School of Environmental Sciences

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Analysis of Peri-Urban Household Solid Waste Management System: A Case of Lwamondo Village

By

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DECLARATION

I, **Nelwamondo Fhumulani**, hereby declare that this research dissertation for Master of Environmental Sciences and herewith topic, *"Analysis of Peri-Urban Household Solid Waste Management System: A Case of Lwamondo Village"* at the Department of Geography and Geo-Information Sciences, within the School of Environmental Sciences, University of Venda has not been previously submitted in this or any other university, and that is my work in design and execution and that all reference material contained therein have been duly acknowledged.

Signature: ..... Date: 22/02/2021

DEDICATION

This work is dedicated to my loving Mother, Ms Mashudu Munyai for her earnest, timely and tireless encouragement.

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I would like to express many special thanks and deepest gratitude to the community of Lwamondo for their cooperation and interest shown and being part of this study.

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ABSTRACT

Peri-urban solid waste management has become a challenge caused by population growth, urbanization which increases the volume of waste generated into bulk quantities and change in the waste composition of solid waste generated, and neglect from a local municipality. It condones illegal disposal of household solid waste and improper use of waste management hierarchy which negatively affects the environment. The overall study examined the current peri-urban solid waste management system at Lwamondo village, with the specific objectives of the study include analysing the waste composition of solid waste generated; examine current solid waste management practices and analyse factors influencing current solid waste management, to achieve the objective of the study. Various quantitative and qualitative techniques were employed. Simple Random Sampling (SRS) technique was used as a sampling method, and 10% of the households in each sub-village were sampled for questionnaire distribution. The study also incorporated convenience sampling as a method for sampling households within 500m proximity to the illegal open dumping spots to conduct interviews. Using the designed checklist, field observation was undertaken for both households and illegal open dumping spots to identify waste composition. The study adopted a mixed-method integrating both qualitative and quantitative techniques. Using the field observation and checklist designed, findings confirmed that most of the waste generated are plastics and tin waste, rubble from demolition and construction activities, dead domestic pets, and metals waste. Due to lack of proper waste management plan, the community practice dockyard disposal, dumping, and burning waste which later have an empirical negative effect on the environment and their health. The study found that villages around the area lack waste management by-laws enforcement, lack of access roads, rapid population growth and urbanisation are the main identified factors influencing solid waste management. Based on the findings, the study recommends a nearby transfer facility and communal skin bins to cover residents, solid waste education and awareness to the community, recycling and reuse initiatives, establishment of formal buy-back centre, and waste composting.

Keywords: Peri-urban, Solid waste, System, Household, Sub-village

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LIST OF ACRONYMS

SRS : Simple Random Sampling

NEM: WA : National Environmental Management: Waste Act

WMS : Waste Management Strategy

IDP : Integrated Development Plan

CBDs : Central Business Districts

RSA : Republic of South Africa

SWM : Solid Waste Management

GDP : Gross Domestic Product

CH4 : Methane

CO2 : Carbon Dioxide

DIY : Do It Yourself

DEA : Department of Environmental Affairs

MSW : Municipal Solid Waste

SWG : Solid Waste Generation

MSWM : Municipal Solid Waste Management

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CHAPTER ONE: INTRODUCTION

1.1 Background to the problem

Globally, solid waste management is a complex task that involves numerous waste fractions because of rapid population growth, and unplanned urbanisation along with improper waste management practices, poor legislation implementation, and lack of capital investment (Aich & Ghosh, 2019). As reported by Singh *et al*, (2014), solid waste management has become a global challenge as waste and resource management lacks a holistic approach. According to Letlape & Gumbo (2016), provinces across South Africa are facing solid waste disposal and management crisis, consequently due to a lack of landfill capacity. Besides, population growth, and growing townships/ rural areas are the result which leads to the inability to establish new landfills (Rasmeni & Madriya, 2019). Due to the growing population and increased resource utilisation, landfill sites fill up quickly and the land becomes scares influencing more illegal dumping Ligneris (2013).

In developed and developing countries, municipalities responsible for effective waste management are facing challenges to provide an efficient and effective system to properly manage solid waste (Guerrero *et al*, 2013). This is due to an alarming generation of waste which creates more burden for the municipal budget because of high costs which are associated with solid waste management.

Solid waste management issues have been recognised not just as a local environmental problem but global (Singh *et al*, 2014). Waste is an unwelcomed concentration of substances that are beyond the environment's capacity and these substances are detrimental to people, other living organisms, and other aspects of the natural environment (Ganda *et al*., 2015). Rural solid waste management has become one of the major environmental management issues globally. The problem is not restricted to a single place rather it covers all parts of the environment which leads to toxic pollutants (Shah *et al*., 2012).

The challenge of illegal dumping is affecting rural areas because they do not have a formal waste pickup system and local governments, however, appear apathetic about addressing rural waste management in their communities. Rural roadside littering seemingly is worsening and this is an indication of inappropriate waste management systems in rural areas (Tunnell, 2008). Dumped waste in the roadblock's creeks, culverts, and other drainage ways. Floodplain often results in runoff with all illegally dumped toxins such as motor oil, herbicides, paints, and household cleaners that contaminate streams, lakes, wells, groundwater, and drinking supplies (Tunnell, 2008).

Rural areas in South Africa are facing challenges when it comes to the implementation of the Waste Management Act. According to the National Environmental Management: Waste Act No. 59 of 2008 (NEM: WA), sustainable development requires that the generation of waste is avoided or where it cannot be avoided, that is reduced, re-used, recycled, or recovered and only as a last resort treated, safely disposed and waste minimization is the key to ensuring that the environment is protected from the impact of waste.

Among other challenges identified there is an increase in volumes of waste generated without recycling initiatives, lack of accessible market for a peri-urban community to sell their waste, poor municipality service delivery leading to waste not collected in these areas, lack of commercially viable and environmentally sustainable recycling projects to address environmental problems and pollution (Peace Foundation, 2015). An effective solid waste management system can contribute in improving public health outcomes through reducing opportunities for spreading diseases and such occurs at unregulated local /illegal dumpsites. The municipalities also face challenges such as lack of community engagement when promoting awareness such as littering and illegal dumping of waste (WMS, 2015).

1.2 Problem statement

Over the years, a rapid increasing population and urbanisation has become a challenge resulting in high consumption of resources and consequently increases the volume of

solid waste generated into bulk quantities and neglected from the local municipality. The increasing volume of solid waste generation in peri-urban areas is not given attention and no remediation thereof is initiated to control solid waste management practices. Most plans by local authority bypass peri-urban interface with a tendency to encourage private sector involvement to serve better-income customers. Thulamela Local Municipality is struggling with the creation of safe and sustainable management of waste because majority of the villages within the municipality are rural or peri-urban. The socio-economic composition between peri-urban systems and urban is not highly heterogeneous because it is subject to change over time and these pose challenges to the efficiency of the municipal waste management system.

Lwamondo village is a peri-urban area under Thulamela municipality and the area has a remarkable expansion, growth, and many anthropogenic activities. This has therefore increased solid waste generated over Lwamondo and the surrounding areas. Areas surrounding urban centres generally benefit from their proximity to urban centres. It is significant to analyse the components that could inform a strategic approach to efficient waste management of the peri-urban interface areas. Thus, the emphasis of the study is to examine the current system of solid waste management over Lwamondo village.

The problem that was identified at Lwamondo village is improper solid waste management methods which might lead to a reduction of environmental quality and causes an environmental impact. Residents and community who reside and passes nearby identified open dumping spots complain about foul odour which is caused by illegally disposed waste and lack of effective enforcement of waste municipal by-laws in the area. Thus, it has influenced the community to depend on other solid waste management practices as an alternative way for managing solid waste generated. Urbanization within the study area has a major impact on increasing volume and change the composition of waste generated. Therefore, it is important to examine solid waste generated over the peri-urban area and their management practices.

1.3 Research questions

- Which solid waste type is generated in the peri-urban area?
- What are the current solid waste management practices in the area?
- Which factors influence solid waste management practices in the area?
- Can recycling be an alternative to solid waste management in the study area?

1.4 Research aim

The main aim of the study is to examine the current rural solid waste management system at Lwamondo village.

1.5 Research objectives:

The specific objective of the study are to;

- Examine solid waste generated in the peri-urban area
- Examine the current solid waste management practices in the area.
- Analyse factors influencing solid waste management practices in the area.
- Determine the potential of recycling as an alternative for solid waste management

1.6 Significance of the study

Solid waste management and service delivery are poorly administrated in most rural areas in South Africa including Lwamondo village. This study is expected to stimulate effective management and operational initiatives of the waste management arrangement in Lwamondo village. Considering how rural waste management practices shape the daily operations of the municipal waste management system and its implications, it remains a territory with little information (Uyarra & Gee 2013). Moreover, this research will establish specifications of what the system could be able to achieve under changing rural waste generation capacity scenarios through time. This, in turn, could further contribute towards a better understanding of the dynamics of the rural

waste management system. In general, effective rural waste management has a significant impact on public health, the environment and economic development (Uyarra & Gee 2013). The importance of undertaking this study was to examine and establish an effective and well-designed rural waste management system that can contribute to improving solid waste management in the study area. The study will help to enhance environmental quality and health by preventing and reducing unauthorized disposal of waste within the area and determine a better system that will provide refuse removal that will be efficient within the study area.

1.7 Description of the study area

1.7.1 Location

Lwamondo village is a peri-urban area found in the Vhembe District within Limpopo Province in South Africa and its coordinates are 23º 00'40" S 30º 21'25" E / 23.011º S 30.357º E along the R524 Road between Tshakhuma and Thohoyandou and it covers the total area 20.72 km². The nearest town is Thohoyandou in the Vhembe District and the study area falls under Thulamela Local Municipality and Dzindi River is one of the most known rivers that run through Lwamondo village (Kabanda & Nenwiini, 2013).

1.7.2 Climate

The area has a subtropical climate and normally receives about 752mm of rain per year, with the most rain occurring mainly in mid-summer, temperatures range from 22.9º c in June to 35.3º c in January and the region is coldest in July (Kabanda, 2004). The climate is ideal for crop farming, although as with other regions of the globe farmers in this area are faced with the challenge of changing environmental and climatic conditions (Khaphathe & Rabumbulu, 2018).

1.7.3 Vegetation

The vegetation communities in the Soutpansberg Mountains occur as east-west bands, following the orientation of the ridges of the mountain range. Higher rainfall on the

southern slopes supports dense deciduous woodlands at lower altitudes consisting of small tree species and evergreen montane forests (Kabanda, 2004).

1.7.4 Pedology

The diverse and complex geology of the study area generally consists of intrusive igneous, sedimentary, and metamorphic rocks of the Soutpansberg and the Waterberg complexes. The study area is composed of two types of soil which are sand and loamy soil. In some areas, the soil types are mixed, giving rise to sand-loamy soil. The most abundant soil within the district is a fertile red loam with a high capacity to retain water, making it an ideal soil for crop farming (Khaphathe &Rabumbulu, 2018).

1.8 Background information on the study area

Table 1. 1 Peri-urban characteristics

pre-determined characteristics of settlement natural setting		
Rural	**peri-urban/ semi-urban/urban sprawl/encroachment/**	**Urban**
Gravel road, traditional chief leadership, communal street taps, pit toilet, keep livestock, RDP houses, open water collection river, communal borehole, water tank delivery schedule. (Basic services)	The new development site, working-class, tap within the yard, sewer line or septic tank, pit toilet, municipal tap water or borehole within the yard, tarred main road and ring/access road, refuse removal pick up point. (intermediate services)	Tarred road, municipal refuse removal scheduled at household, household taps (full basic services) Street lights

A preliminary survey was conducted at Lwamondo. A transect walk in the village was conducted and the focus was to understand and observe physical and non-physical characteristics of the study area and general waste management system. During the survey, it was observed that households have water taps and others have both water taps and boreholes. There is a tarred ring road. Tshishushuru, Zwavhavhili and Tshifulanani 1 have removal pick up points. The majority of households uses pit toilets

and others use both pit and septic toilet. The literature review was done and according to Census 2011, Lwamondo village has 27 sub-villages with a total of 5 061 households and a population of 20 218. According to Thulamela Municipality Integrated Development Plan (2018/19 IDP), they collect 5761 cubic meters (m3) from 50 000 Households respectively (i.e. 1m3 = 2406.53 kg). Waste collection in rural areas is not done systematically therefore villages in rural areas constitute a backlog. There are transfer stations that are established in some rural areas within Thulamela municipality namely Tshikombani, Tshaulu, and Makonde. The collection is done once a week in the proclaimed areas and every day in the CBDs. The above statement confirms that Lwamondo village is not constituted in transfer stations for waste collection waste method therefore it falls under waste collection backlog when the waste collection is not done systematically.

The exclusion, therefore, requires a study to be conducted to analyse how waste is managed at Lwamondo. Large quantities of solid waste disposed of were observed in six sub-villages with a high number of households. Therefore, this study was conducted focusing on the six selected sub-villages from known 27 sub-villages, and below is the table showing identified six sub-villages with households above three hundred as per 2011 Census data provided.

According to Astane and Hajilo (2017) population growth, rural and urban development, lifestyle changes, and the consequent change in household consumption patterns have created problems in modern societies. The change of household consumption pattern has changed the waste volume generated and the waste characteristics. Rapidly increasing population, rising living standards, development of the way of consumerism, developments in the fields of science and technology have caused areas of more growing waste. These factors cause a continuously increase in the quantity and variety of domestic waste. Increasing domestic waste and the consequences of its degradation in the environment can cause serious damage to the environment and the population (Astane & Hajilo, 2017).

Table 1. 2 Selected sub-villages from preliminary survey

Sub-village No.	Preliminary Survey Selected Sub-village	No. of Households per Sub-village (Census 2011)
1.	Tshishushuru	367
2.	Khumbe	440
3.	Tshivhale	580
4.	Zwavhavhili	582
5.	Tshifulanani 1	709
6.	Tshifulanani 2	800

Source: Census 2011

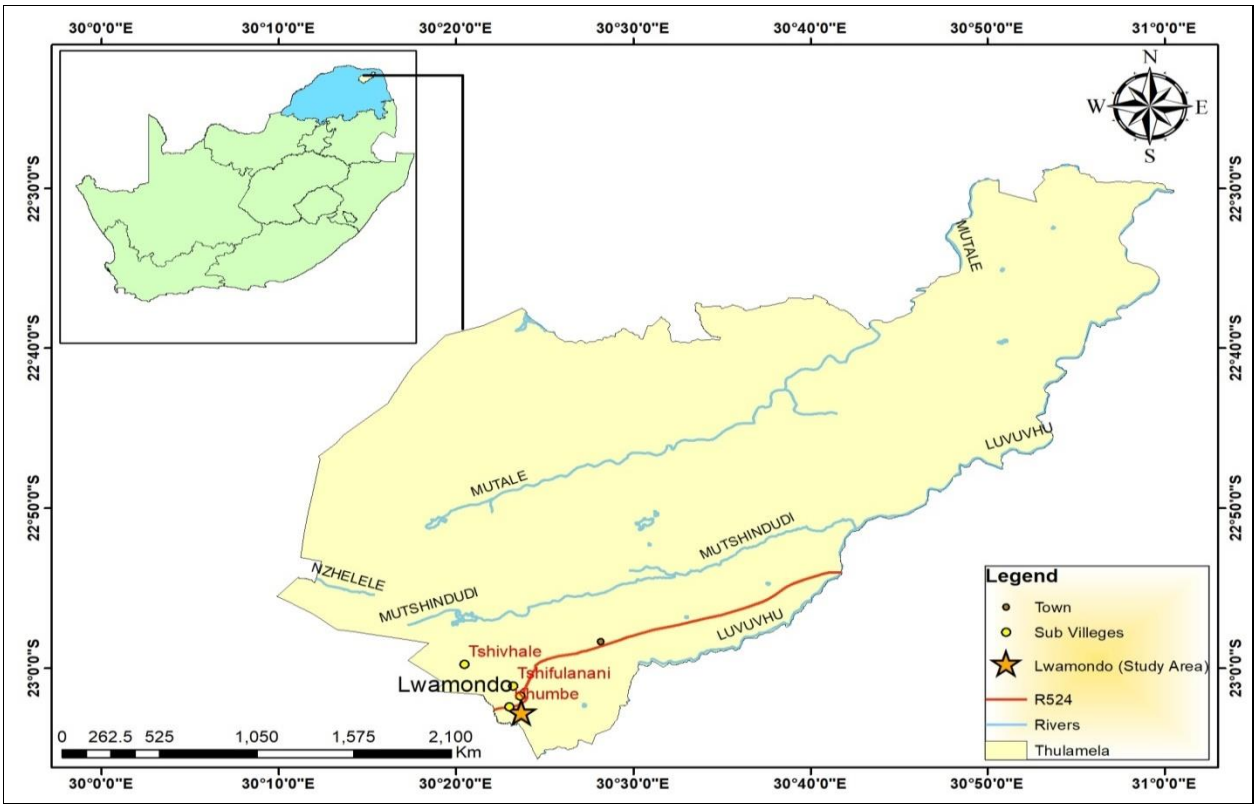

Figure 1. 1: Location of the study area

Below are the satellite maps showing location and coordinates of the sub-villages.

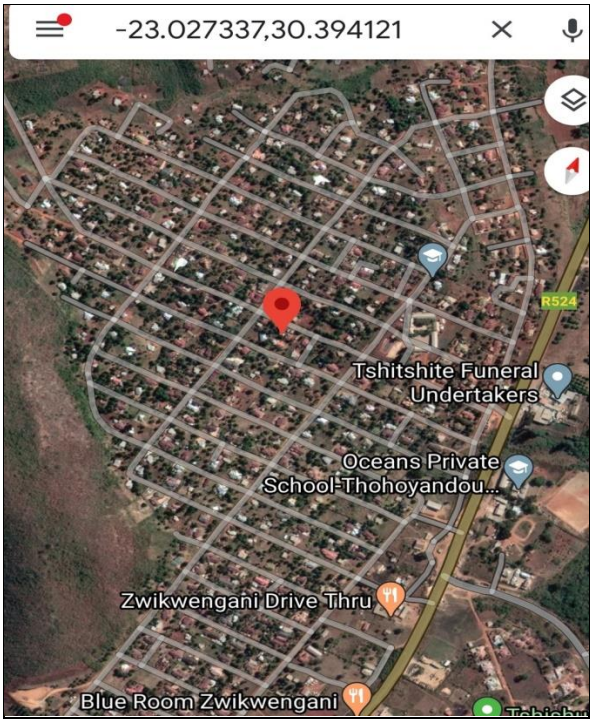

Figure 1. 2: Zwavhavhili Sub-village

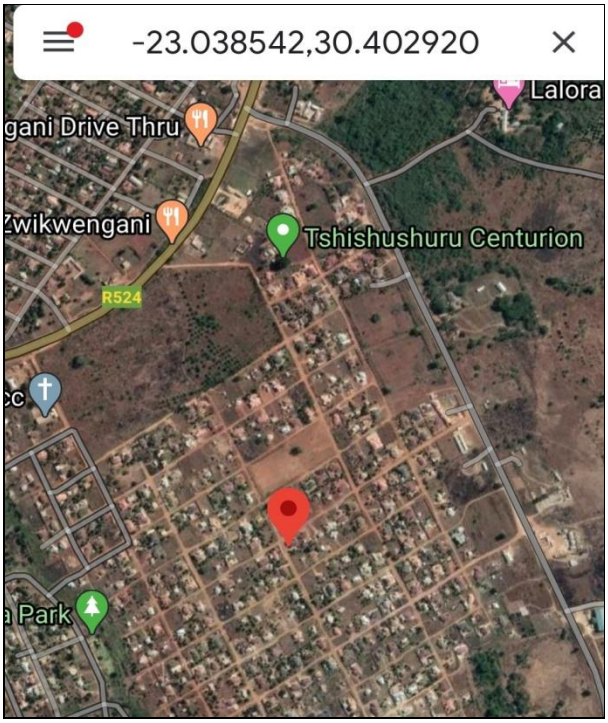

Figure 1. 3: Tshishushuru Sub-village

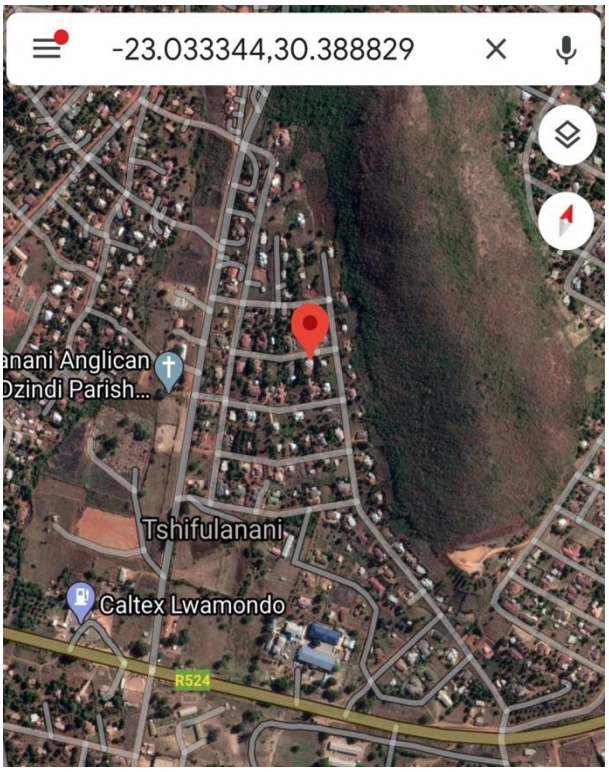

Figure 1. 4: Tshifulanani 1 sub-village

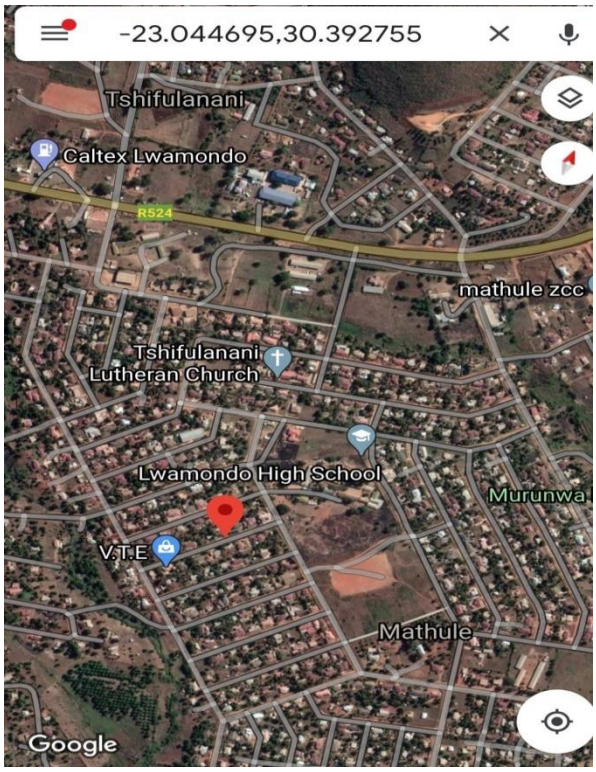

Figure 1. 5: Tshifulanani 2 sub-village

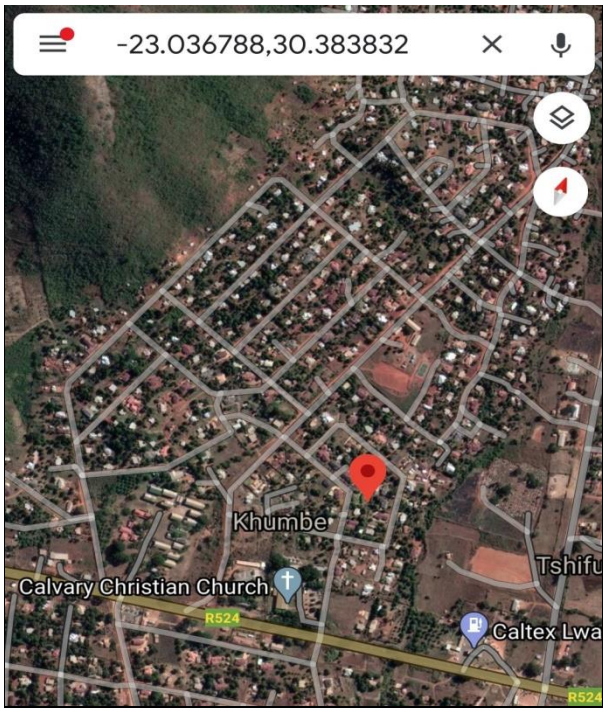

Figure 1. 6: Khumbe sub-village

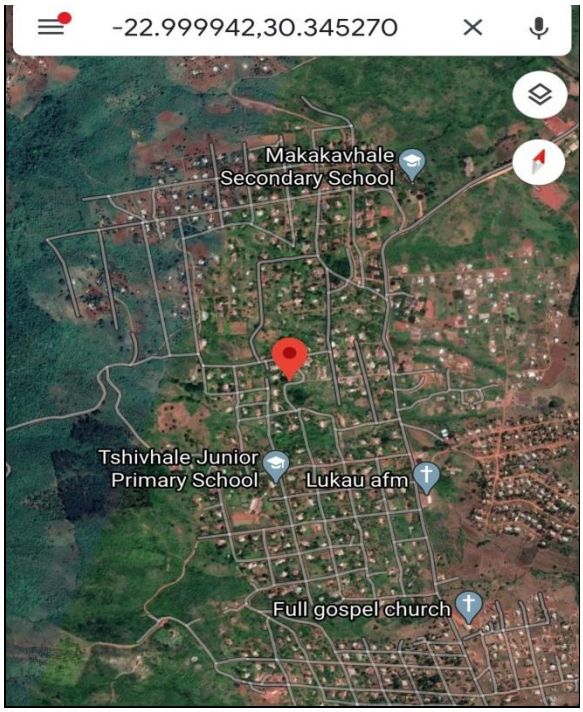

Figure 1. 7: Tshivhale sub-village

1.9 Definition of keywords

Peri-Urban

Peri-urban area refers to a transition or interaction zone, where urban and rural activities are juxtaposed, and landscape features are subject to rapid modifications, induced by human activities (Douglas, 2006).

Solid waste

Solid waste is the useless and unwanted products in the solid-state derived the activities of and if discarded, reused, recycled, recovered, incinerated, and disposed of.

System

A system is a set of detailed methods, procedures, and routines created to carry out a specific activity, perform a duty, or solve a problem (Business Dictionary, 2020).

Household

A household is defined as a basic residential unit in which economic production, consumption; inheritance, child-rearing, and shelter are organized and carried out (UNESCO, 2020).

Sub-village

Sub-village is a cluster of houses that forms part of a village, following the customary practice were residents of the certain sub-village report to the Headman who precedes the matter to the Chief of the Village in which the sub-village falls under.

1.10 Summary

This section introduces the setting of the study, whilst outlining the purpose and objective, and defining the key concepts. The relationship between people and solid waste is explained, while also outlining the impacts of solid waste on the environment and health.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature about the study. The literature review begins with literature material on the regulatory framework in waste management then proceeds to examine the dynamics of peri-urban solid waste management.

2.2 Conceptual framework

The conceptual framework in figure 2.1 is showing the key concepts that have guided the study. Globally, the issue of solid waste management is hard to manage and control in rural, urban and peri-urban areas. Various solid waste management strategies were produced to measure the impacts on the environment, health, economy, and social. In this case, the researcher produced the conceptual framework as guide to follow when studying the household solid waste management systems in the peri-urban. In general, the conceptual framework shows the overflow of the study staring form the concept waste management as a problem identified in peri urban areas. Types of solid waste generated were identified and their impact to socio-economic, natural environment and health was indicated. Therefor these triggers policy makers to develop strategies to combat waste problems and develop policies to manage waste along the conveyance belt. Waste hierarchy is recognised internationally as the guidelines on how to minimise generation of waste to avoid waste being disposed to the landfill.

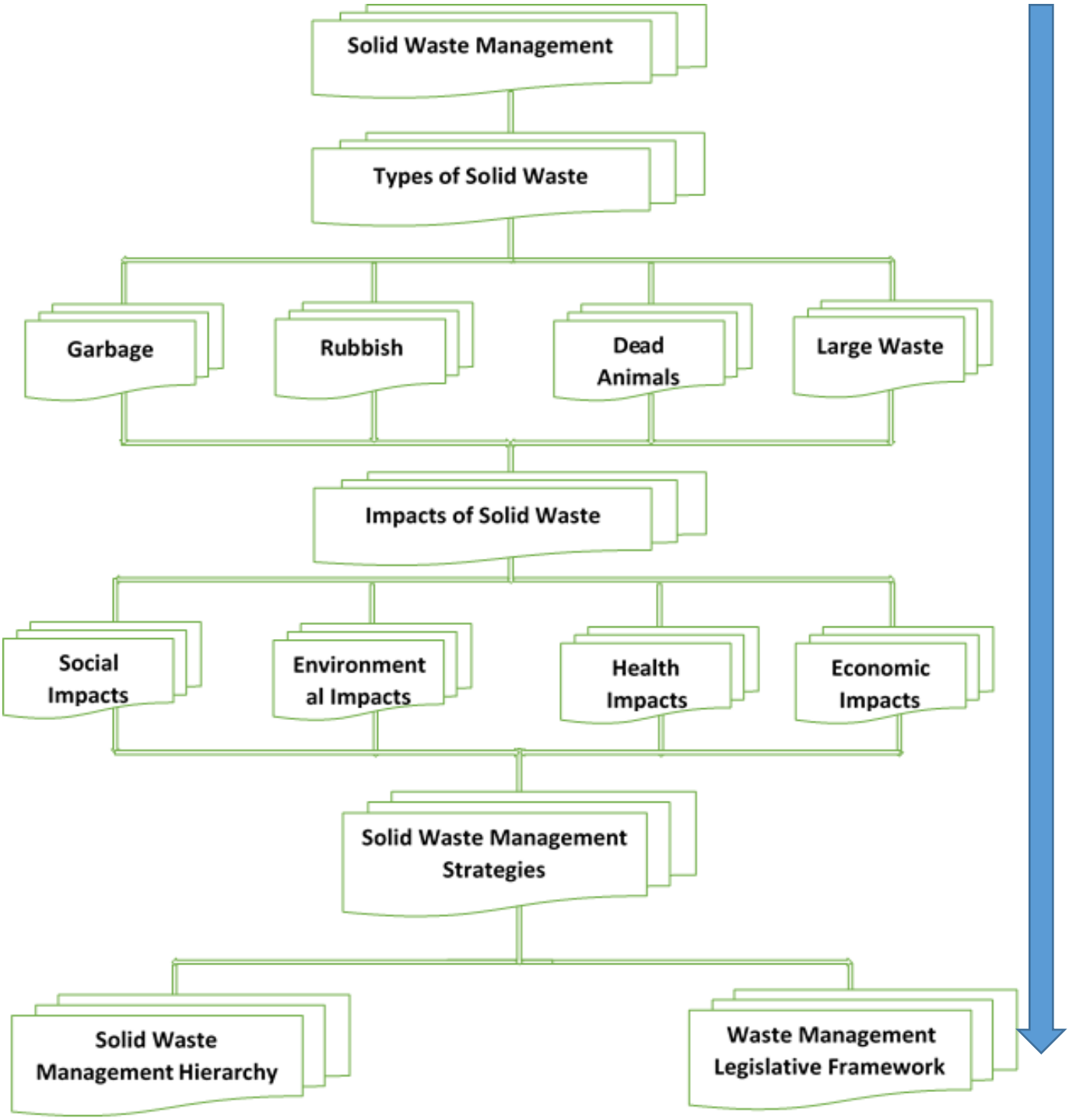

Figure 2. 1: Conceptual framework

2.3 Solid Waste Management

Over the years, rapidly increasing population levels, increased standard of living, and urbanisation have enhanced the generation of solid waste in developing countries (Warunasinghe *et al*, 2016). Globally, solid waste management (SWM) is an issue in both peri-urban and urban areas. The issue of inappropriate and disorganised waste disposal both globally and regionally has created an extreme environmental issue such as pollution, destroying water bodies, loss of wildlife, and the reduction of environmental aesthetic values which directly affects the development of the society and country (Warunasinghe *et al*, 2016). SWM also pose a severe threat to the public health and may decline the quality living standard of people and wildlife (Altaf & Deshazo, 1996). Due to improper SWM system in South Africa, solid waste management is becoming a concern within the country. In addition, the collection of solid waste management is a concern in peri-urban areas, which lead the communities to dump in environmentally sensitive areas. The issue of solid waste management globally has received most attention as it negatively affects the country's economy by destroying the scenic and aesthetic value and consequently increases the health issues (Jayasinghe *et al*, 2019; Warunasinghe *et al*, 2016).

Globally, municipal waste management systems pose a challenge as they should be improved continuously to avoid threatening public health and pollution (Bhada & Hoornweg, 2012). According to Rasmeni & Madriya (2019) municipal solid waste management in South Africa is a major environmental concern. Across South Africa, due to lack of landfill capacity municipalities are facing challenges with solid waste management and disposal (Letlape & Gumbo, 2016). The growth of population across the country leads to fewer dumping sites or the land becomes scarce with landfill sites fill up quicker and thus has resulted in an increased rate of illegal dumping (Rasmeni & Madriya, 2019; De Ligneris, 2013).

2.3.1 Classification of waste

According to Muzenda, 2014, wastes are categorised and divided into two classes, namely general and hazardous waste, which large sub-divided into smaller categories.

General wastes are defined as those solid waste that does not pose a significant threat to the environment or public health (Department of Water Affairs and Forestry & Bredenhann, 1998). In South Africa, the waste classification systems have been documented tremendously. General waste is further classified into industrial, domestic, and institutional waste. Hazardous waste classified as explosives, flammable liquid, and solids is waste that potentially at low concentration poses a significant effect on the environment and public health (Muzenda, 2014). General waste poses little risk to the public's health and environment, meanwhile hazardous waste poses a significant risk.

Table 2. 1 General waste classification,

Source	**Typical Waste generator**	**Types of Solid Waste**
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (i.e., bulky items, consumer electronics, batteries oil, tyres), and household hazardous wastes.
Industrial	Light and heavy manufacturing, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes.
Institutional	Schools, hospitals, prisons, government centres	Paper, cardboard, plastics, wood, food wastes, glass, special wastes, metals, hazardous wastes
Construction and Demolition	New construction sites, road repairs, demolition of buildings.	Wood, steel, concrete, dirt, etc.

Source: Muzenda (2014)

General waste poses little or no significant risk to the environment or public health, for example, general waste would include industrial, domestic, institutional, and construction and demolition and builder's rubble and certain industrial waste (Table 2.3). Although domestic wastes are classified as general waste, some of them contain sufficiently minor components of hazardous and are considered to be of low potential risk (Muzenda, 2014).

Table 2. 2 Hazardous waste sub-classes

Class No.	**Class type**
Class 1	Explosive
Class 2	Gases
Class 3	Flammable Liquids
Class 4	Flammable Solids
Class 5	Oxidising substance and organic peroxides
Class 6	Toxic and infectious substances
Class 7	Radioactive substances
Class 8	Corrosives
Class 9	Other miscellaneous substance

Hazardous wastes require much attention for the management and control, to help prevent damage or harm to public health or the environment (Muzenda, 2014). According to the Department of Water Affairs and Forestry & Bredenhann, 1998, hazardous waste can only be dumped or disposed of on a landfill site designed for hazardous wastes. They can further be classified into ratings to differentiate hazard

waste from moderate to extremely hazardous. Hazardous waste can be classified into 9 classes (Table, 2.4).

2.4 Waste composition of solid waste generated in peri-urban areas

Different activities may generate waste which may be in solid or liquid form and the most dominant in peri-urban areas is solid waste. The quality of solid waste is increasing and if waste is disposed of in an uncontrolled manner this may impact public health and the environment (Majumder, 2010). The peri-urban solid waste consists of organic and inorganic waste which is produced mainly by households and waste has two types of waste which are biodegradable and non-biodegradable. Table 2.1 below explains the physical characteristics of peri-urban solid waste generated within households.

Table 2. 3 **Solid waste type and composition**

Solid Waste Type	**Physical Characteristics**
Garbage	Decomposable waste from food and Slaughter-houses.
Rubbish	Combustible and Non-combustible: Combustible (Paper, Wood, Cloth, Rubber, Leather, Garden Waste) Non-combustible (Metals, glass, ceramics, stones, dirt and masonry)
Large Waste	Demolition and Construction (rubbles, Pipes, Lumber, Masonry bricks, plastic, roofing, and insulating materials, broken plastics furniture, tires, and other broken home appliances)
Dead Animals	Households Pets (Cats and Dogs)

As a result of the changes in consumption behaviours of peoples well as the rapid advances of technology, the composition of MSW has been also changed. Plastics waste disposal is a major global environmental problem. As plastics are essentially

hydrocarbons, they possess a calorific value ranged between 30 and 40 MJ/kg (Shafy & Mansour, 2018).

The physical and chemical characteristics help in the identification of energy recovery potential of waste and also in preparing waste management and disposal (Jain & Singhal, 2014). Characterization may include analysis such as physical and chemical composition, volume, and generation that provide information for the planning and management of waste for its beneficial use and final disposal (Gonzalez *et al*. 2010). Several studies indicate that much of the municipal solid waste from developing countries is generated from households (55% - 80%), institutions among others, and research have further indicated that wastes from these sources are highly heterogeneous in nature and have variable physical characteristics depending on their sources (Douti *et al*. 2017).

2.6 Waste management legislative framework

The Constitution of the Republic of South Africa provides the foundation for environmental regulation and policy in South Africa. The right to environmental protection and to live in an environment that is not harmful to health or well-being is set out in the Bill of Rights (Section 24 of Chapter 2). According to DEA (2011) waste management in South Africa is based on the principles of the White Paper on Integrated Pollution, Waste Management (IP&WM) and the National Waste Management Strategy (NWMS) published by the Department of Environmental Affairs in 1999 and 2000 respectively and the subsequent enactment of the new National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). Waste management services, including refuse storage, refuse removal, refuse dumps and solid waste disposal is a local government function in terms of Schedule 5 of the South African Constitution (RSA. 1996). Provincial Government is mandated with the responsibility to ensure that local government carries out these functions effectively. There are many government policies and statutes that are relevant to waste management at the local government level, which includes but not limited to the following:

- National Environmental Management Act, 1998 (Act No. 107 of 1998);
- National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004);
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008);
- National Water Act, 1998 (Act No. 36 of 1998);
- National Health Act (Act 61 of 2003);
- National Waste Management Strategy and Action Plans of 2010;
- Provincial government waste management legislation
- Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000);
- Municipal Integrated Development Plan (waste Management by-laws)

And below is the chart flow diagram showing the acts and regulations relevant to waste management from national, provincial and local government.

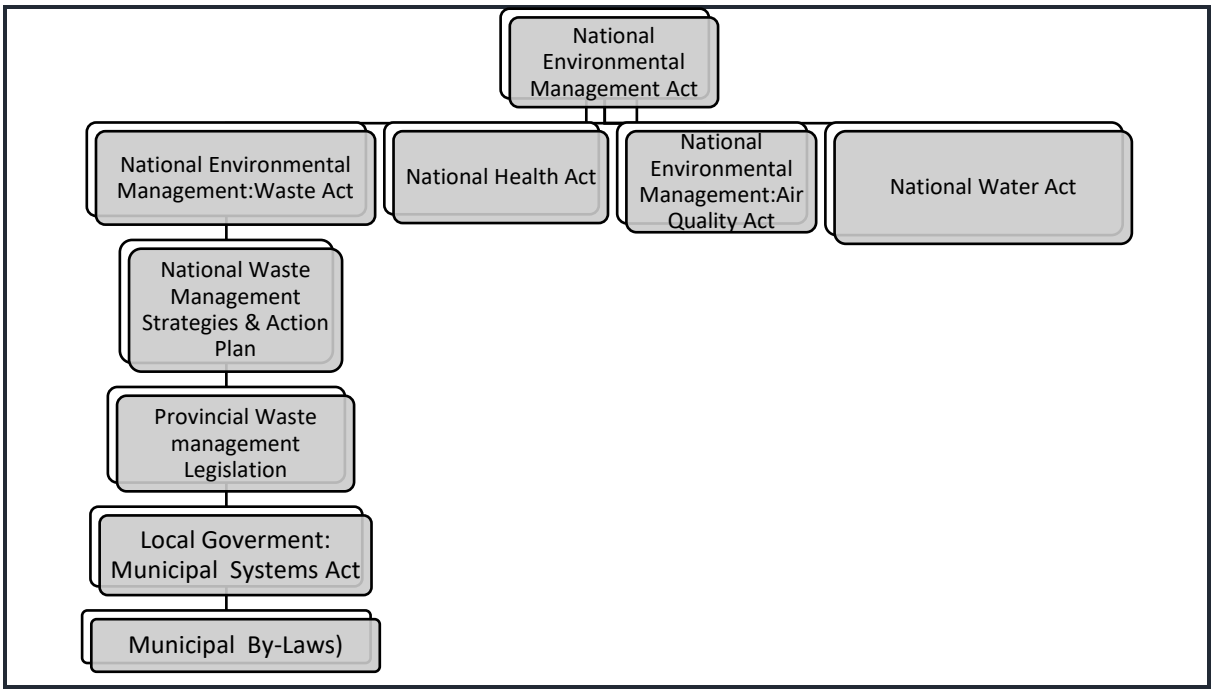

Figure 2. 2: Waste management legislation

According to DEA (2011) amongst the above mentioned, the National Environmental Management Waste Act (NEM: WA) came into effect in 2009 to consolidate most of the previous waste legislation into one framework. NEM: WA has been developed as part of the law reform process enacted through the White Paper on Integrated Pollution and

Waste Management and the National Waste Management Strategy (NWMS). The purpose of the Act was to protect human health, well-being, and the environment by providing reasonable measures for the minimization of the consumption of natural resources; the avoidance and minimization of the generation of waste; the recovery, re-use, and recycling of waste and the treatment and safe disposal of waste. The act stipulates that each municipality must include in its plan the Integrated Development Plan (IDP) and the Integrated Waste Management Plan (IWMP) that is consistent with the relevant provincial integrated waste management plan.

The annual performance report which must be prepared in terms of the Municipal Systems Act (RSA 2000b) must contain information on the implementation of the municipal integrated waste management plan. Successful implementation of NEM: WA goals largely depend on its translation into policy, strategy, and municipal by-laws. Although the Act is informative about the requirements in the National Waste Management Strategy (NWMS), implementation is not quantified (Middleton *et al*., 2011). The NWMS was developed to reduce the generation of waste and the environmental impact of all forms of waste and, thereby, ensure that the socio-economic development of South Africa, the health of the people, and the quality of its environmental resources are no longer adversely affected by uncontrolled and uncoordinated waste management. The NWMS follows the waste management hierarchy approach (Department of Environmental Affairs 2011).

2.7 The concept peri-urban

The most common characteristics of peri-urban areas are: relatively lower population densities, mixed land uses and rapid land-use change, land speculation and uncertain land tenure, fast-growing population and infrastructure requirements, a mix of newcomers and long-established dwellers, heterogeneous and changing social and economic structures, diversified livelihood strategies, and a fragmented institutional landscape, made worse by rapid change and unclear boundaries, jurisdictions, and competencies. The new approach defines the peri-urban areas in relational terms instead of more easily measurable physical or economic terms More specifically, peri-

urban areas can be defined as city fringes in which interactions take place between rural and urban individuals and social groups, and where both traditional rural and urban features coexist (Sadiki and Ramutsindela, 2002).

Rural development planners tend to ignore urban centres and define rural areas as consisting only of villages and their agricultural land. Traditionally, development policy research has adopted a simplified concept of rural and urban areas with rural referring to more remote farming areas and urban to cities25. Likewise, economic activities associated with urban and rural areas have historically been viewed as mutually exclusive land uses. Therefore, the rural-urban dichotomy distorts the reality of rural and urban spaces and fails to address the interdependencies between the two areas. On the one hand, urban development tends to concentrate on the development of the urban areas and neglects both its impact and dependence on rural areas. On the other hand, rural development policies tend to focus on agriculture and related interventions and ignore the urban areas as if rural areas exist in isolation26. The division of spaces into rural and urban areas creates an imbalance and difficulty in developing strategic interventions that can benefit the whole space. As incomes from agriculture decrease, rural households are forced to develop new and more complex forms of livelihood strategies which include both agriculture and non-farm incomes as well as remittances from migrants (Statistics South Africa, 2001).

New spatial and sectoral patterns have emerged along the rural-urban continuum as a consequence of migration, road accessibility, information technologies, and production flows. The analysis highlights that rural and urban spaces are increasingly intertwined and that positive rural-urban linkage can contribute to more equitable development. However, it is worth noting that the conventional dichotomy between rural and urban spaces still dominate the development thinking. More specifically, most development theory and practice are still implicitly or sometimes explicitly based on the dichotomy between rural and urban areas. Likewise, policies tend to reflect this division along spatial and sectoral lines, with the town and regional planners usually concentrating on urban nodes and giving scant attention to rural In-between rural and urban areas are

peri-urban areas where urban and rural areas are spatially intermingled and interactions are most intense. It is also useful to see in the middle of the continuum between rural characteristics and urban characteristics a rural-urban interface in which there are complex mixes of rural and urban characteristics. The relationship between rural and urban areas is increasingly changing throughout the world. Rural and urban areas are no longer mutually exclusive (Sadiki and Ramutsindela, 2002).

2.8 Solid waste management hierarchy

The Solid Waste Management Hierarchy (SWMH) (Figure 2.1) is a recognized model for conceptualizing solid waste reduction and it has been adopted by most industrialized nations. The rational philosophy of SWMH advocates waste avoidance, minimization, re-use, recycling, recovering, treatment, and disposal (Godfrey *et al*., 2011). The fundamental purpose of establishing hierarchical system measures is to improve the efficiency of the performance of the municipal waste hierarchy towards a compliant operation management system.

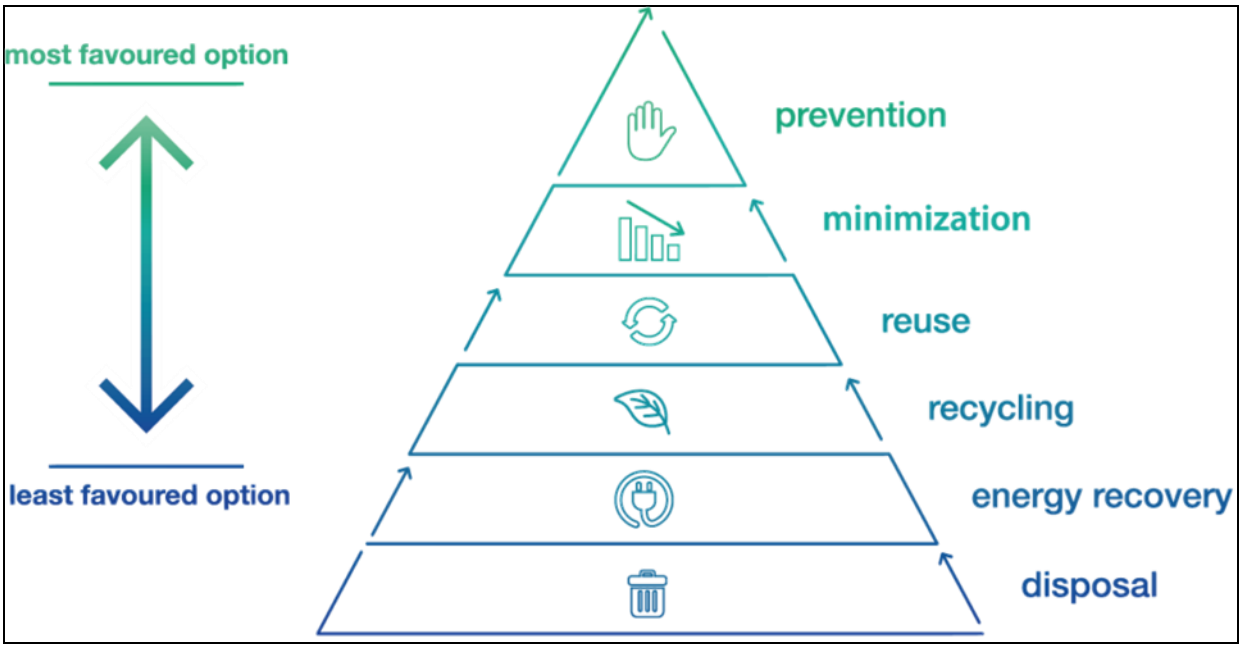

Figure 2. 3: Solid waste management hierarchy (Source: RTS, 2019)

The waste hierarchy is a useful framework that has become a cornerstone of waste management in South Africa (Godfrey *et al*., 2011). The below diagram sets out the order in which options for refuse management should be considered based on environmental impact. It illustrates the pyramid theory designed to give order to dealing with the multiples of waste produced. The options towards the top are the most desirable for dealing with waste, whilst the bottom options of the pyramid are less favourable from an environmental point of view (Godfrey *et a*l., 2011).

Waste avoidance and reduction are achieved by using resources and raw materials efficiently and is the priority when using the waste hierarchy approach then followed by re-use and recycling of waste. Recovery involves reclaiming particular components or materials or using the waste as fossil fuel, and then followed by disposal which entails discarding waste that cannot be recovered (Godfrey *et al*., 2011). And below is an explanation of waste management hierarchy most and least recommended methods for solid waste management best practices.

2.8.1 Waste prevention

Waste prevention affects and depends on a very wide range of stakeholders. It benefits from national targets and local authority engagement, but it depends fundamentally on changes in the attitudes and behaviour of households and businesses and new paradigms in industrial processes and product design. Waste prevention encompasses a range of policy options and has a broad range of benefits. Specifically, waste prevention means reducing the quantity of material used in the creation of products and increasing the efficiency with which products, once created, are used. Preventing waste can be achieved by limiting unnecessary consumption and consuming products that generate less waste (European Environment Agency Statistics, 2013). Waste prevention covers anything from rejecting junk mail to reusing food leftovers; from home composting to donating electrical goods to charities; from buying second-hand clothes to avoiding single-use bags, and so on (Wilson *et al*., 2010).

2.8.2 Waste minimization

Solid waste minimization is one of the ways of reducing the number of waste selected for disposal. The most common economic benefits derived from solid waste minimization are cost avoidance, recycling revenue, reduced raw material costs, reduced energy costs, increased sales, and increased productivity. Adopting an effective waste minimization strategy by the government is seen as another approach sustainable for municipal waste management. Solid waste minimization also involves efforts to minimize resources and energy to reduce environmental pollution. Integrating solid waste minimization through recycling could help in reducing the challenges being faced in municipal solid waste management (Ali & Siong, 2016).

2.8.3 Waste reuse

Waste reuse eliminates the production of waste at the source of the usual generation and reduces the increase in unauthorized disposal sites. Providing reduces and re-uses awareness of solid waste among peri-urban communities and as part of the solid waste management strategy, the local municipality requires public participation from and especially affected communities. To get the public on board, training and educational programs need to be undertaken to educate the public about their role in the process (Khumalo, 2016). The process of reusing starts with the assumption that the used materials that flow through our lives can be a resource rather than refuse. Examples of reuse that mostly relate to household solid waste reuse include reusing wrapping paper, plastic bags, boxes, and lumber, give outgrown clothing to friends or charity, buy beverages in returnable containers, offer furniture and household items that are no longer needed to people in need, friends, or charity, books and magazines can be donated to schools, public libraries, or nursing homes, sheets of paper that have been used on only one side can be used for note-taking or rough drafts and containers can be reused at home or for school projects (Rahman, 2014).

2.8.4 Waste recycling

Waste recycling is environmentally sustainable because it lessens the use of virgin natural resources and energy consumption while generating new products, employment

opportunities, and incomes and it also, recycling is broader than waste recovery and reuse because it represents an entire value chain which involves the direct collection, reclaiming (recovery) and reuse of waste materials such as paper, plastics, and glass either in their original form immediately after separation and cleaning or reprocessing (Dlamini *et al.,*2017). According to Khumalo (2016), recycling initiatives vary from municipality to municipality since some municipalities have embarked on awareness programs of waste management. The local municipality should encourage the separation of waste materials at the household level, as this will prevent any valuable and re-usable materials from being discarded. Following the in-home retention of valuable material, waste-pickers currently remove most valuable materials before garbage enters the waste stream or dumpsite, especially in the lower and middle-income areas of many municipalities (Khumalo, 2016). Dlamini *et al*. (2017) stated that waste separation at source and improved accessibility to buy-back facilities are important determinants and prerequisites for effective recycling programs. To increase the recycling rates, the local government must encourage the markets for the recycled materials and should increase the professionals in the recycling companies (Shafy & Mansour, 2018).

2.8.5 Waste recovery

Dlamini *et al.* (2017) stated that to be more precise, waste recovery simply means that resource materials are extracted from the waste stream to use them as inputs into newer products**.** Through funding and technical expertise provided by international donor agencies, developed countries have had a perceptible influence on the South African waste and recycling landscape. However, progress remains slow, particularly for non-packaging waste streams such as organic waste (including industrial biomass), construction, and demolition. There is a temptation for South Africa to follow the same path that European countries have followed in managing their waste but is there any opportunity for South Africa and other developing countries to leapfrog the technology choices of developed countries and move directly towards stronger materials recovery paradigm (Godfrey & Oelofse, 2017). Traditional recovery of household waste at the household level, home composting, and animal feed has diverted a part of bio-waste

fraction from waste dumping into these applications. The improvement of home composting procedure across rural communities is a cost-efficient and environmentally friendly solution if it is properly performed avoiding bio-waste losses (Mihai & Taherzadeh, 2017).

2.8.6 Waste disposal

Disposal of garbage as solid wastes is a widespread problem in both urban and rural areas in several developing countries. Several canals and drains are widely used to dump varieties of garbage as a source of domestic organic and inorganic waste. Due to the absence of continuous garbage collection systems, convenient landfills, open canals, and drains are being blocked by dumping huge amounts of solid and garbage wastes (Shafy & Mansour, 2018). Lack of MSW management is leading to significant environmental problems and it includes soil, air, water, and aesthetic pollution. Such environmental problems are associated with a human health disorder, due to the increase in greenhouse gas emissions. For sustainable management of solid waste, effective planning, and development strategies about the quantity and categories of such wastes are of great importance (Shafy & Mansour, 2018).

In conclusion, Godfrey *et al.* (2012a) stated that a zero-waste society is one where waste is managed as far up the hierarchy as possible, with treatment and disposal of waste being the last resort. All stakeholders must apply the solid waste management hierarchy in making decisions on how to manage waste. The outcomes of the waste hierarchy analysis provide the basis for establishing accountability to waste management hierarchy regulation. Shah *et al.* (2012) used the analytical hierarchy process (AHP) technique to structure and assess the views and judgments of stakeholders on the environmental impacts of solid waste disposal. These studies show that the desired outcomes are necessary for work evaluation and meaningful performance appraisal.

Therefore, specific measurable targets will indicate or confirm adherence to established standards are significant (Shah *et al*., 2012). Defining performance in terms of desired results is how waste managers and supervisors could make their work assignments

operational. Performance reporting and variance analyses could be accomplished and this would enable the initiation of timely corrective actions needed for effective management and control of waste disposal facilities (Mnisi, 2008). Therefore, municipal waste managers need to develop relevant waste management hierarchy measuring and monitoring tools (Apostol and Mihai 2012). Worldwide, these triple R's methods are recommended consistently and waste reduction in both urban and rural areas is encouraged. The utmost benefits of these methods are that they prevent greenhouse gas emissions and, reduce the release of pollutants. Therefore, these methods should be adopted especially in rural communities and incorporated as part of the waste management plan (Khumalo, 2016).

2.9 Peri-urban solid waste management practices

Peri-urban is usually defined as a place, process, or concept that conceptualised the mix between rural and urban features ((Narian & Nischal, 2007; Mortimore & Wilson, 1965). The peri-urban is often characterised by increasing population density, poor slums, smallholdings, lack of regulation, intensified resource overexploitation, and lack of service provisions (Simon *et al*, 2003; Friedberg 2001). Therefore, due to poor or lack of service provision and intensified resource exploitation, the community becomes more associated with environmental and health problems such as solid waste which requires some control or mitigation (Marshall *et al*, 2009).

Peri-urban is often characterised as a place that comprises of a mixture of urban and rural livelihoods (Narian & Nischal, 2007). The development of rural and urban or peri-urban populations manifests in the rapid urbanization of the peri-rural population. The amount of waste generated is one of the problems with increased developments and the amount of waste is directly linked to GDP per capita, and a developing country is expected to increase the waste production by its inhabitants and the type of waste will change (Marshall *et al*, 2009). Developing rural areas mostly produce an increased amount of plastic, glass, metal waste (Croset, 2014; Marshall *et al*, 2009; Simon *et al*, 2003).

A panel of solutions used to limit the impact of waste in peri-urban society and most recommended is recycle and re-use. The recovery of valuable material is a widely used technic to lower the amount of waste (Croset, 2014; Simon *et al*, 2003). The separation of the recyclable material can be done at the source (in the household, business) or the disposal site (sorting facilities, scavenging) (Croset, 2014; Wilson *et al*, 2006). Nevertheless, recycling is dependent on the possible use of the recycled material by companies located at a reasonable distance from the sorting point (Wilson *et al*, 2006). The recycling opportunities are linked to the price of recyclable which is also related to the presence or not of an accessible market for recyclable (Croset, 2014). Transportation routes, the distance, or the price of the fuel are influencing the access to a market for recyclables.

The presence of industries that could use the recycled material is crucial to develop recycling as well as an appropriate amount of waste to treat (Croset, 2014; Wilson *et al*, 2006). In conclusion, education can also be provided to the informal settlers to inform them the environmentally friendly disposal of solid waste. Another aspect of education can be done within schools. A first step could be to have a small education on recycling given by the teacher or waste management officer (Croset, 2014; Wilson *et al*, 2006). A school competition could also be implemented where each school would collect the cans that the students are bringing and after one month, for instance, the school which collected the larger amount is rewarded with a prize from the municipality (Croset, 2014).

Development and transition promote smart traditional ways to recycle, reuse, and compost/digest the municipal and agricultural wastes from remote rural regions to increase the waste diversion rate from uncontrolled waste disposal practices (open burning, wild dumps, and river/marine dumping) (Mihai & Taherzadeh, 2017). Gonzalez *et al.* (2010) stated that solid waste constitutes a huge challenge for local governments due to its constant increase and most municipalities do not keep records on waste generation, origin and characteristics. Globally there is a lack of knowledge about waste generation and disposal methods in rural areas and their peri urban areas (Gonzalez *et al*., 2010). The rural waste management must rely on a systemic approach involving

technical and financial, social and cultural, environmental, and governance aspects. The rapid growth of the rural population has led to a dramatic increase in rural waste generation with a crucial socio-economic and environmental impact (Gedefaw, 2015). Unsystematic wastes disposal in rural areas has become a major concern due to its cumulative and hazardous effect in the long run. This issue should be addressed before the situation is getting worse and much becomes difficult and costly to manage. The usual methods of solid wastes disposal in a rural area are disposed at the river, roadside, open spaces, and anywhere at their will. The consequences of this habitual littering are dangerous to human health, safety, and wellbeing (John, 2010).

Municipalities are giving preferences only to the collection of waste and dumping in urban areas and little attention is given to peri urban areas. The principles of 3R's (waste reduction, re-use and recycle) are not prioritized for sustainable solid waste management and solid waste generation of households is increasing tremendously. The absence of qualified and efficient municipal solid waste management in peri urban has exposed communities to various health, aesthetic and environmental impacts (Gedefaw, 2015). Environmental pollution only seems to be dissipated across sparsely rural regions, but the threats remain at the same level as for peri urban areas. Furthermore, pollution activities that occurred in rural areas are more predisposed to be made in an uncontrolled manner. Existence of poor monitoring process and law enforcement lead peri urban areas vulnerable to such practices in both developed and emerging economies (Mihai & Taherzadeh, 2017).

Peri-urban communities require major changes in establishing disposal practices in public attitudes and behaviour. As part of the government policy towards sustainable development, there should be sustainable waste management techniques that will reduce environmental impact at an affordable cos, furthermore it be accepted by the public to be applied when managing waste. Everyone within the affected community including government and private sectors plays an important role in improving current peri-urban solid waste management strategies (John, 2010). According to Hernandez and Romero (2018) recent efforts to improve waste management practices are often

limited to better treatment of waste through prominent principles like the 3Rs (reduce, reuse, and recycle) and these efforts do not maximize the potential value of solid waste.

2.10 Factors influencing current solid waste management practices in peri-urban areas.

A high volume of waste is generated in low- and middle-income areas because of the expansion of urbanisation in rural areas and this is also influenced by the change in lifestyles. Solid waste management has been a big challenge for both developing and developed countries globally due to rapid population growth. Most waste generated remains uncollected and simply dumped in open areas, roadside, river courses, and gullies (Gedefaw, 2015). Below are some outlined factors that influence illegal dumping of solid waste in peri-urban areas

2.10.1 Accessibility

According to McAllister (2015), peri-urban communities subject to illegal dumping are very typical areas with limited access to convenient, affordable waste disposal facilities or services and recycling programs. The problem worsens in areas with high population and residents in areas where illegal dumping is common may not be aware of applicable laws or understand harmful impacts and such factors include poorly accessed roads, remote spaces and the presence of illegally dumped materials attracts additional dumping. Narrow streets may not have space for locating storage containers and maybe so narrow, treacherous, or irregular that motorized collection vehicles cannot be used. Houses that distance from the nearest accessible road also pose problems in receiving adequate waste services.

2.10.2 Lack of alternative waste disposal system

Areas without routine or affordable pick-up services for waste and recyclables tend to experience higher incidence of household and yard dumping. Methods of solid waste management vary greatly with types of wastes and local conditions. Therefore, the designing of a waste management system should be taken into consideration as one of

the fundamental goals and a clear analysis of local conditions and factors that should have an understanding of the full range of technology options that are available (Ndum, 2013).

Often in most urban centres, solid waste is disposed of by depositing it in low-lying areas outside the city without following the principles of sanitary landfilling such as leachate collection and monitoring that make this disposal method unsustainable. In rural, peri urban and urban areas, open burning of household waste has become commonplace in areas where the collection is limited or non-existence. Residents living close to the dumpsite are therefore exposed to environmental and disease risks. The disposal sites are in most cases located in environmentally sensitive low-lying areas such as wetlands, forest edge, or adjacent to water bodies. They often do not have liners, fences, soil covers, and compactors as is in most developing countries. Having effective and sustainable waste management systems in place will help regulate waste disposal and will help alleviate some of the pressure consumption has put on the environment. Researchers found that when citizens were exposed to open dumping and burning of waste, they developed increased health problems due to the release of dangerous toxins (McAllister, 2015).

2.10.3 Population growth

Population growth is among the main influence of the increase in waste volume generated in rural areas. An increase in population and consumerism result in a high increase in waste volumes (Kumari & Grover, 2007). The transition from rural to urban lifestyles in rural areas has generally encompassed solid waste generation. A dramatic increase in development and urbanization of rural areas comes with a huge increase in waste volumes without a well-designed strategy of waste collection and disposal systems (Kamara, 2006). The rapid growth of population has created a number of extreme land use planning and infrastructural challenges that have crippled the capability of national and municipal governments in developing countries in increasing SWM service levels at the rate that they are demanded. The first priority for municipalities is to improve waste collection and disposal alternatives. Municipal solid

waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. People who remain without waste collection services are usually the low-income population living in urban and rural areas (McAllister, 2015). According to Ikhlayel and Nguyen (2017), waste-related problems are driven by factors such as increasing population, rapid urbanization, industrial development, and changes in consumption patterns. Similarly, the characteristics of solid waste have changed in the country due to the rapid industrialization and urbanization. Abdullah *et al*. (2017) stated that solid waste management practice needs to be improved to achieve environmental quality and socio-economic development and effective service of solid waste management is an essential device for ensuring environmental protection for both urban and rural communities

2.10.4 Ineffective enforcement of municipal by-laws

Lack of awareness and enforcement of existing municipality legislation and by-laws are the main constraints to solid waste disposal in many rural areas. According to Thulamela Municipality Waste Management By-laws of 2015, published in the Provincial Gazette stated that: “(21)(1) No person may (a) except with the permission of the occupier, owner or of the person or authority having control thereof dump, accumulate, place, deposit, leave or cause or allow to be dumped, accumulated, placed, deposited or left any waste whatsoever, whether for gain or otherwise, on or in a public place; any drain, watercourse, flood-prone areas, tidal or other water in or in the vicinity of any road, highway, street, lane, public footway or pavement, roadside or other open space to which the public have access; or private or municipal land”.

Enforcement of waste management by-laws is expected to have a positive relationship with the effectiveness of solid waste management at the household level. In other words, if the households have awareness on the existence of solid waste related laws and regulation and also the municipality apply it, at least the rate of unauthorized site disposal would be minimized (Haile, 2011). Lack of enforcement of policies and laws is a major institutional issue that greatly contributes to the mismanagement of solid waste in the developing world (McAllister, 2015). According to Farah (2019), some adequate

policies and laws promote effective SWM but they lack strict enforcement by-laws. Lack of enforcement of policies of solid waste is the real challenge to sustainable waste management. However, a straightforward, unambiguous legal and regulatory framework, involving functioning and enforcement procedures at the national, provincial, and local levels is extremely important to the proper functioning of MSWM.

2.10.5 Lack of education and awareness

The need to improve public awareness of community participation in waste management has been widely recognized by researchers as necessary to create sustainable waste systems and to promote environmental citizenship amongst community members. The outcome of non-participation of communities in waste management was manifested in the careless and irresponsible disposal of waste in public streets, along the roads and highways, and around communal bins for residential waste. A problem of this kind highlights the need for the implementation of vigorous programs of public education. Communities should be required to take responsibility for their waste collection and disposal. Through community, environmentally self-help, waste management costs are reduced and community self-interest is increased (McAllister, 2015).

According to Han *et al*. (2018), insufficient knowledge of public awareness to develop an adequate management system can have a detrimental impact on the environment. Public awareness of characteristics of domestic waste generated and management is very important for waste management in rural areas because of growing populations, lifestyle changes, rising community living standards, and increasing waste generation. Farah (2019) stated that to deal with the solid waste problems the conscience of the individual needs to be raised through environmental awareness and concern. Inculcation of sustainable consumption practices and education on waste management and the main limitation seen all over the developing world is the lack of education and awareness of efficient waste-management practices.

2.11 Summary

The chapter covers the comprehensive literature from different studies about solid waste management in the peri-urban and their possible environmental and health impacts. Numerous solid waste management strategies were identified and discussed. The section revealed different waste management techniques, solid waste management hierarchy, and factors influencing solid waste.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents an overall methodology together with the procedures that were used to collect data that enabled the researcher to achieve the research objectives of this study as stated in Chapter One.

3.2 Research design

The study employed a mixed research design integrating both qualitative and quantitative techniques (methods). It involves collecting and analysing data while integrating the findings with both quantitative and qualitative research methods to understand the research problem (Doyle *et al*, 2009; Tashakkori & Creswell, 2007). In terms of qualitative technique, it allowed the researcher to rely on the fieldwork data i.e. checklist results and observation and the views of participants through interviews to collect data and quality, describe the data and characteristics of what is being studied (Doyle *et al*, 2009). Quantitatively, the research collected quantifiable data from participants by asking specific questions through questionnaires and analyse them statistically and unbiased.

This design enables the researcher to obtain the current information and the method focuses on investigating the status, practice, and the nature of the problem within the study area. Data collection of qualitative descriptive studies focuses on discovering the nature of the specific events under study. Thus, data collection involves minimal to moderate, structured, open-ended, individual, or focus group interviews (Lambert, 2012). Meanwhile, quantitative data were collected through a questionnaire and in an unbiased manner to quantify the variables of interest to understand the level of interaction and relationship. The study used a mixed design approach because it permits for greater validity through combining two methods to provide a complete and comprehensive picture of the study and ensure answering questions that could not be answered by quantitative and qualitative methods alone (Mutezo, 2016).

The study adopted a mixed design as it covers both qualitative and quantitative aspects of the study (Doyle *et al*, 2009). Substantially, exploratory design were chosen to explore the phenomenon of solid waste management of Lwamondo village and surrounding areas. In addition, the chosen design help explore and investigate the condition, characteristics, and attitudes of the current status quo, and factors that may have contributed to key issues being investigated (Mutezo, 2016). The sequential research design, namely exploratory design helps to explore the relationship between solid waste management and contributing factors in the area.

3.3. Population and Sample size

3.3.1 Population Selection

When the study of a particular phenomenon is undertaken it is of utmost importance for the researcher to define the targeted population before making choices of sampling (Mutezo, 2016; Daniel, 2012). Thus, it is important to sample the population that represent the targeted population. The study has focused on one local municipality namely, Thulamela municipality, which comprises a population of approximately 618 462 (Census 2011). The targeted population for the study was residence residing in Lwamondo, and the sub-villages around. For population selection, the study employed simple random selection. Random subsets (*n*) of the targeted population (N) are selected, with an equal probability of being selected (Bornstein *et al*, 2013).

3.3.2 Sample Size

The sample size used for this study is presented in Table 3.1 and explained below. The sample size is one element of research design that investigators consider when they plan their study. A sufficient sample size is the minimum number of participants required to identify a statistically significant difference if a difference truly exists. Reasons to accurately calculate the required sample size include achieving statistically significant results and ensuring research resources are used efficiently and ethically (Burmeister and Aitken, 2012).

Table 3. 1 **Study sample size**

Sub-village	**Total Number of Households (Census2011)**	**10 % of households in each sub-village interviewed**
Tshishushuru	367	37
Khumbe	440	44
Tshivhale	580	58
Zwavhavhili	582	58
Tshifulanani 1	709	71
Tshifulanani 2	800	80
Total	**3478**	**348**
N = 348		

The above six sub-villages were selected during the preliminary survey because they were identified to have a high number of households compared to other sub-villages. In each sub-village, households are given a unique household number which is recorded at the local traditional council, and household number information is also recorded at the local municipality. The household numbers were used to randomly select households that were selected for distributing questionnaires for data collection and 10% of households from each sub-village were used, therefore a total number of 348 households were sampled for questionnaire distribution for this study.

During the preliminary survey, three illegal dumping spots were identified in three sub-villages namely Tshivhale (Point 1), Khumbe (point 2), and Tshishushuru (point 3). Field observation was conducted at these illegal open dumping spots to identify the waste composition of solid waste dumped at these illegal open dumping spots. A total number of 9 households situated within 500m proximity to the illegal identified open dumping spots were identified and chosen for interviews conducted to get in-depth information about activities occurring at these identified points rather than relying on observation. A total of 3 Households were chosen at Tshivhale, 3 households chosen at Khumbe, and 3 households were chosen at Tshishushuru. Below are the satellite maps showing the exact location and coordinates of the three identified illegal open dumping spots.

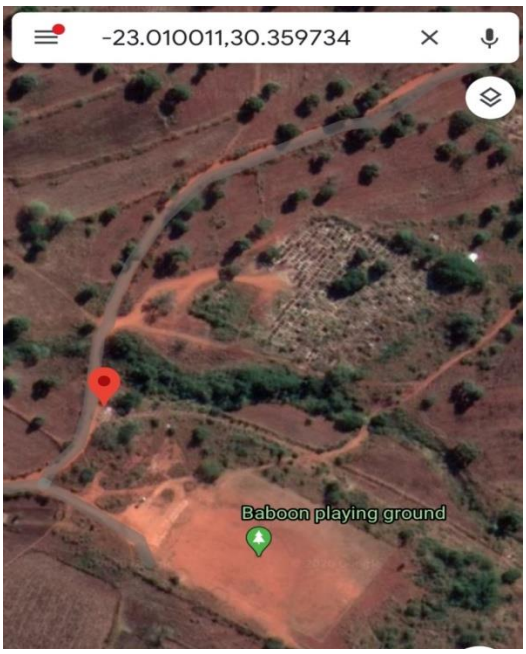

Figure 3. 1: Point 1

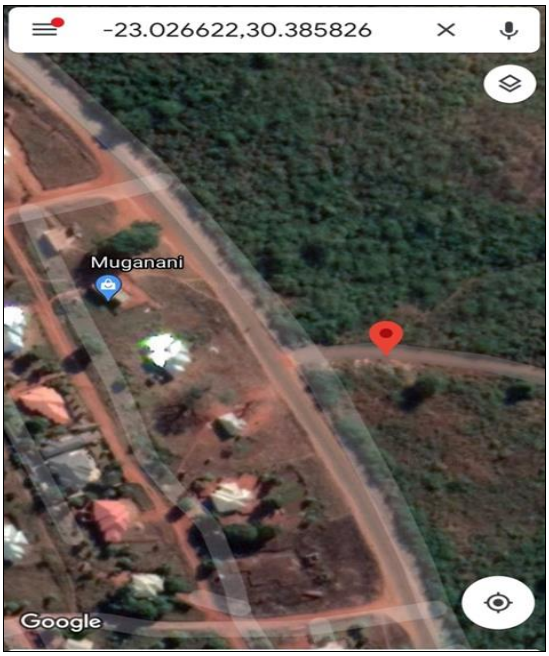

Figure 3. 2: Point 2

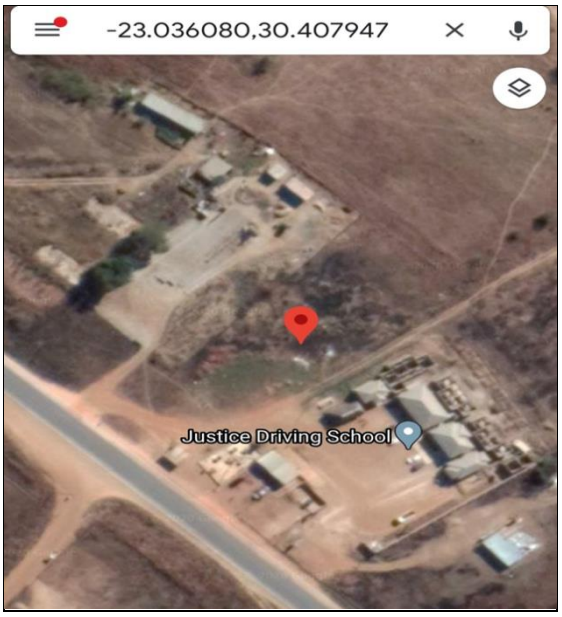

Figure 3. 3: Point 3 (Source: Google maps, 2019)

3.3 Sampling methods

Two sampling methods were used to get a sample for this study which are simple random sampling and convenience sampling and they are explained below. According

to Ramataboe (2015), a sample is a representative of the population that helps the researcher to obtain information necessary for meeting the objectives of the study and it is more manageable to work with than the entire population.

3.3.1 Simple random sampling

Simple random sampling was used as a sampling method to select households for the data collection process and household numbers were used for sampling households in which questionnaires were distributed. Simple random sampling is the basic selection process of sampling and is the easiest to understand. In a simple random sampling of a given size, all members of a sample frame are given an equal probability of being selected. Subjects in the population are sampled by a random process, using either a random number generator or a random number table, so that each person remaining in the population has the same probability of being selected for the sample. Random sampling assumes that the units to be sampled are included in a list, also termed a sampling frame and this list should be numbered in sequential order from one to the total number of units in the population (Frerichis, 2008). The researcher used simple random sampling to sample out households in each sub-village before conducting interviews. Household numbers were selected randomly in each village. 10 % of the households with each sub-village were selected.

3.3.2 Convenience sampling

The convenience sampling method was used to sample households situated near the identified open dumping spots to conduct interviews. Convenience sampling is a type of nonprobability or non-random sampling where members of the target population that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate are included for the study. Convenience sampling was used to sample households that are located 500 m away from the illegal dumping sites. Households that are located 500m within the 500m proximity were selected to explore and investigate the impacts of illegal dumping next to them. Convenience samples are sometimes regarded as ‘accidental samples’ because elements may be selected in the sample simply as they just happen to be situated,

spatially or administratively, near to where the researcher is conducting the data collection (Etikan; Musa & Alkassim, 2016).

3.4 Sampling procedures

The sampling procedure that was used to select households was questionnaires were distributed, and the household which interviews were conducted to gather information about activities that occurs within identified illegal dumping spots. A simple random sampling method was used to randomly select household numbers which were used to select households for questionnaire distribution. From each sub-village, household numbers were numbered in sequence on a Microsoft Excel spreadsheet, starting from the first household number continuing down to the last one, generating a random number for each household number entered, ranging from smallest to largest. The first 10% of household numbers from each sub-village were then used as randomly selected households for questionnaire distribution (refer to Table 3.1). Therefore, a total of 348 households were used to distribute questionnaires for this study.

The convenience sampling method was used to choose households situated near identified illegal dumping spots which were used to conduct interviews. A total of 9 households from three sub-villages where illegal dumping spots were identified were chosen. These households were chosen due to their proximity to the identified points to gather actual information about activities occurring within these illegal dumping spots.

3.5 Data collection methods and instruments

The process of data collection is very essential to the success of a study because the higher the quality of the data collection method, the higher the accuracy of the research conclusion (Brink; Walt & Rensburg, 2006). Data collection of qualitative descriptive studies focuses on discovering the nature of the specific event under study and just like any other qualitative research design; the goal of this design is to obtain rich information to interpret the data (Lambert, 2012).

The study integrated both primary and secondary data to gather the required information. According to Kumar, 2005, primary data involves first-hand information and

allows the researcher to gather information relevant to the study. Primary data used were achieved from questionnaires distributed within households, interviews conducted in the household within proximity to identified illegal open dumping spots, and field observation in both households and illegal open dumping spots. Secondary data used were obtained from published literature such as journal articles, previously conducted research relating to this study, census databases such as Statistics South Africa, and government publications. Primary data collected from questionnaires distributed, interviews, and field observations helped to achieve the research objectives for this study during data analysis and secondary data sources helped to explain and acknowledge the significance for conducting this study on a global scale with specific reference to village peri-urban solid waste management in the literature review.

3.5.1 Questionnaire

Self- administered questionnaires were distributed in sampled household numbers as a tool to collect data. According to Abawi (2013), a questionnaire is a reliable data collection instrument consisting of a series of questions for gathering information from the respondent. They were designed to achieve the first three research objectives for this study which emphasize examining the waste composition of solid waste generated within households, examining current solid waste management practices, and analyse factors influencing such practices at Lwamondo village. Demographic characteristics which were included are age distribution, education level and employment status (refer to Appendix A).

Simple random sampling was used to sample 10% of the household numbers found within Lwamondo and its surrounding sub-villages. The researcher administered questionnaires to 10% of households identified. Questionnaires were distributed between June and August 2019 and they were collected after 3 days from the day they were distributed. Content questions in distributed questionnaires were interpreted and explained in their home language for respondents to understand the questions thoroughly before they answer, especially those with no formal education and primary education level. From 348 questionnaires distributed in sampled households, a total of

312 (100%) questionnaires were successfully completed and were used to analyse data.

3.5.2 Interview

Interviews were conducted using a semi-structured questionnaire for households situated within 500m proximity to the identified illegal open dumping spots. Leedy and Ormrod (2010) described semi-structured interviews as an instrument that involves pre-determined questions as well as allows for further questioning, curious participants' reasoning and interpretations to understand their assumptions and behaviours. A total of 9 households were conveniently interviewed. Interviews were conducted to investigate the views and response of residence with 500m proximity. They were introduced to help pursue the meaning of the central themes of the phenomenon being studied (Creswell, 2017). The interview focused on gathering information on activities that occurs at these illegal open dumping spots such included type of transport that waste dumpers use to carry waste to these identified points (e.g. either if they use a car, a wheelbarrow, or carry buckets), and how often do they see people dumping waste (e.g. hourly, daily or weekly) and lastly, the environmental and health impacts associated illegal dumping spots (refer to Appendix B). These interviews were conducted in September 2019.

3.5.3 Field observation

Field observation within households was conducted during the questionnaire distribution process using a designed observation checklist for household disposed and stored waste. It included observing waste composition for solid waste generated to identify waste type generated so that the researcher can determine the potential for recycling initiatives of solid waste at Lwamondo village (refer to Appendix C). Illegal open dumping spots were visited for observation in were conducted in October 2019 and again in December 2019 to verify if the points are still in use (refer to Figure 3.1, Figure 3.2, & Figure 3.3). Waste composition of solid waste dumped at these points was recorded using a designed observation checklist for illegal open dumping spots (refer to

Appendix D). Photographs were taken as evidence of the current state and waste type disposed at these illegal open dumping spots. Field observation has the advantage of observing actual direct problems at hand including characteristics and current management.

3.5.4 Data collection limitations

The following are some of the limitation faced by the researcher during data collecting within households:

- Some respondents did not give informed consent to be interviewed because they were not interested
- In some sampled households, they were no one around to distribute questionnaires
- Some self-administered questionnaires were not fully completed

3.6 Data analysis method

3.6.1 Descriptive Statistics

The study employed descriptive statistics as a method to summarise the findings with the purpose to describe the event that occurred (Thompson, 2009). Descriptive statistics are graphical and numerical techniques that are used to analyse, organise, and present data (Fisher & Marshall, 2009). Descriptive statistics were used to analyse data and presented in percentage using graphs, tables and evidence from photographs. It also helps the researcher to identify the characteristics of an event being investigated which may influence their conclusion. It uses graphs pictorially to communicate the findings. After conducting interviews and distributing questionnaires, it helps the researcher to know the frequency of each question (Christensen *et al*, 2011).

Qualitative data were analysed using a thematic approach. The researcher closely sorts and examines data into the frequency and identifies common themes and ideas from the response collected from questionnaires and interviews. Data analysis of qualitative

descriptive research design unlike other qualitative approaches does not use pre-existing data. The presentation of data from a qualitative descriptive study involves a straightforward descriptive summary of the informational contents of the data that is organized logically and is a scientific method which involves observing and describing the behaviour of a subject without influencing it in any way (Lambert, 2012). Descriptive analysis is a fundamental component process because of the role it plays in helping observe the world or a phenomenon and, subsequently, in identifying research questions and generating hypotheses based on what has been observed (Loeb *et al*., 2017).

3.7 Ethical consideration

- An appendix for sampled household numbers was not provided due to ethical reasons because respondents were assured that the names and household numbers of respondents will be kept confidential.
- Ethical clearance was obtained from the University of Venda Higher Degrees' Committee (Appendix E) as evidence of permission given by the institution to undertake data collection processes.
- Respondents from the sampled household were informed about the purpose of the study using an informed consent letter (Appendix E). The consent to participate in the study was sought and participants were informed that participation is voluntary. However, participants were encouraged to participate in the interview processes for this study. A detailed letter of informed consent was provided and thoroughly explained and after informed consent was obtained from the participant, a copy of the questionnaires was distributed and thoroughly explained.

3.8 Summary

This chapter describes various methods used to collect and analyse the data. The study used a mixed research design integrating both qualitative and quantitative techniques.

Primary and secondary data were used. The study used descriptive statistics to analyse the collected data.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings based on data from distributed questionnaires (Appendix A: household self-administered questionnaire), conducted interviews (Appendix B: interview for convenient households), observation checklist (Appendix C: household observation checklist) and photographs were used as evidence of waste composition observed in illegal open dumping spots.

4.2 Socio-demographic characteristics

This section presents the socio-demographic characteristics of household respondents. The age distribution, education level, and employment status were the socio-demographics investigated. These Socio-demographic were investigated to find out if they influence current solid waste management practices and compare the results among the six sub-villages. It was crucial to acquire socio-demographic data because of its guided household solid waste management analysis with a specific focus on the first three objectives of this study.

4.2.1 Age distribution

Results in Figure 4.1 shows that the age distribution category from 18 to 49 years showed the highest response. Statistically, it shows that Tshishushuru and Khumbe have a high number of age distribution categories from 18 to 49 years compared to other sub-villages. Khumbe and Tshishushuru are the new residential areas with peri-urban lifestyle. According to Boateng *et al*. (2016), the youthful and growing population in urban communities is increasing mainly because of the migration of youth into the urban communities and this is because urban communities have a better lifestyle compared to rural communities. Therefore, waste composition in sub-villages with high respondents with age category from 18 to 49 years will be different due to their modern lifestyles and consumption pattern compared to sub-villages with respondents with age category from 50 to over 60 years. Other villages such as Tshivhale, Zwavhavhili, and

Tshifulanani have a high number of respondents with age category from 50 to over 60 years which are retired individuals and pensioners. This might be due to their general inactivity and therefore they lose interest in community issues. Results showed that the age category from 18 to 49 years had the interest to participate in this study and they do have concerns regarding solid waste management current practices at Lwamondo village.

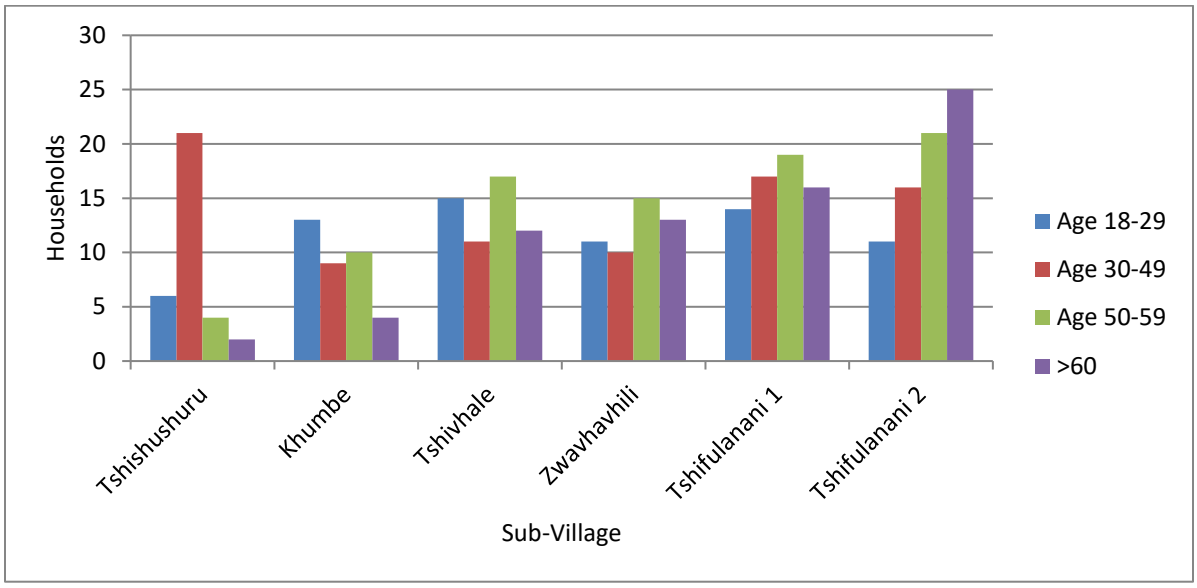

Figure 4. 1: Age distribution in sub-villages (Source: fieldwork, 2019)

4.2.2 Education level

Education level is crucial for this study in terms of giving recommendations for the provision of solid waste management education and awareness. Boateng *et al*. (2016) stated that the educational levels among the residents can significantly affect the success of solid waste management awareness programs aimed at improving solid waste management. Information about waste disposal, including labels on waste containers and educational campaign leaflets, is usually transmitted in written form and so the ability to read and understand such information is very essential. Having a higher number of educated individuals in both secondary and tertiary education categories,

solid waste management education and awareness can be a success at Lwamondo village. The analysis of education level is important for two reasons.

Firstly, the Knowledge about the educational status of the community is important in assisting the service providers in developing strategies to enhance environmental and solid waste management education. Secondly, is that the level of education relates to attitudes towards solid waste management practices. But regardless of education status, without effective enforcement of municipal waste management by-laws and knowledge of proper waste management methods, waste management will continue to be a problem. A notable interest is that all education level categories included in the questionnaire were involved in this study. Having a younger age group interested in this study (Figure 4.1), shows the significance of conducting this study, and where possible it can be a success if solid waste education and awareness programs are offered to a group that has an interest and more active.

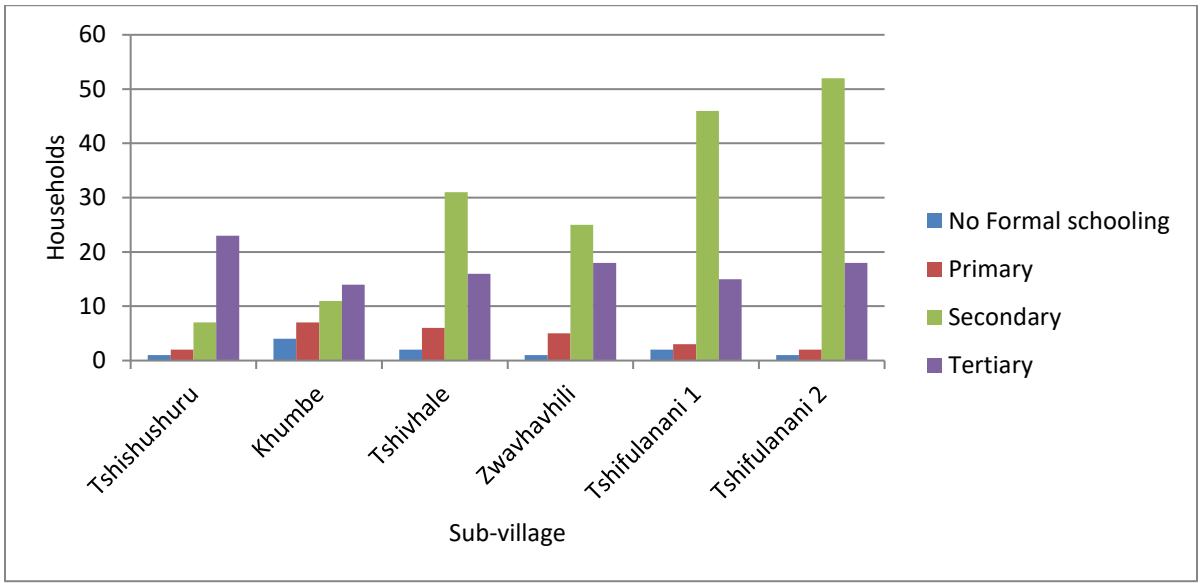

Figure 4. 2: Education level in sub-villages (source: fieldwork, 2019)

Figure 4.2 shows the highest and lowest educational level of respondents within sampled households. Tshishushuru and Tshifulanani 1 and 2 showed a high number of respondents with tertiary education level. The high number of tertiary education level in this area is because is a new residential area with peri-urban characteristics and with a

high majority of young working-class individuals. Zwavhavhili, Tshivhale, Tshifulanani 1 and 2 showed to have a high number of respondents with secondary education level which are mostly retired/ pensioners individuals (. i.e. retired teachers, police officers, and other government officials). Khumbe had an average response in all education categories but with tertiary education having the highest education level in the area. The results show the relativity between age group and education level of sub-villages socio-demographic characteristics.

4.2.3 Employment status

The results presented in Figure 4.3 shows the employment rate within sub-villages. Results showed high response rate in the employed and pensioner category. Dlamini *et al*. (2017) stated that the higher the number of incomes generated is likely to influence the generation of high waste quantities. From Figure 4.3 below, it showed that Tshishushuru has the highest employment rate because the individuals from this sub-village are young working class within the age category of 18 to 49 years (refer to Figure 4.1) and they have shown a high rate of tertiary education level (refer to Figure 4.2) compared to other statistics from other sub-villages. Tshivhale, Zwavhavhili, Tshifulanani 1 and 2 had the highest rate of pensioners because they have a high rate of age category of 50 to over 60 years (refer to Figure 4.1). Results from this study on socio-demographics showed relativity between age distribution, education level and employment status of respondents with specific reference to waste composition generated within sub-villages. For example, waste composition generated at Tshishushuru is determined by age distribution and employment status which is influenced by lifestyle (age) and consumption pattern (employment status). Therefore, waste composition generated at a certain sub-village cannot have the same composition from another sub-village due to the difference in their socio-demographic characteristics.

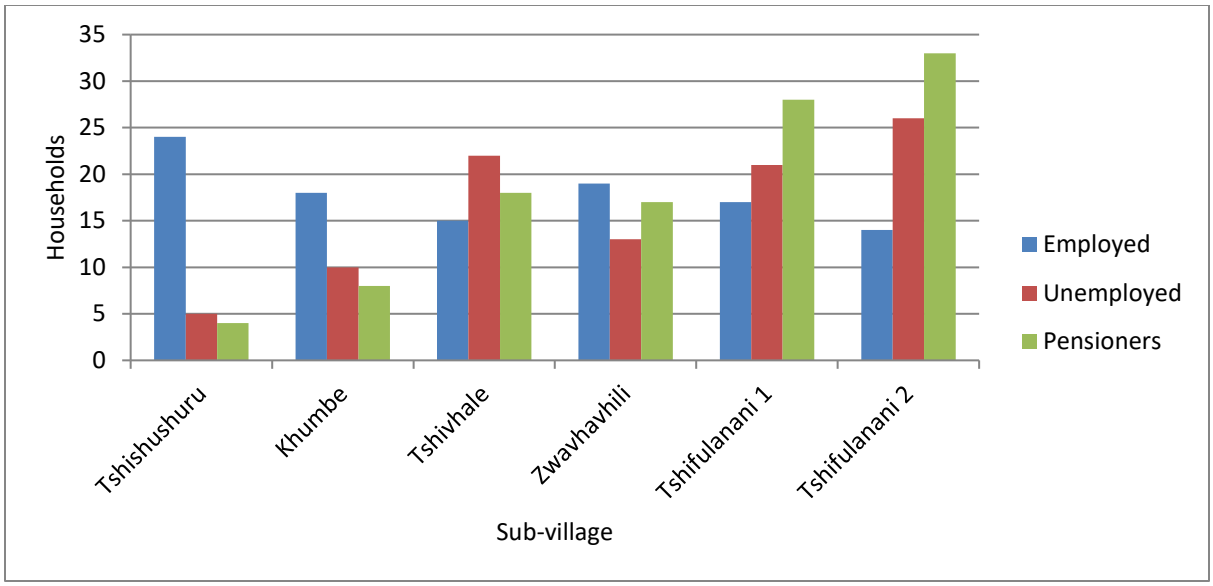

Figure 4. 3: Status of employment in sub-villages

4.3. Peri urban household solid waste composition

Household observation of waste type generated was undertaken to identify major types of waste using a household observation checklist provided (Appendix C).

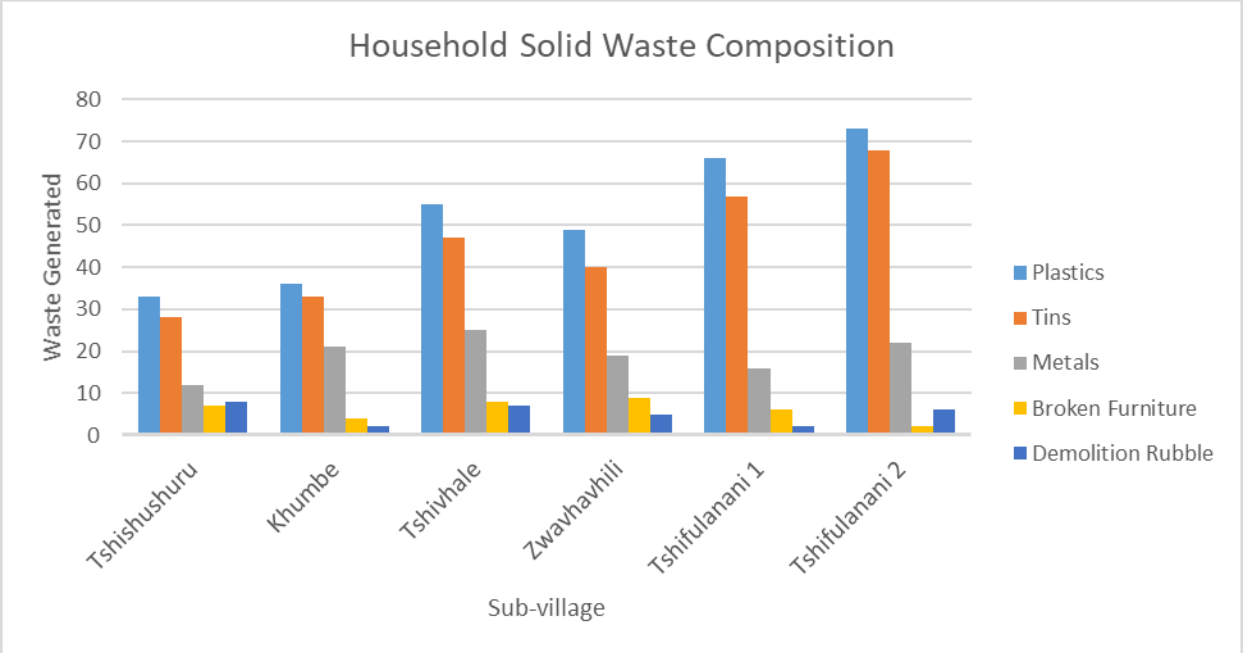

Figure 4. 4: Household solid waste composition

Figure 4.4 above presents the findings obtained during the survey. From the percentages presented below plastic and tin wastes is the most generated waste type within households and then followed by metals, demolition rubble, and plastic furniture, especially roofing material (i.e. Corrugated iron and Harvey tile waste). Farah (2019) stated that plastic consumption in the world is at an average annual growth rate of 7.5% and in developing communities without waste collection services plastic waste quantity is highly increasing. With lower percentage of metal waste in a peri-urban area and modern developmental activities respondent, was asked what do they with waste metal generated? And replied, *"We sell metal waste to a local metal scrap yard in exchange for money, which is not much but we sell because we do not have space to store such waste inside the yard"* **(respondent 1).**

Therefore, it shows that respondents partially practice waste recycling at the recycling facilities around. With high percentage of plastic and tin waste observed it is confirmed that there are no plastic and tin waste recycling opportunities in this area.

With the lowest percentage of rubble demolition within households, respondent was asked what they do with rubble waste generated, and relied that *"We use demolition rubble to patch potholes on gravel roads which are eroded during rainy seasons since we do not receive road maintenance services from the local municipality*" **(respondent 2).**

The statement above confirms that Lwamondo village does have a problem in terms of lack of access roads which constitute a backlog for waste collection services as stated on the Thulamela Local Municipality IDP 2018/19 financial year (P.143).

The photograph below in Plate 1 is evidence of plastic and tin waste generated in households and Plate 2 shows photograph evidence of metal and rubble waste that were disposed within households in the study area.

Plate 1: Plastic and tin wastes (source: fieldwork, 2019)

Plate 2: Rubble and metal waste (source: fieldwork, 2019)

4.3.1 Household Storage

From the study observation undertaken, household open rubbish pits are used as storage for solid waste generated before burning practices. Furthermore, it was observed that many households have a rubbish pit for storing waste to avoid littering inside the yard and waste was disposed of without being separated. Often rubbish pits are located in the corner of the yard, 20m to 30m away from the house to avoid unpleasant smells, breeding rats and flies that are attracted by a mix of waste disposed.

Plate 3: Open rubbish pit (source, fieldwork, 2019)

4.3.2 Collection and transportation

Respondents confirmed that they practice roadside drop-off of waste refuse bags for collection by municipality waste trucks and most of them reside 100 meters radius from the main road (R524). The municipal waste trucks collect waste along the R524 road. From the selected sub-villages, only Zwavhavhili and Tshifulanani 2 are the sub-villages that practice roadside waste drop-off for pick-up because the main road (R524) passes via these sub-villages.

Plate 4: Waste refuse bags for pick up at Zwavhavhili (source: fieldwork, 2019)

Thulamela Local Municipality IDP 2018/19 Financial Year (p.59), Services Norms and standards stated that rural areas refuse is collected once per week. However, respondent have complained and stated that

"Roadside pick-ups in the area can take up to three to four weeks or even longer without being collected and it later results in roadside littering because animals disperse waste from refuse bags" **(respondent 3).**

Dispersed waste causes land and water pollution. Land pollution can be a result of soil contamination because of untreated waste disposed and water pollution can be a result of waste that is washed directly into rivers through runoff and direct disposal of solid waste in floodplains during rainy seasons (Amato et.al, 2019). Thulamela Local Municipality IDP 2018/19 Financial Year (p.59) stated that access roads in rural or isolated residential areas are gravel roads and are not maintained all the time and waste collection in these areas is not done systematically therefore they constitute a backlog. Some resident expressed that,

" *Residents who reside near the main road (R524) sometimes receive waste collection services by dropping waste at the collection point and other residences that own a*

vehicle residing at sub-villages that are located distances away from the main road, transport and drop-off to the nearest collection point" **(respondent 4).**

However, from the statement above, residents who do not own vehicles rely on other methods to dispose and manage waste generated, and this results in improper solid waste disposal and management in the community of Lwamondo Village.

4.4 Illegal Open Dumping Spots Solid Waste

Open solid waste dumping at Lwamondo is becoming a dominant practice for managing solid waste generated and it is becoming more convenient to the majority of households. Without any formal waste collection services rendered in the area and other alternatives for waste collection, residents then choose to dispose of waste in open spaces nearby. During field observation, foul smells were experienced due to disposed remains of dead domesticated pets (mostly cats and dogs) and used disposable diapers in dumping spots rather than burying them in their yards. In each sub-village, a total of three households situated 500 meters radius from the open dumping spots were conveniently interviewed using the Appendix B: Interview questionnaires for convenient households (Table 4.1) is presenting findings from conveniently interviewed households f and they are explained below:

Table 4. 1 **Identified illegal dumping points**

Dumping time	**Point 1**	**Point 2**	**Point 3**	**Total**
	Number Household responded	**Number Household responded**	**Number Household responded**	
hourly	0	0	0	0
daily	1	1	2	4
Weekly	2	2	1	5
				N = 9
Mode of transport				

Car	0	0	1	1
wheelbarrow	2	3	2	7
bucket	0	0	0	0
Refuse bags	1	0	0	1
				N = 9

The table above is showing the response from the 9 households that were interviewed regarding activities occurring in open dumping spots. It shows that they transport waste to dumping spots mostly using a wheelbarrow other than mentioned mode of waste transportation. Results show that residents residing within these points are dumping waste daily and this is a problem that requires urgent intervention from the local municipality and traditional leader too.

- **Point 1**

This illegal dumping hot spot is located at Tshivhale and is situated near the graveyard and playing ground. The characteristics and background of the dumping spot show that the dumping spot has been in use for a long time. The up-close photograph below shows the type of solid waste disposed.

Plate 5: Mix of solid waste disposed (fieldwork, December 2019)

The type of solid waste disposed at this open dump is a mix of non-biodegradables which are plastic, ceramics, glass, and plastic bottles, and used disposable diapers. The reason why they choose to dispose such type of waste is that non-biodegradable waste cannot be used for composting. One respondent complained about to environmental and health problem associated with this dumping spot and stated that,

"The smell from the dumping spot is so irritating and sometimes people intentionally set fire on the waste and the foul odour from the smoke will last for days until the fire put itself out" **(respondent from household 1)**

- **Point 2**

This illegal dumping hot spot is located at Khumbe and there is a Spaza shop nearby apart from households situated near this open dumping spot. The characteristics and background of the dumping spot showed that the dumping spot has been in use for a long time.

Plate 6: Non-biodegradables waste disposed of (fieldwork, December 2019)

Characteristics or type of waste at this open dump is a mix of non-biodegradables which are plastic, disposable diapers, and poly cans (plastic buckets). Residents dispose this type of waste because they do not have space to store or bury such waste which cannot be used for composting. Used disposable diapers are disposed of in open dumping spots to avoid unpleasant smell within household premises. Disposed waste is from both households and Spaza shop nearby. During interviews, a respondent expressed that,

"There are no yet health-related problems and incidents reported that emerged due to uncontrolled waste at this open dumping spot. Regardless of no incidents reported, urgent intervention is required to reduce or prevent health problems that may arise from this" **(respondent from household 2).**

*"We are not aware of environmental and health risks associated with open dumping of solid waste. If they conduct awareness program maybe they will help us understand the impact of dumping waste in open spaces***" (respondent from household 1).**

- **Point 3**

Plate 7: Recent wastes disposed of (fieldwork: December 2019)

This illegal open dumping spot is located at Tshishushuru and is situated near a driving school. Waste characteristics shows that this open dump has been in use for a long time and there is evidence showing recent activities of waste disposal which can be clearly distinguished from burnt waste. From the site visit, it was observed that there are waste burning practices at this open dump and the dominant type of waste observed at this open dump are non-biodegradables which included glass bottles, and newly disposed selling cardboards, used disposable diapers, plastics, and tins.

In conclusion, characteristics of waste in points 1, 2, and 3 have the potential for recycling. This statement is supported by the results shown in Figure 4.5 where plastic waste and tin waste constitute as most generated waste type in Lwamondo and it is the dominant waste type observed at these points that has potential for recycling. There is a notable trend of disposing of used disposable diapers in identified points. Disposable diapers seem to be affordable and save time and cost in washing baby linen and this is one of the reasons why there was a high volume of disposable diapers introduced to the general waste stream of household waste.

Plate 8: Dumped used disposable diapers (fieldwork, December 2019)

Residents expressed that they have concerns regarding used disposable diapers disposed in open dumps and one respondent said that,

"We previously lodged complaints regarding uncontrolled disposal of used disposable diapers which are causing unpleasant smells to the local headmen, nothing was done and till to date, and residents continue to dispose of used diapers in open dumping spots" **(respondent from household 3)**

4.5 Solid Waste Management Practices

Lwamondo falls within the municipality backlog for waste collection services has and Figure 4.5 below presents the findings on current solid waste management practices within the study area.

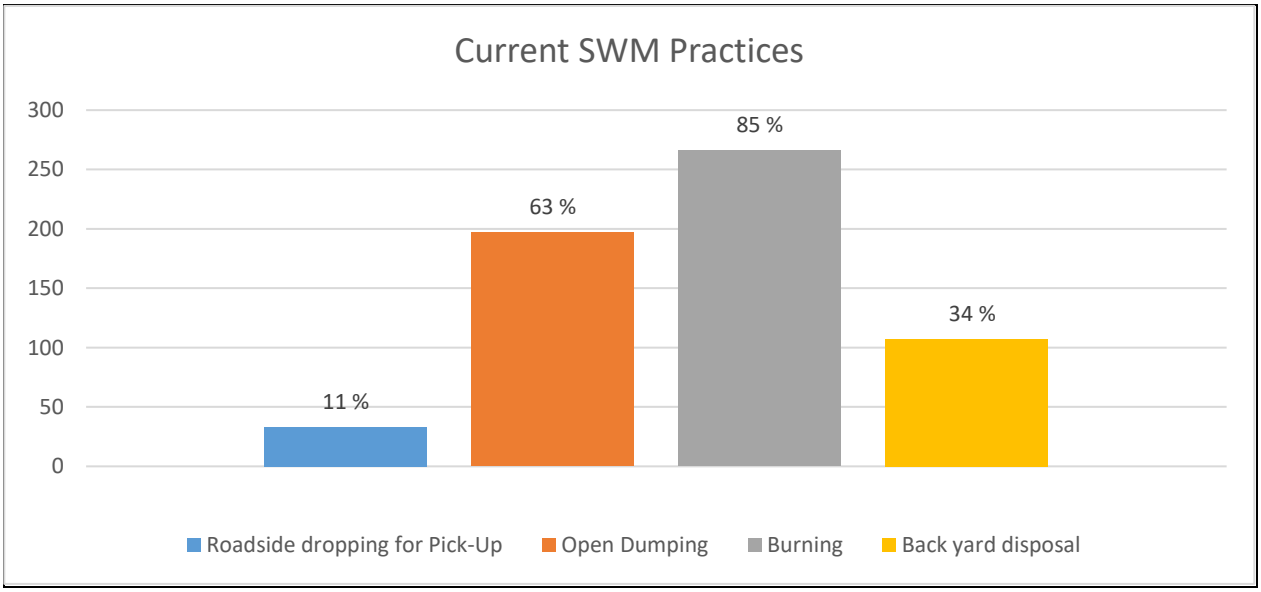

Figure 4.5 Current solid waste management practices

4.5.1 Open dumping

Findings from the figure above showed that solid waste management in the study area is solely dependent on household disposal and management methods which are dumping, burning and backyard disposal of solid waste generated. Results from this study presented in Figure 4.5 above, showed that 63% of residents dump generated solid waste in open dumping spots because they do not receive formal waste collection services and there is no other alternative waste disposing centre in the area. Respondent expressed why they prefer open dumping from other alternatives such as

digging an open rubbish pit. During surveys, two respondents stated that that they do not have a transfer facility nearby and there are no formal waste collection services in the area.

"Since we do not have formal waste collection service from the local municipality, perhaps they should provide skip bins or a transfer facility. More residents dump waste in open spaces, there more such waste will increase to a volume that we as residents we will not be able to control it and in return, it will create health problems to the community **"(respondent 5).**

"Since I have no space to keep waste in my yard, dumping waste is the only solution because we do not have waste collection services here at Lwamondo" **(respondent 6).**

Plate 9: Livestock grazing at an open dumping spot at Tshishushuru (source: fieldwork, 2019)

Tharzigan et.al (2014) stated that there are many major environmental risk factors associated with poor solid waste management which cause many diseases and uncontrolled solid waste disposal can have detrimental effects on human health and

degrade environmental quality. During site visits at Tshishushuru, livestock was seen grazing in an open dumping spot (Plate 9). This can have a detrimental health impact on livestock and also affect subsistence livestock farmers negatively. Therefore, this problem requires urgent intervention by residents, community leaders, and the local municipality to come up with other alternatives that can decrease the creation of open dumping spots.

4.5.2 Burning

Results from this study shows that 85% of residents practice waste burning to manage combustible waste generated such as plastic, paper, and cardboard. With a high number of plastic generations, residents practice waste burning as a method to reduce volumes of plastic waste generated because there are no plastic recycling opportunities in the area other than metal waste recycling. Some respondent stated that,

"It is simpler for them to burn waste generated because it aids in avoiding unwelcome pest and insects such as rodents and flies that may become a result of disposed of generated solid waste" **(respondent 7).**

Plate 10: Solid waste burning (source: fieldwork, 2019)

Yintii *et al*. (2014) stated that the traditionally applied methods of dealing with wastes including burning have been unsuccessful which results in air nuisance and air pollution. Some respondents have stated the very same problem associating with the statement above. Kamara (2006) stated that most preferred methods, especially in areas transitioning from rural to urban areas are dumping and open burning which is associated with air pollution.

4.5.3 Backyard disposal

Results from this study shows that 34% of residents dispose waste in their back yards without an open rubbish pit. From the study site visit, it was observed that large quantities of glass bottles and discarded corrugated Iron (roofing material) which are non-combustible are disposed at backyards in some household and business units. The main accelerating reason for backyard waste disposal is that there is no recycling initiative for potential recyclables identified. Lack of recycling opportunities and waste collections for non-combustible or non-flammable waste increases the creation of illegal dumping spots. Results from conducted interviews showed that there is no solid waste transfer facility nearby or provided in the area. Another reason for practicing backyard disposal is that waste such as green glass bottles has less recycling potential compared to colourless glass bottles.

Plate 11: Liquor store backyard (source: fieldwork 2019)

In conclusion, the most practiced disposal and management methods are dumping and burning of waste and the least practiced are backyard disposal and roadside drop-off for pick up. Residents at Lwamondo village require education and awareness for proper solid waste management methods. They can be encouraged to dispose solid waste in open rubbish pits dug inside the yard to reduce or prevent creation of illegal dumping spots. This can help mitigate impacts that may cause a health problems, for example, Asthma and other respiratory complications which can be triggered by air pollution nuisance. Municipal waste by-laws should be effectively enforced to minimize open dumping practices in the area.

To minimize backyard disposal and burning method, it requires the intervention from the local municipality to come up with strategies that will minimize practicing such methods. Khumalo (2016) stated that there are many problems associated with this method of waste burning such as the release of CH4 and CO2 (regarded as greenhouse gases), contamination of groundwater by leachate from the decomposition of waste, and the contamination of soil with waste from untreated solid waste. Uncontrolled dumping and improper waste handling cause a variety of problems, including contaminated water, attracting insects and rodents, and creating a feeding ground for pests that spread diseases.

4.6 Factors influencing solid waste management practices

Figure 4.5 is presenting the results of factors influencing current waste management practices from the study and Identified factors are explained below.

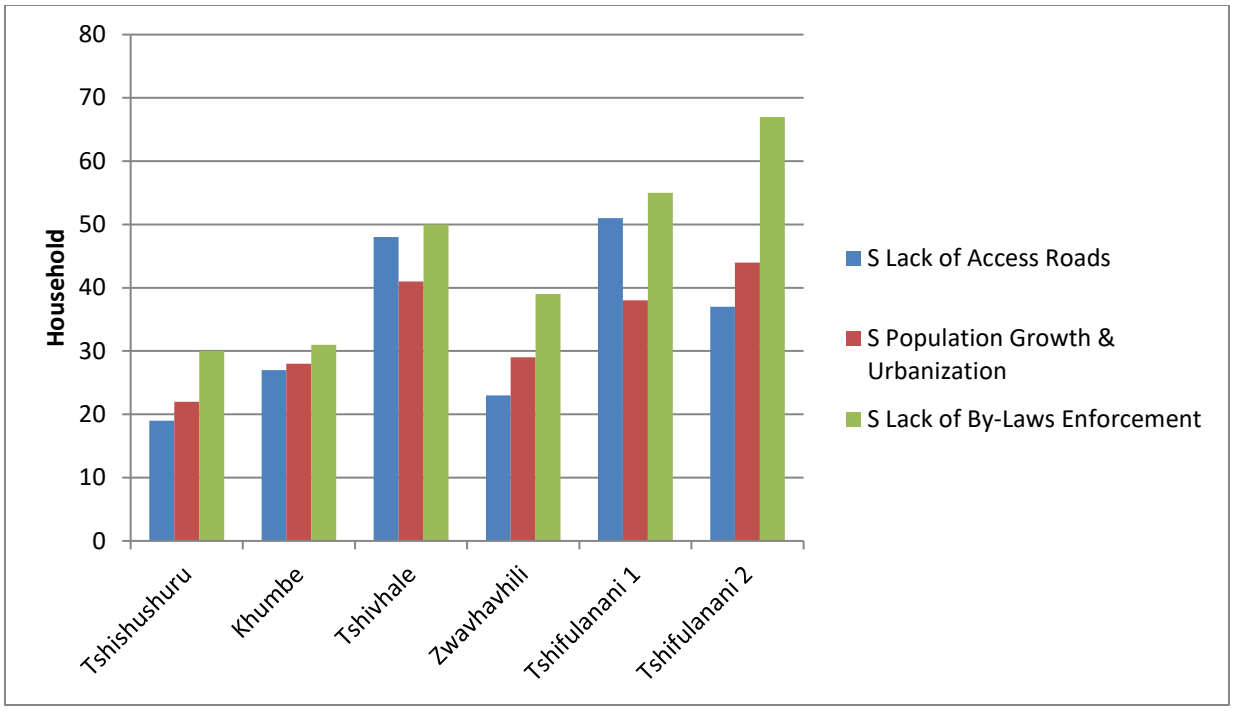

Figure 4. 6 Influencing factors of solid waste management practices (source: fieldwork)

4.6.1 Lack of by-laws enforcement

Findings from this study showed that there is a lack of effective enforcement of municipal waste by-laws at Lwamondo village. One respondent expressed that,

"*There is a lack of effective enforcement of waste by-laws from the local municipality that restrict illegal dumping here in Lwamondo and we have never received education and awareness about solid waste management and that is why community residents are disposing and managing solid waste generated however they see fit because they do not have knowledge that relates to the risk of illegal dumping"* **(respondent 10).**

"Community leaders also tried to curb this illegal dumping of solid waste by assuring penalties to those who will be caught dumping waste in open spaces, but so far they have failed because they cannot do it alone without assistance from the local municipality regarding this problem" **(respondent 11).**

Continuous lack of effective by-laws enforcement will result in the increasing generation of open dumping spots and increased waste volumes in open dumping spots. As a

result, it will cause environmental and health nuisance especially to those who reside near open dumping spots. Ibrahim (2014) stated that by-laws focus mainly on solid waste collection and thus other areas of solid waste management are ignored such as open space disposal and waste generation. Haile (2011) mentioned that for by-laws to be effective people need to know the presence of laws and should penalize the households who violate the regulation. To achieve this, the local municipality should give in-depth suggestions on how they will come about when it comes to implementing effective waste by-laws enforcement.

4.6.2 Lack of access roads

Results from this study shows that lack of access roads accelerate the problem of solid waste management. Respondents agreed that lack of access roads is the influencing factor of current solid waste management practices and the majority of Lwamondo sub-villages are found in an area that only has gravel roads and topographical description of Lwamondo village consists of high gradient slopes. These factors can hinder access to waste collection trucks. Thulamela Local Municipality IDP 2018/2019 (p.143) stated that the municipality has approximately 237.7km of sealed roads and 582.2km of gravel roads which most of which are in rural areas. Therefore, it confirms that the local municipality has a higher number of gravel roads than tarred ones which hinder access to areas such as Lwamondo for waste collection services. Douti *et al*. (2017) stated that the poor nature of roads hinders the waste collection services. With lack of access, the local municipality should come up with alternatives that will minimize illegal waste disposal by providing several communal skip bins in inaccessible locations within the area which will cover both vehicle owners and those who will use a wheelbarrow to transport waste to the nearest communal skip bin One of the respondents explained that,

"Regardless of unmaintained gravel roads, as a community, we feel that the local municipally is neglecting its role to play, such as finding alternatives that reduce the problem of solid waste management in rural areas if they cannot render formal waste collection services" **(respondent 8).**

4.6.3 Population growth and urbanization

Findings from the study indicated that population and urbanization are the influencing factors of current solid waste practices. These factor increases the volumes of solid waste generated and a change in physical characteristics of solid waste generated compared to previous years. The majority of the respondents are from sub-villages that have new residential areas and such sub-villages are Khumbe, Tshishushuru, and Tshivhale. Residents in these sub-villages are building and renovating their houses which result in generating high volumes of roofing and other construction waste. Waste generated from developmental activities is cement paper bags, discarded pieces of roofing materials such as corrugated iron, the rubble of clay roofing tile, and discarded pieces of ceramic floor tiles.

In a socio-demographic context, increasing population growth and urbanization are accelerated by increasing new residential developments, where younger couples are moving out of their former households to owning their households. This statement is supported by age distribution and employment status findings (Figure 4.1 and Figure 4.3). Tshishushuru as a new residential area that has a high number of age categories of 18-49 years old can have a high population number because the category dominant is still in the reproduction age. Therefore consumption patterns and lifestyle will vary due to age categories in other sub-villages. Renton and Luginaah (2018) stated that with population growth, urbanization, and improved living standards, urban regions globally are increasingly producing more waste. Some respondents expressed that

"Since the community population is increasing and residents are practicing modern house developments, it leads to an increased volume of waste generated which requires municipality assistance to manage such volume of solid waste generated in the area" **(respondent 9).**

4.6 Solid waste education and awareness

Table 4.2 below presents the findings of education and awareness of solid waste management. Results from conducted interviews showed that respondents have never

received education and awareness about solid waste management. Awareness campaigns should be used to encourage behavioural change and to consider reusing waste were applicable .The fact that respondents have never received education and awareness also influences current solid waste practices because they do not know the harmful effects that may arise from such methods, Yintii *et al*. (2014) stated that even if a household is already aware of the impacts of plastics such awareness and educational campaigns must still be carried out to remind people continuously. Some respondent expressed that,

"*Even if solid waste management education and awareness is created, with no practical implementation of solid waste management best practices, the solid waste management problem will continue to affect us as a community."* **(Respondent 10)**

Table 4. 2 Education and awareness

Sub-villages	**Household Education and Awareness Received**	
	Yes	**No**
Tshishushuru	0	33
Khumbe	0	36
Tshivhale	0	55
Zwavhavhili	0	49
Tshifulanani 1	0	66
Tshifulanani 2	o	73
Total No. of Households	**0**	**312**
Percentage	**0 %**	**100 %**

Provision of education and awareness at Lwamondo village is very crucial. This will help residents to understand the environmental risk associated with improper disposal of solid waste.

4.8 Solid waste recycling and re-use

Figure 4.7 below shows the recycling and reuse of solid waste within households. These findings will help in determining the potential of recycling initiatives. However, some respondents expressed that,

"We do not get enough money from recycling metals but it reduces metal waste litter in the yard" **(respondent 12).**

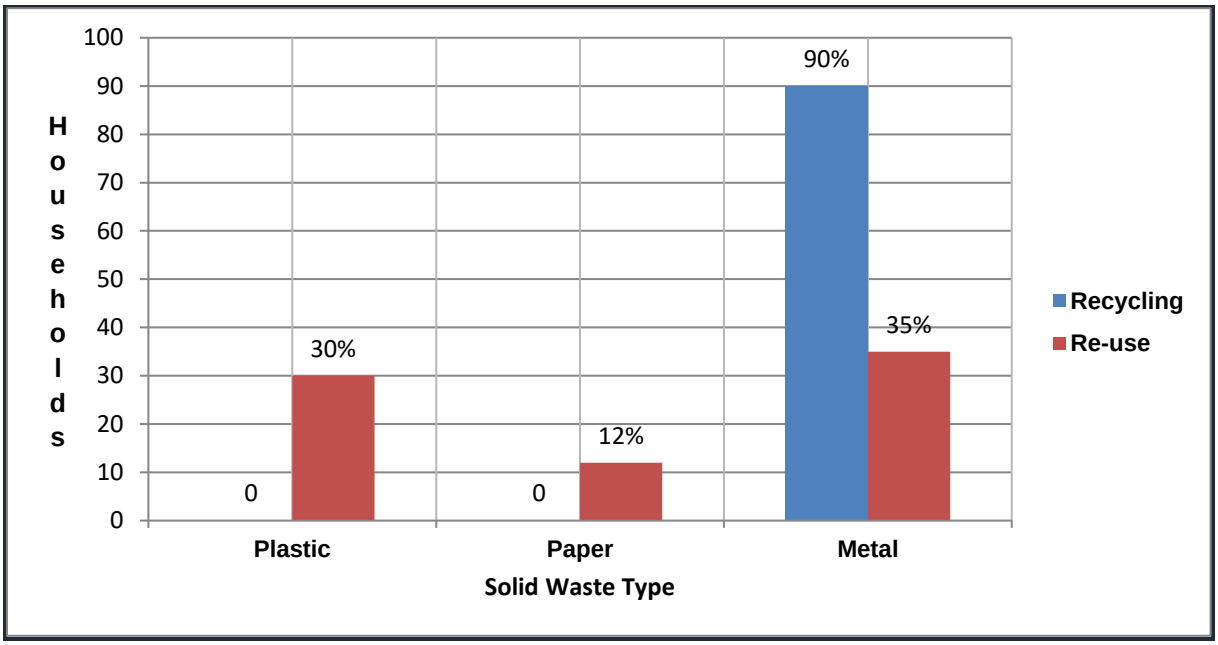

Figure 4. 7: Household recycling and reuse practices (source: fieldwork, 2019)

Figure 4.7 above shows that respondents re-use and recycle metal waste within their households. They stated that they do not throw away plastics bags, especially shopping plastic bags. Some respondents expressed that they re-use saved shopping plastic bags when doing shopping purposes. They also re-use the paper waste generated for their household's minimal uses. There are no paper and plastic recycling initiatives in the area, so residents end up burning or dumping plastic and paper waste. However, some residents store aluminium cans and tins for recycling opportunities, but they expressed that waste collectors prefer heavier metal waste, for example, roofing materials (especially corrugated iron and Harvey tiles), household metal kitchen tables,

broken electric appliances, because they can make better cash-back profit when selling to potential and certified recyclers.

Plate12: Household stored recyclable materials (source: fieldwork, 2019)

Residents also store plastic bottles even when currently they do not have recycling opportunities. Some store them in their yards because they refrain from dumping or burning them. However, they are concerned that with continuous storing of plastic bottles that do not have recycling opportunities in the area, which will lead to disposing them or burning them to reduce volume size.

4.9 Summary

In this section, the demographic characteristics namely age distribution, education level, and emplyment status over Lwamondo village were investigated. Across the village, the composition of waste management and illegal dumping sites were identified. The section also investigated factors influencing the solid waste management and best management practice over Lwamondo village and its surrounding area.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings from the study area and also suggests several recommendations that can be implemented to introduce environmentally friendly solid waste management practices and an effective solid waste management system at Lwamondo village.

5.2 Conclusions

From the results obtained from this study was concluded that at Lwamondo village there is no solid waste management system in the area. Results have indicated that residents of Lwamondo solely depend on themselves to manage waste generated and as such it condones the disposal and management methods that are not environmentally friendly and not regulated or recommended by National Environmental Management: Waste Act 59 0f 2008.

- **Waste Composition of Solid Waste Generated in the Study Area**

Findings from the field survey confirmed that the most waste generated in the study area is plastic and tin waste, and then followed by metals waste. From identified illegal open dumping spots at Tshivhale, Khumbe, and Tshishushuru, most dumped solid waste is plastic, tin, rubble from demolition and construction activities, and dead domestic pets. Plastic waste generation within households is accelerating practicing burn and dump methods. However, if the local municipality can intervene and introduce commercial recycling opportunities and establish buy-back centers could help to recycle the generated recyclables.

- **Current Solid Waste Management Practices**

Findings from this study concluded that residents of Lwamondo village are practicing solid waste management methods that are believed to have empirical negative impacts on the environment and public human health. Such employed methods are dumping, burning, and backyard disposal of solid waste. They practice such methods as an

alternative for managing waste generated because they do not have formal waste collection services, communal skip bins provided, or rather a transfer facility nearby. Residents also confirmed that they do not know how to practice recycling and reuse methods because they have never received education and awareness in solid waste management for them to understand environmental and health risks associated with the methods they are practicing.

- **Factors Influencing Current Solid Waste Management Practices**

Identified and explained factors influencing the current solid waste management practices at Lwamondo village are a lack of waste management by-laws enforcement, lack of access roads, population growth, and urbanization. However, there is no transfer facility nearby and available transfer facilities mentioned on the Thulamela Municipality IDP 2018/19 are Tshikombani which is 33.3 km away, Tshaulu is 60.8 km away and Makonde is 44.4km away from Lwamondo village. Some residents expressed that they have never seen government officials inspecting the area, especially in illegal open dumping spots. Therefore, this confirms a lack of effective waste management by-laws enforcement within the area. They also indicated that they have never heard about education and awareness programs of solid waste management being conducted in the area.

- **Population Growth and Urbanisation**

Population growth and urbanization are influenced by a change in living standards and increase in consumption which increases solid waste volumes generated and the introduction of solid waste characteristics that are were not previously generated. Lwamondo village was described as a peri-urban area in which is still in the transition process of fully becoming an urban area because residents have adopted the modern lifestyle and consumption pattern has increased, which further influences generation of high waste volumes with the waste composition that is generated in an urban area. Thus, it is the responsibility of the local municipality to conduct inspections, especially in illegal open dumping spots so that they can understand waste characteristics which will enable best choosing clean-up techniques or methods.

5.3 Recommendations

The results obtained in this study with an 89.65% response rate shows that residents are interested in understanding the justification of the problem because they too want a solution to the problem at hand. Recommendations are necessary to determine best practices that will help mitigate the problem and introduce best and environmentally friendly solid waste management practices within the study area. And below are the recommendations based on the findings of this study.

- **Transfer Facility and Communal Skip Bins**

Due to lack of road access, and residents confirming that they do not have a transfer facility nearby, the local municipality should establish a nearby transfer facility which will cover residents of Lwamondo village and other nearby communities. This will reduce the creation of illegal open dumping spots, roadside littering which is caused by roadside refuse bags that are dropped for pick-ups. According to Thulamela Municipality IDP 2018/19, based on the provincial macro spatial planning initiatives, Lwamondo village has been identified as a nodal point for Local Strategic Partnership (LSP). And already sub-villages like Zwavhavhili and Tshifulanani 2 which are located near the main road (R524) they have well-established businesses such as roadside hawkers and supermarkets. Heading to this level of spatial and business development, communal skip bins are a necessity along with establishing a waste transfer facility in the area.

- **Solid Waste Education and Awareness**

Findings from this study showed that residents of Lwamondo village are practicing disposal and management methods that are not environmentally friendly and if continued they may pose public human health. Given the results, from a total of 312 (100%) interviewed respondents confirming that they have never received solid waste management education and awareness, it is recommended that the local municipality should conduct education and awareness campaigns and inspections to regulate solid waste management practices within the area, especially in open dumping spots. This idea will help the communities to understand consequences that may arise from

dumping, burning untreated solid waste, and the importance and the benefits of reuse and recycling waste generated.

- **Recycling and reuse**

The local municipality and the community should work together to establish community initiatives and projects that will teach and help introduce the re-use of solid waste. Especially with plastic waste generated within households, DIY activities reusing plastic bags are considered as plastic reuse (e.g. plastic mat weaving or crocheting from plastic bags and other household DIY re-use of plastic bottles). Residents are practicing metal waste recycling, since there local scrapyards that buys metal waste although plastic recycling initiatives should be introduced and practiced as well. This help will reduce the dumping burning of plastic waste generated and reduce stored volumes of plastic waste within households.

- **Establishment of Formal Buy-back Centre**

Findings from the study shows that already 28.85% confirmed that they practice recycling but only for metal waste in exchange for money. With a higher percentage generation of plastic and tin recyclables, commercial recycling initiatives could be a success at Lwamondo village and other nearby communities. With rapid increase in population growth and urbanization as an influential factor, solid waste generation volumes will increase in bulk quantities. Therefore with the increase in solid waste recyclables volume, successful commercial recycling business will be in the area.

- **Waste Composting**

Through education and awareness campaigns, it is recommended that residents should be taught to generate compost waste because it saves storage and is more environmentally friendly compared to waste burning. Composting avoids methane emissions because these program is a way of reducing both waste management emissions and cost. Compost is a valuable soil amendment and its benefits include increased soil organic matter, soil nutrients, improved plant growth, reduce erosion, and to help control plant diseases. It only requires using biodegradable materials to build composts. Therefore, residents should be encouraged to undertake home composting.

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APPENDIXES

Appendix A: Household Self-administered Questionnaire

Good morning/ afternoon, I am Fhumulani Nelwamondo; I am a student at the University of Venda conducting a study on *Analysis of village Peri-urban household Solid Waste Management System: A Case of Lwamondo* for Master's Degree in Environmental Sciences. This questionnaire is designed to examine current of solid waste management system within Lwamondo. The information to be collected will be used to identify challenges and constrains and enable accurate assessment of solid waste management system at Lwamondo Village. The names and household numbers will be not be mention during analysis and completed questionnaire records will be kept confidential.

Do you agree to be interviewed today?

☐ Yes
☐ No

Place: …… Date: ……

1. **Demographic Characteristics**

Age (Tick were applicable)

18 - 29	
30 - 49	
50-59	
>60	

Education Level (Tick were applicable)

No formal schooling	
Primary	
Secondary	
Tertiary	

Employment Status (Tick were applicable)

Employed	
Unemployed	
Pensioners	

2. Current Solid Waste Management Practices

(Choose as many as applicable)

☐ Formal waste collection services

☐ Roadside dropping for pick up

☐ Open dumping

☐ Burning

☐ Burying

3. A Factors Influencing the Current Solid Waste Management Practices

(Choose as many as applicable)

☐ Lack of access roads

☐ Population growth and urbanization

☐ Lack of by-laws enforcement

Are there any solid waste transfer facilities nearby or provided?

☐ Yes ☐ No

If yes where? .....

Have you ever received education and awareness regarding solid waste management from the local municipality?

☐ Yes ☐ No

If yes, When? ……

Does your household practice the following solid waste management strategies in your area?

Recycle ☐ Yes ☐ No

Re-use ☐ Yes ☐ No

Solid Waste Type: Metals ☐ Plastic ☐ Paper ☐

Thank You.

Appendix B: Interview questionnaires for convenient households

Good morning/ afternoon, I am Fhumulani Nelwamondo; I am a student at the University of Venda conducting a study on *Analysis of village Peri-urban household Solid Waste Management System: A Case of Lwamondo* for Master's Degree in Environmental Sciences. This questionnaire is designed to examine current of solid waste management system within Lwamondo. The information to be collected will be used to identify challenges and constrains and enable accurate assessment of solid waste management system at Lwamondo Village. The names and household numbers will be not be mention during analysis and completed questionnaire records will be kept confidential.

Do you agree to be interviewed today?

☐ Yes
☐ No

Place: …… Date: ……..

1. How often do you see people dumping waste at this this illegal open dumping spot? (Point No……..)

☐ Hourly

☐ Daily

☐ Weekly

2. What do they use to carry or transport waste to the dumping spot?

☐ A car

☐ A wheelbarrow

☐ Buckets

☐ Refuse bags

3. Are the any environmental and health impacts you experience associated with this open dumping spot? If yes, explain.

……

……

……

……

Thank you.

Appendix C: Household Observation Checklist

Waste Composition	Tick
Tins	
Plastics	
Demolition Rubble	
Metals	
Broken furniture	
Ceramics	
Used disposable diapers	

Appendix D: Ethical Clearance Certificate

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Ms F Nelwamondo

Student No:
11570177

PROJECT TITLE: **Rural solid waste management system: A case study of Lwamondo village**

PROJECT NO: **SES/19/GGIS/14/2011**

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr NV Mudau	University of Venda	Supervisor
Mr MJ Mokgoebo	University of Western Cape	Co - Supervisor
Ms F Nelwamondo	University of Venda	Investigator – Student

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: November 2019
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: .....
Name of the Chairperson of the Committee: Senior Prof. G.E. Ekosse

UNIVERSITY OF VENDA
DIRECTOR
RESEARCH AND INNOVATION
2019 -11- 20
Private Bag X5050
Thohoyandou 0950

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950λ LIMPOPO PROVINCEλ SOUTH AFRICA
TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University"

Appendix E: Informed Consent Letter

RESEARCH ETHICS COMMITTEE

UNIVEN Informed Consent

LETTER OF INFORMATION

Title of the Research Study : Rural Solid Waste Management System: A Case Study of Lwamondo Village

Principal Investigator/s/ researcher : Fhumulani Nelwamondo, Honours

Co-Investigator/s/supervisor/s : Dr Mudau N.V, PhD
: Mr Mokgoebo M.J, Masters

Brief Introduction and Purpose of the Study: The main aim of the study is to examine current rural solid waste management system of Lwamondo Village

Outline of the Procedures: The study will use the mix of open-ended and close-ended questionnaires as a method of collecting data from participants of the randomly selected households. Expected outcome of the interview is to acquire data on current solid waste management practices, factors influencing such practices and observation of physical characteristics of generated solid waste using observation checklist.

Risks or Discomforts to the Participant: The discomforts may only occur to participants that may feel uncomfortable being interviewed and no risks are expected during the interview process

Benefits: The study will enhance rural solid waste management practices in an environmental sustainable way by bringing awareness to the community about other environmental viable ways of managing and recycling solid waste that will enhance environmental quality and lessen environmental pollution and illegal disposal of solid waste within the study area.

Reason/s why the Participant May Be Withdrawn from the Study: who don't understand the study and expect to be compensated for being interviewed.

Remuneration : No remuneration for Participants.

Costs of the Study : The study will not cost anything to the participant.

Confidentiality: Participant will be assured that information will be kept confidential and never be disclosed without their consent.

Research-related Injury: There will be no research-related activity that will cause an injury during the study Persons to Contact in the Event of Any Problems or Queries:

Please contact the Researcher, Fhumulani Nelwamondo (Cell no. 0834898358), Research Supervisor Dr Mudau N.V (Tel no. 015 962 8591) or the University Research Ethics Committee Secretariat on 015 962 9058. Complaints can be reported to the Director: Research and Innovation, Prof GE Ekosse on 015 962 8313 or Georges Ivo.Ekosse@univen.ac.za

General:
Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, (*name of researcher*), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _,
- I have also received, read and understood the above written information (*Participant Letter of Information*) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant Date Time Signature

I, ……... …… …… ……..
(*Name of researcher*) herewith confirm that the above participant has been fully Informed about the nature, conduct and risks of the above study.

Full Name of Researcher

Ms Fhumulani Nelwamondo Date…….. Signature……

Full Name of Witness (If applicable)

…….. Date …….. Signature……..

Full Name of Legal Guardian (If applicable)

…….. Date…….. Signature……

Please note the following:

Research details must be provided in a clear, simple and culturally appropriate manner and prospective participants should be helped to arrive at an informed decision by use of appropriate language (grade 10 level- use Flesch Reading Ease Scores on Microsoft Word), selecting of a non-threatening environment for interaction and the availability of peer counseling (Department of Health, 2004)

If the potential participant is unable to read/illiterate, then a right thumb print is required and an impartial witness, who is literate and knows the participant e.g. parent, sibling, friend, pastor, etc. should verify in writing, duly signed that informed verbal consent was obtained (Department of Health, 2004).

If anyone makes a mistake completing this document e.g. a wrong date or spelling mistake, a new document has to be completed. The incomplete original document has to be kept in the participant's file and not thrown away, and copies thereof must be issued to the participant.

References:

Department of Health: 2004. *Ethics in Health Research: Principles, Structures and Processes*

http://www.doh.gov.za/docs/factsheets/guidelines/ethnics/

Department of Health 2006. *South African Good Clinical Practice Guidelines*. 2nd Ed. Available at:

http://www.nhrec.org.za/?page_id=14