Cape Peninsula University of Technology

SOLID WASTE MANAGEMENT SYSTEMS IN THREE URBAN AREAS OF NAMIBIA

By

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DECLARATION

I, Lovisa Nangula Amwele, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore,it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed  **Date** 2023 Mar 22

ABSTRACT

Globally, environmental concerns on the issue of waste have taken a significant position in many discussions and programmes dealing with environmental management. A problem among developing towns is the lack of proper mechanisms to tackle the solid waste management demands. Rapid urbanisation, inadequate management, poor environmental management awareness and disadvantaged technological and financial availability have constrained the capability of town councils to provide good waste management services, resulting in numerous social and environmental harms. The Namibian Constitution similar to other countries stipulates that every citizen has the right to a clean environment.

This study investigated the status of the existing management systems of solid waste collection, transportation, and disposal in 3 Namibian towns namely, Oniipa, Ondangwa and Ongwediva Towns. Moreover, the study examined the impacts of solid waste management on the environment and assessed the community's perceptions of solid waste management.

The methods used to collect data included questionnaires, surveys, interviews, and physical observation. Eighty - Four (84) community members across the informal settlements of the three towns were randomly selected to collect data.

The study found the following vital factors affecting solid waste management systems in the cities: poor methods of waste disposal, few skip containers distributed, inadequate transport infrastructure, low waste collection frequencies, financial constraints, and poor public awareness of waste management. These conditions degraded the environment in the study area.

Furthermore, based on the study's results, several recommendations have been provided for an improved solid waste management system in the towns. Part of the solutions might be a provision of more educational awareness on solid waste management in the towns, distribution of adequate waste bags and bins for each household, increasing waste collection points, skips and frequencies, as well as raising funds to construct a landfill for the Oniipa town and the management of Ongwediva and Ondangwa dump fills. Addressing the challenges reported in this study will lead towards a clean environment and shed light on methods to be used to manage waste appropriately.

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DEDICATION

I dedicate this thesis to my mother and my grandmother.

Omuwa ondeku pandula unene.

(Lord I am thankful)

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ABBREVIATIONS / ACRONYMS

COW	City of Windhoek
DEA	Department of Environmental Affairs
ECC	Environmental Clearance Certificate
GRN	Government of the Republic of Namibia
ISWM	Integrated Solid Waste Management
ISWMH	Integrated Solid Waste Management Hierarchy
ISWMP	Integrated Solid Waste Management Plan
MEFT	Ministry of Environmental Forestry and Tourism
N$	Namibian Dollar
NEWS	Namibia Environment and Wildlife Society
NSA	Namibia Statistics Agency
PPP	Polluter Pays Principle
SDAC	Sustainable Development Advisory Council
SWM	Solid Waste Management

CHAPTER ONE (1) INTRODUCTION

1.1. Introduction and Background

Waste alone threatens the integrity of the environment due to its negative environmental impacts, which also press threats such as air pollution, illegal dumping of waste, and poor sanitation (Hasheela, 2009). The Environmental Management Act 7 of 2007 has highlighted waste management as one of the essential aspects of environmental management in Namibia. The effectiveness of the MSWM system is highly linked to a good understanding of waste generation, collection and disposal drivers, the amount of waste produced, economic costs involved, and the technology used in combating waste (Kadhila, 2019). In the Namibian context, the process of MSWM has evolved, and the population has grown over time; this demands the need to update waste management plans accordingly to keep up with these changes. Through adequate research activities, Namibia can be in a better position to advance its MSWM system in its towns, cities, and villages to manage waste appropriately.

Despite the necessity to address the environmental problems, challenges are often experienced, notably because some towns lack the institutional capacities to deal with some of these problems (Hasheela, 2009).

The focus of this study was to investigate the solid waste management systems in urban areas, Oniipa, Ondangwa and Ongwediva of Namibia. The sample population comprised 84 participants. Both quantitative and qualitative data were collected through one-on-one and telephonic interviews as well as through the completion of questionnaires. In carrying out this study, ethical considerations were followed.

1.2. Statement of the research problem

Over the past decades, population growth and urbanisation have resulted in environmental problems such as solid waste due to poor management practices (Abubakar et al., 2022). Local government institutions are usually liable for waste management in towns. The management of solid waste stands as the most visible environmental challenge that is faced by countries which are reaching a troublesome depth with the increasing rate of urbanisation. The rising rate of solid waste production sets a weight on the infrastructure which results in many problems regarding settlement waste management, where solid waste is seen in most parts of the town, along the roads, within the neighbourhoods and around residences. The Environmental Management Act No. 7 of 2007 provides the strategic basis for waste management in Namibia (Ruppel et al., 2022). The Act requires that all public and private institutions put in place effective waste management systems to avoid damage to the environment and negative human health impacts emanating from waste. Nevertheless, most towns and settlements still do not have comprehensive environmental management systems, policies and strategies in place, due to capacity issues and inadequate resources (Ferronato and Torretta, 2019).

Around the world, a number of studies have been conducted around solid waste topics which include

but are not limited to environmental impacts of solid waste, waste disposal systems and impacts associated with landfills or dumpsites. However, it is questionable whether their values have been apprehended. And if so, whether they are being implemented in Namibia, particularly because some town management systems seem to be ineffective with the issue of solid waste. additionally, there has been no research conducted in the northern region towns of Namibia. Furthermore, the inability to address squander-related issues is relied upon to prompt various social and ecological problems; hence the need to enhance mechanically perplexing, institutionally productive and financially savvy strong waste management systems.

1.3. Aims and Objectives

This study aimed to assess the status of solid waste management systems in Oniipa, Ondangwa and Ongwediva towns. Besides the principal aim as stated above, the study also included a number of more specific objectives, which are seen as fundamental factors to recognising the principal aim. These objectives were:

1. To investigate the status of the existing management systems of solid waste collection, transportation and disposal in Namibia's northern region towns (Oniipa, Ondangwa, and Ongwediva)
2. To examine the impacts of solid waste on the environment
3. To investigate and record the community's perceptions, viewpoints and expectations with regard to the waste management system in Oniipa, Ondangwa, and Ongwediva.

1.4. Research questions

To achieve the above objectives, the following research questions were used:

1. What is the status of the existing management system of solid waste collection, transportation and disposal in Oniipa, Ondangwa, and Ongwediva towns?
2. Do community members and other stakeholders understand solid waste management?
3. What is the extent of solid waste management issues in Oniipa, Ondangwa and Ongwediva towns?

1.5. Significance of the study

Arranging basic infrastructure services for the community is crucial to the concept of environmental sustainability in developing countries. The seriousness of poor solid waste management systems in developing nations, calls for more research to be done in discovering solutions to minimise the cases attributed to the problem. Nations have not adopted proper and efficient solid waste management systems, especially in newly established towns. This study proposes new solid waste management systems that northern Namibia towns such as Oniipa, Ondangwa, and Ongwediva can adopt to improve the current implemented systems.

However, ensuring a smooth running and constantly improved waste management systems in

a town will also depend on the feedback gained through the involvement and participation of the community. Such data and exercises can be acquired uniquely through research and studies; thus, a study, for example, can aid the improvement and execution of solid waste management strategies in developing towns. However, if the issue is abandoned, this can pose devastating consequences on the state of the environment in terms of human health and social and economic factors. This research will benefit these towns' community members and the neighbouring town of Oshakati since they are connected. To future researchers, the proposed study will be helpful in using it as a guide to successful research.

1.6. Limitations of the study

There is a variety of limitations of this study such as time limitations and cost constraints. The study was localised in 3 Namibian towns and more areas would have increased the study's generalisability. But now it will only cover a small area which makes the study to be less generalisability. While carrying out the study, the researcher realised that some respondents had not enough information on solid waste management. They were not aware of the financial, technical, social, political, and institutional aspects of Solid Waste Management. During the research, the researcher found out that some respondents were avoiding giving sensitive information since they feared victimisation. Due to the days and period, the survey was completed, the researcher only managed to work with a sample size of 84 community members who were surveyed employing questionnaires and interviews mostly from the informal settlements of Okalevona and Okakwiyu, New inception, Omashaka, Okangwena, and Uupopo to provide their input on the topic at hand.

1.7. Organisation of the thesis

This thesis has been structured in chapters as below:

Chapter 1: Introduction – This chapter gives the background to the study, research problem, objectives of the study, questions of the study, significance of the study,

Chapter 2: Introduction – Literature review which gives a detailed analysis of the literature related to this study.

Chapter 3: Research Design and Methodology – This chapter discusses the design and methodology used in this study. The study population, sample and sampling techniques, methods and procedures for data production, and data analysis were discussed.

Chapter 4: Results and Discussion – This chapter presents, discusses and interprets data to give meaning to the research findings.

Chapter 5: Conclusion and Recommendation – In this chapter, the researcher summarises the entire study, made conclusions and offered recommendations based on the research findings.

1.8. Conclusion

This chapter introduced the study and provided the statement of the research problem, aims and objectives, research questions, the significance of the study, and the organisation of the thesis. The next chapter discusses the literature review related to this study.

CHAPTER TWO (2) LITERATURE REVIEW

2.1. Introduction

This section presents a review of different literature that is related to this study. There are minimal historic studies conducted in the study area on the subject matter. For this reason, it is significant to review a variety of literature to justify the research and identify the purpose of this study. As per Anderson (2013) three different types of literature sources are primary literature sources, grey literature, and published literature sources.

2.2. Global solid waste management systems

Waste is a global problem, especially in developing countries, this is particularly true in upcoming urban areas where the population is quickly growing, and the amount of waste generated is increasing continuously (Ferronato and Torretta, 2019). Urbanisation and industrialisation cause behaviours that affect the waste composition, especially from organic to synthetic materials that last longer, for instance, plastics and other packaging materials (Idris *et al*., 2004). Waste is mainly generated from households, commercial centres, institutions, hotels and health facilities. Sujauddin *et al*. (2008) and Guerrero (2013) have identified factors influencing waste management systems in developing countries, such as family size, education level, and monthly income. Furthermore, Babayemi (2009) states that waste generation in Nigeria is influenced by the kind of commercial activities being practised. Moreover, Asase *et al*. (2009) emphasised that the factors affecting the environmental aspect of solid waste management in developing countries are the deficiency of environmental control systems and the evaluation of the natural impacts. It should also be noted that the lack of consideration of perceptions and awareness of communities that are both producers of solid waste and often victims of improper Waste Management Systems are an important factor often neglected in the quest to improve waste management and policies, especially in developing countries (Oyedotun *et al*., 2020).

The collected fraction of waste in low-income countries almost entirely goes to open dumps and landfills (Laurent, 2014). Due to the increasing amount of waste received in landfills triggers other disposal options since constructing new landfills can be demanding, for example, scarcity of land (Manaf *et al*., 2009). Likewise, Guerero (2013) argued that an inadequate supply of waste containers and a longer distance to these containers raises the chances of waste being dumped in open areas and along the roads instead of using the provided containers. Furthermore, Pokhrel and Viraraghavan (2005), who did a study on the practices and challenges of Municipal Solid Waste Management (MSWM) in Nepal, added that there is a lack of financial resources and absence of legislation which is a limiting factor to constructing safe well-furnished and engineered landfills. Consequently, it causes severe environmental harms, for instance, excellent methane release that will contribute to climate change (Bogner *et al*.,

2007), human health impacts via direct exposure to hazardous constituents and pathogens (for workers, waste pickers and surrounding population) and indirect exposure via ingestion of contaminated water and food (Giusti, 2009).

The waste management system is mainly controlled through certain aspects that include technical, environmental, financial, socio-cultural, institutional and regulations (Yukalang, 2017). In European countries, waste prevention is part of the European legal framework and is prioritised in the waste hierarchy. However, to effectively quantify the environmental benefits of waste prevention, there should be knowledge of the studied waste management system and the upstream product system (Laurent, 2014). The U.S. EPA (2009), as a guardian of the environment, advocates for trash reduction through source reduction, recycling, and composting to accomplish long-term solid waste management (Chatterson, 2018). Waste prevention activities may be linked to changes in other activities that could have a more impact than the waste generated before the prevention activity took place; this is called rebound effects. However, their identification and environmental quantification have to be systematically performed in Life Cycle Assessment (LCA), and there is currently no consensus on how this can be done (Hertwich, 2005). The operational productivity of solid waste management also depends on the municipal agencies and the public's active involvement, meaning community awareness and involvement in decision-making should be considered (Ngeleka, 2010).

In another study by Subramani *et al*. (2014), in Salem District (India), waste is collected by local authorities from homes through a regular waste collection with frequencies that vary from 14 times a week to 1 time a week or by special collections for recycling. Olukanni *et al*. (2016) reported that the collection, transfer, and transportation of waste practices in Nigeria are affected by inappropriate bin collection systems, poor route planning, lack of awareness about collection schedules and insufficient infrastructure. Another hindering factor is deprived roads and the number of vehicles for waste collection (Henry *et al*., 2006). Furthermore, in Rawalpindi city (Pakistan), solid waste is collected through the deployment of sweepers and sanitary crew in the street using wheelbarrows and hand carts provided by the municipal authority. However, in the remote area where municipal authorities are not providing any facility for the collection and disposal of solid wastes, scavenging by people and animals, natural biodegradation of organic wastes, and burning are also considered disposal practices because there is no appropriate landfill or waste disposal site (Ejaz *et al*., 2010).

To ensure an effective and efficient SWM, the system must be integrated, which is also known as Integrated Solid Waste Management (ISWM) (Hoornweg and Thomas, 1999). Furthermore, the utilisation of technology in SWM in cities and towns is encouraged. Though, as per Sankoh *et al*. (2013), the correct technology choice becomes paramount. Based on this, it was claimed by Lee et al. (2016), who appealed that the waste crisis is caused mainly by factors such as mass consumption, technological advancement, the change in people's practices in consumption, and waste disposal behaviour.

Different factors determine the effectiveness of the ISWM, for example, employees working with

SWM, the appreciation of critical roles of the community, and professionalism among solid waste managers (Van de Klundet and Anschütz, 2001). Regarding Lee *et al*. (2016), the ladders of waste management, namely reduce, re-use and recycle, are essential tools to manage municipal solid waste. Nevertheless, the increase in resource scarcity in the contemporary world makes it challenging to secure land for landfills or dumpsites Lee *et al*. (2016). Based on the preceding sentence, it is significant that experts responsible for solid waste management within municipalities and town councils select ISWM and use the 4Rs that prioritise more on reduction, recycling, recovery, and prevention as an alternative to waste treatment and disposal only. Moreover, Modak (2010) suggested that ISWM should be directed by the Integrated Solid Waste Management Plan (ISWMP).

2.3. Status of solid waste management systems in Namibia

Namibia also historically known as Southwest Africa, is located in southern Africa and shares boundaries with South Africa, Angola, Botswana, Zambia, and Botswana. According to Namibian Statistics Agency (2011), the country covers a surface area of approximately 825 814 km². The Namibian population increased from 1.4 million in 1991 to 1.8 million in 2001 and 2.1 million in 2011. The trend shows a steady increase in the Namibian population and is expected to increase. Namibia is a multifocal environment with a vast number of natural resources on which its economy almost depends (NSA, 2011). Namibia is one of the resource-rich countries in southern Africa and is not classified among the poorest countries in the world (Hasheela, 2009).

Like many countries in the world, Namibia faces many environmental threats resulting from the dichotomy between development and environment, which require holistic management to attain the goal of sustainable development (Ruppel *et al*., 2022). The Department of Environmental Affairs (DEA) under the Ministry of Environmental Forestry and Tourism (MEFT) is the leading agency for promoting sustainable development (Nangombe, 2021). Generally, environmental threats are the factors that impact the environment negatively, in many cases resulting in environmental problems such as pollution, population growth, increasing pressure on resources, and urbanisation (Omofonmwan, 2008). When not managed, such threats negatively impact the environment, resulting in disasters such as species decline and extinction, health problems and diseases, climate change, and land degradation (Miller, 2007).

Although there are many stakeholders in waste management in Namibia, waste management is a priority for the government. The management of solid waste in Namibia is the local authority's responsibility, including municipalities and town councils. These authorities work closely with the private sector and businesses. Generally, the current waste management systems leave much to be looked for, meaning wastes generated from all the sectors of the economy are currently not well managed. Waste disposal sites in most areas of jurisdiction are either not there or poorly managed (Kadhila, 2019). Taking the capital city (Windhoek) situation as the point of reference, less than 15 % of the waste generated in the urban centres finds its way to the disposal sites (Mulenga, 2001). In addition, there is generally inadequate data for other waste streams, especially for areas outside

Windhoek. Managing various waste types has been complex and challenging over the years.

Improvements are desired in waste management, covering minimisation of waste generation, collection, re-use, recycling, treatment, and disposal. In this regard and to promote recycling, various partners from the private sector, particularly the recycling companies, have started an initiative that encourages using bins for collecting recyclable products (Schenck, 2009). During this initiative, recycling stations have been placed in front of various shopping centres and dumpsites, where the following waste products: cans, glass, papers, and plastics are collected for recycling purposes. The initiative, previously only operational in Windhoek, has spread across to other towns of Namibia, such as Ondangwa and Ongwediva. The partners in this initiative are Rent-a-Drum Group of Companies (Rent-a-Drum and Namibia Environment and Wildlife Society (NEWS) (Hasheela, 2009).

Furthermore, the Government of the Republic of Namibia enacted legislation such as the Environmental Management Act No. 7 of 2007 to control activities related to environmental protection. Most municipalities and town councils in the country have not been able to adequately deliver services to their residents. The poor performance of such local authorities is primarily due to the financial problems due to a narrow resource base, untapped potential for income generation and outdated policies (Schenck, 2009).

2.4. Types and sources of solid wastes

Ramachandra (2006) noted that daily human activities produce different types of solid waste. The types of solid waste such as plastic, recyclable metals, tires, glass, wood, used batteries, food waste, and paints, among others, are produced from different sources, for example, residential, industrial, commercial, institutional, construction and demolition, municipal services, process (manufacturing), and agriculture (Abubakar *et al.,* 2022).

The table below summarises the classification of types and sources of solid waste:

Table 1 - Sources and types of solid wastes (source: Hoornweg and Thomas, 1999)

Sources	Typical generators	Types of solid wastes
Residential	Single and multifamily dwellings.	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires) and household hazardous wastes).
Industry	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, and special wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, and hazardous wastes.
Institutional	Schools, hospitals, prisons, and government centres.	Same as commercials.
Construction and demolition	New construction sites, road repair, renovation sites, and demolition of buildings.	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water, and wastewater treatment plants	Street sweeping, landscape and tree trimmings, general wastes from parks, beaches and other recreational areas, and sludge.
Process (manufacturing)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction, and processing.	Industrial process wastes, scrap materials, off-specification products, and slay tailings.
Agriculture	Crops, orchards, vineyards, dairies, feedlots, and farms.	Spoiled food wastes, agricultures waste, and hazardous wastes.

2.5. Integrated Solid Waste Management Hierarchy

The integrated solid waste management Hierarchy (ISWMH) is a notion that encourages waste avoidance and general minimisation ahead of reduction, re-use, recycling, and disposal (Zhang *et al*., 2022). According to Gertsakis and Lewis (2003), the shortened version of the hierarchy, "reduce, re-use, and recycle", is often used in community education campaigns and has become a well-recognised catchphrase for waste reduction and resource recovery. As a notion, the hierarchy is relevant in a challenging way to oppose. It echoes methods prevalent in human health and medicine: prevention is better than cure (Gertsakis and Lewis, 2003). The majority would agree that preventing problems from the onset is far better than pumping resources into reactive solutions once the problem has been presented. The parallels between environmental protection and human health are the same and reinforced by substantial scientific evidence and knowledge (Manisalidis *et al*., 2010).

In Namibia, the hierarchy embedded in the City of Windhoek (CoW) Solid Waste Management Policy explicitly states that "waste avoidance and reduction should be the first option; if waste cannot be avoided, then efforts should be made to minimise the quantities generated". Further, the policy provided that after all avoidance and reduction options have been explored, the on-site recovery, re-use and recycling should be considered. However, treatment and disposal can be considered and accepted as a last resort. The hierarchy is a significant cornerstone in guiding the formulation of more waste-related policies, strategies and programs (CoW, 2020).

Table 2 provides a better understanding of the integrated solid waste management hierarchy. The goals are further discussed.

Table 2 - Integrated Solid Waste Management Hierarchy (Source: Gertsakis and Lewis 2003)

Goal	Attribute	Outcomes
Reduce	– Preventative	Most desirable  Least desirable
Reuse	– Predominantly ameliorative – Part preventative	
Recycle	– Predominantly ameliorative – Part preventative	
Treatment	– Predominantly assimilative – Partially ameliorative	
Disposal	Assimilative	

2.5.1. Reduce

This method is the most effective method of solid waste management because it prevents waste generation to a larger extent in the first place. Many nations have adopted these methods. For example, in New Jersey (United States of America), the town implemented a program called the Pay-as-You-Throw system. In terms of this program, community members are charged for collecting household waste based on the amount they throw away. This program is a good initiative because

it builds a direct economic inducement to recycle more and generate less waste. Namibia has an interesting practical example of the integrated solid waste hierarchy designed by the CoW. The CoW's integrated solid waste hierarchy aims to "reduce the amount of waste through the Polluter Pays Principle (PPP) that transfers the cost to the polluters themselves" (Kadhila, 2019).

2.5.2. Reuse

Reuse follows that we reduce in the Integrated Solid Waste Management hierarchy. Items generally discarded as waste, such as furniture, glass jars, appliances, bottles, old tires, used wood, paper items and books, old clothes, and organic waste. These items can be re-used as initially intended or as new products (O'Leary, 1999). Re-using items by revamping them, donating them to charity and less fortunate community members, or reselling them also reduces waste. Re-use is the best method because items do not need to be reprocessed before they can be used again.

In comparison, both reduce and re-use, decrease resource use, and protect the environment. Moreover, reducing and re-using methods also reduce dependency on traditional methods of solid waste management, for example, landfilling, which frequently faces capacity and regulatory restrictions and incurs high environmental and economic costs (Hong, etc.,.2016). Table 3 below depicts examples of how items can be re-used to contribute to waste management.

Table 3 - Solid waste items and their potential reusable (Source: Conserve Energy Future, 2018)

Items	Re-used purposes
Furniture	Donate to less fortunate.
Glass jars	Store them in storerooms or sell them at cheap prices.
Old books	Resell them or donate to public library.
Bottles	Send to recycling plants
Old Tyres	Send to tyre recycling plants
Used wood	Use them as firewood
Old newspapers and paper items	Send to recycling plants
Old clothes	Donate to less fortunate

2.5.3. Recycle

Recycling is where materials destined for disposal are collected, processed, and remanufactured (Rosengren and Li, 2019). The process follows that we reduce and re-use in the ISWM hierarchy. Recycling is the best solution to waste disposal because it saves energy and natural resources, reduces landfill space depletion, provides valuable products, and provides economic benefits. In Namibia, there is a private firm known as Rent-A-Drum. Rent-A-Drum is a leading institution in waste management and recycling in Namibia. It operates in Windhoek, Swakopmund, Walvis Bay, Oshakati, Oranjemund and Rundu. Rent-A-Drum collects a different range of recyclable materials, such as aluminium cans, food and aerosol cans, super mix paper, newspaper, glass bottles and

carton boxes, among others, and sends them to South Africa, where the process of recycling them back into new products begins (Croset, 2014).

Unquestionably, recycling is the best method in ISWM. It saves resources and energy and reduces the need for landfills and resource recovery facilities. Concerning the study by Ezyske (2011), the town of New Jersey saved 128 trillion BTU'S of energy in 2001. That was a milestone achievement because that energy saving equals 22 million barrels of oil and enough power for almost 1.2 million homes a year. Lastly, recycling may also result in the reduction of emissions of air and water pollutants.

2.5.4. Treatment

The purpose of this method is to reduce the waste volume or its hazardous nature (Schenck, 2009). Treatment boosts energy recovery from waste through chemical, physical, thermal, or biological processes. The treatment of waste takes different forms, for example, incineration. Incineration is a method of converting waste to residues or gases by thermal means. According to Farah (2002), this method has been recognised as a significant way of recovering energy while simultaneously minimising the harmful environmental impact components, such as methane. Farah (2002) added that about 70% of waste mass could be minimised, whereas approximately 90% of waste volume can be lessened through incineration. However, incineration can negatively impact the environment, which may result from the emissions and solid residues produced through solid residues (Lorek, Striewski and Spangenberg, 2001 and Manisalidis *et al*., 2020). Apart from incineration, other waste treatment methods may also have negative environmental impacts, for example, soil pollution.

2.5.5. Disposal

The last method of solid waste management is disposal. In terms of this method, waste is buried, dumped, or released in places where it may remain for a long-time. In many aspects, solid wastes are dumped in engineered landfills, specifically in urban areas. This method is not very recommended. It is just a final step to dispose of wastes that cannot be treated or recycled (Rousta, 2008). It is also important to mention that disposal of solid waste in landfills and open spaces is regarded as a poor waste management method because it may damage land, water and air resources.

2.6. Regulatory requirements on solid waste management in Namibia

In Namibia, regulatory requirements for environmental management are embedded in different legal and policy instruments of which the constitution remains the cornerstone (Ruppel *et al*., 2022). Various institutions, government departments, Non-Governmental Organisations (NGOs) and individuals have obeyed the constitution by implementing various approaches, policies and legislation to curb environmental damage and enhance public welfare. The sustainable waste management concept requires discussing various environmental matters, including the economic costs of the most suitable municipal solid waste management techniques, aiming to maintain

environmental quality and promote public health (Kadhila and de Wit, 2022). Equally important, there is a need to recommend the best alternative municipal solid waste management and disposal approaches. Municipal Solid Waste management systems are fundamental instruments incorporated into successfully integrated waste management systems (Asheela, 2010).

Modak (2010) stressed that the absence of adequate management policy and framework confounds SWM. As a result, legal and institutional framework should be in place to guide effective management and governance. Many role-players deal with waste management. These include government, ministries, municipalities, private companies, and single individuals. According to Kadhila (2019), all activities and factors that may pose environmental threats, such as scarce resources, the vulnerability of Namibia's environment, and extreme poverty, are controlled using prescribed environmental laws and policies to protect the environment from benefiting the people of Namibia. Before independence, Namibia's environmental laws and policies were the same as those that have been in use in South Africa, but after independence, everything changed (Department of Environmental Affairs, 2003). Several outdated laws, regulations, and policies were amended and clarified to match the practicality of the recent environmental activities taking place in Namibia. Some of the primary environmental-related laws, regulations, and policies in Namibia are discussed below.

2.6.1. The Namibian Constitution

The Namibian constitution places a legal duty on the government to design relevant laws to protect the environment and ensure that relevant bodies enforce them.

Article 91 (c) places the duty on the Ombudsman to investigate complainants relating to the over-utilisations of living natural resources, the irrational exploitation of non-renewable resources, the degradation and destruction of the ecosystem and the failure to protect the beauty and character of Namibia. This includes solid waste.

2.6.2. Environmental Management Act 7 of 2007

This Act promotes the sustainable management of the environment and the use of natural resources through established principles for decision-making on issues affecting the environment. Further, it establishes the Sustainable Development Advisory Council (SDAC) and provides for the appointment of the Environmental Commissioner and environmental officers. Lastly, the Act provides for a process of assessment and control of activities that may have significant effects on the environment.

2.6.3. Soil Conservation Act 76 of 1969

The purpose of this Act is to consolidate and amend the law concerning the combating and prevention of soil erosion, the conservation, improvement, and manner of use of the soil and vegetation, and the protection of the water sources in the territory of Namibia.

2.6.4. Hazardous Substances Ordinance 14 of 1974

This Act regulates substances that may cause ill health or death of human beings because of their corrosive, toxic, irritant, flammable nature or strongly sensitising or generation of pressure, thereby in certain circumstances. It also plays a role in dividing such substances into groups about the degree of danger. Finally, the Act regulates and controls the dumping of such substances.

2.6.5. The National Solid Waste Management Strategy (2018 – 2028)

The National Solid Waste Management Strategy of (2018 -2028) is a national strategy that aims at future directions, regulation, funding, and action plans to strengthen solid waste management (Ruppel *et al*., 2022). This strategy ensures that solid waste management is coordinated as it should be and consistently in line with national policy and assists with cooperation between stakeholders. The main objective of this strategy is to improve the organisational, institutional, and legal framework for solid waste management, together with capacity development.

2.6.6. Namibia's Pollution Control and Waste Management Policy, 2003

This policy ensures the management of non-hazardous waste, hazardous and special waste in the country. It also provides legislative, regulatory, and economic incentives for correctly managing waste reduction, reclamation, and recycling. Moreover, primarily necessary, it encourages implementing comprehensive pollution control and waste management education and capacity-building programmes by the government and the private sector.

2.7. Potential impacts associated with solid waste

An inefficient solid waste management system may have seriously negative environmental impacts, land and water pollution, infectious diseases, obstruction of drains and loss of biodiversity (Mekonnen *et al*., 2019; Chen *et al*., 2020). This leads to several questions about who is affected by this waste and who handles it (Mbongwe, Mmereki and Magashula, 2008). The incorrect management of solid management can directly impact individuals, communities, and the natural environment. Health risks linked to solid waste include infection, injuries or death caused by incorrect handling or inadequate poorly controlled dumpsites or by open burning, which may release dangerous compounds to the environment; air and water pollution may also have severe consequences for public health.

Furthermore, infections from solid waste to waste handlers may be transmitted through contact and then the transfer of infectious diseases to friends, families, neighbours, and those close to them. According to Ferronato and Torretta (2019), infections may also be transmitted through the uncontrolled disposal of contaminated wastewater into public drains and the movement of disposal bins from dumpsites to other areas.

Municipal and environmental workers are at significant risk from infected solid waste. This is because of the absence of priority on basic worker safety when dealing with solid waste. Some complications

that may arise from the poor collection, storage and disposal of solid waste include flies, cockroaches, and environmental nuisances of foul odours, vermin and rodents. As per Omang, John, Inah and Bisong (2021), diseases such as cholera, diarrhoea, and typhoid may be transmitted through the mismanagement of solid waste.

A study on the environmental impacts of improper solid waste management in developing countries carried out in Rawalpindi City has detected several problems associated with solid waste management. Ejaz *et al.* (2010) stated that solid waste dumps are ruining the environmental conditions in developing countries, and negative environmental impacts from improper solid waste dumping may be seen all over developing countries. In developing countries, factors such as lack of legislative implementation and funding, solid generation rate, and management deficiencies make solid waste management systems ineffective (Ejaz *et al*., 2010).

A study by De and Debnath (2016) in Kolkata, India, found that different types of diseases can infect people due to exposure to unavoidable harmful waste and living close to dumping sites. Moreover, due to improper disposal of solid waste, it was observed that residents of Kolkata have health and hygienic problems such as asthmatic, allergic, skin irritation, bronchitis, and gastrointestinal diseases (De and Debnath, 2016). In a related study, Jerie (2016) stressed that some solid waste contains small amounts of hazardous waste and poses a risk to human health and the environment. Jerie (2016) and Manisalidis *et al*. (2020) put forward that solid and toxic wastes are capable of causing injury or death through inhalation or absorption, and some may cause cancer, genetic mutation and foetal growth problems. Lastly, explosive waste may be easily set on, while corrosive waste may destroy and burn living tissue or other materials when brought into contact with them (Jerie, 2016).

2.8. Conclusion

This chapter discussed several pieces of literature related to this study. The chapter provided an in-depth understanding of solid waste management systems worldwide and in Namibia. Further, the study gave an account of the types and sources of solid waste. The integrated solid waste management Hierarchy was also highlighted in this chapter. Lastly, the section looked at Namibia's regulatory requirements for solid waste management. The following chapter will discuss the research design and methodology.

CHAPTER THREE (3) RESEARCH METHODOLOGY

3.1. Introduction

This chapter covers the research design and methodology utilised in this study. Maxwell (2012) states that the research design is crucial for a research document because it helps the researcher to ensure that the methods utilised in the study match the research aims, that the researcher collects high-quality data, and that the researcher uses the right kind of analysis to answer the study questions, using credible sources. This allows the researcher to draw valid and trustworthy conclusions. On the other hand, a research methodology is an approach or technique used by the researcher to select, identify, and analyse information related to the topic (Kumar, 2018).

This study used quantitative and qualitative research methods to collect data. The literature was consulted to reflect on what is known and what is not yet known about the topic under investigation. Literature sources comprised of unpublished and published documents such as dissertations, theses, scholarly journal articles, and some government reports among others.

3.2. Study Area

Oniipa, Ondangwa, and Ongwediva are located in the Oshikoto and Oshana Regions of Northern Namibia (Figure 1). These towns are divided into different sectors, some of which are rural and others urban. The key marketable activities in the three towns vary from dry industries, tourism, trading and transportation. The towns have easy accessibility to the railway as likewise to the critical national road network. Furthermore, Ondangwa is in the middle of Oniipa, and Ongwediva and the towns are accessible via the C46 main road that connects the three towns. According to the Namibian Statistics Agency (2011), the population of Oniipa, Ondangwa, and Ongwediva was 6535 23 000 and 27 396, respectively, primarily people aged 15 to 59. Prior to upgrading to a town on 30 April 2015, Oniipa operated as a settlement area under Oshikoto Regional Council since 15 January 2004 after being administered by the Ondonga Traditional Authority. As a local authority, Oniipa Town Council is responsible for the urban governance of the town for the government Republic of Namibia and its people, together with all the people residing within its area of jurisdiction. Prior to upgrading to a town on 30 April 2015, Oniipa operated as a settlement area under Oshikoto Regional Council since 15 January 2004 after being administered by the Ondonga Traditional Authority. Oniipa is the district capital of the Oniipa Electoral and is home to the first Hospital in Namibia, known as Onandjokwe Lutheran Hospital, established in 1911 Constituency (Oniipa Town Council, 2016). Ondangwa is one of the oldest historic towns in northern Namibia; that was established as a missionary centre in the 18th century and later used as a centre of assembly for most people in the north. Before independence, the South African Army used the town as its administrative centre. Ondangwa was proclaimed a town in 1992 under the Ministry of Regional Local Government and Housing and became an autonomous town in 1998 (Ondangwa Town Council, 2020). Ongwediva, as a modern settlement, was established by the South African Government dispensation in the 1960s. On the dissolution of the South African Government dispensation, upon passing the Local

Authorities Act of 1992, Ongwediva has proclaimed a Town with a Town Council (Ongwediva Town Council, 2020). As a local authority, Oniipa, Ondangwa and Ongwediva Town Councils are accountable for urban governance of the towns for the government Republic of Namibia and its people together with all the people residing within its area of jurisdiction.

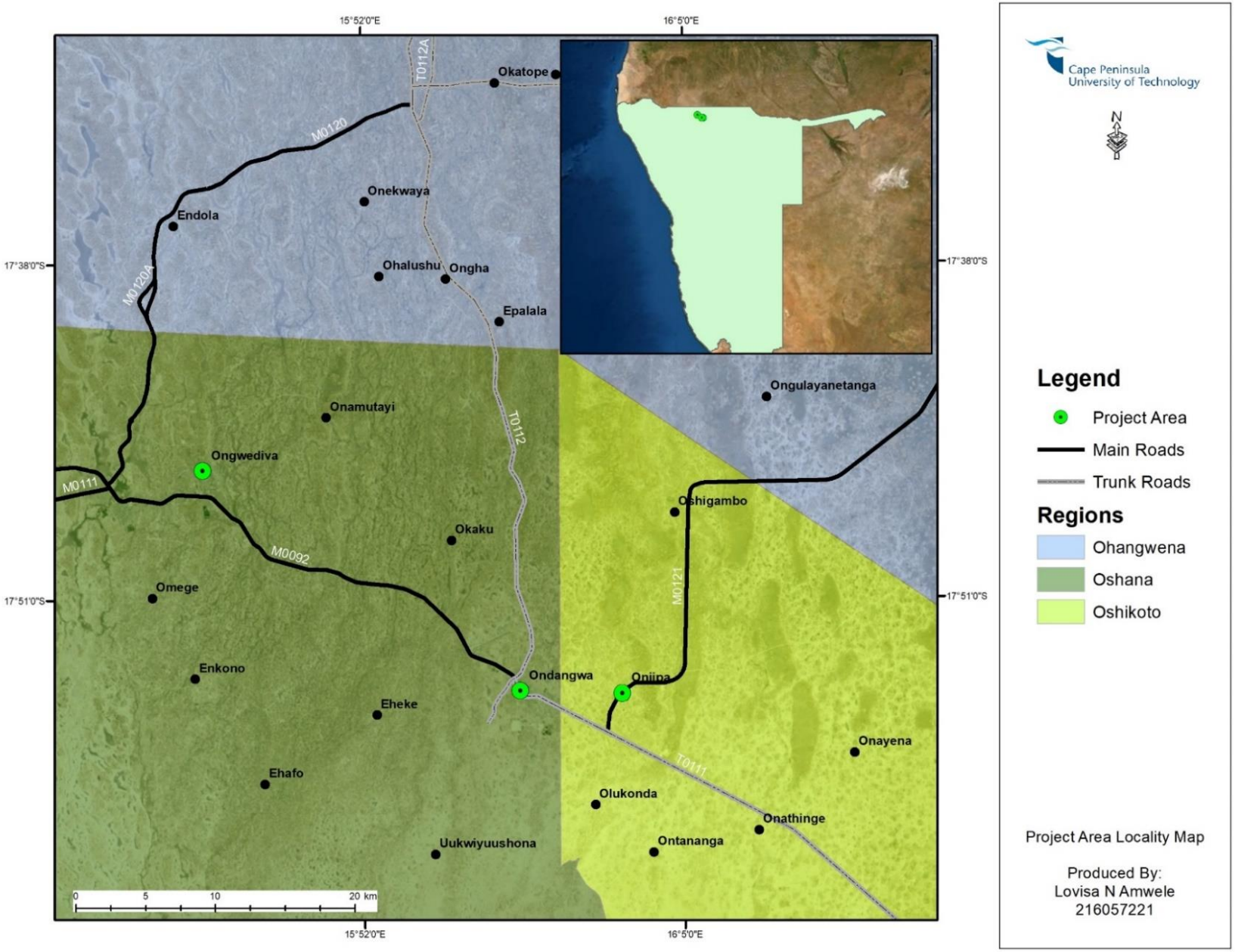


Figure 1 - Locality map (Researcher, 2022)

3.2.1. Delineation

The area covered in this research was Oniipa, Ondangwa, and Ongwediva Towns in the Oshikoto and Oshana Regions (Namibia), and hence excluded the other significant towns that share boundaries with them that are equally responsible for this problem due to geographical constraints. Additionally, members of the community had equal chances of selection. However, due to the days and periods the survey was taken, the sample was limited to 84 community members between the ages of 15 to 55 and above.

3.3. Research Design

A research design provides a layout of the research by showing all the steps that will be considered in collecting data (Ngeleka, 2010; Sileyew, 2020). Additionally, it is a master plan showing the nature and pattern the research aims to follow (Oso and Onen, 2008). Furthermore, this research used quantitative and qualitative methods to collect secondary and primary data. The study was conducted using a qualitative method by understanding underlying issues, reasons and motivations through personal field observations. On the other hand, the researcher employed quantitative data through questionnaires and face-to-face and telephonically interviews. When the questionnaire and interview feedback was overseen, the raw data collected was systematically organised to facilitate the analysis using Microsoft Word 2010, Excel 2010 and SPSS to present the results in table and charts format. The researcher also used Arc GIS 10.5 to create maps for the study area.

3.4. Data Collection

This encompasses the extraction of information from the field investigation in order to get first-hand information. The researcher used questionnaires, photographs, interviews and observations during the study to obtain important information about solid waste management systems in Oniipa, Ongwediva and Ondangwa. Each item in the questionnaire addressed the study's specific objective, including examining the performance of the existing solid waste management system. The study used structured or closed-ended and unstructured open-ended questionnaires formulated for this study. The researcher conducted self-administered structured and unstructured interviews with members of the community, including head of households; the focus was on the age groups from 15 to 55 and above years old and environmental health officials in the area to hear their thoughts and viewpoints about the solid waste management system in the towns. During physical field observation, the researcher captured photographs to provide images of the environment's state during this research period.

3.4.1. Primary Data

This encompasses the extraction of information from the field investigation in order to get first-hand information (Loftus, 2022). The researcher used questionnaires, photographs, interviews and observations during the study to obtain important information about solid waste management systems in Oniipa, Ongwediva and Ondangwa. Each item in the questionnaire addressed the study's specific

objective, including examining the performance of the existing solid waste management system. The study used structured or closed-ended and unstructured open-ended questionnaires formulated for this study. The researcher conducted self-administered structured and unstructured interviews with members of the community, including head of households; the focus was on the age groups from 15 to 55 and above years old and environmental health officials in the area to hear their thoughts and viewpoints about the solid waste management system in the towns. During physical field observation, the researcher captured photographs to provide images of the environment's state during this research period.

3.4.2. Secondary Data

Secondary data are data that is already published in some form, unlike primary data which is first-hand information (Taherdoost, 2021). Oso and Onen (2008) stated that secondary data help by an enlightening theory that will later assist with informed data analysis and interpretation. Various sources were used to obtain data, including census data, organisational records, newspaper articles, historical documents, policies and policy briefs, government legislation, strategic reports, journal articles and books on the topic. This data contributed towards the literature review and assisted the researcher with collecting, sorting and interpreting a variety of existing data and information about solid waste management systems.

3.4.3. Sampling

A sample is a representative collection of elements from a whole, which provides facts about that population (Oso, 2008). Sampling can also be described as a subset of the population selected by either probability or non-probability methods (Bickman, 2008). Furthermore, for this research study, the researcher used both quantitative and qualitative methods for sampling, hence both probability and non-probability sampling methods, in order to produce precise numeric and verbal findings to strengthen the research. Bickman (2008) defined probability sampling as a technique that involves gathering samples so that all the individuals in the population have equal chances of being selected. The researcher used Slovin's formula to determine the sample size for data collection.

n=N/(1+Ne^2), equation (1)

with 95% confidence interval and marginal error is 0.05%, where n = number of samples, N = total population, and e = marginal error.

T to get n=6535/(1+6535e^2)=376 samples.

However, due to the days and period the survey was completed, age restrictions and the effect of Covid 19 pandemic the researcher only managed to work with a sample size of 84 community members who were spotted in the respective areas during the days the data collection was conducted. The members of the communities were surveyed employing questionnaires and interviews mostly from the informal settlements of Okalevona and Okakwiyu, New inception, Omashaka, Okangwena, and Uupopo to provide their input on the topic at hand.

Alternatively, non-probability sampling involves gathering samples in a way that does not give all

individuals in the population equal chances of selection. The qualitative phase of this research used a purposive or judgmental sample based on the population's knowledge and the study's purpose. The researcher targeted specific relevant officials involved in solid waste management within the Oniipa, Ondangwa and Ongwediva Town council and the development committee of the area.

3.5. Data analysis

The study employed both descriptive and statistical analysis. Non-numerical data obtained through questionnaires were aggregated and assigned numerical values to allow the statistical analysis of data. The researcher used data analysis software (Microsoft Excel 2010 and SPSS version 26) to analysis data and produce the output in the form of tables, graphs, and pie charts.

3.6. Conclusion

This chapter covered the research design and methodology utilised in this study. The chapter provided a short description of the study areas. The data collection methods, sampling, data analysis, and delineation were discussed. The next chapter covers the discussion of the results and presentation of data. Based on the above, the number of participants was deemed sufficient for the study considering the small population that occupies the settlements.

CHAPTER FOUR (4) RESULTS AND DISCUSSION

4.1. Introduction

This chapter presents the findings and discussion of the results obtained from the study. The chapter is organised into four sections; (1) Demographic and socio-economic characteristics of respondents; (2) solid waste management systems of Oniipa, Ondangwa, and Ongwediva towns (collection, transportation, and disposal), (3) impacts of solid waste unto the environment; and (4) solid waste management systems awareness among community members.

4.2. Demographic and socio-economic characteristics of respondents

4.2.1. Participant's gender

Figure 2 below presents the genders of the participants in the 3 towns.

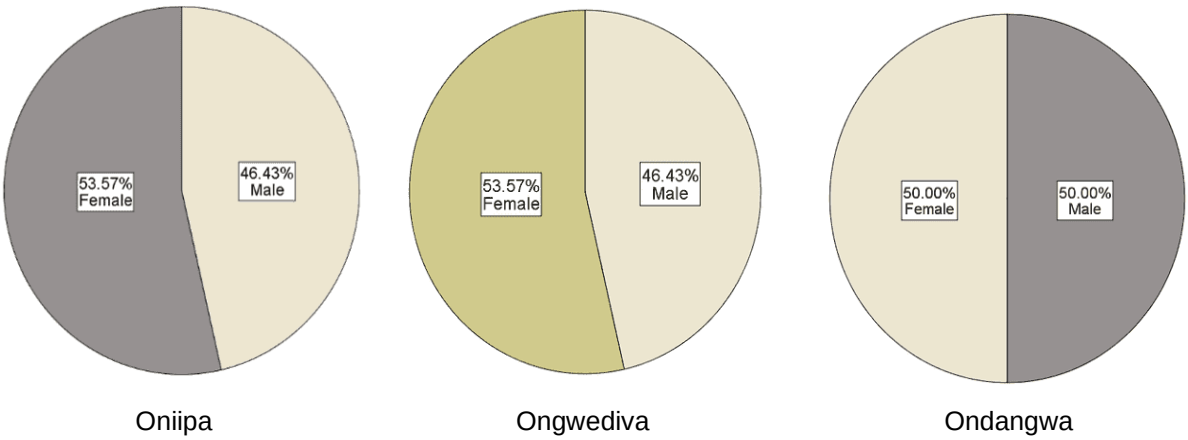


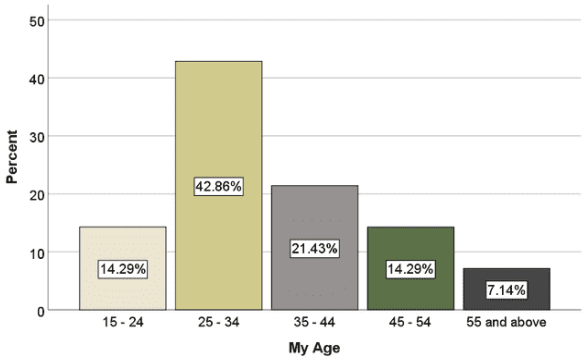
Figure 2 - Participants' Gender

The majority of the respondents in the survey combined were females (52.32%) and males (47.62%), as shown in Figure 2. This correlates with the Namibian Statistics Agency, 2011, which released that Oniipa, Ondangwa and Ongwediva's populations consisted of 55.1%, 53.6%, 55.3% females and 44.9%, 46.4%, and 47.7% males respectively. The difference in the statistics is sore because as many as more females participated in the survey than males; not the entire population was considered for this research. Of the respondents, 60 % were heads of households.

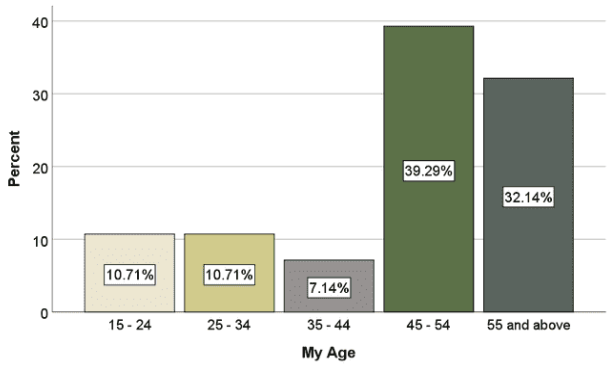
4.2.2. Age distribution among participants

The graphs below indicate the age distribution of the participants.

Oniipa



Ongwediva



Ondangwa

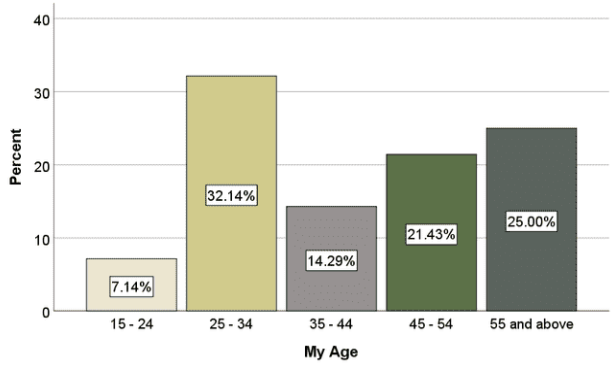


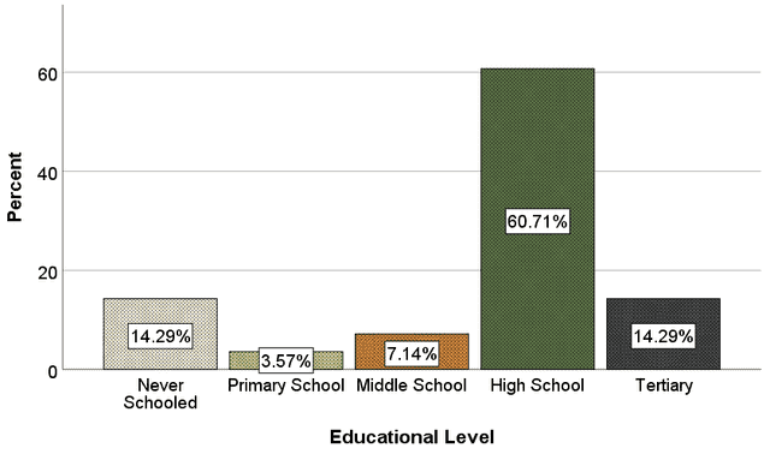
Figure 3 - Age of respondents

The majority of the participants in Oniipa and Ondangwa were in the age range of 25-34 (42.88% and 32.14%). Ongwediva's majority were in the age range of 45-54 (39.29%). The least number of participants were in the 55 and above category for Oniipa, 15-24 for Ondangwa and 35-44 for Ongwediva. Figure 3 concludes that the majority of people that participated in the overall survey were youth between the age of 25 to 34.

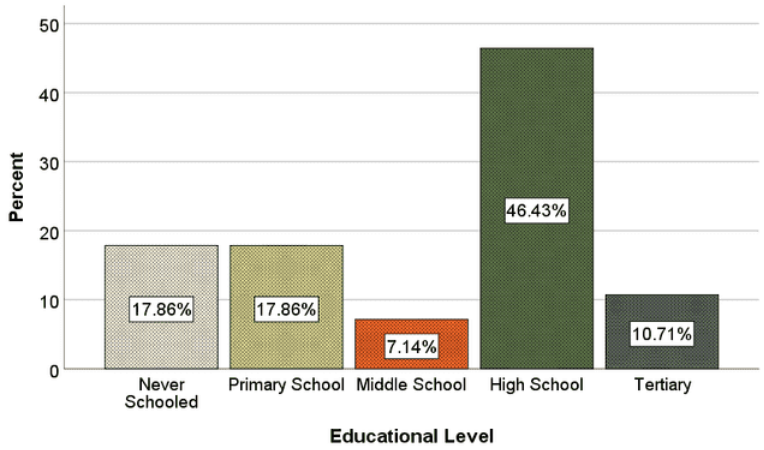
4.2.3. The educational level of the participants

The education level of the participants is shown in the graphs below.

Oniipa



Ongwediva



Ondangwa

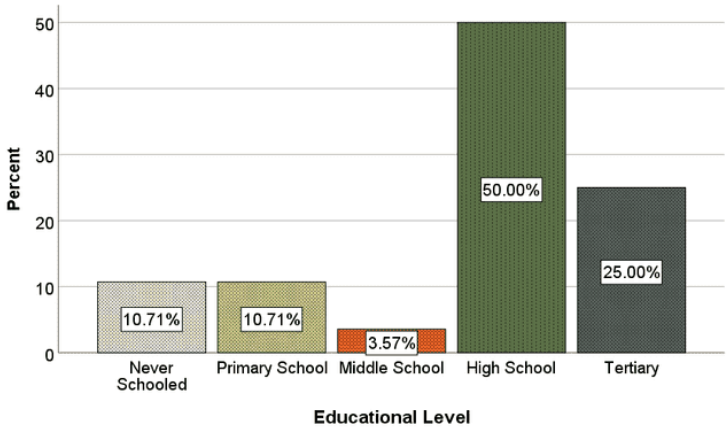


Figure 4 - Educational level of respondents

Figure *4* indicates that, on average, 52% of the respondents from all towns said they had reached high school, and 16.6% gave their highest qualification as tertiary education. However, 21.43% of the respondents indicated that they had never been schooled, whilst 5.95% said they had reached middle school. Overall, the data shows that most of the respondents have an excellent educational foundation and are aware of essential solid waste management.

4.2.4. The Monthly income of the respondents

Tables 4 -6 below discuss the monthly income of the respondents.

Table 4 - Monthly income of Oniipa respondents

Oniipa					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< N$ 5000	23	82.1	82.1	82.1
	N$ 5000 to N$ 10 000	4	14.3	14.3	96.4
	N$ 10 000 <	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

Table 5 - Monthly income of Ongwediva respondents

Ongwediva					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< N$ 5000	26	92.9	92.9	92.9
	N$ 5000 to N$ 10 000	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

Table 6 - Monthly income of Ondangwa respondents

Ondangwa					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< N$ 5000	23	82.1	82.1	82.1
	N$ 5000 to N$ 10 000	5	17.9	17.9	100.0
	Total	28	100.0	100.0	

Most (85.7%) respondents said they receive a monthly income of less than N$5000 (R5000) Table 4 to 6. Furthermore, only 3.7% of the participants from Oniipa receive a monthly income of more than N$10000 (R10000), including business owners. None of the respondents from Ongwediva and Ondangwa stated that they earn a monthly income above N$10000 (R10000). Additionally, 13.1% of respondents earn a monthly income between NS$ 5000 (R5000) to N$10000 (R10000). As observed in the tables, a few people earn a decent salary in Oniipa, Ondangwa and Ongwediva to sustain themselves and their families.

According to Kamran, Chaudhry and Batool (2015), the high-come group generates more solid waste than middle- and low-income groups. Therefore, from the results, it is clear that the respondents generate a moderate amount of solid waste in the study areas.

4.3. Solid waste management systems of Oniipa, Ondangwa and Ongwediva (collection, transportation, and disposal)

4.3.1. Waste disposal in Oniipa, Ondangwa and Ongwediva

On average, thirty-two percent (32%) of the participants shared that they have bins in their houses, whereas 68% said they do not have bins in their homes Figure 5. Ondangwa demonstrated that more than half (54%) of the respondents have bins in their houses as opposed to Ongwediva and Oniipa, with 21% each. Some of the respondents from the three (3) towns said they have bins, the town council provided them, and the others have bought the bins themselves. However, the researcher asked 68% of the 84 participants who said they do not have bins what methods they use to dispose of their waste Table 7. Moreover, 19 out of the 57 respondents without bins highlighted that they use black plastic bags that they purchase themselves, and five mentioned that the town council provided them with black refuse bags.

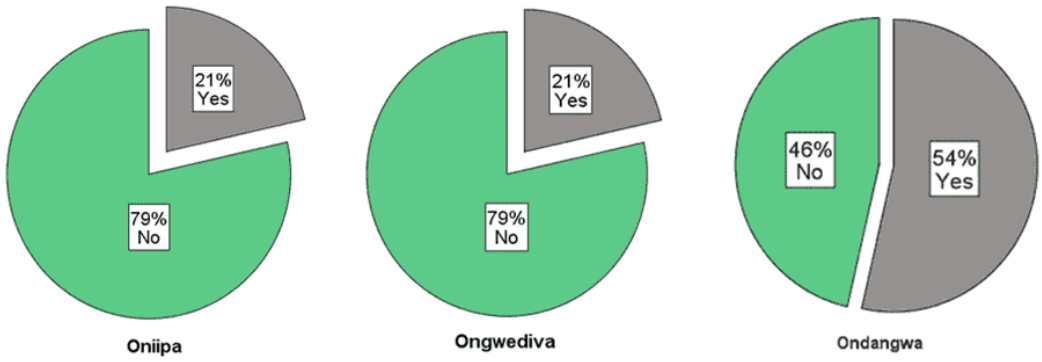


Figure 5 - Response to the availability of bins in participant's houses

Table 7 - Response to how the participants without bins dispose of their waste

		Frequency	Percent
Valid		57	68
	Black plastic bag	19	33
	Burning	14	25
	Burying	9	16
	Plastic bag	15	26
	Total	56	100.0

The 15 participants have also indicated that the town councils have erected small bins to use in their streets; however, they are full most of the time and end up throwing the waste on the ground around the bin in plastic bags (Figure *6*). The other 14 said they burn the waste they generate in their houses.

However, burning waste is against the Namibian national waste management policy, which states that burning should be under official supervision (Magen, 2010). Furthermore, 16% dispose of their waste by burying and using shopping plastic bags. Regarding Ngeleka (2010), when waste is buried, it may have a devastating effect on the underground water sources if the type of waste can leach into the soil.

Figure 6 - The types of bins erected in some informal streets of Oniipa, Ondangwa and Ongwediva (Source: Researcher, 2021).

4.3.2. Waste collection in Oniipa, Ondangwa and Ongwediva

Among the 56 participants from Ongwediva and Oniipa, 79% indicated no skips near their houses, and 21% said the skips were near Figure 7. Additionally, 86% of the 28 participants from Ondangwa indicated that they do not have skips near their houses. Seven people said they walk or have to travel 16 to 20 minutes to get to the skips. The results show that people in Oniipa walk shorter distances to the skips provided by the town council.

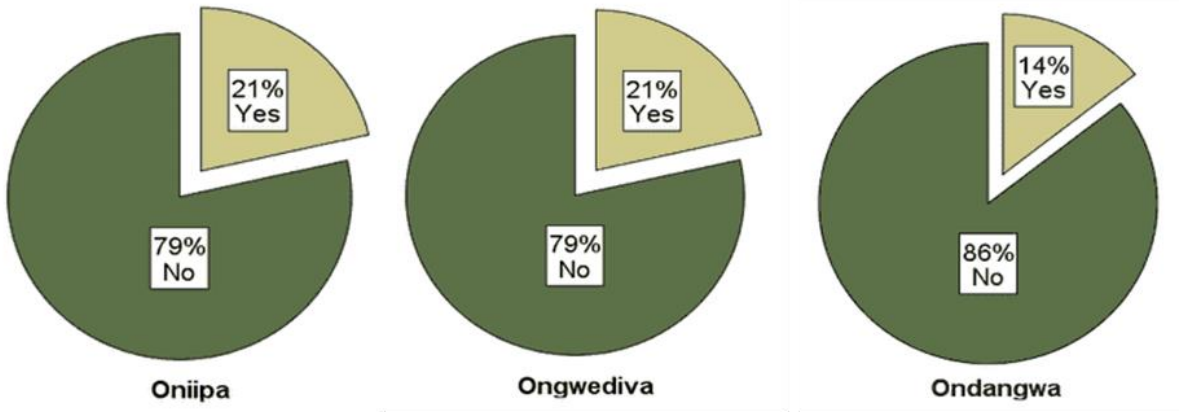
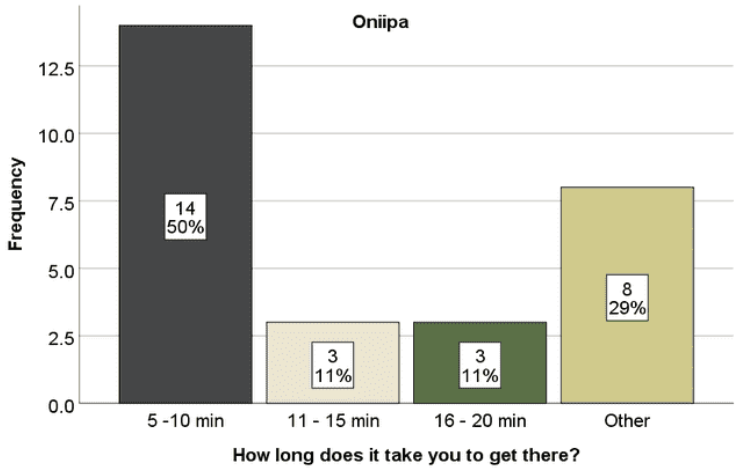
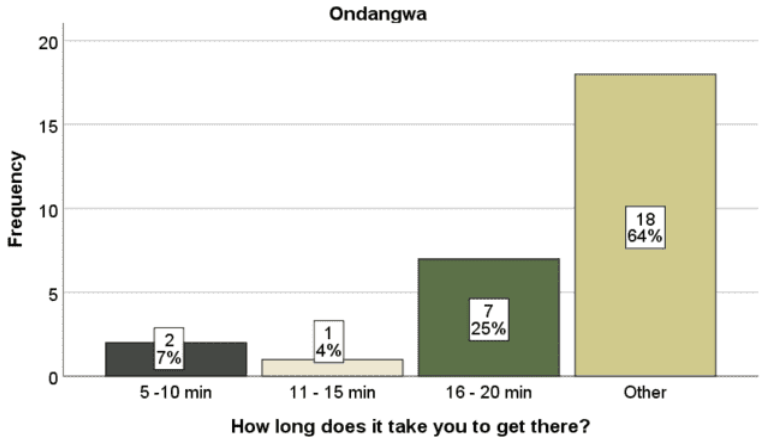


Figure 7 - Availability of public skips near participants' houses

Figure 8 - Refuse bags gathered at a collection spot by some members of the communities (Researcher, 2021).

In Ongwediva, 18% of the participants walk about 5 to 10 minutes to get to the skips and 4% lives within a distance of 11 to 15 minutes from the skips, as shown in Figure 9. Likewise, Guerero (2013) argued that long distance to containers raises the chances of waste being dumped in open areas and along the roads instead of using the provided containers. Figure 10 renders images of waste skips in the study area.





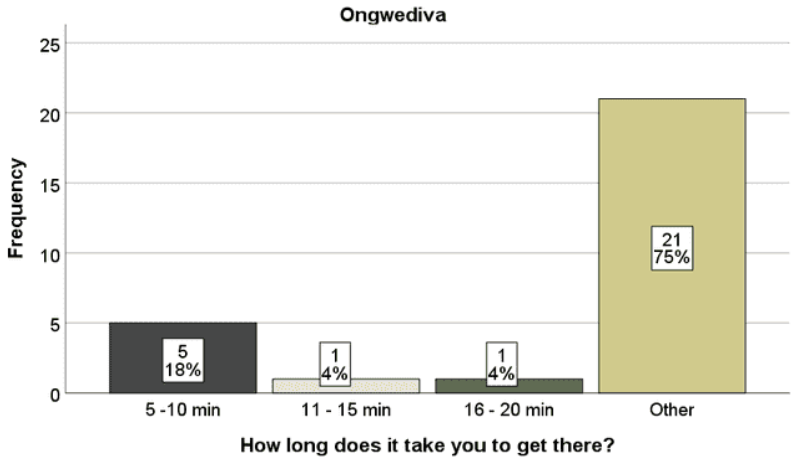


Figure 9 - How long it takes the respondents to the nearest skip

Figure 10 - Waste skips in the study area

4.3.3. Location (Town) versus Are there any skips near your house?

Null hypothesis (Ho): The location of town does not influence the availability of skips near the house.

Alternative hypothesis (H1): The location of the town influence availability of skips near the house.

We Accept the null hypothesis because the p-value (0.734) is greater than the level of significance (0.05) and conclude that there is no relationship between the location and availability of skips near the house (Table 8 and Table 9). The location of the town does not influence the availability of skips near the house.

It seems in all towns, a significant number of respondents state that there is no skip in the house. Generally, it seems respondents in all towns have the same concerns about the availability of skips near the house.

Table 8 - Location (Town) versus Are there any skips near your house?

			Are there any skips near your house?		Total
			No	Yes	
Town	Ondangwa	Count	24	4	28
		%	85.7%	14.3%	100.0%
	Ongwediva	Count	22	6	28
		%	78.6%	21.4%	100.0%
	Oniipa	Count	22	6	28
		%	78.6%	21.4%	100.0%
Total		Count	68	16	84
		%	81.0%	19.0%	100.0%

Table 9 – Chi-square test for location (Town) versus Are there any skips near your house?

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.618[a]	2	0.734
Likelihood Ratio	0.642	2	0.725
N of Valid Cases	84		
a. 0 cells (0.0%) have an expected count of less than 5. The minimum expected count is 5.33.			

As indicated in Figure 11, all respondents from Ongwediva have responded that their town council collects waste from their areas. In the case of Ondangwa, 86% of the respondents answered yes, and the remaining 14% said no. Respondents from Oniipa also provided different answers. When asked if their town council collects waste from their particular areas, 39% said yes, while the remaining 61% said no. The results show that Oniipa Town Council does not regularly collect waste from many homes. This is because of the limited number of pick-up trucks. However, this differs from the results of a study conducted by Subramani *et al*. (2014) in Salem District (India), where the local authorities collect waste from home regularly.

Ondangwa Town Council does better because 86% of the respondents stated that their town council collects waste regularly. All respondents from Ongwediva answered yes to the question, which indicates that Ongwediva Town Council is doing well regarding waste collection in that particular town. Every town council has to collect waste regularly. Figure 12 renders an image of the types of trucks that collect waste in the area. In support, Olukanni *et al*. (2016) stressed that the collection, transfer, and transportation of waste practices in Nigeria are affected by several factors, such as poor route planning, inappropriate bin collection, insufficient infrastructure, and lack of awareness about collection schedules. These factors might be the ones as well affecting the collection of waste in Oniipa and Ondangwa.

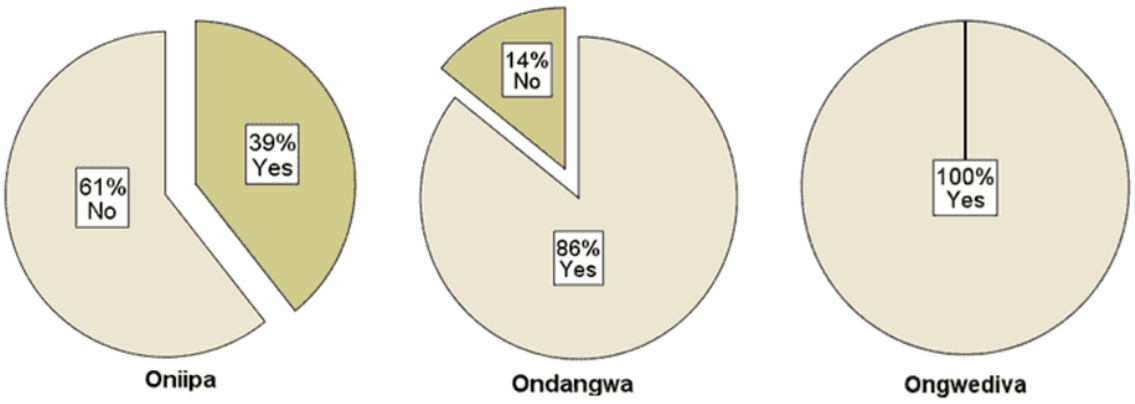


Figure 11 - Respondents answer as to whether the council collects waste in their areas

Figure 12 - Trucks that collect waste from the surroundings

Figure 13 represents the results from the respondents on how often their town council collects waste. As shown 39% of respondents indicated their town council collects waste once a week, 14% stated twice, and 11% indicated thrice weekly. In comparison, 36% had no idea how often waste is collected around Oniipa. This should be because of the distance the people are from their nearest collection points as well as the fact that they do not dump waste there daily. Moreover, 58% of the respondents from Ondangwa said the town council collects waste once a week, whereas 18% stated it is twice a week. The remaining 14% indicated that they do not know. Lastly, 21% of respondents from Ongwediva said their town council collects waste twice a week, and 79% indicated a week thrice.

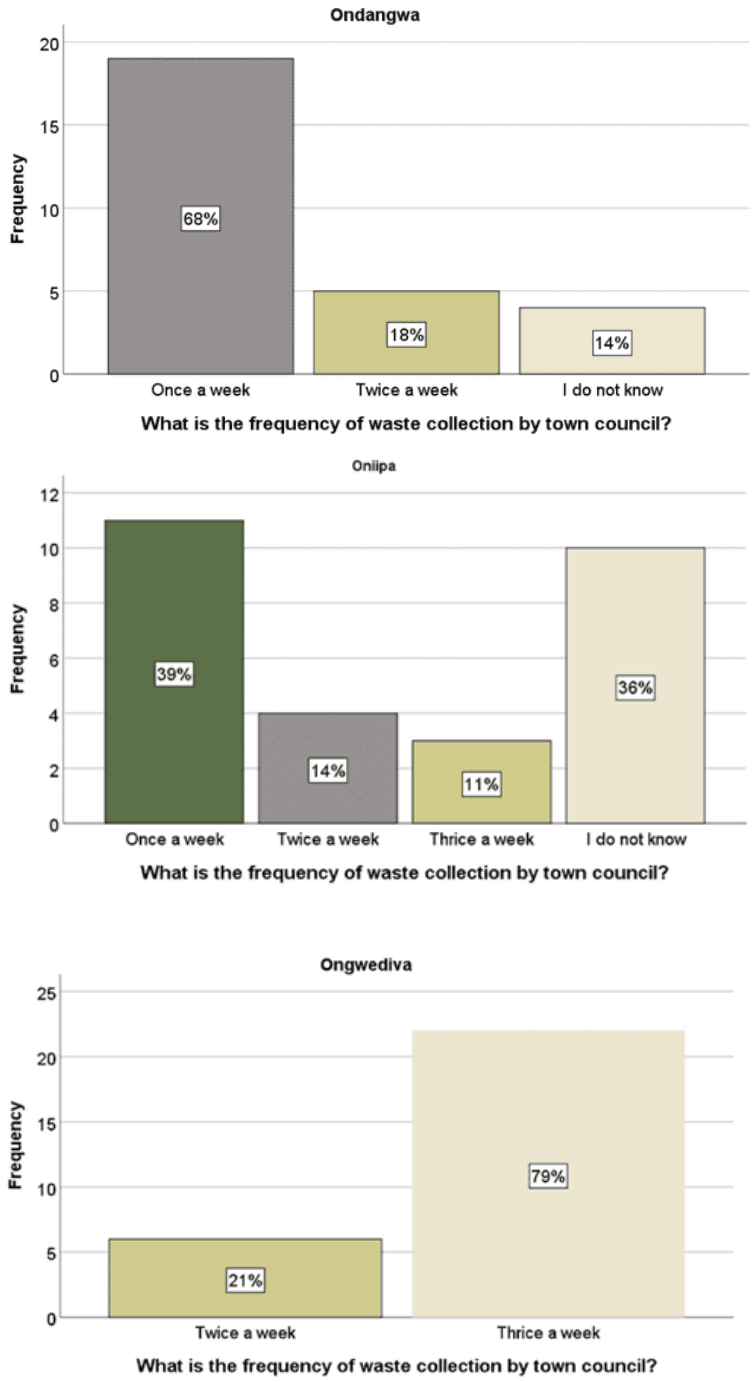


Figure 13 - Response from participants to how often the council collects waste

4.3.4. Location (Town) versus frequency of waste collection by the town council

Null hypothesis (Ho): The location of the town does not influence the frequency of waste collection by the town council (Town and frequency of collection are independent, i.e., there is no relationship between the two).

Alternative hypothesis (H1): The location of the town influence frequency of waste collection by the town council (Town and frequency of collection are not independent, i.e., there is a relationship between the two).

We reject the null hypothesis because the p-value (0.001) is less than the level of significance (0.05) and conclude that there is a relationship between location and frequency of waste collection by the town councils (Table 11 and Table 14). Location of the town influence frequency of waste collection by the town council.

Table 10 - Location (Town) versus frequency of waste collection by the town council.

			What is the frequency of waste collection by the town council				Total
			Once a week	Twice a week	Thrice a week	I do not know	
Town	Ondangwa	Count	19	5	0	4	28
		%	67.90%	17.90%	0.00%	14.30%	100.00%
	Ongwediva	Count	0	6	22	0	28
		%	0.00%	21.40%	78.60%	0.00%	100.00%
	Oniipa	Count	11	4	3	10	28
		%	39.30%	14.30%	10.70%	35.70%	100.00%
Total		Count	30	15	25	14	84
		%	35.70%	17.90%	29.80%	16.70%	100.00%

Table 11 - Chi-square test Location (Town) versus frequency of waste collection by the town council.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	63.617[a]	6	<.001
Likelihood Ratio	77.484	6	<.001
N of Valid Cases	84		
a. 3 cells (25.0%) have an expected count of less than 5. The minimum expected count is 4.67.			

From the cross table, the frequency of collection in Ondangwa town is very low. A glance at the table, 67.9% state that it was collected once a week, and 0 % state that it was collected thrice a week. However, the frequency of collection is very high in Ongwediva town, with 78% of respondents stating that it is collected thrice a week.

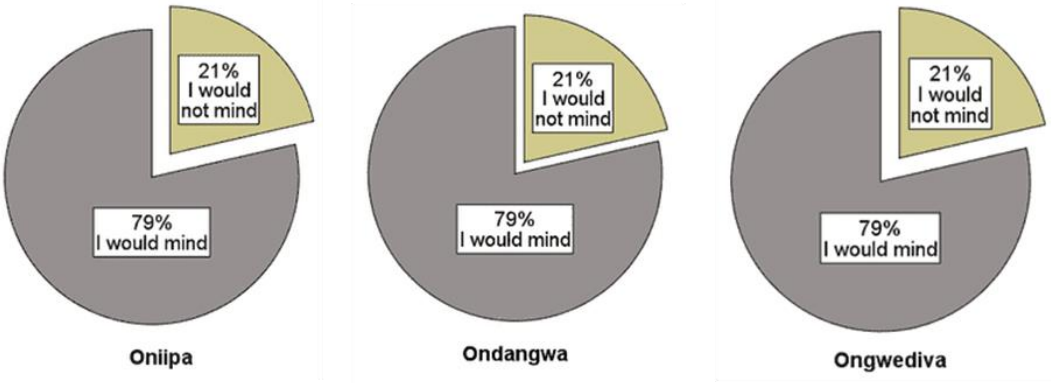


Figure 14 - Feedback if the participants would mind paying for the service fee

As shown in Figure 14, 79% of respondents from both towns indicated that they would mind paying for service delivery of waste collection. In comparison, 21% said they do not have a problem paying for service delivery.

Regarding the effectiveness of the waste collection system, 46% of respondents from Oniipa said the waste collection system is ineffective, whereas 54% said the waste collection system is effective. In addition to Oniipa, 46% from Ondangwa said no, while 54% said yes. Finally, 79% of respondents from Ongwediva said no, whereas 21% said yes (Figure 15). In comparison, the results show that respondents from Ongwediva are not happy with the effectiveness of the waste collection system.

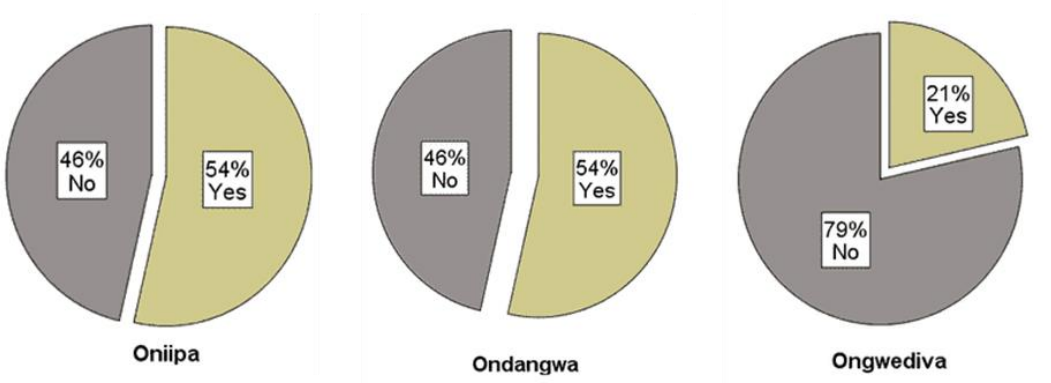


Figure 15 - Participants' response to the effectiveness of the waste collection system

4.4. Impacts of solid waste on the environment

4.4.1. Waste collection in Oniipa, Ondangwa and Ongwediva

During the survey, the researcher asked the participants if they noticed any waste in water resources. Among the 84 people asked, 15% indicated that they notice waste in water bodies. However, these are not water for human or animal consumption sites, mostly sewage water areas, whilst 85% said no. Water pollution is one of the significant environmental problems worldwide that results when any input into the water cycle alters water quality to the extent that genuine use is impaired or lost (Asase, 2009).

Figure 16 shows a polluted water source to confirm with the respondents that they had observed waste in water bodies; animals like pigs drink this water.

Figure 16 - A small polluted dam at Punyu village, Oniipa (Source: Researcher, 2020)

4.4.2. Other noticed factors of waste and the environment

The researcher has encountered some communal waste heaps in the towns, especially around the areas where small metal bins were present, mainly because the bins are small and not sufficient (Figure 17).

Figure 17 - A heap of communal waste outside Punyu hotel in Oniipa (left), rubbish at an area in New Inception Ongwediva (right) (Source: Researcher, 2020)

Figure 18 - Cattle at the waste disposal site (Source: Researcher, 2020)

When asked if they had noticed other environmentally unfriendly factors that could alter the state of the surrounding, the majority (40%) of the participants said they noticed domestic animals around the dumping areas, such as dogs and cattle. Animals such as cattle and goats are present in town because there are village houses around the town that still hold them. However, 30% complained about the odour emitted from the dumping areas; among the factors is the presence of rats (15%) and mosquitoes (15%). The presence of all the factors agrees with Olukanni (2016), who, during his study in Nigeria, encountered that mosquitoes and rats were the most present at dumping sites in Nigeria. The author further highlighted that mosquitoes and rats enter the nearest homes to the sites, which is a bad human health indicator because mosquitoes may cause malaria.

4.5. Solid waste management systems awareness in the Oniipa community

The participating community members, when asked if they have heard of any environmental awareness programs in Oniipa. The majority (82%) of the respondents said no, they have not heard of any awareness programs in the town, and those who said yes (18%) have, however, not participated in the awareness Figure 19. In Oniipa, the respondents said there was road show awareness where the council gave out black plastic bags to community members to encourage them as a disposal method instead of others such as burning. According to the Namibian national waste management policy, burning is prohibited without official supervision.

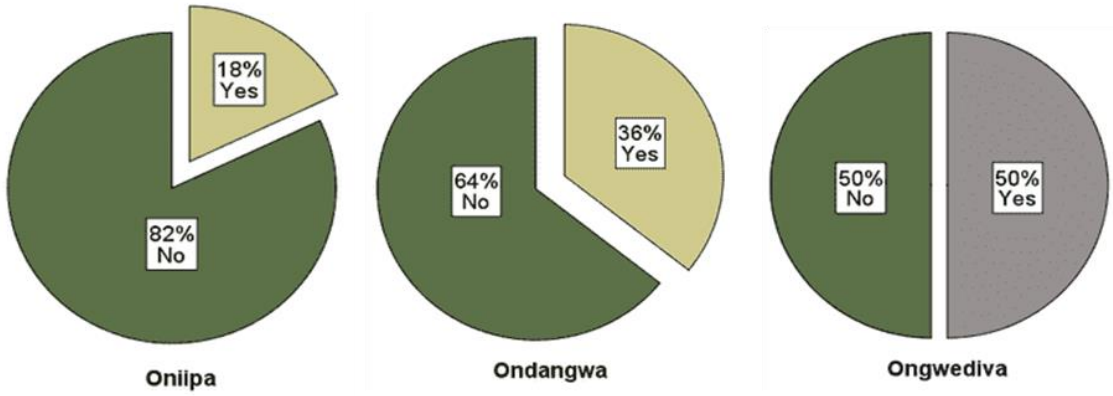


Figure 19 - Response to environmental awareness in the town

Additionally, a follow-up question was, if they think there is enough information concerning solid waste management in the town. None of the participants said yes; the information was not enough. When asked if they feel leaving a better environment for the future is essential,100% indicated that it is something fundamental. This means that the community cares about the environment they live in and will do anything to protect it from attaining sustainability in the future. The operational productivity of solid waste management also depends on the involvement of the municipal agency and the public, meaning community awareness and involvement in decision-making is essential (Ngeleka, 2010).

4.5.1. Location (Town) versus Environmental Awareness

Null hypothesis (Ho): The location of the town does not influence the availability of environmental Awareness (there is no relationship between town and environmental awareness)

Alternative hypothesis (H1): The location of the town influences the availability of environmental awareness (there is a relationship between town and environmental awareness)

We reject the null hypothesis because the p-value (0.033) is less than the level of significance (0.05) and conclude that there is a relationship between location and availability of environmental Awareness (**Table *11***_Table 12_ and _Table 13_). The location of the town does not influence the availability of environmental Awareness.

Table 12 - Location (Town) versus Environmental Awareness

			Environmental awareness		Total
			No	Yes	
Town	Ondangwa	Count	16	12	28
		%	57.1%	42.9%	100.0%
	Ongwediva	Count	14	14	28
		%	50.0%	50.0%	100.0%
	Oniipa	Count	23	5	28
		%	82.1%	17.9%	100.0%
Total		Count	53	31	84
		%	63.1%	36.9%	100.0%

Table 13 - Chi-Square Location (Town) versus Environmental Awareness

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.851[a]	2	0.033
Likelihood Ratio	7.284	2	0.026
N of Valid Cases	84		
a. 0 cells (0.0%) have an expected count of less than 5. The minimum expected count is 10.33.			

In Ondangwa and Ongwediva, the difference between respondents who state that there is environmental awareness is roughly equal to those who indicate that they never received it**.** However, 82.1% of respondents in Oniipa town state that they never received environmental awareness training.

4.6. Report from Oniipa Town Council

Furthermore, the research asked how waste is collected in the town and at what frequency the EHP highlighted that 4-ton refuse trucks collect refuse daily from Monday to Friday and when necessary, on weekends and public holidays Figure 20. The waste is collected from homesteads, businesses, and collection points within the town boundary. The council also mentioned that they had introduced a litter pick-up model where casuals are employed on a contract of six months to pick up litter from Mondays to Fridays. However, this contradicts the response from the 28 respondents because none of them mentioned that waste is collected daily. The EHP further indicated that the only fee involved in service delivery depends on the collection frequency. On that note, some respondents said they do not have a problem paying for service delivery.

Figure 20 - Waste collection tipper truck in Oniipa (Source: Oniipa TC 2019)

The researcher further *asked the EHP how and where they dispose of the waste in the town. The response was, "Currently; we do not have a waste disposal site; however, we arranged with our neighbour town Ondangwa to use their facility at no cost. The waste is loaded by hand and transported to the disposal site. Since our truck is a tipper, it does not take much time to offload waste at the site".* The official was asked if there are any activities presented to the resident as a way of promoting waste reduction at source, to which he said yes, they create awareness on the hierarchy of waste management in our community which is Avoid, Reduce, and Reuse, Recycle and Dispose of in an environmentally friendly manner. However, the participants did mention that there was not enough information.

Additionally, the Oniipa Town council, in collaboration with their junior councillors, had a road show campaign where they gave plastic bags to taxi drivers, in particular 16 (Figure 21). The exercise is confirmed by the participants who have seen it. Lastly, the EHP argued that financial constraints are hindering the town from achieving a better waste-managed town because they need to have resources at their disposal to manage waste efficiently. Nevertheless, there is a lack of equipment, human resources, maintenance of equipment, fuel, tools etc., at their council.

Figure 21 - Campaign of giving waste plastic bags to taxi drivers in Oniipa (Source: Oniipa TC, 2020)

4.7. Report from Ondangwa Town Council

The Ondangwa Town Council highlighted that waste volumes have increased over the years due to the influx of people coming to settle in the town from the nearby villages and other areas. The representative further stated that waste is collected around the whole town by five (5) contractors, who collect waste daily from different premises. Collection per household happens twice a week, whilst waste is collected three times a week at business premises. This is not at par with the community, where the majority has stated that waste is only collected once a week from their households. Regarding waste collection fees, the council stated that an amount of approximately N$ 119.00 (R 119.00) is charged to the residents with Erf numbers in the town for both garden and general waste collection, billed to their monthly municipal bill.

The waste bins are only provided in formal residential areas at the moment. An informal settlement has metal bins, and although not sufficient, the target is that by 2024 all residences, including informal settlements. Since the budget is limited, it is difficult to provide all residences with refuse bins in their homes. Refuse skips are limited, and the budget is insufficient to accommodate everything in the town. Disposal site visits and direct observation was conducted during data collection week to access data about waste composition and quantity and to scrutinise the 4Rs strategic approach. The study found that source reduction toward improving MSWM. However, in the towns, these strategies are applied to a minimal degree.

The waste collected in the town is disposed of at the Ondangwa dumpsite, and the community is encouraged to use garden waste as compost. To reuse waste, some community members collect clothing pieces from tailors around the town to tailor them together to make clothes and blankets. In contrast, others collect tins to sell at the aluminium collectors in Ongwediva to earn a few cents Figure 22.

Figure 22 - Uupopo (Ondangwa) Residents recycling clothing pieces from tailors (left) and tins (right). (Source: Researcher, 2021)

Since waste is not separated when dumped, several companies at the site collect the recyclables (cardboard boxes, plastic bottles and lids), as indicated in Figure 24. Once recyclables are collected, waste is burned and moved into heaps. However, the disposed tonnage is not measured at this facility.

Figure 23 - Cardboard boxes and plastic lids collected for recycling at the Ondangwa dumpsite (Source; Researcher, 2021).

The Oniipa town council also responded that they use the Ondangwa dump fill to dispose of their waste at no cost. On this basis, the researcher asked the Ondangwa Town council representative if this has affected their work scope. The dump fill was constructed in the late 1960s during apartheid, said the Ondangwa Town council. The representative indicated that the issue had affected them, so it put constraints on the cost of weekly maintenance. Additionally, it is a burden because the site's space will shorten the site's life span from what they had anticipated; in turn, they will have no site to dispose of their waste in future. This is in agreement with Manaf *et al*. (2009), who stated that the increasing amount of waste in landfills triggers other disposal options since constructing new landfills can be demanding; for example, scarcity of land.

Regarding community awareness, the community representatives mentioned that the council promotes waste reduction through clean-up campaigns, promotions at schools around the town through competitions where schools come up with waste management projects, and winners are awarded prizes sponsored by local businesses. The council further stated that attending awareness meetings is reasonable; public meetings are conducted where the department goes out to present waste and other contributing factors to the waste issues. However, only 36% of the respondents agreed to have somewhat heard/attended awareness raised by the council.

The official also states that the council cleans up most waste found on surface water. The standard issue the council receives from residents is when waste is not collected from their premises on time, and all these complaints are kept in a register book at the health department. Further, the council is in a position of an Environmental Management Plan (EMP) and has obtained an Environmental Clearance Certificate (ECC) issued by the Department of Environmental Affairs. The council submits biannual environmental reports in compliance with the Ministry of Environment Forestry and Tourism (MEFT) regulations. However, a copy of the EMP is not at the dumpsite; the people responsible for operations at the site are aware of the measures stipulated in the EMP.

4.8. Report from Ongwediva Town Council

Like Oniipa and Ondangwa, Ongwediva also experiences urbanisation as the town develops. Furthermore, nearby villages have started dumping waste on the roadsides near the town, hoping that the council will collect it. In Ongwediva, waste is clustered into two groups: domestic and garden, and different contractors collect domestic waste (twice a week) and garden waste (twice a month or more). Residential and business waste is collected twice a week. A fee for both garden and general waste collection is accounted for in the monthly municipal bill.

Waste is collected from all places within the Ongwediva Town boundaries. This is at par with the residents, whom 100% highlighted that the council collects their waste. Additionally, refuse bins for households are not given for free, but they sell them at a reduced price; either way, the residents are not limited from purchasing them from other suppliers.

The waste collected is disposed of at the Ongwediva dumpsite, divided into two (building rubbles and garden and domestic waste); the community is encouraged to use garden waste as compost. Building

waste is used in areas that require levelling around the town and at the dump site. The waste is levelled around the site to create space for incoming rubbish. Like many dumpsites in the country, the waste disposed of tonnage is not measured; only condemned goods from the shops are measured. A caretaker at the dumpsite records the movement of vehicles and trucks that come to dispose of their waste. The council promotes waste reduction through clean-up campaigns, and this was happening more before the COVID-19 pandemic when they used to do awareness house-to-house throughout the town. The council also holds community meetings to tackle the waste issue. Attendance at this meeting is not significant during weekdays as opposed to weekends. The council's constraints include finances and community members that do not cooperate. There is a company in Ongwediva that collects, and buys used empty tins for recycling Figure 24. This was evident as the tin waste since the company opened in Ongwediva has reduced.

Figure 24 - The scrapyard in Ongwediva.

Further, the council is in an Environmental Management Plan (EMP) position and has obtained an Environmental Clearance Certificate (ECC) issued by the Department of Environmental Affairs. However, the official was unsure if the council submits biannual environmental reports in compliance with the Ministry of Environment Forestry and Tourism (MEFT) regulations. However, a copy of the EMP is not at the dumpsite; the people responsible for operations at the site are aware of the measures stipulated in the EMP.

4.9. Summary of results

The movement of people from rural areas to urban areas and industrial and construction activities are contributing to the rapid increase volume of solid wastes in Oniipa, Ondangwa and Ongwediva. The local authorities are trying their best to manage solid waste to ensure the protection of the environment as well as the well-being of the community as set in the Constitution of the Republic of Namibia; however, there are challenges, such as limited resources. For this reason, solid waste will continue as a significant threat to the environment and well-being of the community. Issues like environmental pollution have been reported within Oniipa, Ondangwa and Ongwediva. On the other hand, institutions responsible for solid waste management invest much effort in protecting the

environment and the community's well-being through legal instruments to make solid waste management an effective practice. Lastly, as developing town councils, there is a need to introduce low-cost solid waste management methods, improve community awareness, provide sufficient funds, enhance technical solid waste management knowledge, implement mandatory legislation and policies, and embrace accountability.

The pivot table below summarises the results obtained from the survey conducted in the three towns.

Table 14 - Comparison pivot table for results obtained

		ONDANGWA	ONGWEDIVA	ONIIPA	GRAND TOTAL
GENDER	Female	50.00%	53.57%	53.57%	52.38%
	Male	50.00%	46.43%	46.43%	47.62%
	Female	50.00%	53.57%	53.57%	52.38%
AGE	15 - 24	7.14%	10.71%	14.29%	10.71%
	25 - 34	32.14%	10.71%	42.86%	28.57%
	35 - 44	14.29%	7.14%	21.43%	14.29%
	45 - 54	21.43%	39.29%	14.29%	25.00%
	55 and above	25.00%	32.14%	7.14%	21.43%
EDUCATIONAL LEVEL	High School	50.00%	46.43%	60.71%	52.38%
	Middle School	3.57%	7.14%	7.14%	5.95%
	Never Schooled	10.71%	17.86%	14.29%	14.29%
	Primary School	10.71%	17.86%	3.57%	10.71%
	Tertiary	25.00%	10.71%	14.29%	16.67%
MONTHLY INCOME	< N$ 5000	82.14%	92.86%	82.14%	85.71%
	N$ 10 000 <	0.00%	0.00%	3.57%	1.19%
	N$ 5000 to N$ 10 000	17.86%	7.14%	14.29%	13.10%
HOW LONG HAVE YOU LIVED HERE?	2 to 5 years	25.00%	0.00%	25.00%	16.67%
	6 to 10 years	0.00%	21.43%	28.57%	16.67%
	Less than 1 year	7.14%	0.00%	10.71%	5.95%
	More than 10 years	67.86%	78.57%	35.71%	60.71%
DO YOU HAVE A BIN AT YOUR HOME?	No	46.43%	78.57%	78.57%	67.86%

	Yes	53.57%	21.43%	21.43%	32.14%
DOES THE TOWN COUNCIL COLLECT WASTE IN YOUR AREA?	No	14.29%	0.00%	60.71%	25.00%
	Yes	85.71%	100.00%	39.29%	75.00%
ARE THERE WASTE SKIPS NEAR YOU?	No	85.71%	78.57%	78.57%	80.95%
	Yes	14.29%	21.43%	21.43%	19.05%
HOW LONG DOES IT TAKE YOU TO GET TO THE WASTE SKIP?	11 - 15 min	0.00%	0.00%	10.71%	3.57%
	16 - 20 min	25.00%	0.00%	10.71%	11.90%
	5 -10 min	7.14%	21.43%	50.00%	26.19%
	Other	67.86%	78.57%	28.57%	58.33%
WHAT IS THE FREQUENCY OF WASTE COLLECTION BY THE TOWN COUNCIL?	I do not know	14.29%	0.00%	35.71%	16.67%
	Once a week	67.86%	0.00%	39.29%	35.71%
	Thrice a week	0.00%	78.57%	10.71%	29.76%
	Twice a week	17.86%	21.43%	14.29%	17.86%
IS THE WASTE COLLECTIVE SYSTEM EFFECTIVE?	No	46.43%	10.71%	46.43%	34.52%
	Yes	53.57%	89.29%	53.57%	65.48%
IF NO WOULD YOU MIND PAYING FOR SERVICES?	I would mind	78.57%	78.57%	78.57%	78.57%
	I would not mind	21.43%	21.43%	21.43%	21.43%
DO YOU EVER NOTICE WASTE IN WATER RESOURCES?	No	78.57%	10.71%	78.57%	55.95%
	Yes	21.43%	89.29%	21.43%	44.05%
COMPLAINTS	No	64.29%	0.00%	64.29%	42.86%
	Yes	35.71%	100.00%	35.71%	57.14%
PRESENCE OF FOLLOWING AROUND BIN	Domestic	17.86%	21.43%	17.86%	19.05%
	Mosquitoes	28.57%	17.86%	28.57%	25.00%
	Odour	46.43%	60.71%	46.43%	51.19%
	Scavengers	7.14%	0.00%	7.14%	4.76%
ENVIRONMENTAL AWARENESS	No	57.14%	50.00%	57.14%	54.76%
	Yes	42.86%	50.00%	42.86%	45.24%
IS THE INFORMATION PROVIDED	No	60.71%	82.14%	60.71%	67.86%

ENOUGH?	Yes	39.29%	17.86%	39.29%	32.14%
IS WASTE MANAGEMENT IMPORTANT FOR FUTURE GENERATIONS?	Very Important	100.00%	100.00%	100.00%	100.00%
	Very Important	100.00%	100.00%	100.00%	100.00%

CHAPTER FIVE (5) CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

Each individual is responsible for protecting the environment, and local authorities and municipalities should ensure the implementation of solid waste management systems to provide the necessary support. The effectiveness of solid waste management merely depends on active participation from individuals, local authorities and municipalities, the private sector, and the government at large. It is significant to recognise that local authorities, municipalities, and the government are working hand in hand to ensure the environment is protected. Moreover, it is vital to recognise that the institutions responsible for solid waste management systems in Oniipa, Ondangwa, and Ongwediva are trying their best to manage solid wastes; however, that is not enough. For this reason, it indicates that more needs to be done to ensure effective solid waste management systems in Oniipa, Ondangwa and Ongwediva.

5.2. Conclusion

The findings revealed in this chapter answered the research objectives and questions. Although the study collected different responses and opinions from the interview and the questionnaire analysis, the result indicates that most of the population desires an improved waste management service. This study investigated the status of the existing management systems of solid waste collection, transportation and disposal in Oniipa, Ondangwa, and Ongwediva Towns, examined the impacts of solid waste management on the environment and assessed the community's perceptions. Methods used to collect data included questionnaires, surveys, interviews and physical observation. One Hundred and Twenty (120) community members were randomly selected to collect data.

Additionally, the community members responded that they dispose of their waste in bins, domestic black bags, and burn and bury the waste. The councils responsible for waste collection have trucks that collect garbage from their municipal skips, and from those, they have provided bins. The participants have argued that they observe waste in water bodies, a lousy health indicator and a terrible sight for aesthetic purposes. Furthermore, the respondents also showed a lack of awareness, stating that they had not heard of any awareness programs in the town. The study found that the status of solid waste management systems in the towns is not up to standard due to poor waste disposal methods, few skip containers distributed, inadequate transport infrastructure, low waste collection frequencies, financial constraints and poor public awareness of waste management. These conditions degraded the environment, especially the water sources in the area.

5.3. Recommendations

Based on the findings of this research, there is a need to improve the solid waste management practices in Oniipa, Ondangwa and Ongwediva. To accomplish this, some recommendations are highlighted below:

- Increase education awareness on solid waste management in Oniipa, Ondangwa and Ongwediva.
- Provide adequate waste bags and bins for each household.
- Waste collection and skips points should be increased.
- Increase waste collection frequencies.
- Raise funds to construct a landfill for Oniipa, Ondangwa and Ongwediva.
- Charge service fee for waste collection to raise funds and purchase extra transport infrastructure.
- Waste like glass, tins and plastics should be recycled and not burned.
- Councils should develop and implement modernised waste management strategies and practices supported by technology and benchmarked with the best practices in the world.
- There is a need to find the actual cost of solid waste management because this was not covered in this study.

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APPENDICES

APPENDIX A: QUESTIONNAIRE SURVEY

An investigation of solid waste management systems of urban areas: Oniipa, Ondangwa, and Ongwediva Towns (Namibia)

A. DEMOGRAPHY

1. MY AGE:

15 – 24 ☐ *35 - 44* ☐ *55 and above* ☐
25 - 34 ☐ *45 – 54* ☐

2. I AM:

Female ☐ *Male* ☐

3. WHAT IS YOUR EDUCATIONAL LEVEL:

Never schooled ☐ *Primary school* ☐
Middle school ☐ *High school* ☐
Tertiary ☐ *Other specify……..*

4. MONTHLY INCOME:

< N$5000 ☐ *N$ 5000 to N$10000* ☐ *N$10 000 <* ☐

5. HOW LONG HAVE YOU LIVED IN THIS AREA:

Less than 1 year ☐
2 to 5 years ☐
6 to 10 years ☐
More than 10 years ☐

B. SOLID WASTE MANAGEMENT

6. DO YOU HAVE A BIN IN YOUR HOUSE? IF NO, WHERE DO YOU DISPOSE OFF YOUR WASTE?

Yes ☐ *No* ☐

……
……
……

7. DOES THE TOWN COUNCIL COLLECT WASTE IN YOUR AREA?

Yes ☐ *No* ☐

8. ARE THERE ANY PUBLIC SKIPS NEAR YOU RHOUSE?

Yes ☐ *No* ☐

9. HOW LONG DOES IT TAKE YOU TO GET THERE?

5 – 10min ☐ *11 – 15min* ☐ *16 – 20min* ☐
Other……..

10. WHAT IS THE FREQUENCY OF WASTE COLLECTION BY THE TOWN COUNCIL?

Once a week ☐ *Twice a week* ☐ *Thrice a week* ☐
Every day ☐ *I don't know* ☐ *Others ……...*

11. IS THE WASTE COLLECTION SYSTEM EFFICTIVE?

Yes ☐ *No* ☐

12. IS THERE ANY WASTE COLLECTION FEES INVOLVED? IF NO, WOULD YOU MIND PAYING FOR SERIVCE?

Yes ☐ *No* ☐

……
……
……

C. ENVIRONMENTAL IMPACT

13. DO YOU EVER NOTICE WASTE IN WATER RESOURCES?

Yes ☐ *No* ☐

14. HAVE YOU HEARD ANYBODY COMPLAINING ABOUT HEALTH PROBLEMS DUE TO SOLID WASTE?

Yes ☐ *No* ☐

15. HAVE YOU NOTICED ANY PRESENSE OF THE FOLLOWIN IN AND AROUND PUBLIC WASTE BIN OR DUMPING LAND?

Odour ☐ *Mosquitoes* ☐ *Scavengers* ☐
Rats ☐ *Domestic* ☐ *Others ……*

D. ENVIRONMENTAL AWARENESS

16. HAVE YOU HEARD ABOUT ANY ENVIRONMENTAL AWARENESS PROGRAMS IN YOUR TOWN? IF YES, HAVE YOU ATTENDED? WHAT TYPE OF AWARENESS?

Yes ☐ *No* ☐

……
……
……..

17. DO YOU THINKTHERE IS ENOUGH INFORMATION AVAILABLE ABOUT ENVIRONMENTAL IMPACTS OF SOLID WASTE IN YOUR AREA?

Yes ☐ *No* ☐

18. DO YOU THINK THAT LEAVING A BETTER ENVIRONMENT TO FUTURE GENERATIONS IS SOMETHING?

Very important ☐ *Not very important* ☐

APPENDIX B: INTERVIEW QUESTIONS BETWEEN THE RESEARCHER AND THE WASTE MANAGEMENT DEPARTMENT IN THE ONIIPA, ONDANGWA, AND ONGWEDIVA TOWN COUNCILS

1. The Town's population is growing, how does this affect the issue of solid waste management in your Town?
2. How waste is collected in your town and what is the frequency of waste collection?
3. Are there any user fees involved?
4. How and where do you dispose the waste in your Town?
5. Are there any activities presented to the resident as way of promoting waste reduction at source? If yes, mention them.
6. What provision has been made to avoid waste polluting surface water?
7. Has the Oniipa Town council hosted any environmental awareness about solid waste? If yes, list them, how was the attendance?
8. What do you think is the constraints hindering the town from achieving sustainability through a better waste managed environment?
9. How much budget is allocated into waste management per year? Has it been sufficient from your point of view?
10. Does your office have complaints register for waste related issues? If yes, how is the community response towards this?
11. When was the dump fill constructed?
12. Does your landfill have an Environmental Clearance certificate (ECC) from the Ministry of Environment Forestry and Tourism (MEFT)? Do you submit biannual environmental reports to them?
13. How do you calculate the tonnage dumped at your site?
14. How has the issue of Oniipa Town using your dump fill affected Ondangwa's scope of work?

APPENDIX C: DATA COLLECTION CONSENT LETTERS FROM ONIIPA, ONDANGWA AND ONGWEDIVA TOWN COUNCILS

ONIIPA TOWN COUNCIL

Tel: +264 65 245700/10
Fax: +264 65 245 711

PO Box 25179
Onandjokwe, Namibia

Onandjokwe Road
Oniipa, Namibia

OFFICE OF THE CHIEF EXECUTIVE

Enquiries: Mr. Daniel Nicodemus
E-mail: dnicodemus@oniipatc.org.na

17 February 2021

Our Ref: 5/17

TO WHOM IT MAY CONCERN:

PERMISSION TO COLLECT DATA FOR ACADEMIC RESEARCH PURPOSE FOR MS. LOVISA NANGULA AMWELE STUDENT NUMBER 216057221 AT CAPE PENINSULA UNIVERSITY OF TECHNOLOGY,

AN ACADEMIC FULFILMENT REQUIREMENT TOWARDS A MASTERS DEGREE IN ENVIRONMENTAL MANAGEMENT

We hereby acknowledge your request to carry out a research in **Oniipa Town Council** in fulfilment of your aforementioned academic qualification.

Permission is hereby granted to you to conduct a research on the topic of **"An investigation on Solid Waste Management Systems in urban areas: Oniipa, Ondangwa and Ongwediva upcoming urban areas (Namibia)."**

We wish you the best in your studies and it is our hope that, upon successful completion of your study research, you will share its findings with us to build on in transforming our institution for better in the area of waste management.

We trust that that this will suffice.

Yours sincerely,

ONIIPA TOWN COUNCIL
P O BOX 25179
ONANDJOKWE • ONIIPA
2021 -02- 17
TEL: 065-245700
FAX: 065-245711
OFFICE OF THE CEO

MR. JUNIAS JAKOB
CHIEF EXECUTIVE OFFICER
E-mail:jjakob@oniipatc.org.na
JJ/dn/ai/02-2021

All official correspondences should be addressed to the Chief Executive Officer

ONDANGWA TOWN COUNCIL

Tel [065] 240101
Fax [065] 240453
E-mail ceoadmin@ondangwatown.com

Private Bag 2032
Ondangwa

Enquiries: F. Sheya

23 June 2021

Ms.Lovisa Nangula Amwele
P.O.Box 24
Ondangwa

RE: REQUEST FOR PERMISSION TO COLLECT DATA FOR MASTERS THESIS IN ONDANGWA TOWN.

I refer to your email of 08 June 2021 regarding the above and hereby inform you that your request is granted to collect data for purposes of compiling your thesis for the Master's degree in Environmental Management. The information requested is solely for your research purposes and should be handled with confidentiality. // You are also kindly requested to submit a copy of your final report to my office once your thesis is completed and approved.

You are also hereby requested to prepare and administer your research instrument taking into account the prevailing COVID-19 situation.

Wishing you all the best with your thesis.

Yours faithfully

ONDANGWA TOWN COUNCIL
OFFICE
OF THE C.E.O
24 JUN 2021
Nangolo Mbumba Street
Private Bag 2032 Ondangwa
Sign: .....
REPUBLIC OF NAMIBIA

.....
Ismael I. Namgongo
CHIEF EXECUTIVE OFFICER

ONGWEDIVA
FREEDOM & HARD WORK
ONGWEDIVA
TOWN COUNCIL
Private Bag 5549, Ongwediva
Tel: 00264 65 233700
Fax: 00246 65 230521
Website:
www.ongwediva.com.na

Ref : U - 3
Enquiries: Mr Mathew Mbombo
E-Mail : mmbombo@otc.com.na

Thursday, February 18, 2021

Ms Lovisa Nangula Amwele
P. O. Box 24
ONDANGWA

Dear Ms Amwele

REQUEST FOR PERMISSION TO COLLECT MASTER'S THESIS DATA IN ONGWEDIVA TOWN - YOUR SELF.

Your letter dated February 16, 20201 refers.

Kindly be informed that the Council considered favourably your request to collect data in Ongwediva subject to the following conditions:

- The information / materials given to you during the research project should be kept confidential during and after the research project.
- The research findings should be used for study purpose and be shared with the Council upon completion of the research project.
- The research schedule should be communicated to Council and agreed upon by both parties.

I trust you will find the above in order.

Sincerely yours,

OFFICE OF THE CHIEF EXECUTIVE
P/Bag 5549
Ongwediva
18 FEB 2021
Tel: 065 233 700
Fax: 065 230 521
ONGWEDIVA TOWN COUNCIL

Mr. Damian E. Egumbo
CHIEF EXECUTIVE OFFICER
ONGWEDIVA TOWN COUNCIL

FILE

APPENDIX D: CPUT ETHICS CLEARANCE

Cape Peninsula University of Technology

Statement of Permission

Data/Site permit is required for this study.

Reference no.	216057221/01/2021
Surname & name	Lovisa Nangula Amwele
Student Number	216057221
Degree	Master of Environmental Management
Title	An investigation on solid waste management systems in urban areas: Oniipa, Ondangwa and Ongwediva (Namibia)
Supervisor(s)	Prof K Shale
FRC Signature	
Date	13/01/2021

Cape Peninsula University of Technology

P.O. Box 1906 · Bellville 7535 South Africa ·Tel: +27 21 953 8677 (Bellville), +27 21 460 4213 (Cape Town)

Provisional Ethics Approval Letter **Reference no:** 216057221/01/2021

Office of the Chairperson **Research Ethics Committee**	**Faculty of Applied Sciences**

On 11 January 2021, the Faculty Research Ethics Committee of the Faculty of Applied Sciences granted provisional ethics approval to **Lovisa Nangula Amwele** for research activities related to a project to be undertaken for a degree (**Master of Environmental Management**) at the Cape Peninsula University of Technology. The study can begin once a site permit is obtained from the local town council.

Title of project:	An investigation on solid waste management systems in urban areas: Oniipa, Ondangwa and Ongwediva (Namibia)

Comments (Add any further comments deemed necessary, e.g., permission required)

1. Human subjects are involved in the proposed study.
2. This permission is granted for the duration of the study.
3. Research activities are restricted to those detailed in the research proposal.
4. The research team must comply with conditions outlined in AppSci/ASFREC/2015/1.1 v1, CODE OF ETHICS, ETHICAL VALUES AND GUIDELINES FOR RESEARCHERS.

	**11/01/2021**
Signed: Chairperson: Research Ethics Committee	**Date:**