate in environmental campaigns as a form of striving for the clean environment and to help each other as it benefits the community. There are respondents that hear about sorting waste in platforms such as school, work, and environmental campaigns. However, there were respondents that have not heard about sorting waste.

5.2.2 Socio-economic and environmental impacts of sorting waste

Households sort waste such as cardboards, glass, plastic, paper, aluminum, organic waste, etc. The types of waste that are sorted most are paper, plastic and aluminium. Respondents recycle waste to benefit from the generation of income. The households are willing to sort the waste to keep the environment clean, which will reduce pollution. The sorting of waste empowers communities as they work with one another to keep their streets clean through cleaning environmental campaigns. The households are willing to participate in any kind of environmental campaign to benefit the environment and for community livelihood. Recycling is beneficial in ensuring that the waste is recovered and contributes to saving natural resources and for sustainable waste management. Households are participating in sorting waste to promote clean environment and participate in taking care of the environment through environmental campaigns.

The effects of unseparated waste impacted the environment are pollution (air and water), visual pollution such as littering and the health impacts. The unseparated waste is found to be the cause of the visual pollution especially if waste will not be separated and stored in labeled bins. The unseparated waste stored in one bin such as organic waste, plastics, and paper smell easily than the waste that will be stored separately, especially when the organic waste will be separated to produce compost

5.2.3 Challenges faced during recycling of unseparated solid waste

The challenges of sorting waste at source that were identified are lack of environmental awareness, lack of storage in households and lack of infrastructure. The challenges of sorting waste can be resolved, starting with environmental education and awareness campaigns. Respondents indicated that sorting waste in households should be encouraged, and they be provided with knowledge of how to sort properly.

The collection service delivery becomes a challenge when waste is not collected regularly. The waste ends up littering and causing pollution when not properly managed. The municipalities are not providing adequate resources to sort waste and to guarantee that waste is managed in an environmentally friendly manner. The

challenge of not having infrastructure to improve sustainable waste management is quite challenging as there is lack of MRF that manage waste, that could be recycled and engage communities in incentives such as coupons to encourage them to sort waste.

5.2.4 Strategies of the Municipality on encouraging source separation

Lepelle-Nkumpi Local Municipality by-laws and the legislations related to waste management are enforced. There is an implementation plan towards separation of waste in Lebowakgomo Zone A and F. The implementation intends to increase the quantities of recyclable waste in Lebowakgomo Zone A and F.

The service delivery of waste collection take place once in a week in Lebowakgomo Zone A and F. The collection service has been implemented although there are incidents where waste is not collected due to vehicle breakdown or other delays. The Lepelle-Nkumpi Local Municipality lacks the capacity to raise awareness and education to the communities about the knowledge and benefits of sorting waste as some of the respondents don't know about sorting of waste. The community is willing to participate in environmental campaigns, there are only occasionally environmental clean-up campaign, and the municipality provides PPE.

Lepelle-Nkumpi Local Municipality provides refuse bag to other communities, and some do not receive. There is provision of one bin per household and it will encourage the households to sort waste when there will be labeled bins to store waste.

5.3 Conclusions

It can be concluded that:

- ❖ The residents in Lebowakgomo Zone A and F are willing to sort waste and are aware of the process of sorting waste.
- ❖ In Lebowakgomo Zone A and F, the respondents are willing to continue to sort waste at the source in the future.
- ❖ There are participants who do not have a optimistic attitude towards sorting waste as it is regarded as the work for hired people.
- ❖ The people 's willingness to sort waste is based on their attitude

- The main factor is the awareness about sorting waste. The education and awareness are a challenge; however, the environmental campaigns can make a difference and educate the communities of the importance of sorting waste.
- The sorting of waste in households will contribute great change in waste management sector and the communities.
- There are challenges that hinder sorting waste in households such as lack of resources, lack of environmental awareness and lack of storage.
- The community is recycling waste and there is a recycling centre in the community.
- There are councillors that are engaging communities to ensure that they access waste collection service as a basic need.

5.4 Recommendations

- Environmental education and awareness to encourage communities to sort should be introduced by Lepelle-Nkumpi Local Municipality.
- Environmental campaigns need to be funded and the communities participate.
- The education and awareness programmes are needed to encourage the community to recycle all different types of waste such as plastics, and paper, etc.
- The sorting of waste should be promoted to increase the environmental and socio-economic benefits.
- There is a need to improve the perception of communities to participate fully in separation of waste to increase recyclable material, better income through job creation, clean environment and producing food in gardens and to socially encourage resident to empower their communities.
- Waste collection services must be improved to encourage residents to sort waste.
- Recyclers must give better incentives to attract more households to bring in sorted waste.
- The recycling centre must be diverse and give coupons for all recyclable materials to encourage households to sort waste
- Integrated waste management infrastructure needs to be assessed to be in good conditions and be serviced.

❖ Service delivery mechanism of municipalities will have to get more private sector involvement and alternative funding for municipal waste management services to improve collection of waste.

❖ The community management forums should be implemented where the municipality, ward counsellors and community members meet to discuss the issues of waste management at hand and seek solutions in a collaborative manner.

❖ The Lepelle-Nkumpi Local Municipality should equip the households with knowledge on how to sort waste and educate them in some of the environmental campaigns so that they will be more willing towards taking care of the environment.

❖ The municipality needs to engage communities in environmental campaigns and educate them about sorting waste, as good practices of waste management.

❖ The waste that is not properly managed causes pollution on the environment, to minimize waste that is generated and reduce the amount that is disposed in landfill, the sustainable waste management need to be practiced.

❖ The Lepelle-Nkumpi Local Municipality should implement by-laws that promote sorting waste at source.

❖ The government can play a role in ensuring that the environmental education is funded, and the communities are empowered to be able to take care of their communities and in return benefit them environmentally, socially, and economically.

❖ The government need to improve provision of collection services to encourage residents to sort their waste knowing that it will be recycled and not left to litter the streets to pollute the environment.

❖ The stakeholders need to work together to ensure sustainable waste management.

❖ The government should make provision of resources such as labeled waste bins and refuse bags.

5.5 Conclusion

The summary of the chapter, conclusion and recommendations of the study shows that households are willing to sort waste. There is lack of environmental awareness. The recycling facilities ae encouraging households to bring separated waste. The Lepelle-Nkumpi Local Municipality need to implement the recommendations to equip the households in the future. The references and appendices are following the chapter.

6. REFERENCES

(BIPRO/CRI) European Union and Copenhagen Resource Institute. (2015). Assessment of separate collection schemes in the 28 capitals of the EU. www. ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final %20Report.pdf

3rd Baseline Report (2012). National Waste Information Baseline Report.Departmentment of Environmental Affairs, South Africa.

Abdel-Shafy, H. and Mansour, M. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorisation. *Egyptian Journal of Petroleum 27*(4): 1275–1290. doi:10.1016/j.ejpe.2018.07.003

Alexis, M. T. and Ames, R. M. (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste Management* 29(2): 915–923.

Andreoni, J. (1990). Impure altruism and donations to public goods: A theory of warm glow giving. The Economic Journal, 100, 464-477.

Andrzej, M. and Arkadiusz, M. K. (2012). The problem of preparation the food packaging waste for recycling in Poland. *Resources, Conservation and Recycling* 69: 10–16.

Arafat ,H. A., Jijakli ,K. and Ahsan ,A. (2015) Environmental performance and energy recovery potential of five processes for municipal solid waste treatment. *Journal of Cleaner Production* 105: 233–240.

Argus. K . and Carl, B. (2001). European Packaging Waste Management Systems. Final report. European Commission DGXI.E.3, Brussels.

Asase MAD. (2000). Pilot source separation of household waste in the Asokwa sub-metroarea of Kumasi. Kumasi: Chemical Engineering Department, Kwame NkrumahUniversity of Science and Technology.

Asase, M.A.D., Mensah, Y.M and Amponsah, S.K. (2008). Development of data-based decision-support system for management of source separated municipal waste in Kumasi, Ghana. Kumasi: Kwame Nkrumah University of Science and Technology.

Australia, T. G. (2014). Waste Authority: Source Separation of Waste: Position Paper Waste Authority, WA. Too Good to Waste.

Babazadeh,T., Nadrian, H., Mosaferi, M. and Allahverdipour ,H .(2018). Identifying Challenges and Barriers to Participating in the Source Separation of Waste Program in Tabriz, Northwest of Iran: A Qualitative Study from the Citizens' Perspective. Resources. Published 29 August 2018.

Balwan, S. and Kour. (2022). *5R's of Zero Waste Hierarchy*. Improving local economy through integrated waste management in Bandung City, Indonesia (Case study of Sukasari district)

Balwan,W.K , Sing, A . and Kour,S (2022). 5R's of Zero Waste Management to save our green planet: A Narrative review: European Journal of Biotechnology and Bioscience, ISSN: 2321-9122, Volume 10, Issue 1, 2022, Page No. 7-11

Barros, E. M., Filho, G. L. T., Moura, J. S., Peironi, M. F., Vieira, F. C., Luge, L. R., Mohr, G. S and Casros, A. S. (2013). Design and Implementation study of a permanent selective collection programme (PSCP) on a University Campus in Brazil.

Basic Facts. (2006). US Environmental Protection Agency.

Batsioula, M. (2018). *Environmental Impact assessment of Municipal Solid Waste Management.*

Beer. (2015). Environmental impacts of waste management and valorisation pathways for surplus bread in Sweden. Waste Management. Volume 117, November 2020, Pages 136-145.

Bell, R. G. and Russell, C. (2018). Environmental Policy for Developing Countries. In G. E. Helfand and P. Berck (Eds.), The Theory and Practice of Command and Control in Environmental Policy (1st ed.; pp. 239–246). By P. Berck. doi:10.4324/9781315197296-10

Bennagen, E.C, Nepomuceno., G and Ramil, C. (2002). Solid waste segregation and recycling inmetro Manila: households' attitude and behavior. In: Resource, Environment and Economic Centre for Studies (REECS).

Bolaane, B. and Isaac, E. (2015). Privatization of solid waste collection services: lessons from Gaborone. *Waste Manag.* 40: 14–21.

Borland, J., Hanks, J., Wiechers, H.N.S., and Scott, W. (2020). A framework for sustainable post-consumer waste recycling in South Africa. In Proceedings of the Biennial Congress of the Institute of Waste Management of Southern Africa, Waste Con, Cape Town, South Africa, 5–7 September 2020; pp. 65–72.

Brunner, P. H. and Rechberger, H. (2014). Waste to energy—key element for sustainable waste management. Waste Management, *Waste Management,* 37: 3-12. https://doi.org/10.1016/j.wasman.2014.02.003

Cambridge Dictionary. (2020). Age definition. (Retrieved: 04 November 2022.)

Census. (2011). Statistics *South Africa Polokwane City.* Available from: https://census2011.adrianfrith.com/place/974044032 [Accessed on11 July 2021]

Center for Sustainable Systems. (2013). Municipal solid waste factsheet. University of Michigan. 2013. "Municipal Solid Waste Factsheet." Pub. No. CSS04-15

Chandler, A. J., Eighmy, T. T., Hjelmar, O., Kosson, D. S., Sawell, S. E., Vehlow, J. and Sloot, H. A. (1997). Municipal Solid Waste Incinerator Residues. Amsterdam: Elsevier.

Chen H. W., Yu R. F., Liaw S. L. and Huang W. C. (2010). Information policy and management framework for environmental protection organization with ecosystem conception. Int J Environ Sci Technol 7(2):313–326.

Chimuka, L., Ogola, J.S. and Tshivhase, S. (2011) Management of Municipal Solid Wastes: A Case Study in Limpopo Province, South Africa, Integrated Waste Management. Vol. I.

City of Johannesburg Integrated Waste Management Plan (COJ IWMP). (2011) Guideline for waste management Strategy.

Claridge,T. (2004). Designing social capital sensitive participation methodologies. *Report, Social Capital Research, Brisbane, Australia.*

Climate Action. (2016) Accessible from: https://www.climateaction2016.org/environmental-campaigns/

Collins Dictionary (2022). *Household ownership, Collins English Dictionary. Copyright © HarperCollins Publishers*

Constitution of the Republic of South Africa (Act 108 of 1996), (1996). Pretoria. Republic of South Africa

Coraile, H. (*2019).* Household Waste Sorting and Engagement in Everyday Life Occupations After Migration—A Scoping Review*. Sustainability. 2019, 11(17):4701. https://doi.org/10.3390/su11174701*

Council for Scientific and Industrial Research (CSIR). (2011). Municipal waste management - good practices. Edition 1. CSIR, Pretoria.

Council for Scientific and Industrial Research (CSIR). (2016). Municipal Waste Management – Good Practices. Edition 1. CSIR, Pretoria.

Council for Scientific and Industrial Research (CSIR). (2018). Waste Management Outlook. Copyright United Nations Environment Programme.

Czajkowskia M., Kadziela., T and Hanley, N. (2014). We want to sort! Assessing households' preferences for sorting waste. *Resource and Energy Economics* 36: 290–306.

Denison, R. A. (1996). "Environmental life-cycle comparisons of recycling, landfilling and incineration: A review of recent studies Documents to aid measurement of recycling'.' *Annu. Rev. of Energy and the Envir.*, 21: 191–237.

Department of Environmental Affairs (DEA). (2009). National Waste Management" macroeconomic trends, targets, and economic instruments".

Department of Environmental Affairs (DEA). (2011). National waste management strategy. DEA. Pretoria: RSA.

Department of Environmental Affairs (DEA). (2011). *South Africa state of waste report, first draft. DEA*. Pretoria: RSA.

Department of Environmental Affairs (DEA). (2012). National Waste Management Strategy.

Department of Environmental Affairs (DEA). (2013). *National norms and standards for disposal of waste to landfill.* Retrieved from https://www.gov.za/documents/national-

environmental-management-waste-act-national-norms-and-standards-disposal-waste.

Department of Environmental Affairs (DEA). (2016a). *Policy brief 8: Transitioning South Africa to a green economy: opportunities for green jobs in the waste sector.* Retrieved 25 July 2022 from: https://www.sagreenfund.org.za/wordpress/wpcontent/uploads/2016/11/Policy-Brief-No-8.pdf

Department of Environmental Affairs (DEA). *(2018)* Status report on separation of waste at source National domestic waste collection standards. Available from: https://www.csir.co.za/getting-south-africans-separate-waste-source

Department of Environmental Affairs (DEA). (2018). *South Africa state of waste. A report on the state of the environment. First draft report.* Pretoria: RSA.

Department of Environmental Affairs (DEA). (2019). *National waste management strategy.* Retrieved on 20 July 2022

Department of Environmental Affairs and Tourism (DEAT). (2000). White paper on integrated pollution and waste management for South Africa. Available from www.environment.gov.za/sites/default/files/legislations/integrated_polluationand_wastemanagement_0.pdf

Department of Environmental Affairs and Tourism (DEAT). (2014). National Waste Management Strategy Implementation in South Africa Recycling, Extended Producer Responsibility, South Africa.

Department of Forestry, Fisheries and Environmental Affairs (DFFE).(2014) Operation Phakisa: Chemicals and Waste Economy. Lab outcomes; Department of Environmental Affairs, Planning, Monitoring and Evaluation: Pretoria, South Africa.

Department of Science and Technology (DST). (2014). A National Waste R&D and Innovation Roadmap for South Africa: Phase 2 Waste RDI Roadmap. Trends in waste management and priority waste streams for the Waste RDI Roadmap. Department of Science and Technology.

Department of Science and Technology (DST). (2016). A waste RDI roadmap for South Africa. Available from: https://www.wasteroadmap.co.za/download/presentation_06.pdf

Department of Water Affairs and Forestry (DWAF). (2017). National Water Guide. Accessible from: http: ward 2forum.org.za.

Dlamini, S., Simatele, M and Kubanza, M. (2019). Municipal solid waste management in South Africa: From waste-to-energy recovery through waste-to-energy technologies in Johannesburg. Local Environment, 24(3): 249–257. doi:10.1080/13549839.2018.1561656

Ebikapade, A. (2016). The *concept of waste and waste management*, Journal of management and sustainability Vol.6 No.4 2016nm : Canadian Center of science education.

Elijah, A., (2017). Theories and concepts for human behaviour in environmental preservation, *Journal of environmental science and public health* (1) (2).

Emery, A. D., Griffiths, A. J and Williams, K. P. (2003). An in-depth study of the effects of socio-economic conditions on household waste recycling practices. *Waste Management and Research* 21(3): 180–190.

Enabel, N. (2020). Solid Waste Management in African Cities, Belgium.

Environmental Affairs and Development Planning (EADP) (2019). *A guide to separation of waste at source.* Western Cape, government, South Africa.

Environmental Producer Responsibility (EPR). (2020). Waste Act. Government Gazzete.

Environmental Protection Agency (EPA). (2007). Municipal Solid Waste in the United States: Facts and Figures., US Environmental Protection Agency.

Environmental Protection Agency (EPA). (2020). Best practices for solid waste management, A guide for decision maker in developing countries.

Environmental Protection Agency (EPA). (2021). Greenhouses gas emissions.

ESRI 2021. ArcGIS Desktop: Release 11. South Africa, University of Limpopo: Department of Geography. Accessed: 12 October 2021.

Exposito, A. and Velasco, F. (2018). Municipal solid-waste recycling market and the European 2020 Horizon Strategy: A regional efficiency analysis in Spain. *Journal of Cleaner Production* 172: 938-948.

Fadhullah,W.., Nor Ifah Najwa., I , Sharifah N.S.I ,.Mohd Hafidz., J and Hasmah A.(2022). Household solid waste management practices and perceptions among residents in the East Coast of Malaysia,MMC Public Health: Springer.

Fadhullah,W.., Nor Ifah Najwa., I , Sharifah N.S.I ,.Mohd Hafidz., J and Hasmah A.(2022). Household solid waste management practices and perceptions among residents in the East Coast of Malaysia,MMC Public Health: Springer.

Fakoya, M. (2018). Institutional challenges to municipal waste management service delivery in South Africa. *Journal of Human Ecology,* 45(2): 119–125. doi:10.1080/09709274.2014.11906685.

Fakoya, M.B (2014). Institutional Challenges to Municipal Waste Management Service Delivery in South Africa. Journal on Human Ecology, 45(2) 119-125 (2014)

Fei, F., Qu, L., Wen, Z., Xue, Y and Zhang, H. (2016). How to Integrate the Informal Recycling System into Municipal Solid Waste Management in Developing Countries: Based on China's case in Suzhou urban area. *Journal of Resource, Conservation and Recycling.* 110:74-86, ISSN 0921-3449.

Gallardo, A., Prades, M., Bovea, M. D and Colomer, F. J. (2011). Management of organic waste, Separate Collection Systems for Urban Waste (UW): InTech.

Gans, P., Hemmer, I., Hemmer, M and Miener., K. (2018). The perception of geography among the German population. Findings of a representative survey. *Erdkunde* 10: 72-73

Gerke, G. and Pretz, T. (2004). Experiences with waste management by means of collecting recyclable materials separately. In: Waste 2004 Conference. Stratfordupon-Avon, Warwickshire, UK.

Ginindza, B. and Muzenda, E. (2016). Waste management challenges to opportunities in the west rand district municipality, Gauteng, South Africa: initiatives. Johannesburg: RSA.

Glushkov,D., Paushkina, K., Shabardin, D., Strizhak P. and Gutareva., N. (2019). Municipal solid waste recycling by burning it as part of composite fuel with energy generation, *Journal of Environmental Management* 231: 896–904.

Godfrey, L. (2019). Waste plastic, the challenge facing developing countries. *Recycling*, 4(3): 1–6.

Godfrey, L. and Oelofse, S. (2017). Historical Review of Waste Management and Recycling in South Africa. *Resources*, 6(4) :57. doi:10.3390/resources6040057

Godfrey, L., Strydom, W. and Phukubye, R. (2016). Integrating the informal sector into the South African waste and recycling economy in the context of extended producer responsibility. Available from: https://www.wasteroadmap.co.za/download/informal_sector_2016.pdf

Google Earth Version 17(2021) Lebowakgomo data set. *Image Airbus 2021* Accessed 18 August 2021.

Government Gazette. (2011). Act No. 59: National Environmental Management: Waste Act (2008).

Government Gazette. (2014). Act No. 26: National Environmental Management: Waste Act (2014).

Guita, S. (2019). Sorting and miniaturization of household waste. *European Journal of Scientific Research* (3): 283-298 Retrieved from: http://www. europeanjournalofscientificresearch.com

Gutberlet, J. (2018). Waste in the city: Challenges and opportunities for urban agglomerations, urban agglomeration Mustafa Ergen: Intech Open. Available from: https://www.intechopen.com/ books/urban-agglomera

Hammond, A., Adriaanse, A and Rodenburg, E. (1995). Environmental Indicators: A Systematic Approach to Measuring and Reporting on Environmental Policy Performance in the Context of Sustainable Development. World Resources Institute.

Han, Z., Duan, Q., Fei, Y., Zeng, D., Shi, G and Li, H. (2017). Factors that influence public awareness of domestic waste characteristics and management in rural areas. *Integr. Environ. Assess. Manag.* 14: 395–406. [CrossRef] [PubMed]

Hanmann, M.W, Loomis, J.B. and Kanninen, B. (1991). Statistical efficiency of double-bounddichotomous choice contingent valuation. American Journal of Agricultural Economics 1991;73(4):1255–63.

Haviland, W. A. (2003). *Anthropology*. Wadsworth/Thomson Learning. ISBN 978-0-534-61020-3.

Hellwig, C., Häggblom-Kronlöf,G., Bolton, K. and Rousta, K. (2019). Household Waste Sorting and Engagement in Everyday Life Occupations After Migration—A Scoping Review. Sustainability , 11, 4701. https://doi.org/10.3390/su11174701

Hettiarachchi, H., Meegoda, J and Ryu, S. (2018). Organic waste buyback as a viable method to enhance sustainable municipal solid waste management in developing countries. *International Journal of Environmental Research and Public Health*, 15(11): 1–15. doi:10.3390/ijerph15112483 PMID:30405058

Infrastructure News. (2015). *First bottle-2-bottle plant in Africa*. Retrieved 14 July 2022 from: https://infrastructurenews.co.za/2015/05/12/first-bottle-2-bottle-plant-in-africa/

Integrated Development Plan (IDP). (2020/2021). Lepelle-Nkumpi Local Municipality, Integrated development plan.

International Solid Waste Association (ISWA). (2015). Wasted Health: The Tragic Case of Dumpsites. ISWA.

Kehila,Y. (2014) .Country report on solid waste management in Algeria (2014) : GIZ

Lian, H. (2021). Waste sorting and its effects on carbon emission reduction: Evidence from China, *Chinese journal of population, resources, and environment,* 18: Issue 1, 26-34, ISSN 2325-4262

Mannie, N. M. and Bowers, A. (2014). Challenges in Determining the Correct Waste Disposal Solutions for Local Municipalities - A South African Overview. Proceedings of the 20th wastecon conference

McDonald, S. and Oates, C. (2003). Reasons for non-participation in a curbside recycling scheme. *Resources, Conservation and Recycling* 39:369–85.

McGlade, J. (2013). Highest recycling rates in Austria and Germany - but UK and Ireland show fastest increase. London: European Environmental Agency.

McLeod, S.A. (2008). Qualitative vs Quantitative. Retrieved from: https://www.simplypsychology.org/qualitative-quantitative.html [Accessed on 05 July 2021

Mead, M. (2017). What is sustainability. University of Albertina

Meredith, L. (2019). What is Material Recovery Facility. Accessible from: https://www.rubicon.com/blog/materials-recovery-facility/

Merriam-Webster dictionary. (2022). Marital status. https://www.merriam-webster.com/dictionary/marital%20status.(Accessed 26 Nov. 2022).

Minciardi, R., Paolucci, M., Robba, M. and Sacile, R. (2005). Multi-objective optimization of solid waste flows: Environmentally sustainable strategies for municipalities, Waste Management, Volume 28, Issue 11, 2008, Pages 2202-2212, ISSN 0956-053X.

Mpinganjira, M., Mornay, R .and Issock Issock ., P.B.(2020). Understanding household waste separation in South Africa: An empirical study based on an extended theory of interpersonal behaviour. University of Johannesburg,South Africa.

Mubaslat, A. (2021). Introduction to Waste Management .SN - 978-9957-67-886-9

National waste Management Strategy (2011). Reviewed plan, Department of Environmental, Forestry and Fisheries, South Africa.

National waste Management Strategy (2020). Department of Environmental, Forestry and Fisheries, South Africa.

Naziev. (2017). Future of Education, 7 edition, At: Florence (Italy)

Ndlangamandla, M. (2017). PIKITUP: Create the platform for dialogue and engagement to chart a way forward. PIKITUP Special Projects. Retrieved from http://www.pikitup.co.za/wp-content/uploads/2017.

Niekerk, S. and Weghmann, V. (2019). Municipal solid waste management services in Africa. Working Paper, Public Service International, Johannesburg, RSA.

Nnhubu, T., Mbohwa, C., Muzenda, E and Patel B., (2019). Opportunities and limitations for source separation of waste generated in harare.1st Edition, CRS Press.

Nyborg, K. (2000). Household sorting of waste at source.

Oelofse, S. (2018). Opportunities and challenges in waste management. CSIR. Available from: http://sustainabilityweek.co.za/assets/files/Day%203%20-%20CSIR%20-%20Waste.pdf.

Owusu, V., Adjei-Addo, E. and Sundberg, C. (2013) Do Economic Incentives Affect Attitudes to Solid Waste Source Separation? Evidence from Ghana. Resources, Conservation and Recycling, 78, 115-123.

Oxford dictionary. (2020). Income definition. (Retrieved: 04 November 2022)

Pitchayanin Sukholhaman, A. S. (2016). *A system dynamics mo*del to evaluate effects of source separation of municipal solid waste management: A case of Bangkok, Thailand. *Waste Management*, (52) 50-61.

Rafia, A., and Muhammad, M. M. (2011). Using a contingent valuation approach for improved solid waste management facility: Evidence from Kuala Lumpur, Malaysia. *Waste Management*, 31(4): 800–808.

Rodseth K.L., Schoyen, H. and Wangsness, P.B(2020) Decomposing growth in Norwegian seaport container throughput and associated air pollution, Transportation Research Part D: Transport and Environment, Volume 85, 2020, 102391, ISSN 1361-9209.

Rousta , K., Zisen, L. and Hellwig,. C. (2022). Household Waste Sorting Participation in Developing Countries—A Meta-Analysis

Rousta, K. (2018). Household waste sorting at the source. Sweden.

Rousta, K. (2020) Household Waste Sorting Participation in Developing Countries—A Meta-Analysis. Journal: Volume 2. ISBN

Rousta, K. and Bolton, K. (2019) Sorting household waste at the source. In: Taherzadeh, M., Bolton, K., Wong, J and Pandey, A. Sustainable resource recovery and zero waste approaches. St. Louis: Elsevier; 2019. p. 105–14.

Rousta, K. and Ekström, K.M. (2013). Assessing incorrect household waste sorting in a medium-sized Swedish city. *Sustainability* 5: 4349–4361.

Rozsa, *G. (2021). Development of the level of sorting of municipal waste in the selected locality IOP Conf. Ser.: Mater. Sci. Eng.* 1209 012024, Department of Sanitary and Environmental Engineering, Faculty of Civil Engineering, Slovak University of Technology in Bratislava, Vazovova 5, 812 43 Bratislava, Slovakia.

Sentime, K. (2014). The impact of legislative framework governing waste management and collection in South Africa. *African Geographical Review* 33(1): 81–93. doi:10.1080/19376812.2013.847253

Setiawan, R.P. (2020) Factors determining the public receptivity regarding waste sorting: a case study in Surabaya city, Indonesia. *Sustainable Environment Research* 30 :1

Sewerage and Solid Waste Project Unit (SSWPU). (2000). The solid waste management programme. Sewerage and Solid Waste Project Unit: Barbados.

Shay-Wei, C., Slow., H and Lee-Lee., C. (2017). The Perception of households about solid waste management issues in Malysia published by Environ Dev Sustain (Sustain).

Shrivastava, P. and Berger, S. (2005). Sustainability principles: A review and directions: Organisation Management Journal, 7:246-261.

Simelane, O. (2016). Implementing Alternative Waste Treatment Technologies: A Comparative Study of South Africa and the European Union. *South Africa 11*(7), 427-430.

Songsore, J. and McGranahan, G. The political economy of household environmental management: gender, environment and epidemiology in the Greater Accra Metropolitan Area. World Development 1998;26(3):395–412.

South African Weather Information Centre (SAWIC). (2018). Waste information today: reporting on South African SAWIS. Available from: http://sawic.environment.gov.za/documents/8545.pdf

Statistics South Africa (Stats SA). (2018). Only 10% of waste recycled in South Africa. Pretoria: Stats SA.

Sterner, T., Bartelings, H. (1999). Household waste management in a Swedish municipality:determinants of waste disposal, recycling and composting. *Environmental and Resource Economics* 13:473–91.

Stubs, K. (2019). South African industry forced to adapt as waste streams are prohibited from landfill disposal. Available from: https://blog.interwaste.co.za/know-waste/sa-industry-forced-toadapt-as-waste-streams-are-prohibited-from-landfill-di

Study.com (2022). environmental awareness. tudy.com/academy/lesson/environmental-awareness-definition-history importance.html#:~:text=Environmental%20awareness%20means%20being%20aware,recycling%2C%20activism%2C%20and%20others.

Teresa, C. (2021). Encyclopidia. Accessible from: https://www.encyclopedia.com/environment/encyclopedias-almanacs-transcripts-and-maps/source-separation

The National Health Act. (NHA) (2019)., The National Health Act, Third Edition: Section 27. SiberInk.

Thornhill, C. (2012). Improving local government transformation in South Africa. *Administratio Publica* 20(3): 128–143.

Troschinetz, A. M. and Mihelcic J. R. (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste Management* 29: 915–923.

Tsheleza, V., Ndhleve, S., Kabiti, H., Musampa, C and Nakin, M. (2019). Vulnerability of growing cities to solid waste related environmental hazards: The case of Mthatha. Jamba. *Journal of Disaster Risk Studies* 11(1): 1–11. PMID:31205617

United Nations Environment Programme (UNEP). (2010). Global Partnership on Waste Management. Integrated solid waste management. United States:International

Environmental Technology Centre. Available from www.unep.org/gpwm/sponsoredareasofwork/integratedsolidwastemanagement

United Nations Environment Programme (UNEP). (2015). *The Millennium Development Goals Report, 2015*. United Nations: New York.

United Nations Environment Programme (UNEP). (2018). International Source Book on Environmentally Sound Technologies (ESTs) for Municipal Solid Waste Management (MSWM).

Vergara, S. E. and Tchobanoglous, G. (2012). Municipal Solid Waste and the Environment: A Global Perspective. *Environment and Resources*, 37(37): 277-309. https://doi.org/10.1146/annurev-environ-050511-122532

Viljoen, J.M.M., Schenck, C.J., Volschenk, L., Blaauw, P.F. and Grobler, L. (2021). Household Waste Management Practices and Challenges in a Rural Remote Town in the Hantam Municipality in the Northern Cape, South Africa. *Sustainability* 13: 5903. https://doi.org/10.3390/su13115903

Viljoen. (2010). Advanced Organic Waste Management: Sustainable Practices and Approaches: Published by Elsevier: ISBN: 9780323857925

Wahied, K.B., Arashdeep,S.,and Sachdeep ,K.(2022) .5R'S of Zero Waste Management to save our green planet: Volume 10, Issue 1 2022 Page 7-11 Published 19-01-2022.

Wang, Z., Ding, X and Zhou, D., (2018). Research on the sorting and recycling of urban household waste in China—experience reference of urban waste sorting in Japan. J. Northeast. Univ. (Nat. Sci.) 10 (6): 501–504 (In Chinese).

Waite, R. (2017). Household Waste Recycling (3rd ed.). Routledge.

Watie., R. (2000). "Household waste recycling". Published by Earthsac publications.London

Wen X., Luo Q., Hu H., Wang N., Chen Y., Jin J., Hao Y., Xu G., Li., F and Fang ,W. (2014).comparison research on waste classification between China and the EU, Japan, and the USA. *Journal of Material Cycles and Waste Management* 16: 321–334.

Western Cape government, (2019). A guide to separation of waste at source. Published by Green Edge Communication. Available www.westerncape government.co.za

Wikepedia. (2011). Waste Management and waste segregation. Available from: https://en.wikipedia.org/wiki/Waste_management#Waste_segregation

Wikepedia. (2019). Accessible from: https://www.google.com/search?q=perception+definition&biw=1536&bih=656&sxsrf= ALiCzsb4e_kGv0NVqbpzvIn0I_IXjASrIQ%3A1658521924079&ei=RAnbYq69BOuBi- gP5IqfkAs&oq=perceptdefinition

Wikipedia (2021). Recycling Practices. (Accessed from https://en.wikipedia.org/w/index.php?title=Recycling&oldid=102622957)

Wikipedia. (2022). Household. In *Wikipedia, The Free Encyclopedia*. Retrieved 09:29, November 26, 2022, from https://en.wikipedia.org/w/index.php?title=Household&oldid=1122265546

World Bank (2012). What a Waste: A Global Review of Solid Waste Management. Urban development series; knowledge papers no. 15. World Bank, Washington. *https://openknowledge.worldbank.org/handle/10986/17388 License: CC BY 3.0 IGO."*

World Bank. (2018). What a waste 2.0: A global snapshot of solid waste management to 2050. Washington: International Bank for Reconstruction and Development / The World Bank. (:www://openknowledge.worldbank.org/handle/10986/30317; Accessed : on 25 June 2022.)

World Health Organization (WHO) (2022) Accessible from: https://www.who.int/health-topics/gender#tab=tab_1

Zaman, A.U. (2010). Comparative study of municipal solid waste treatment technologies using life cycle assessment method. *Int J Environ Sci Technology* 7(2):225–234.

Zhakata, E., Gundani, S. R., Chauke, V and Odeku, K. O. (2016). A Critic of NEMA: Waste Act 59 of 2008, Many Promises, Little Implementation and Enforcement. In SAAPAM Limpopo chapter 5th annual conference proceedings. Limpopo: RSA.

Zhuang, Y., Wu, S.W., Wang, Y.L., Wu, WX. and Chen, Y.X. (2008). Source separation of household waste: A case study in China. *Waste Management* 28: 2022-30.

Ziakhinis, S. and Djaja, I.M. (2017) The Importance of Waste Management Knowledge to Encourage Household Waste-Sorting Behaviour in Indonesia. *Int J Waste Resource*, 7: 309. doi: 10.4172/2252-5211.1000309

APPENDICES

Appendix A: Letter of proposal approval from FHDC

Appendix B: FHDC Approved proposal

Appendix C: Household Questionnaire

Appendix D: Ethical clearance certificate

Appendix E: Letter of request to collect data from University of Limpopo by Supervisors

Appendix F: Permission letter from councillors to collect data at Lebowakgomo Zone A and F

Appendix A: Letter of proposal approval from FHDC

19/04/2022

NAME OF STUDENT: Molaba JR

DEPARTMENT: Geography
SCHOOL: Agricultural and Environmental Sciences
QUALIFICATION: MSCA01

Dear Ms Molaba

FACULTY APPROVAL OF PROPOSAL (PROPOSAL NO. 66 OF 2022)

I have pleasure in informing you that your **masters** proposal served at the Faculty Higher Degrees Committee meeting on **14 April 2022** and your title was approved as follows:

"Evaluating the awareness and perception of sorting municipal solid waste: a case study of Lebowakgomo zone A and F, Lepelle-nkumpi Local Municipality, Limpopo Province."

Note the following: The study

Ethical Clearance	Tick One
Requires no ethical clearance Proceed with the study	
Requires ethical clearance (Human) (TREC) (apply online) Proceed with the study only after receipt of ethical clearance certificate	√
Requires ethical clearance (Animal) (AREC) Proceed with the study only after receipt of ethical clearance certificate	

Yours faithfully

Prof P Masoko
Research professor: Faculty of Science and Agriculture

CC: **Dr JM Letsoalo**
      Dr MR Ramudzuli
      Prof TP Mafeo

Appendix B: FHDC Approved proposal

Faculty of Science and Agriculture

School Higher Degrees Committee (SHDC)

Assessment of Research Proposal

Name and Surname: JULIA RAPHAHLE MOLABA

Title: EVALUATING THE AWARENESS AND PERCEPTION OF SORTING MUNICIPAL SOLID WASTE: A CASE STUDY OF LEBOWAKGOMO ZONE A AND F, LEPELLE-NKUMPI LOCAL MUNICIPALITY, LIMPOPO PROVINCE

Discipline and Qualification:

Supervisor(s): DR J.M LETSOALO and PROF M.H.N MOLLEL

Assessor(s):

	Criteria	**Comments**
Supporting documents	The following accompanying documents must be attached and duly completed and signed: • Proof of registration • SRC Proposal approval letter • Proposal submission memo from the SRC Chairperson • H-Checklist form • Turnitin report	• All documents are attached.
Title	The title must be relevant to the discipline and appropriate to the proposed study. The title must be aligned with the objectives of the study.	• Title is relevant to the discipline
1. Problem statement	• A problem statement must clearly describe the research problem and identifies potential causes or solutions, and supported by recent literature • A problem statement must convey the reason the problem to be investigated is important.	• Problem statement clearly described

2. Rationale or Motivation	The following must be clearly articulated and well supported with relevant and recent literature • The reasoning or principle that underlies the proposed study. • Substantiation why this particular question/problem needs to be addressed and what will be learnt from it NB: • This section must include a concise literature review • Dominance of self-citations is strongly discouraged.	• Rationale clearly articulated
2.1 Aim **2.2 Objectives** **2.3 Research questions/hypotheses**	The aim, objectives and research questions/hypotheses must align to the purpose and title of the study.	• The aim, objectives and research questions/hypotheses are aligned.
3. Methodology and analytical procedures	This section must clearly indicate a specific way of performing an operation that implies precise deliverables at the end of each stage. Processes assisting to determine the specific outcomes, values and interpretations of experimental research results, i.e., • The stated methods must be relevant, brief but sufficiently descriptive for the stated objectives. • It must be made clear how data analysis will be conducted.	• Methodology is adequately described
4. Scientific contribution	• State that which adds to the knowledge of science and innovation or the number of attributes that can be achieved by the results of the study. • Alignment of the benefits of the proposed study to the mission and vision of the University must be clearly stated.	• Scientific contribution is explained
5. Availability of resources	Appropriate resources must be available and easily accessible to support this study through to completion.	• Resources indicated to be available to carry the study

6. Ethical consideration	• For research involving human or animal subjects which require ethical clearance, specify the principle of clearance needed; • For biological material falling under biosafety level 2 and above - specify the *Facility that will be used, handling, storage and disposal of such material). NB: * Provide a letter of access to the facility if it is not housed within own Department.	• Ethics to be considered. Attach questionnaire in the appendix • The University of Limpopo Turfloop Research Ethics Committee (TREC) will provide ethical clearance because the study involves human participation.
7. Reference list	All cited publications must be included. Harvard and Vancouver style of referencing or its common variations must be followed with consistency.	• Check references in-text • Reference edited (page 3, 4 and 14)
Recommendation / Decision	Approved with minor corrections	

Scale: 1 = Disagree, **2** = Fair and **3** = Agree

Item	Marks (%)	Allocated mark (%)
Supporting documents	5	
Title	5	
1. Problem statement	20	
2. Rationale or Motivation	20	
2.1 Aim 2.2 Objectives 2.3 Research questions/hypotheses	10	
3. Methodology and analytical procedures	20	
4. Scientific contribution	5	
5. Availability of resources	5	
6. Ethical consideration	5	
7. Reference list	5	
TOTAL	**100**	**88**

≤59 = Rework, **60-89** = Conditionally approved with major corrections, **90-100** = Approved with minor/no corrections

Appendix C: Household Questionnaire

HOUSEHOLD QUESTIONNARE

EVALUATING THE AWARENESS AND PERCEPTION OF SORTING MUNICIPAL SOLID WASTE: A CASE STUDY OF LEBOWAKGOMO ZONE A AND F, LEPELLE-NKUMPI LOCAL MUNICIPALITY, LIMPOPO PROVINCE

I am Julia Raphahle Molaba, I am registered with University of Limpopo studying towards Master of Science in Geography. The questionnaires will be used as a tool to collect data from householders for research purpose and the topic of the study is mentioned above.

Your household has been randomly selected and we would like to discuss these issues with you, or an adult member of your household. The information collected will be treated with confidentiality and there won't be any harm that will occur. The information will be used to enhance the scientific field of science and improve the waste management sector. The information will be protected as per POPI Act from when is collected until when will be destroyed.

There are no right or wrong answers. Your answers will be confidential. I will not be recording your name, and it will be impossible to pick you out from what you say, so please feel free to tell me what you think.

A. SOCIO-ECONOMIC CHARACTERISTICS

1.Lebowakgomo Zone

☐ Zone A

☐ Zone F

2.Age

☐ 18-28

☐ 29-38

☐ 39-48

☐ 49 and above

3.Gender

☐ Male

☐ Female

4.Marital Status

☐ Single

☐ Married

☐ Divorced

☐ Widowed

☐ Other

5.Education

☐ No Education

☐ Primary Education

☐ Secondary Education

☐ Tertiary Education

6.Occupation

☐ Government Official

☐ Construction

☐ Wholesale and Trade

☐ Community Social services

☐ Agriculture

☐ Mining

☐ Other _____

7.Estimate how much income per month?

☐ R0-R5000,00

☐ R5001-R10 000,00

☐ R1001-R15000,00

☐ R1501-ABOVE

8.How many people reside in a household?

☐ 1-3

☐ 4-6

☐ 7-9

☐ 10 and above

9.Do you own the household or rented?

☐ Owned

☐ Rented

☐ Other

10.How are you related to the Household owner?

☐ Household Owner

☐ Landlord

☐ Tenant

☐ Relative

☐ Other_____

B. WILLINGNESS OF HOUSEHOLDERS TO PARTICIPATE IN SORTING MUNICIPAL SOLID WASTE

11.Are you aware of sorting waste at source?

☐ Yes

☐ No

12.Are you willing to sort solid waste at household/home which is your source?

☐ Yes

☐ No

13.What is the reason you are willing or not willing to sort waste at source

_____

14.Which benefits of source sorting are you aware of?

_____

15. Do you take source sorting as your responsibility?

_____

16.Do you see yourself sorting waste going forward?

_____

17.Do you know the value of solid waste source sorting?

_____

18.Are you willing to participate in community environmental campaigns?

☐ Yes

☐ No

19. Which type of environmental campaigns would you like to participate in?

_____

20.Which waste do you sort mostly?

☐ Paper

☐ Glass

☐ Plastic

☐ Aluminium

☐ None

21.How many waste bins do you have in your household?

☐   1

☐   2

☐   3

☐   4 and above

22. Will you be willing to add resources such as waste bin and refuse bag or it should be bought by municipality?

☐   Willing to buy

☐   Provision by Municipality

23.Do you buy your own refusal bags or provision made by Municipality?

☐   Buy

☐   Municipality

24.Do you recycle your waste?

☐   Yes

☐   No

25.Have you sorted and recycled waste before?

_____

26.How often does your waste get collected in a week?

☐   Once a week

☐   Twice times a week

☐   Three times a week

27.Which type of solid waste do you generate mostly?

☐   Paper

☐   Plastic

- [ ] Aluminium
- [ ] Glass
- [ ] Garden waste
- [ ] Organic waste
- [ ] Other_____

28. What will encourage you to sort solid waste?
- [ ] Saving Recyclable material
- [ ] Better waste management services
- [ ] Income from recyclable materials
- [ ] Environmental awareness

C. CHALLENGES FACED DURING RECYCLING OF UNSEPARATED SOLID WASTE

29.What are the challenges that hinders separation at source?
- [ ] Lack of Infrastructure
- [ ] Non-collection services
- [ ] Lack of environmental awareness
- [ ] Lack of storage in households

30.How can these challenges be resolved?

_____

31.What are the benefits of sorting Municipal Solid Waste?
- [ ] Clean environment
- [ ] Income Generation
- [ ] Community Participation
- [ ] Other_____

32.Will the benefit of sorting at source motivates you?

_____

33.Where have you heard of sorting of municipal waste?

	Environmental Campaign
	School
	Work
	None
	Other_____

34.Have you encouraged other people about source sorting?

_____

35. If you are equipped with resources for waste separation, will you separate waste?

	Yes
	No

36. Which resources will you require?

_____

37.What will you say about your main challenge when coming to sorting waste?

_____

38. How does unseparated waste affect you?

_____

39.Which impacts have you experienced from unseparated waste?

_____

RESEARCH CONSENT FORM

Dear participant: _____

I JR Molaba, I understand that as part of my research am asked to collect data through a questionnaire form. I am studying Master of Science in Geography at University of Limpopo. I am conducting a research study of evaluating the awareness and perception of sorting municipal solid waste: a case study of Lebowakgomo zone A and F, Lepelle-Nkumpi Local Municipality, Limpopo province. I will ask you questions related to sorting municipal waste and your answers will be kept confidential. In the records, your record will no be associated with you or any identification that will make you known. The information will be coded, and the records will not be associated. This session will take approximately 15 to 20 minutes.

Your participation is voluntary, and you may withdraw from the session at any time or decline to answer any questions that make you uncomfortable. You will not be asked to do anything that exposes you to risks beyond those of everyday life. The benefit of the study, scientifically, is to help understand more about how people think about sorting waste and if they are willing to participate in sorting waste.

If you have further questions about the study, please contact JR Molaba at 082 3595 093, Email: molabajulia@gmail.com. If you have questions about your rights as a research participant, please call the University of Limpopo TREC office at 016 268 3935. Thank you for your participation. We are grateful for your help and hope that this will be an interesting session for you. You may keep this portion of the page.

…………………………………………………………………………………………

I agree to participate in the study of evaluating the awareness and perception of sorting municipal solid waste. I understand my participation is voluntary and that my name will not be associated with my responses. By signing below, I acknowledge that I am 18 years or older.

Participant's Signature…………………….   Date……………………………….

Appendix D: Ethical clearance certificate

University of Limpopo

Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 3935, Fax: (015) 268 2306, Email: anastasia.ngobe@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: 22 August 2022

PROJECT NUMBER: TREC/379/2022: PG

PROJECT:

Title:	Evaluating the Awareness and Perception of sorting Municipal Solid Waste: A Case Study of Lebowakgomo Zone A and F, Lepelle-Nkumpi Local Municipality, Limpopo Province.
Researcher:	JR Molaba
Supervisor:	Dr JM Letsoalo
Co-Supervisor/s:	Prof MHN Mollel
School:	Agricultural and Environmental Sciences
Degree:	Master of Science in Geography

PROF D MAPOSA
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: REC-0310111-031

Note:

i) This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.

ii) Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.

iii) PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.

Finding solutions for Africa

Appendix E: Letter of request to collect data from University of Limpopo by Supervisors

INTERNAL MEMO

To	:	**Secretariat (SRC: SAES)**
From	:	**Dr J.M Letsoalo (Supervisor: Department of Geography and Environmental Studies)**
Date	:	**21/01/2022**
Subject	:	**Substantiation of Molaba JR MSc project proposal**

The above matter bears reference.

1.Herewith receive Ms Molaba's research proposal for discussion and approval. The research project will be on "EVALUATING THE AWARENESS AND PERCEPTION OF SORTING MUNICIPAL SOLID WASTE: A CASE STUDY OF LEBOWAKGOMO ZONE A AND F, LEPELLE-NKUMPI LOCAL MUNICIPALITY, LIMPOPO PROVINCE."

Waste management includes the recycling process which is one of the processes of sustainable management of waste. The municipal solid waste that is generated in households can be separated at households in categories of glass, paper, aluminium, and plastic. The separated waste has high value of being recycled and contributes to social, environmental, and economic sustainability of communities (Basic Facts, 2006). Sorting at source is the process where the user is involved in the waste management system that contributes to the waste separation system. Therefore, it is important to understand the importance of this process both from householders and municipal standpoint when coming to the services that need to be provided (Rousta et al., 2013). In South Africa, for the sorting programme to be successful, participation and involvement of householders are a key factor (DEA, 2018). Community participation is regarded as one of the pillars of success towards a positive outcome of separation at source. The collection and sorting of recyclable waste materials in South Africa are supported by a recycling infrastructure where waste is turned into recyclable materials. The recyclable waste collection system is joined to existing waste

collection services and disposal sites which are converted into waste management sites. The material recovery facilities and buy-back centres are established in different municipalities, and space is provided to sort waste into re-useable and recyclable waste (Wikipedia, 2021). There are challenges such as lack of environmental awareness when coming to waste management. The problem of not separating waste leads to high amounts of waste which will end up in landfill areas. The separation of solid waste at source helps in ensuring that the materials that will be recycled will be of good quality and more materials can be released from separated solid waste (Zaman et al., 2010). Sorting of solid waste is still a problem in many local municipalities of South Africa. The challenges encountered are lack of infrastructure, lack of environmental campaigns, lack of municipal budget to accommodate waste management and the increasing population that generate high quantities of waste (Troschinetz et al., 2009). Lepelle- Nkumpi Local Municipality is no exception to these challenges when coming to sorting of Municipal Solid Waste. This study would therefore like to find out if people in Lebowakgomo Zone A and F are aware and willing to sort MSW before recycling.

2.The results will entail the following: the willingness of householders in sorting Municipal Solid Waste at households' level before collection services in Lebowakgomo Zone A and F; the socio-economic and environmental impacts of sorting solid waste at source in Lebowakgomo Zone A and F; the challenges faced during recycling of unseparated solid waste in Lebowakgomo Zone A and F and finally, the strategies of Lepelle-Nkumpi Local Municipality on encouraging source separation at Lebowakgomo Zone A and F.

Regards

Dr J.M Letsoalo

	Signature	Date
Supervisor		21 January 2021
Head of Department		
Director of School		

Appendix F: Permission letter from councillors to collect data at Lebowakgomo Zone A and F
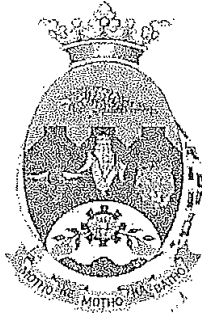
LEPELLE-NKUMPI
LOCAL MUNICIPALITY

Ms. Molaba JM

University of Limpopo

Private Bag X1106

Sovenga

0727

Dear Madam,

SUBJECT: PERMISSION TO CONDUCT A RESEARCH STUDY: EVALUATING THE AWARENESS AND PERCEPTION OF SORTING MUNICIPAL SOLID WASTE

Municipality hereby grants you permission to conduct research at Lebowakgomo Zone A and F for your Degree of Science in Geography with University of Limpopo as requested. We hope that the research will be conducted with strict adherence to all the human rights and research ethics and that once published, it will also benefit our local community.

Wishing you all the luck in your academic endeavours.

Kind regards,

M A MONYEPAO
MUNICIPAL MANAGER

11/09/2022
DATE