Assessing Public Awareness of Risks Posed by Petrol Storage within the Maseru Industrial Area

BY

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Declaration

By submitting this dissertation, I, Puleng Edith Sehloho, declare that the entire work contained therein is my own original work; that I have acknowledged all sources utilised; that reproduction and publication thereof by the University of the Free State will not break any third-party rights; and that I have not previously submitted this work for obtaining any qualification.

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To God Almighty; "for everyone who keeps on asking receives, and he who keeps on seeking finds, and to him who keeps on knocking, it will be opened." Matthew 7:8.

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Dedication

I dedicate this work to fellow Disaster Managers, present and upcoming. I believe that in this piece of work you will find inspiration and content that will make your work easier. Also, it is dedicated to my parents, Mr. Lets'aba Sehloho and Mrs. 'Malebina Sehloho by virtue of being educators and pursuing your own education and learning, I have been motivated to reach for the stars and broaden my knowledge.

Abstract

The hazardous installation in Maseru Industrial Area is situated among the many industrial area economic operations. This placement puts a lot of people and properties close to the installation in danger. The study investigated the extent of public awareness of the risks posed by petrol storage in Maseru Industrial Area, among other land uses. The study assessed the hazards that can come about from the petrol storage, and evaluated the vulnerability of people, livelihoods, and properties of companies nearby. With the objective to determine suitable land zoning for petrol storage and ways of reducing the impact of petrol storage industrial accidents on surrounding communities and the environment. The complex nature of disaster risk reduction of hazardous installation locations led to a review of several theoretical frameworks in order to analyse the disaster risk of people located near the petrol storage. The research identified the conceptual framework to identify disaster risk as being the ideal framework to use.

The study used pragmatic philosophy. Using a mixed method approach and a population drawn from plots in the Maseru industrial area, random sampling was used to select the 73 participants within the radius of 500m of the petrol storage facility. The technique used for data collection is face-to-face interviews using a pre-designed questionnaire.

The results suggest that though the current situation at the petrol storage facility is well managed, in the case of an accident it will expose the surrounding developments to fires and explosions. The results also suggest that land-use planning at the moment does not consider hazards produced by petrol storage. In addition, while observations at petrol storage facilities suggest the potential for major fires accidents, preparedness to respond to fires seems to be low. This leads to the critical need for public awareness of land uses near petrol storage to better prepare for, respond to, and recover from any eventual industrial disaster caused by fire or explosions. Most important is to incorporate land zoning as a tool to mitigate (better build back for future) major hazardous installations accidents.

Keywords: Land Zoning, Disaster Risk, Awareness, Petrol Storage facility/Major Hazardous Installation, Risk Assessment, disaster Risk Reduction

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List of Abbreviations

ARSDRR: African Regional Strategy for Disaster Risk Reduction

CHEMAC: Chemical Management Committee

DRR: Disaster Risk Reduction

EPA: Environmental Protection Agency

ES: Emergency Services

EU: European Union

HAZOP: Hazard and Operability

LAA: Land Administration Authority

MHI: Major Hazardous Installation

OCHA: UN Office for the Coordination of Humanitarian Affairs

SHE: Safety, Health, and Environment

SPSS: Statistical Package for the Social Sciences

UNECE: United Nations Economic Commission for Europe

UNEP: United Nations Environment Programme

Definitions

Communities: are composed of various aspects, including built, natural, economic, and human. They can take many different shapes, from high-density metropolitan centres to suburban, rural, or more "natural" ones. Communities are made up of intricate systems with a variety of needs met and connections to the economic, social, and environmental systems (Australian Government, 2002).

Disasters: are severe disruptions of a community's or society's ability to function at any scale brought on by hazardous events interacting with exposure, vulnerability, and capacity conditions, which may result in one or more of the following: losses and effects relating to people, things, money, or the environment (National Disaster Risk Reduction Framework, 2018).

Disaster Management: is an ongoing and integrated multi-sectoral, multidisciplinary process of planning and implementing procedures intended to prevent or reduce the risk of disasters, to mitigate the intensity of disasters, or to improve emergency preparedness. It is a prompt and effective response to disasters, as well as to rehabilitation and reconstruction following a disaster (South African Disaster Management Act 57 of 2002).

Disaster Risk: is the potential loss of life, injury, destruction, or damaged assets that could occur to a system, society, or community (UNISDR, 2009).

Disaster Risk Reduction: the idea and practise of reducing disaster risks through methodical efforts to analyse and manage the causes of disasters, including by lowering exposure to hazards, reducing people's and property's vulnerability, managing land and the environment wisely, and improving preparedness for unfavourable events (UNISDR, 2009).

Exposure: describes the things that are at risk from a natural or man-made hazard event. Individuals, homes, communities, buildings, structures, public spaces, infrastructure, agricultural products, environmental assets, and commercial activities could all fall under this category. Exposure information describes what is at risk by describing the location and properties, or attributes, of each element (Australian Government, 2002).

Hazards: a risky phenomenon, drug, human activity, or circumstance that could result in a loss of life, harm to one's health, property damage, a loss of one's livelihood and services, societal economic decline, or environmental harm (UNISDR, 2009).

Mitigation: process of minimising or limiting of unpleasant hazards impact (UNISDR, 2009).

Preparedness: is the knowledge and skills created by authorities, specialised response and recovery groups, communities, and people to efficiently anticipate, respond to, and recover from the effects of potential, impending, or existing hazards, events, or circumstances (UNDRR, 2017).

Prevention: effects from hazards and associated disasters (UNISDR, 2009).

Public Awareness: The level of public awareness of disaster risks, the causes of disasters, and the steps that may be taken both individually and collectively to lessen susceptibility and exposure to hazards (UNISDR, 2009).

Recovery: Restoration or improvement of the economic, physical, social, cultural, and environmental assets, systems, and activities of a community or society that has been affected by a disaster in accordance with the principles of sustainable development and "build back better" to prevent or lower the risk of future disasters (UNDRR, 2017).

Resilience: is the capacity of a system, group, or society exposed to risks to resist, absorb, accommodate, adapt, transform, and recover from a hazard in a timely and efficient manner, including through the preservation and restoration of its fundamental basic structures and functions (UNDRR 2017).

Response: to preserve lives, minimise health effects, protect public safety, and meet the basic subsistence needs of those affected by a disaster, emergency services and public assistance must be provided during or right away after the disaster (UNISDR, 2009).

Vulnerability: is described as the circumstances determined by physical, social, economic, and environmental elements or processes that make a person, a community, a system, or an asset more vulnerable to the effects of hazards (UNISDR, 2009)

Chapter 1

Research Introduction

1.1 Introduction

This chapter introduces the study on assessing public awareness of the risks posed by petrol storage in Maseru industrial area, Lesotho. The topic was inspired through observing the location of petrol storage tanks in the Maseru Industrial Area. The storage is located within other different land uses, like the textile industries, mortuary, car fixing and mechanical businesses, office spaces, flour milling factory, brewery, the railway station, hardware stores and cash and carry, so in the event of an explosion and fire from the petroleum product, the land users nearby could be seriously affected. The impacts may include the loss or injury to people, damage to property, loss of livelihoods, and damage to the environment. This raises the question, are the land users aware of the risks surrounding them?

The location of petrol storage facilities, among other land uses in the industrial area of Maseru, Lesotho, can pose a serious threat to the public. Since there are different economic activities that are beneficial to any economy, there is a need for land zoning. Land zoning is a crucial issue in the developed countries and, as such, has helped limit human-induced disasters, particularly the industrial types of disasters that can lead to great damage (UNDRR, 2013). As defined by Haileslasie (2018), land zoning is a procedure of conglomeration with the aim of controlling the uses of land and setting restrictions for every land use. According to their types or their daily activities, agglomerating industries can reduce industrial disasters because those industries are often located away from communities and office spaces (Haileslasie, 2018). To achieve sustainable development, land use zoning takes into account interests in a number of issues linked to food security, urbanisation, better livelihoods, globalisation, and industrialization. Land use safety planning, on the other hand, is the method of dealing with potential conflicting sources of risk like potential hazardous industries and nearby land uses (New South Wales Government, 2011).

The aim of land zoning is to make communities more resilient and less vulnerable. Resilience takes an interest in everyone and strikes a balance between economic progress and the social

well-being of a society through excellent governance and ethical practices that value human rights, traditions, and cultures. A fair balance between social, economic, and environmental sustainability is another aim of resilience (Haileslasie, 2018; Roy & Ferland, 2015).

To foster a climate that is favourable for the welfare of its citizens and a variety of economic activities, including but not limited to industrial activities like clothing factories and petrol storage, governments around the world employ a variety of policies and techniques. In light of this, all nations pursue industrialisation as an economic strategy. This calls for appropriate land administration practices and impacts evaluations. Systems of land administration include land usage and land development. Implementing land use controls and rules for planning and spatial issues is part of the land use component. Once more, the land development activities include regulating and implementing land use plans, building, and issuing permits (Haileslasie, 2018).

As argued by Haileslassie (2018), the urbanisation rate and the growth of different land uses for economic activities have been large and rapid. Haileslasie explained that this rapid change is often taking place without thinking of undesirable environmental and social consequences, as seen in the encroachment of arable lands, grasslands, and forest areas into urban centres and industrial sites.

The United Nations Office for Disaster Risk Reduction (UNDRR) (2013) explains that poor land planning can result in unintended hazards. For example, storing flammable substances among other land users may create risks. This is the case with petrol storage facilities in the Maseru industrial area. This research is therefore focused on raising awareness of the risks faced by other land users around petrol storage areas in the Maseru Industrial Area. Lack of risk awareness will mean people may not be taking measures to reduce them; therefore, this will increase their vulnerability to possible industrial emergencies and disasters.

Such disasters can be sparked by fires, which are very popular to Basotho as they are dependent on biodegradable gas especially in Winter. This could be likened to the burning of the Kuwait Oil fields in 2001 which caused respiratory and environmental challenges. Oil wells caught fire as a strategy to slow down the American troops which were fighting Kuwait. 11 people lost lives while numerous experienced respiratory and water problems as the Mexico gulf was polluted with oil residue.

1.2Description of the Study Area

As stipulated by the Bureau of Statistics (2016), Lesotho is a small country with a total population of 2,007,201 people. Found on the African continent, Lesotho is situated between latitude 28°S and 31°S and longitude 27°E and 30°E. It is land-locked entirely by the Republic of South Africa and has a total surface area of 30,355 square kilometres. Parthan (2013) further notes that Lesotho is divided into four agro-ecological zones, which are the mountainous, foothills, lowlands, and Senqu river valley zones, of which the mountainous and foothills zones cover about 74% of the land that is mostly used for grazing, water development projects, and mining. The remaining land is covered by other zones, which are the lowlands and the Senqu River Valley where most of the economic activities include agriculture, industry, commerce as well as human settlement. The study focused on Maseru, which is the capital city of Lesotho. Maseru and the Maseru district has a population of 519,186 and falls in the Lowlands ecological zone (Mbata, 2001). At one time, Lesotho's economy was based on various activities like mining, textiles, construction, and crop and animal farming, but recently the country is more reliant on output from services. Major industries in Lesotho are mining, construction, textiles, and food products, while there are also services and wholesale and retail trade. Maseru is where industries are concentrated, along with different office spaces and the depots of petrol, where there are huge tanks that store petrol (Parthan, 2013; Mbata, 2001).

Common hazards in Lesotho include droughts, floods, frost, hailstorms, snow, and tornados, which are exacerbated by climate change, and this produces vulnerable communities that are greatly impacted upon by these hazards (Letsie, 2015; Disaster Management Authority, 2011). In recent years, Lesotho has been subjected to climate shocks that result in regular droughts, dry spells and floods that negatively affect the people's livelihoods. The impacted livelihoods increase the poverty rates in the country, together with the high unemployment rates (Government of Lesotho, 2017). The unemployment rate in Lesotho currently stands at 23.6% of the total population, which renders the youth most vulnerable. The unemployment rate is highest among young people, at about 40%. The population of Lesotho youth is 39.8% of the total population (Government of Lesotho, 2017; The World Bank, 2020).

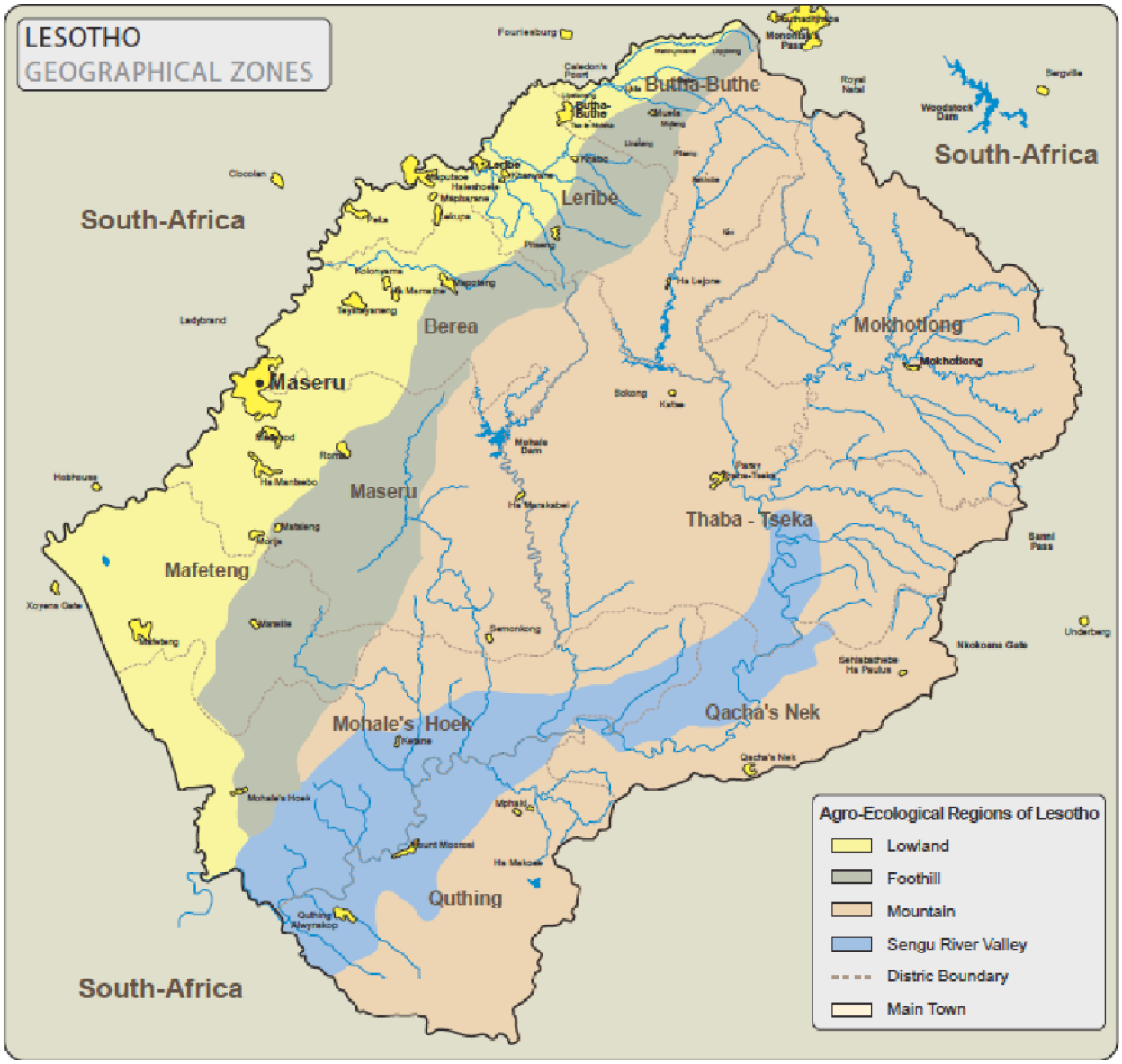

Figure 1. 1 Study Area: Map of Lesotho Ecological Zones
Source:(Palerm, 2012)

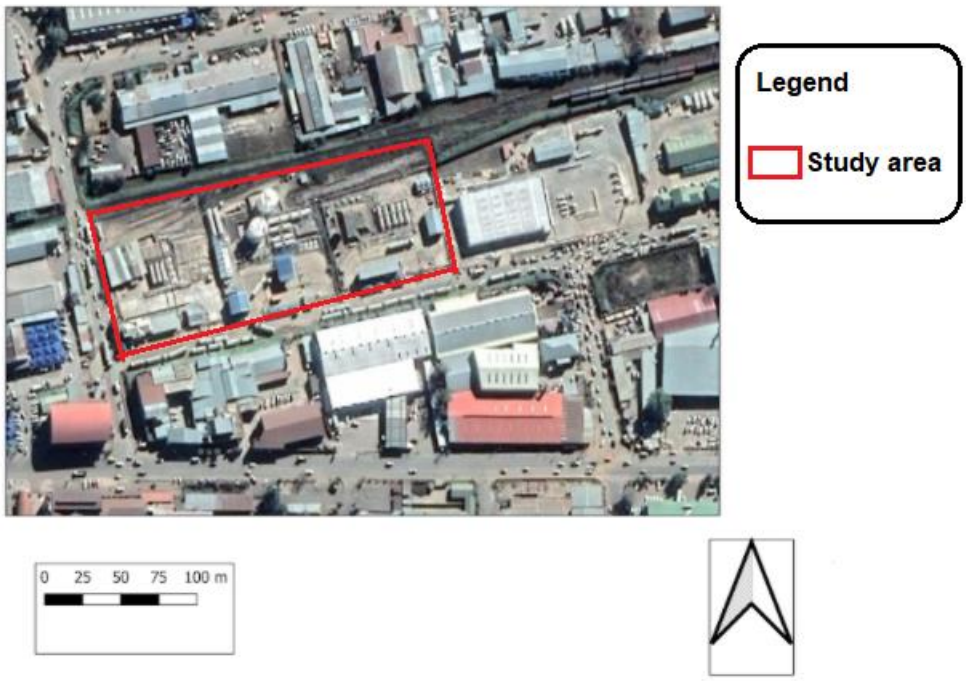

Figure 1. 2 Petrol Depot in Maseru Industrial Area
Source: (Adopted from Google satellite, 2019).

1.3 Research Problem

In an ideal situation, Fuentes-Bargues and Carmen (2017) outline that the fuel storage is expected to meet the greatest levels of risk control, such as ensuring that the storage location is convenient and that nearby land users are aware of the danger. The safety of hazardous installations sparked a lot of interest in safety and has led to safety processes. Which is a scientific subject that focuses on the avoidance of fires, explosions, and unintentional chemical releases in chemical processing facilities, with the goal of improving prevention in the facilities (Englund, 2007).

The hazardous installation in Maseru Industrial area is located within the different economic activities of the industrial area, namely: the textile industries, mortuary, car fixing and mechanical businesses, office spaces, flour milling factory, brewery, the railway station, hardware stores and cash and carry. This location exposes many people and properties around the hazardous installation to risk (Morgan-Jarvis, 2018). The hazardous installations to be discussed is the petrol storage, which handles 700 GL of petrol (Ministry of Tourism Environment and Culture, 2010). A petrol storage of this size will affect a large area if anything goes wrong. Hence, measures must be put in place to avoid the risk.

As indicated in the Major Hazards Installations Regulations (2001), properly zoning these areas can reduce the risk to damaging properties and saving livelihoods, or people. As a result, the possible intensive risk will be avoided. Such intensive risk is of low probability but has occurred in the past in other countries, for example, Seveso in Italy. Haileslasie (2018) explains that the availability of legislation allows a country to protect the health, morals, public safety, and general welfare of its population.

The petroleum fund in Lesotho was established and approved by the government in 1995 but legally established under Legal Notice No. 96 of 1997. The establishment of the fund was mainly to facilitate the measures for the supply of fuel securely, especially because there were no strategic storage facilities for the fuel. The regulation was amended by the Legal Notice No.118 of 2009 and, among other things, was directed to facilitate the national storage of petroleum products if need be and the improvement of safety at storage facilities (Petroleum Fund, 2020).

In the same vein, the Lesotho Building Control Act 1995 promotes consistency in the construction of buildings in the country. It also sets down the building standards and incidental matters. The Land Act (2010) was meant to overcome the land administration and acquisition challenges and promote the markets.

Hazardous facilities like petrol storage can be dangerous. Hazardous facilities are installations or factories where a substance is manufactured, handled, or stored that can cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage if there is an error or ignition of some sort (Abdalla, Apramian, Cantley, & Cullen, 2017). These disaster risks are referred to as "human-induced risks" because they occur directly and entirely because of human activity, either as a direct cause of a disaster or during the construction or operation of a hazardous installation or facility. As mentioned by Khalilov (2015), there are simple factors that determine the degree of hazard and risk of hazardous installations, such as:

1. The record of supply and properties of those hazardous materials: are they of explosive nature, toxic or reactive?

2. The nature of the process or the circumstances of the operation.

3. If the operation is complicated.

4. The relationship between design and operation in relation to standards and codes.

5. How is the equipment laid out?

6. Because of the plant's layout, the equipment is separated.

7. All necessary measures for prevention and protection are taken.

8. The distance to centres with people, the vulnerability of the surroundings of the plant site.

9. The efficiency of the plant management, whether they are trained for operation and production against risk issues,

However, personal observations point to the fact that the law is not followed at all or is not strictly implemented. The land allocation in Lesotho is disorganised so much that it leads to different land uses being located in the same area. Also, formal land acquisition is expensive and difficult to manage, resulting in land use efficiency and productivity being affected. The land users who obtain land informally intensify unplanned land use, which lacks basic services. Again, the land use regulation is frail, with land prices that are irregular and not fit for the demand of a functional land market.

Furthermore, the construction industry remains a challenge also, as it is not effectively regulated, leading to environmental problems in the country. To concur, the Government of Lesotho (2018–2023) shows that lack of resources for the implementation of proper built environment activities is also a challenge.

This study, therefore, is necessary to proactively assess the degree of public awareness of the risks that the petrol storage facility can pose in the industrial area of Maseru in Lesotho. There has been no research on assessing public awareness on risk posed by the petrol storage in Maseru Lesotho. Most academic literature on Lesotho has focused on fuel prices, economic benefits of petrol, fuel demand and the health and environmental impacts (Mpholo et al., 2014; Ministry of Health,n.d). Maseru Industrial area has not experienced a petrol storage accident at large scale, but some fire accidents have occurred in the area, like in 2014, one factory named Dragon Pak, which produces fomo (kaylite) packs, experienced a fire that ignited from one of the company's

machines. The factory burned down, and the next one nearby, named KHY Plastics. Two factories caught fire, sparing other factories nearby, namely, Pressure Garment and Super Knitting, which only had to shut down for the safety of employees. As for casualties, only two people died, and one was injured and hospitalised. The night shift staff of 40 employees from Dragon Pak and 7 employees from KHY Plastics managed to evacuate safely. The miserable impact of about 89 people losing their jobs is palpable. Dragon Pak had a total of 60 employees, and KHY Plastics had 29 employees, adding to the high unemployment rate in Lesotho. The impact ended up being this extensive because of lack of resources from the fire brigade, which was alerted on time and arrived, but they could not put out the fire (Maama, 2014).

1.4 Research Questions

The research problem presented above reveals the following research questions:

1.4.1 Main Research Question

What is the level of awareness of the risks posed by petrol storage to the people, properties, livelihoods and environment located near the petrol installation in Maseru industrial area?

1.4.2 Sub-research Questions

- What are the hazards and risks posed by petrol storage to the surrounding land uses?
- Are nearby people, properties, livelihoods and environment vulnerable to risks posed by the petrol storage?
- What are the various land uses near the petrol storage facility?
- What are suitable land-use zoning for petrol for petrol storages facility?
- What are ways to reduce the impacts of petrol storage industrial accidents on surrounding communities and environment?

1.5 Objectives

1.5.1 Overall Objective

The overall objective of the study is to assess the level of awareness of the risk factors posed by petrol storage to the people, properties, livelihoods and environment concerned with the location of petrol storage within several other land uses in the industrial area of Maseru, Lesotho.

1.5.2 Sub-Objectives

- To assess the hazards that can occur from the petrol storage

- To evaluate the vulnerability of people, properties and livelihood of people near the petrol storage
- To determine the various land users around the petrol storage facility
- To determine suitable land zoning for petrol storage
- To recommend ways to reduce the impact of petrol storage industrial accidents on surrounding communities and the environment.

1.6 Significance of the Study

The chief aim of the study is to assess awareness of the risk factors posed by petrol storage, to people, properties, livelihoods and the environment, around petroleum storage concerned with the location of the petroleum storage within other land uses in the industrial area of Maseru, if ever the storage explodes and causes fire, resulting in a disaster. The study also discusses the literature on suitable land zoning of petrol storage facilities to avoid major risk impact in the event of a catastrophic event.

The study will contribute to the progress that Lesotho has made towards the Sustainable Development Goals (SDG), particularly SDGs 11 and 9. The goals advocate for safe, resilient and sustainable cities, communities, and human settlements as well as building resilient infrastructure and promoting inclusive and sustainable industrialization. Finally, the study will contribute towards the literature on industrial disasters in Lesotho, as currently there is very limited information on risks surrounding petrol storage disasters.

1.7 Methodology

Neuman (2006) defines methodology as the umbrella of methods used in research, while methods are techniques used to select cases, measure, and examine social life features, collect, and analyse the data, then produce the results and present them. Neuman further explains that methods and methodology relate to each other and depend on each other.

1.7.1 Research Design

Research design gives the right framework for the study (De Vaus, 2001). Sileyew (2018) adds that most importantly, it is about the choice of the approach the research will take as it

establishes how the information will be acquired. To acquire the information, data collection tools are used.

Rakotsoane (2012) aver that research can either be qualitative or quantitative or even both in nature. Outlining that qualitative research entails a thorough understanding of human behaviour and the reasons for that behaviour. It looks at what, where, and when the decision is made and is mostly textual in nature. On the other hand, quantitative research depends on reasons that lie behind different behavioural aspects and explores the how and why of making decisions and mostly produces numeric data (Rakotsoane, 2012). This study used both qualitative and quantitative (mixed) research methods within an exploratory research classification. An exploratory research is defined as a study carried out to look into a problem which is not clearly defined. It is carried out to gain a deeper comprehension of the current issue, but it will not produce definitive findings. When doing such a study, the researcher begins with a broad concept and uses the research as a tool to identify potential research topics (Creswell, 2015). For this study, due to gaps from inadequate research, exploratory research is used. The gaps coming from the awareness of risks posed by petrol storages. The approach deals with verbal data, with procedures that are not strictly formal and a scope that is undefined.

1.7.2 Data Collection Tools

The research used interviews to collect data from all relevant stakeholders located near the petrol storage facilities. Information was collected from a sample population located within a circumference of 500 metres from the petrol storage facility. The questions were mixed, with closed and open-ended questions to suit the mixed nature of the research conducted. The researcher conducted face to face interviews with the business's personnel in Maseru Industrial area near the petrol storage. 73 individuals from the businesses were interviewed with the guide of the pre structured questionnaire. Consent was sort out before beginning the interview.

1.7.3 Population and Sampling

Greener (2008) identifies a population in a study as the large group of participants from which a sample can be selected. Additionally, Majid (2018) highlights that research is done mainly to benefit the entire population, but because of the large scope of the population, the researcher cannot test every subject, as it can be time-consuming and costly. So only a sample has to be selected. A sample represents a certain portion of the population. The population of this research

entailed the people working in the Maseru industrial area, while the sample was a random selection of land users in the immediate vicinity of the petrol storage, as well as the petrol storage staff who elucidated the issue of operations and maintenance of the facility. The population of the area that was used came from the total plots in the vicinity of the petrol storage facility, which is 104 as provided by Lands Administration Authority (2020), and the sample was 37 plots, which fell within the buffer zone of 500 metres. Only adults working in activities that fall within the 37 plots were sampled. From these 37 plots, 73 respondents were randomly selected and interviewed.

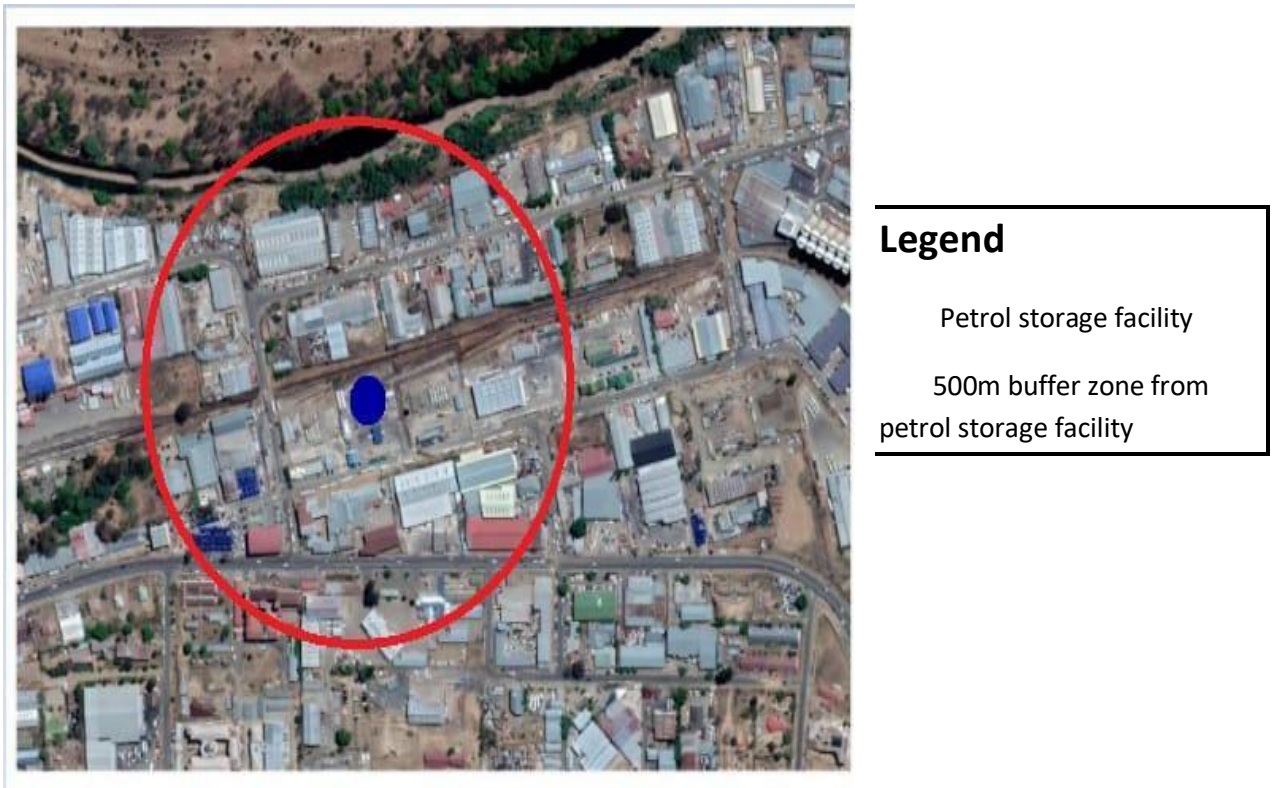

Figure 1. 3 Buffer Area
Source: (Adopted from Google satellite, 2019).

1.7.4 Data Analysis

Ibrahim (2015) argues that data analysis comes after data collection, whereby the data is calculated and evaluated so as to obtain information that is relevant from the data. The data gathered in this study was analysed using the IMB SPSS statistics 22 for quantitative data and Microsoft Excel spreadsheet for qualitative data. Most of the textual data was grouped into themes and analysed in themes.

1.7.5 Data Validity and Reliability

To test the validity and reliability of the collected data, different tests were conducted to ensure whether the collected data is accurate and consistent. Reliability measures the extent to which the instrument is consistent and repeatable (Hofstee, 2006). It is repeatable if, when done repeatedly, the results are the same. Reliability is important for a study but is sufficient when it is used together with validity. For a test to be reliable, it will also need to be valid. Validity gives details of how well the data that is collected takes place in the area of study (Taherdoost, 2016). It is the extent to which the instrument measures what it is supposed to measure. Construct validity is used because it is used in standardising the degree that measures whether different constructs correlate with one another (Hofstee, 2006; Taherdoost, 2016). The data collection instrument used was the same questionnaire. It was inspected by my supervisor to ensure that it was standardised before it was rolled out. Also, other research experts in the field of research were consulted.

1.8 Limitations and Delimitations of the Study

The use of a sample in the study was a weakness, as the information was based on the views of a small portion of the study. In the context of this study, only the land users within the near parameters were interviewed. Since the land use in the area is formed by the economically active population, it was hard to access a number of them for interviews as they were busy with their duties. The researcher therefore scheduled repeated appointments with the respondents and with follow up. Time was another limitation as finding people was not on the researcher's account but on the participants' available time.

Delimitations of the study were restricted to interviewing only those people working very close to the petrol depot, within a radius of 500 metres. There were about 37 plots that fell within the radius. The risk assessments were not conducted as well as the public awareness campaigns regarding the disasters that can occur in the area. The study selected a sample of 100 adult respondents working in activities that fall within 37 plots using random selection.

1.9 Ethical Consideration (s)

When conducting research, there are ethical and moral codes to adhere to in both stages of interviews and reporting. Weatington et al. (2010) indicates that the objects to be interviewed are human beings and they ought to be protected. The researcher should not put his/her interest

above that of the participants. First, the ethical clearance was applied for and obtained from the University of the Free State Ethics Committee (See appendix C). The researcher ensured that no harm was inflicted on the participants, by avoiding any emotional distress and by observing safety and COVID-19 protocols. Furthermore, the researcher observed the principle of anonymity. The names of participants were not used but coded with numbers, to protect their dignity (Rakotsoane, 2012).

The participant's consent was fully and freely provided before the interview took place. The participant knew that they were taking part in research and agreed to take part. A clear understanding of what they were doing and what was expected from them was outlined (Du Plooy-Cilliers, Davis, & Bezuidenhout, 2014). A consent form was attached to each questionnaire, and the participants were required to sign it before responding to the questions in the questionnaire.

The researcher did not in any way disturb the daily operations of the companies that the participants work at, as the questionnaires were sent via email and the consultations were done telephonically. The participants completed the questionnaires after hours in their own spare time.

1.10 Summary

This section of the research project covered the introduction, which outlined the problem at hand, starting with the background where the problem emerged. The chapter has also discussed the historical information down to the current situation. The subsection that follows is the problem statement, where the chapter highlighted the problem along with its causes, and all issues concerning the problem in order to confirm that indeed there is a problem. This is followed by the description of the study area as well as the location and the map that depict the study area. Research questions that emanated from the overall problem at hand and the objectives of the study that guided the questionnaire construction were next, followed by the significance of the study, which is concerned with how the study relates to the country, Lesotho, and the topic under investigation. The next subsection dealt with methodology and the methods that were used for data collection. The limitations of the study, whereby the study had shortcomings that may have hindered the research's ability to achieve the intended goal, were explained. The ethical considerations on how to protect the information provided by the participants conclude this first part of the research.

The next chapter will discuss the theoretical and the legislative frameworks related to the study.

1.11 Chapter Outline

Chapter 1: Introduction

The research problem made mention of the fuel storage being intended to achieve the highest levels of risk control, such as when the storage location is convenient and surrounding land users are aware of the threat. While the petrol storage in Maseru Industrial Area is actually positioned within the various economic operations, exposing a number of people, property and livelihoods to risk, as a result, this research was required to investigate the level of public awareness of the potential risks that the petrol storage facility poses.

The overall objective of the study is to assess and raise awareness of risk factors concerned with the location of petrol storage within several other land uses in the industrial area of Maseru, Lesotho. The objective and sub-objectives are to: assess the hazards that can occur from the petrol storage; to evaluate the vulnerability of people, properties, and livelihoods of people near the petrol storage; to determine the various land users around the petrol storage facility; to determine suitable land zoning for petrol storage; and to recommend ways to reduce the impact of petrol storage industrial accidents on surrounding communities and the environment.

Chapter 2: Theoretical and Legislative Frameworks

This chapter reviewed legislative and theoretical frameworks that are relevant to the study, such as the land use planning theories, which outlined land zoning as a regulatory tool best to remedy the situation, as it stipulates the importance of zoning the same land uses in one place, which reduces risks if the hazard occurs. The Hyogo Framework for Action (HFA) and Sendai Framework for Disaster Risk Reduction emphasised reducing disaster risk even before it occurs and the study also discussed other supporting theories. The constitution, acts, regulations, and contracts are among the documents that make up a legal framework. This section also looked at how they relate to each other and how one has more weight than the other. This chapter also looked at the disaster management cycle, which reveals the planning for and reduction of the impact of disasters. The focus is on understanding the risk, hazard, exposure, vulnerability, and capacity to overcome the risk.

Chapter 3: Review of Literature

The purpose of this chapter was to review literature concerning the topic of assessing public awareness of risks posed by petrol storage within the Maseru Industrial Area. A literature review acts as an inspection of the whole lot that has been written about an actual topic, a theory, or a research question. This chapter reviewed literature concerning the topic of assessing public awareness of risks posed by petrol storage within the Maseru Industrial Area. This chapter was organised into reviewing disaster risk reduction; disaster risk assessment; risk avoidance; risk awareness; history of industrial accidents; land use planning; and public awareness.

Chapter 4: Research Methodology

The fourth chapter examined the research problem using a particular research strategy. This chapter describes the methodological approaches utilised to address the research issue. All aspects of the research's philosophy, approach, strategy, goal, and timeframe are justifiable. Furthermore, ethical questions and limitations of the research technique are addressed.

Chapter 5: Data Analysis and Presentation of Results

In this chapter, the data collected using the questionnaire was analysed, interpreted and presented. determining the various land uses surrounding the petrol storage facility, determining appropriate land zoning for petrol storage, and recommending methods to reduce the impact of petrol storage industrial accidents on surrounding communities and the environment.

Chapter 6: Conclusions and Recommendations

This chapter discusses the findings of the study and draws necessary conclusions and recommendations; based on research findings and further studies.

Chapter 2

Legislative and Theoretical Frameworks Related to Risk Awareness Posed by Petrol Storages Located Among Other Land Uses

2.1 Introduction

This chapter outlines and evaluates the theories and legislation relevant to the study at hand which focuses on the awareness of risks of petrol storage among other land use activities in the Maseru industrial area, Lesotho. A theoretical framework, as defined by Sakaran (2000), is a conceptual model that explains how a researcher connects several elements that have been identified as crucial to the problem. While the legislative framework refers to the set of laws and policy that govern the adoption and use of performance management systems (Sakaran, 2000). The constitution, legislation, regulations, and contracts are among the documents that make up a legal framework. The documents are aligned in a way that they relate to each other and how one has more weight than the other (Natural Resource Governance Institute (NRGI), 2015).

When the surrounding land users are aware of the dangers they face from hazardous installations, then they can take wise measures to ensure their safety. The conceptual framework for identifying disaster risk focuses on understanding the risk, hazard, exposure, vulnerability, and the capacity to overcome the risk. Then the use of a land zoning regulatory tool will be best to remedy the situation, as it stipulates the importance of zoning the same land uses in one place, which reduces risks if the hazard occurs. The same land uses that are agglomerated are less risky. Among others, a few supporting theories will be discussed to enhance the importance of safety, theories such as sustainable development and disaster risk reduction frameworks, specifically the Hyogo Framework for Action (HFA) and the Sendai framework for disaster risk reduction, which emphasize reducing the disaster even before it occurs. To wrap up those theories, this chapter will also look at the legal frameworks for Lesotho that surround the issue under this research.

2.2 Theoretical Frameworks Related to Risk Awareness Posed by Petrol Storages Located Among Other Land Uses

The theory that explains why the research problem under inquiry occurs is introduced and described in theoretical frameworks (Abend, 2004). Therefore, theoretical frameworks can be seen as important elements of the research process acting as a foundation for the gathering of observed knowledge.

2.2.1 The Disaster Management Cycle

The disaster management cycle describes the ongoing process through which governments, businesses, and members of civil society prepare for and mitigate the effects of disasters, respond during and immediately after a disaster, and recovery after a disaster (Sakalasooriya, 2015). Concerning the study, it shows the importance of preparing prior to a disaster so that it does not occur or lessens its impacts. In a case of petrol storage risks, mitigation and preparedness like proper land zoning of petrol storages and conducting extensive public awareness to nearby land uses, can reduce disasters greatly in a pre-disaster stage. With proper preparations the intensive risk maybe avoided. Making during and post disaster phase in the disaster management cycle less or not necessary affected. This highlights the awareness of dangers that may occur, that is best done before the disaster occurs. The Disaster Management Cycle Diagram is illustrated below in, Figure 2.1; it Shows the pre, during and after stages of a disaster. The risk reduction phase of disaster management is first explained.

Figure 2. 1 The Disaster Management Cycle Diagram
Source: (DDMA, 2021)

- **Mitigation**

Bosher and Chmutina (2017) describes mitigation as adaptations in the preventative stage. They can be structural and non-structural measures taken to reduce the negative effects of risks or threats. In an ideal world, this would entail identifying potentially harmful physical processes, phenomena, or human activities. It lowers the risk by implementing building principles such as vulnerability analysis updates, zoning management and land use, building use regulations and security codes, providing preventive health care, and educating the public in the event of disasters. These are also some of the steps that can be taken in the face of catastrophe. Reductions will only occur if sufficient measures are incorporated into national and regional

development plans. The availability of information concerning threats, emerging risks, and actions to be taken also affects effectiveness. The decision-making process during disaster mitigation is critical to ensuring that what occurs during and after the disaster can be controlled (Tariq, Noor & Juni, 2019). Technically, without a public awareness campaign, a mitigation approach will fail (Davis, Hosseini & Izadkhah, 2003). Mitigation stage is followed by the preparedness stage.

- **Preparedness**

This pre-disaster stage also guarantees that an appropriate response to the disaster's effects, as well as relief and recovery from its consequences, will be carried out in advance, eliminating the need for any last-minute efforts (Maskuriy *et al.*, 2020). Governments, organizations, and people establish strategies to save lives, minimize disaster damage and improve disaster response operations during the phases of preparation. Furthermore Bosher, Chmutina and van Niekerk (2021), show that the stakeholders at this stage have developed knowledge and capacities to successfully foresee, respond to, and recover from the effects of likely, imminent, or ongoing disasters. Steps in the preparation process include creating preparedness plans, emergency plans, training exercises, developed warning systems, emergency communication systems, transfer and training plans, searching source inventories, emergency personnel and contact lists, mutual aid agreements, and education information for the general public. The effectiveness of preparedness results from the availability of information on the hazard, the risk and the actions to be taken(Tariq, Noor & Juni, 2019). This stage is followed by the response stage which takes place during the disaster phase.

- **Response**

Maskuriy *et al.* (2020) further explored **the Disaster Management Cycle** Diagram in figure 2.1 by looking at response during, and shortly after a hazard occurrence. Emergency management comprises measures aimed at limiting injuries, loss of life, and property damage, as well as the environment. Following the response is the recovery stage, the emergency management function by which governments, communities, families, or individuals repair, reconstruct, or begin the loss that resulted from the disaster, to reduce the danger of a repeat disaster.

- **Recovery**

The final stage is the recovery stage. Under this stage there is rehabilitation and reconstruction. Rehabilitation comes after a disaster, stated UNDP (2008), and further outlined that it refers to the actions made to restore society to its pre-disaster state while promoting and supporting the necessary adjustments to the changes the disaster produced.

Reconstruction comes after rehabilitation following a disaster, reconstruction is the action taken to re-establish a community or a business. The construction of permanent homes, comprehensive renovation of all services, and full restoration of the pre-disaster status are all included in the list of actions (UNDP, 2008).

At this final stage it means helping businesses to bounce back from disaster or say building back better to recover from the devastations of disasters. As per the research, there have been no experiences of disasters resulting from petrol storage, so the recovery phase has not come to place. In the recovery stage, the inclusion of recoveries of companies may be set up, which are the business continuity plan (BCP) and the disaster recovery plan (DRP). These can be the best solution that the nearby land users can practise since they are mostly businesses. Snedaker (2013) characterises a business continuity plan as a process for developing and validating a plan for ensuring uninterrupted business operations before, during, and after a crisis. Disaster recovery plan as defined by Sahebjamnia, Torabi and Mansouri (2015), is a plan working to ensure that all disrupted operations are fully recovered to their pre-disaster state or "build back better" as a goal of the Sendai framework (2015-2030)**.**

Application of Disaster Management Cycle in the Study

In this study, from the beginning of the cycle, awareness can be used as a mitigation strategy to ensure that nearby land users are aware of dangers and contingencies. University of Central Florida (n.d) describes mitigation as the most important of all the stages because, if done properly, it can reduce the impact of the next emergency. Also, under mitigation, the building code changes can be seen, where if reinforcement is needed, it should be applied to ensure

safety. Land use also falls under the mitigation strategy in which proper land use planning results in minimal disaster impact.

After the mitigation phase, preparedness follows. The University of Central Florida (n.d) purports that it involves conducting trainings to respond to disasters so that the level of readiness is guaranteed. Training land users near the petrol storage on what to do in the event of an emergency can be essential because they can be aware of the emergency services in the area and assess whether they are capable of rescuing people in a state of emergency. As a result, the land users can be resilient to risk that maybe posed by the hazardous installations.

Since the emergency has not occurred with regards to Maseru petrol storage facility, response measures have not been taken before. However, with proper preparations in the pre-disaster stage such as mitigation and preparedness, if the crisis occurs, the impact will be minimal since the nearby land users will be well aware of what to do (University of Central Florida, n.d).

2.2.2 Conceptualisation of Disaster Risk

Prevention web, (n.d) and UNISDR (2015) states that understanding what risk is, will be helpful to know what the study is dealing with. Disaster risk is the likelihood that loss of life or injury and damage to properties will occur because of a disaster. Risk arises from uncertainty which the disaster Risk reduction aims at eliminating. Risk comprises both hazards and exposure. The two can lead to the loss of several lives, a number of people being injured, the number of properties lost, and the economic activities disturbed. It thus depends on the hazard magnitude, vulnerability of the exposed factors and the value of those factors (Archer, 2002).

- **Formula for Risk**

Risk=Hazard×(Vulnerability/capacity).

The elements as explained by (Asian Disaster Reduction Center (ADRC), n.d) are;

Risk= the likelihood of negative effects

Hazard=the threat that can materialise

Vulnerability= the degree to which the element exposed to that source is susceptible

Capacity= linked to ability of people to successfully deal with, tolerate, and recover from risks.

The formula encompasses distinct elements that influence the amount of risk the hazard can create in a community. If the hazard, exposure and vulnerability are higher than capacity, then the risk will be high (UNISDR, 2009).

To manage petrol storages properly, it is important to assess the risks that they pose, to the people, livelihoods, environment and properties.

National Academies of Sciences Engineering and Medicine (2018) stipulate that the hazardous industries must always be regulated to ensure safety, and to provide their goods and services with less harm, especially to their workers, the environment and the public at large. Regulation cannot at all times prevent all incidences but in formulating them, there should be confidence that they will achieve the intended purposes. Failure to adhere to the safety measures will lead to damage to properties, environmental damage, death and injuries. In major hazards cases, nothing is perfect, either by designs, procedures, equipment, supplies, operations or environment there can be failures.

The Conceptual Framework to Identify Disaster Risk

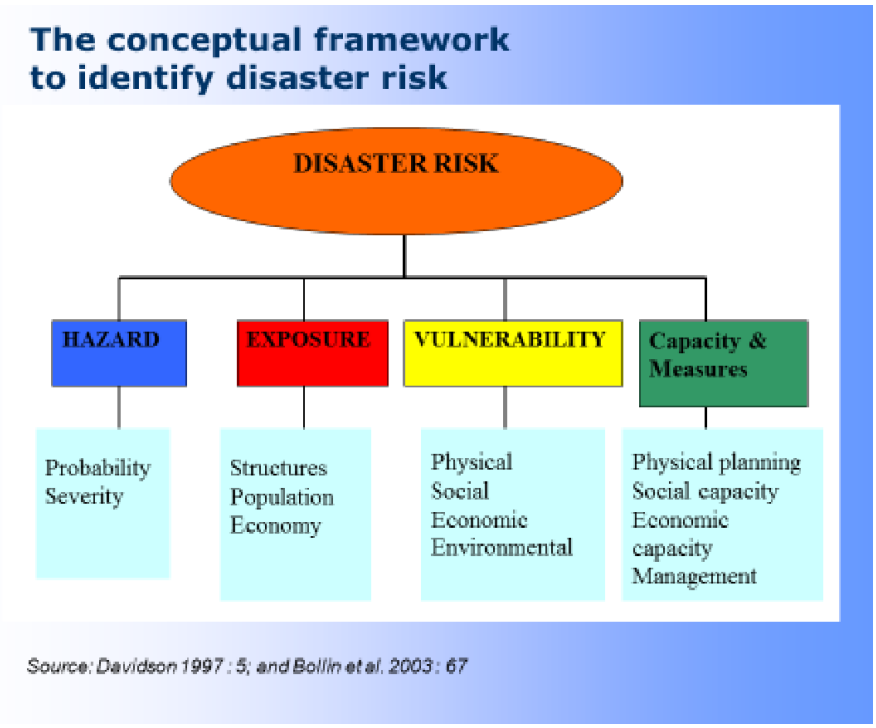

Figure 2. 2 The Conceptual Framework to Identify Disaster Risk
Source: (Bollin et al., 2003)

As discussed by Greiving, Fleishhauer, & Luckenkotter (2006), technical disasters have proven to impact local and regional developments, so planning and emergency management determine ways to detect extremely susceptible areas to the overall risk. Integrated risk assessment of multi-hazards is the best approach to be used for the spatial risk management process. The process produces an integrated risk map by evaluating different hazards together with the vulnerable region. Industrial hazards and disasters result in physical structures and developments being destroyed. The impact of the hazards tends to be increased by other hazards, the area with a lot of economic activities around and the social vulnerabilities. So where all the various hazards, economic and social vulnerabilities prevail, there is a serious need for spatial risk assessment. The assessment considers all risks relating to the area in question.

The petrol storage poses a high risk, as the land use pattern is mixed; there are infrastructures as well as the businesses and houses. These expose them further to disaster risk. The urban population and their assets end up being vulnerable. The employment of land use planning can reduce the high-risk use management procedures, which further allows understanding of the

hazard itself that can occur. Proper land-use planning and the conceptual framework to identify disaster risk go hand in hand. In order to understand disaster risk; firstly, we have to know the hazard, secondly, what is the likelihood of the occurrence of the hazard, then thirdly, the exposure which talks about the elements exposed to the hazard, and fourthly, the vulnerability of the physical, social, economic and environmental things or activities and lastly the capacity and measures, of physical planning, social capacities and economic capacity and management (Asian Development Bank (ADB), 2016).

In applying the risk equation to the study of assessing public awareness of risks posed by petrol storage to nearby land uses. The risk of petrol storage accidents management, depends on the probability of severe fires, explosions and oil spills from the petrol storage. Against the level of exposure of the properties (equipment and buildings), people (both workers at the petrol storage and nearby land uses) and the environment; the degree to which they are exposed. Then the capacity, which will depend on effective management, so increasing the public awareness of risks posed by petrol storage will ensure that risk is reduced. Which is why the risk equation is the best framework to use for the study.

Disaster Risk

Looking first at the definition of Disaster to adequately understand what disaster risk is Bosher and Chmutina (2017), defines a disaster as a major interruption of a society's functioning that results in enormous human, material, or environmental losses that surpass the affected society's ability to deal using its own resources. Alexander (2002) outlines various characteristics of disasters, such as extensive destruction and a mass casualties, without placing monetary values on the scale of the disaster, stating that small monetary losses can lead to major struggling and problems, or conversely, giant losses can be pretty sustainable, depending on the chain of circumstances. Wisner et al. (2004) declare that a disaster happens when a large number of vulnerable people are exposed to a hazard and endure serious harm and affect their livelihood system to the point that recovery is difficult without outside assistance.

Disaster risk refers to the potential for a community to suffer losses in terms of lives, livelihoods, property, health, and services as a result of a disaster. Disaster risk entails a wide range of potential losses that are frequently difficult to estimate. Risk is defined as the possibility that anything or someone will be severely harmed by a hazard (American International Group (AIG),

2013). Furthermore, risk is defined as the possibility that something or someone may be severely harmed by a hazard (Fuentes-Bargues, Gonzalez-Cruz, & Baixauli-Perez, 2017).

Karageorgos (2017) describes people, property, and the environment as all types of risk. When it comes to individuals, the risk is to everyone who may be on site, such as employees, maintenance professionals, or visitors. Property-the risk is to the owner's, operator's, supplier's, or any other person who gains access to the site for whatever reason. Environment-related risks include potential environmental impact such as harmful emissions into the air, water, or earth. Risk can be disastrous as well as systemic. According to the United Nations Disaster Risk Reduction (UNDRR) (2019), even though it is difficult to quantify disaster risk, it may be easily analysed and mapped with knowledge about current hazards, demographic patterns, and socio-economic development.

As indicated by the National Disaster Management Framework (NDMF) (2005), disaster risk is divided into two categories: acceptable risks and residual risks. United Nations International Strategies for Disaster Risk (UNISDR) (2009) refers to acceptable risks as the level of potential losses that the community considers acceptable, in the context of social, economic, political, cultural, technical, and environmental conditions. Further, residual risks are defined as risks that persist even after disaster risk reduction measures have been implemented and for the maintenance of emergency response and recovery capacity. In line with the existence of residual risk the United Nations Disaster Risk Reduction (UNDRR) (2019a), explains the necessity to create and maintain effective emergency services, readiness, response, and recovery capacities, as well as socio-economic policies such as safety nets and risk transfer mechanisms. Consequently, Htay et al. (2014), mentions risk transfer measures as able to reduce residual risk. Risk transfer is the process of transferring the financial costs of residual risks from one party to another; it is the process of a household, community, company, or state being compensated in the form of social or financial benefits for losses suffered as a result of a disaster caused by another party. A notable example of risk transfer is insurance. Moreover, Evans (2019) posits that after the risk has been identified and evaluated there is a risk mitigation plan to be made. Risk mitigation plan is meant to reduce the impact of an unexpected phenomenon. The risk is mitigated in several ways but among those this study will look at risk avoidance.

Risk Avoidance

Risk avoidance according to Snedaker and Rima (2014), is a strategy for totally avoiding a risk. Avoidance reduces the risk to zero, but it often comes at a heavy price. As a result, the cost of risk management is high, while the cost of recovery is cheap. According to the UNISDR in (Ahmed, 2010), prevention is the outright avoidance of harmful effects of hazards and related disasters.

In risk avoidance, the existence of exposure is not permitted. This is accomplished by simply refraining from engaging in risky behaviour. If a person wishes to avoid the hazards of property ownership, they should lease or rent instead of buying. If the use of a product is hazardous, it should not be manufactured or sold. This is a negative method, not a positive one. It can be an ineffective strategy for dealing with a variety of dangers. If risk avoidance were adopted excessively, the company would be deprived of many profit opportunities and would most likely fail to meet its goals (Fennelly & Perry, 2017).

According to the hierarchy of control, the first and most successful approach of controlling a hazard is to eliminate it (risk avoidance). There is no need to be concerned if the danger has passed. Moving operations to a lower-risk area and relocating the facility are two examples. From most effective to least effective, the hierarchy specifies the desired sequence of controls: The steps in the hierarchy are usually removal, substitution, engineering, and administrative controls (Broder &Tucker, 2012).

Health and Safety Executive (HSE), (2009) states that Regulation 4 of Control of Major Accidents Hazards Regulation (COMAH) mandates that every operator take all reasonable precautions to avoid serious accidents and minimise their impact on people and the environment. Regulation 4 requires duty holders to minimise the risk of a major accident to the greatest extent possible.

However, Peterson (2010), considers Risk avoidance impossible because the actions required to totally eliminate risk which would practically undermine the project's ability to perform its purpose or achieve its goals. Therefore risk reduction remains the best measure to use in addressing risk. In this perspective, Peterson further states that the most common and direct strategies of lowering risk are behaviours that reduce vulnerability in the risk equation as discussed above. Security measures, policy enforcement, staff education and awareness, as well

as financial and legal positioning, are all common risk mitigation techniques. This allows the study to conclude that emerging education and awareness is still an important mitigation tool.

2.2.3 Hyogo Framework for Action (HFA) (2005-2015)

From the inception of the Hyogo Framework for Action (HFA) (2005-2015), The goal was to reduce disaster risk depending on the type of hazard and degree of exposure, as well as to enhance community resilience. The framework was built on the premise that disasters cause significant damage to development in a short period, depending on both sustainable development and poverty eradication. It also demonstrates that, if disaster risks are not appropriately considered during development, vulnerability grows. As a result, coping with and reducing disasters to improve sustainable development has become a major problem for communities.

The framework's goal is to reduce deaths and property damage. Disaster risk is a global issue since it is the growth in vulnerabilities that result from changing technologies. The framework incorporates goals such as successfully integrating disaster risk into sustainable development policies, planning, and programming, particularly on topics such as disaster prevention, mitigation, preparedness, and vulnerability reduction, to accomplish the intended outcomes (United Nations International Strategy for Disaster Reduction (UNISDR), 2005).Governance, knowledge and education, risk management and vulnerability reduction, risk assessment, and disaster preparedness and response are the five themes that Twigg (2007), used to condense the HFA.

The HFA identified a number of factors that need to be taken into account when carrying out the main tasks anticipated under the priority actions, such as the significance of a multi-hazard approach to all actions, gender perspective or influence, cultural diversity, community and volunteer participation, capacity building, and technology transfer. Through the research, risk should be lessened, awareness should be increased, and proper land zoning should be encouraged as a way to try to reduce the risk. By ensuring that the land users near the petrol storage as well as the government authorities (involved in ensuring the safety of the general public) are aware of the risks that the petrol storage poses, then proper land use planning, which is zoning, may be

encouraged, thus disaster risk is reduced. The framework was enhanced further in 2015, as the sendai framework.

2.2.4. Sendai Framework for Disaster Risk Reduction (SFDRR) (2015-2030)

Over the duration of 15 years as of 2015-2030, United Nations Disaster Risk Reduction (UNDRR) (2015), points that the Sendai framework for action intends to significantly reduce disaster risk and losses in lives, livelihoods, and health, as well as in the economic, physical, social, cultural, and environmental assets of individuals, and businesses, communities, and countries. Meaning, that throughout the disaster, which can be natural or manmade, reducing disaster risk will lessen the losses. The Sendai Framework for Action Priorities directly supports industrial and chemical accident prevention, readiness, and response. This mutual importance is shown in the Industrial Accidents Convention's specific operations (United Nations Economic Commission for Europe (UNECE), n.d).

The Sendai Framework for action's purpose according to Chen, Shirazi, and Wang (2021), is to boost preparedness for disaster response and recovery through two courses of action:

1. Minimizing risk by lowering hazard exposure and susceptibility; and

2. Raising preparedness for disaster response and recovery.

They further exclaimed that, looking at the two courses of action concerning the study echoes the importance of reducing risk, especially by lowering hazards. In the case of a hazardous installation, which can be dangerous and classified as a hazard, ensuring that people around it are aware of the danger so that they can reduce vulnerability is key. When the nearby land users are aware of the hazard, preparing for disasters can be made easier for those responding to and recovering from the disaster.

The Sendai framework for action makes provision for 4 priorities. United Nations Economic Commission for Europe (UNECE) (n.d) outlines that under priority 1, which is understanding Disaster Risk, the emphasis was made on the significance of identifying potentially hazardous activities so that preventative, preparedness, and response actions can be targeted. It outlines preventative steps that national authorities and operators must take, including legislative and

institutional measures. It also addresses hazardous installation placement as part of land-use planning regulations and initiatives to reduce population and environmental risks.

Australian Institute for Disaster Resilience (2020) initiated an increase in public awareness of disaster risks and impacts, as well as participation in disaster response. This relates well with the research problem of this study, which aims to assess the awareness of land users near. In assessing the awareness, conclusions reveal whether or not they are aware of the risk, and if not encourage measures to increase risk awareness so that they can know their state and how to be safe from risk. The Institute additionally emphasizes improving disaster risk disclosure to all stakeholders under priority 1, which shows the importance of risk being translated to every person involved as clear as possible for all to understand. In the case of the study, the people involved are all land users near the petrol storage. Furthermore Planning Institute Australia (2015) states that land use planning also requires a thorough understanding of existing and future disaster risks to make well-informed decisions. The ability to be resilient is enhanced by linking to hazard information and implementing risk assessments early in the planning process. Bring the study to Priority 2 of the Sendai framework.

Priority 2 is Strengthening disaster risk governance to manage disaster risk. It established a framework for parties to establish their legislative and institutional frameworks at the local, national, and regional levels to address industrial accident prevention, preparedness, and response. It focuses on reducing disaster risk because of hazardous operations that can have a trans-boundary impact in the event of an accident. The Sendai framework can be viewed as a framework for regional and sub-regional cooperation because it covers local and trans-boundary disaster risk reduction and capacity building if the consequences of an accident spread across boundaries (United Nations Disaster Risk Reduction (UNDRR), 2015).

Priority 3, As covered by United Nations Disaster Risk Reduction (UNDRR) (2015); United Nations Economic Commission for Europe (UNECE) (n.d), is investing in disaster risk reduction for resilience supported by the adoption of institutional, regulatory, and practical steps by authorities and operators to reduce the of technological disasters risks. As a result, operators of hazardous facilities must ensure and show the safety of their operations through the adoption of legislation for disaster risk reduction. Parties must also include the financial resources necessary

to ensure the implementation of these measures. Therefore, by mandating cooperation among national agencies, which includes the business sector, it also fosters coherence across sectors. Resilience must be strengthened by wise investments in all aspects of DRR and industrial accident prevention.

As mentioned by United Nations Economic Commission for Europe (UNECE) (n.d), priority 4 is enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction to encourage the holding of cross-border exercises to teach appropriate authorities and the public about preparedness and response. In particular, it contains obligations to:

(a) Prepare, review, and update disaster preparedness and contingency policies, plans, and programs, ensuring the participation of all sectors and stakeholders, in particular when preparing on- and off-site contingency plans as required by the Sendai framework.

(b) Promote regular disaster preparedness, response, and recovery exercises under the Sendai Framework.

(c) Develop coordinated regional approaches and operational procedures, where needed, to prepare for and ensure prompt and effective disaster response, such as through the use of the Industrial Accident Notification System to request and deliver cross-border mutual aid.

Application of Sendai Framework for Action

The Sendai Framework for Disaster Risk Reduction (SFDRR) is a viable framework to use in this study since it focuses on disaster risk reduction in depth, even deeper than the Hyogo Framework. Actually, the Sendai framework was introduced to enhance the shortcomings of the Hyogo framework. Looking at the location of hazardous installations in the Maseru industrial area, the understanding is that the petrol storage can pose risk to the nearby land uses. Priority 1 starts off with understanding the disaster risk. Then the second priority talks about strengthening the disaster risk governance, ensuring that the strategies are in place to reduce the risk, capacity for the land uses is enhanced to ensure that they are aware of risk and capacitated in how they can be resilient to it. Priority 3 is about investing in disaster resilience to promote prevention and

have legislations in place to ensure safety of the vulnerable people. The fourth and last priority talks about enhancing disaster preparedness for effective response and recovery, ensuring that when the disaster strikes the response will be undertaken effectively. Based on these priorities, the study concurs that if preparedness prior to disaster is carried out effectively, the impact during disaster will be minimal.

2.2.5 Sustainable Development Goals

Sustainable development is coined as the development that meets the needs of the present generation without compromising the needs of the future generation, in the Brundtland report (Sustainable Development, 2020). Sustainable development goals 9 and 11 very apply to the present study since they focus on disaster damage, infrastructure, and basic services disturbance. Sustainable development goal 9 focuses on building resilient infrastructures, promoting all-encompassing and sustainable industrialization and fostering innovation, which encourages industries growth to increase employment and Gross Domestic Product (GDP). Nevertheless, industrialization with resilient infrastructure will ensure the safety and wellbeing of the people. Sustainable development goal 11 also concentrates on ensuring that sustainable cities and human settlements are also safe, inclusive and resilient. Having cities that are resilient to Disaster, applied mind to the Sendai framework for disaster risk reduction. ensuring that effective disaster risk management contributes to sustainable development (United Nations, n.d).

2.2.6 Land Use Planning Theories

According to Friedman (2013), theories are important in planning to obtain sustainable practices. There are several theories that influence different types of planning. This study will be based on the land use planning theories. Theories of planning are constructed from the observations and experiences of what planning is viewed as, they are derived from different philosophical standpoints such as the Sustainable Development, Marxist and others. Sustainable practices are procedures that are employed within services to keep up the qualities that are of importance in the physical environment, it also relates to all other aspects like consumption, health, community and poverty (ACECQA, 2013).

Every planning practice is based on a theory relating to how it should be practised, especially for the planning practice to be sustainable. Planning theories are theories that address all specializations that can be there in all kinds of planning, they are derived from the observations and experiences of what is planning (Friedman, 2013). Newton (2008) further details that the theory of land use planning aims at controlling land uses. In the case of major hazardous sites, the close surroundings have to be decided whether to be put in a way that they are safe or they can be open to change if the risk is posed by the hazardous site. The most important principle of land use planning lies in the decision making, which has to be taken by the authority in charge of the planning in the area. The decision will be based on careful considerations of the economic, social and safety issues.

Using land zoning can be beneficial in Maseru for the location of major hazardous storage, whereby they will be segregated and located on the outskirts of the town, away from other different land uses. Whittemore (2017) describes land zoning as a land-use planning control tool that is used in regulating the built environment and is designed to protect the health of the public, their safety and their welfare. It permits particular land uses to segregate; similar ones are located in one place and other land uses are located in another area. Land zoning determines the size, location, density and use of the buildings. Its main purpose is to control and regulate land uses to allow complementary uses. Zoning divides land uses into layers (The World Bank Group, 2015). According to Rodrigue (2020), functional land zoning is the most appropriate, as the zones are defined according to their functions, such as the residential zone, commercial zone and industrial zone. The zones are also separated by their types in each zone. For example, the industrial zone will be divided into other zones, whereby the clothing industries will be on one side and hazardous storage on one side.

Zoning regulations include a zoning map which shows the designation of zones boundaries including the details of the users permitted, the standards to meet as well as the requirements for each zone. Indeed, zoning can be used as an effective tool to regulate the development of major hazardous industries and effectively decrease the exposure of people and properties to the hazards that can occur. For zoning to effectively reduce disaster risk, the disaster risk areas should be identified, considering all the information on hazards while considering the density of

permitted developments. Also, considering the proximity of the land users away from each other, the creation of buffers will be helpful (Asian Development Bank (ADB), 2016).

2.2.7 Social Capital Theory

Social capital has caught the interest of disaster researchers, in part because it is at the heart of collective action, cooperation, and the therapeutic community that emerges during disasters. While social capital has been recognized as a positive aspect for communities in the face of disasters, there are still some unanswered questions (Meyer, 2018).

The decision to use Social capital theory was based on the fact that it encourages people to take part in identifying and fixing problems. The notion that the Social Capital Theory allows individuals and/or organizations to achieve desired outcomes through collective action also inspired it. By empowering populations at risk, public awareness is a key component of catastrophe risk reduction. Education is also defined as the acquisition of knowledge and skills that enable people to make informed decisions (Meyer, 2018).

The level of general knowledge of disaster risks, the reasons that cause disasters, and the measures that can be taken individually and collectively to limit exposure and vulnerability to hazards are referred to as public awareness (United Nations International Strategy for Disaster Risk (UNISDR), (2009). Since they both have an interest in increasing the well-being of local individuals active in recognizing and solving problems that affect the community, the Social Capital Theory and public awareness are inextricably linked. The theory also encourages a sense of belonging by emphasizing the value of diversity in others and similar life experiences (Babb, 2005).

There are three different types of social capital theories that is:

1. The bonding social capital- which ideally promotes homogeneity and exclusivity by forming relationships between people who have similar characteristics and/or interests.
2. Then there is the theory of bridging social capital- incorporates relationships between people from various backgrounds and is considered inclusive.

3. And lastly the linking social capital theory- is concerned with relationships between people of various levels of power that give access to resources, ideas, information, and knowledge within a community or organization (McGonigal et al. 2005).

According to Silici (n.d), the first and third types of social capital, which are the bonding social capital and the linking social capital involve all stakeholders. In the first social capital theory the stakeholders are those who share similar characteristics and the linking social capital involves stakeholders in power. These two social capital types are rather more relevant to this study, especially to the primary goal of assessing the state of public knowledge of the prevalence of risk, influence this study. Since they are exposed to the risk outlined in type one above, the study aims to look at how public knowledge establishes links among neighbouring land users to hazardous installation. Social systems are thought to allow land users to share information and learn from one another.

The International Strategy for Disaster Reduction (ISDR) (2001) mentions the important principal purpose of raising worldwide public awareness of disasters, with the overarching goal of lowering risks and making all communities more robust to the consequences of natural, technological, and environmental hazards, then to move from risk mitigation to risk management by incorporating preventative efforts into long-term development. Gherardi *et al.* (1999) stated that at some point, disasters occur as a result of a lack of knowledge. Making knowledge critical in disaster risk reduction can reduce the disaster risk.

2.2.8 Institutional Framework on Land Governance and Administration in Lesotho

The physical, land use planning and site allocation functions in Lesotho are undertaken by the local councils. The local councils are of 4 levels of the local government structure, which are the District council, Municipal council, Urban council, and community council. They obtain their powers from the local government Act of 1997 (as amended). Maseru is the only municipal council in Lesotho, where the petrol depot is located. The municipal city is mandated to govern the control of natural resources, protect the environment, physical planning, land or site allocation, control grazing and control building permits. The responsibilities of councils on governing land are very restricted from the very legislation that it is based on. This yields conflicts over the mandate, with the department of land survey and physical planning (LSPP)

which is also the arm of the local government and chieftainship. Thus, there has to be a clear delineation of boundaries for each to perform their mandate effectively (Leduka, Ntaote, & Takalimane, 2018).

The department of land survey and physical planning (LSPP) handles urban land use planning and control as gazetted in the town and planning Act of 1980 sections 2,5 and 9. So conflicts arise especially within the urban council (Leduka, Ntaote, & Takalimane, 2018). The government of Lesotho (2015) states that since there are many agencies, which are mandated in land use and work in silos, conflicts will keep arising.

2.3 Legal Frameworks of Lesotho

The allocation of land is based on the Constitution of Lesotho, land is vested in the hands of Basotho nationals, under the trustee of the King of Lesotho. The land act 2010 among others outlines who has the right to ownership of land, the type of land use and for how long. Land Act 2010 (Act No. 8 of 2010) allocates land and leasing.

Urban land-use planning framework and process are extracted from the Town and Country Planning Act (TCPA) 1980, which is the legislation that regulates land use planning in urban areas. The development plan has to be made and will be a binding document for the development in the area to conform. There is also the development permit system that is important in the building control Act no.8 of 1995 which gives out building standards to be adhered to, to ensure the safety of buildings, building materials to be used, fire resistance, ventilation, sanitation, plumbing and drainage. To ensure compliance, there is a review board, building authority and Building Control Officers with clearly defined roles. Also, there is a set charge for buildings that are not complying. When the area has a development plan, developers acquire application forms from the municipal or urban council to apply for the development of the area. Then the commissioner of lands will approve or not approve applications. The Challenge of the execution becomes a problem when the municipality or urban council has to act. Challenges such as corruption, non-compliance, lack of physical and financial resources, and political interferences (Leduka, Ntaote, & Takalimane, 2018). Even though the legal frameworks are stipulated, the

clash in the institutional framework results in the unsafe location of other facilities, in this case, the petrol storage facility, which may cause major disasters.

2.3.1 The Constitution of Lesotho of 1993.

The Constitution of Lesotho (1993), on which all legislations are based on. Outlines rights of every person in Lesotho, among the rights, is the most important right which is the right to life. It stipulates that every person in the Kingdom of Lesotho has a right to live and nothing and no one has the power to end that life. This supports the research in ensuring that the lives of people living or working near and within the petrol storage area are safe and lives will be saved.

Further, the constitution discusses the Land acquisition in the Kingdom of Lesotho. Portraying that land is vested in the Basotho Nation but under the trust of the king. Every Mosotho has the right to own land, but the land is regulated and administered by the LAA. This brings us to the study, whereby the people and businesses have the right to be allocated land but under strict regulations of the authority.

The Constitution of Lesotho (1993:24) expresses that:

> Lesotho shall adopt policies aimed at ensuring the highest attainable standard of physical and mental health for its citizens, including policies designed to improve environmental and industrial hygiene; provide for the prevention, treatment and control of epidemic, endemic, occupational and other diseases.

This brings us to the constitution of Lesotho encouraging policies that ensure safety of the people. Whereby National Occupational Safety and Health Policy for the Kingdom of Lesotho came into place to ensure employees are safe at their place of work.

2.3.2 Land Administration Authority Act 2010

Land Administration Authority Act No.9 of 2010 goal is to create an autonomous Land Administration Authority to strengthen Lesotho's land administration services. The establishment of the Land Administration Authority, according to the Government of Lesotho's Ministry of

Local Government and Chieftainship Affairs, will be a significant step toward improving land tenure security for all Basotho and promoting the use of land and real property as a valuable asset for citizens and businesses alike. The reason for the Land Administration Act was because the 1979 Land Act, as well as the present Land Survey and Physical Planning Act, had flaws that encouraged uneven land allocation and inefficient land services. Land, as an economic asset, is likewise hampered by the inadequacies.

The overall state of urban governance has been described as ineffective and weak. This has ramifications for the management of urban lands. The World Bank threatened to remove support for urban site and service initiatives in Lesotho, therefore the Maseru City Council was formed in 1993. 70 percent of the population, both wealthy and poor households, continued to access land in informal ways in 2012. According to UN-Habitat in de Satgé (2021), 7% of urban landowners purchased their plots from a private individual or company, while 67 percent had the land granted to them by chiefs, and 20% inherited it. This has resulted in a largely undeveloped formal property market in Lesotho (de Satgé, 2021).

Maseru City Council (MCC) provides building codes in the Maseru city area. The building Act (1995) defines a building as any structure, whether permanent or temporary, made from any form of construction material, used for accommodation, manufacturing, processing, storage and others, not excluding fuel pumps or tanks. The Act further states the importance of reporting the adequacy of certain measures, among them stating the capability of fire, flood, and other disaster-prevention measures in connection with structures in its control, and offers recommendations to correct any deficiencies. Which on paper shows the building act being able to prevent the disaster that may occur and report. Therefore, the petrol storage being located within other land uses may be an oversight in the case of the building act.

2.3.3 The Land Act (2010)

The Land Act (2010) came about as a result of the formation of the Land Administration Authority (LAA), as an amendment of the Land Act 1979, which came about to strengthen the LAA as the land administration body. The land act mentions that the allocation authority which is the (LAA) may not grant title to land for commercial or industrial purposes unless the application has been referred to the relevant District Council, which shall include a

representative from the Ministry of Trade and Industry, a representative from the Department of Lands, Surveys and Physical Planning, and a representative from the local business community.

2.3.4 Town Planning Act (1980)

According to de Satgé (2021), The town planning act is an old document as it was established in 1980 to control land distribution in metropolitan areas. This was meant to put a stop to chiefs allocating urban land, based on customary tenure criteria. Due to a lack of state capacity, these laws struggled to acquire traction, which was somewhat remedied with the passage of the Urban Government Act of 1983 and the Local Government Act of 1987. Rents and rates, on the other hand, were mostly uncollected in practice.

The Town and Country Planning Act (1980) encourages planned towns, with segregation of land uses, as an effort to provide safety. For this research, the petrol storage as a hazardous installation should be segregated from residential, offices and other land users. The Act gives planning authorities the authority to establish development plans to guarantee that land is developed sustainably. This Act applies to any region identified by the Minister in a Public Notice. The Town and Country Planning Board is established by the Act. In each region to which this Act applies, the planning authority must produce a development plan.

2.3.5 Occupational Health and Safety Act of 1992

Occupational health and safety act, taking power from the Labour Code Order No. 2 of (1992) stipulates that every employer has a responsibility to safeguard the safety, health, and welfare of all of his or her employees at work, to the extent that it is reasonably practicable and also has a responsibility to conduct his or her business in such a way that, as far as is reasonably possible, those who are not his or her employee are not exposed to hazards to their safety or health. In a case of the study that if labour codes are followed then it will minimize the impact of the hazards experienced from the petrol storage to stuff of petrol storage and the land uses nearby. Moreover, the National Occupational Safety and Health Policy emphasises on each and every company having a resident occupational health and safety officer.

2.3.6 Chemical Management in Lesotho

Chapter 19 of Agenda 21 (1992) is dedicated to environmentally sustainable chemical management. The legal and technical infrastructure for environmentally sound chemical management is critical in this regard. By the year 2000, national systems for environmentally sound management of chemicals, including laws and provisions for implementation and enforcement, were planned to have been in place in all countries to the degree practicable, as agreed by participating states. Chemicals are widely acknowledged as an important tool for achieving socio economic development in countries all over the world, including Lesotho. To be consistent with the government's developmental goal of sustainable development, chemical use must maximise advantages while limiting negative effects on human health and the environment (Ministry of Tourism Environment and Culture, 2010). The Ministry additionally states that although Lesotho hasn't had any major technological disasters, the country's rising industrialization raises the risk of technological or industrial disasters.

2.3.7 Disaster Management Act 1997

The Disaster Management Authority (DMA) is an organisation that focuses on emergency response. DMA was founded in 1997 by Act No.2. It was discovered that there was a gap in response operations and a new entity called Emergency Services was formed. Fire and chemical emergencies are included in the group, and like the other groups, DMA organises multi-sectoral role actors such as private dealers, parastatals, and government institutions. The Authority is taking a fresh look at disaster management, focusing on planning, which is a risk-reduction strategy that includes readiness. However, nothing has been done in the area of chemicals, while the introduction of emergency services is a move in the right direction (Ministry of Tourism Environment and Culture, 2010).

Moreover the ministry of tourism, environment and culture (2010), extends that Disaster Management Authority has recognised the necessity to include issues of chemical management and the environment in general in their plan of action. This is due to the Authority's holistic approach to disaster management.

2.3.8 Awareness-In South African National Disaster Management Framework (NDMF)

This study draws from the South African national disaster management framework as in it the importance of public awareness in disaster risk reduction is outlined. The NDMF addresses the

need to create and support a broad-based culture of risk avoidance through increased public awareness and accountability. A culture of risk avoidance among stakeholders through capacitating all role actors through integrated education, training, and public awareness backed by scientific research. The adoption of public information campaigns and other communication outlets through the media, according to the NDMF (2005), are essential success factors in instilling risk-avoidance behaviour to all stakeholders.

2.4 Chapter Summary

In summary, the purpose of the chapter was to outline and evaluate the theoretical and legislative frameworks relevant to the study. The study looks at the awareness of potential risks and impacts of petrol storage within other land use activities in the Maseru industrial area, Lesotho. The conceptual framework to identify disaster risk/risk equation can be used together with the land zoning tool of land use planning to segregate the land uses with buffers for a safe distance of separating land uses, to ensure safety for people as well as properties. The two theories above are supported by the theories of sustainability and disaster risk reduction to ensure adequate measures of safety. The principle of understanding risk is emphasised as, to effectively reduce disaster, risk must be identified and understood. Also, all the institutional frameworks and legal frameworks were identified. The legal frameworks seem to be outlined clearly, but institutions are the ones failing or rather clashing in the execution of their mandates, resulting in ad hoc planning all over the country. The petrol storage being within different land uses, like offices, clothing factories and shops, poses a real risk and can cause a potential disaster.

Chapter 3

Literature Review

3.1 Introduction

The purpose of the chapter is to review literature concerning the mentioned topic under investigation, ***'Assessing public awareness of risks posed by petrol storage within the Maseru Industrial Area'***. The literature review is the part of the thesis where there is extensive reference to be related with research and theory in the area of study; it is where connections are made between the source text that is drawn on and where the researcher positions the research among these sources. Literature review acts as an inspection of what has been written about an actual topic, a theory, or a research question. This will aid in the process of learning and enhance the writing by being able to identify what has or has not been in previous research. Furthermore, literature reviews lay bare to readers that the writer has a solid understanding of the topic (Denney & Tewksbury, 2012).

This chapter is organised in areas related to the study which are as follows: reviewing technical hazards, petrol as a hazard, human induced technical disasters, history of industrial accidents; internationally, regionally and locally, importance of disaster risk reduction, disaster risk assessment, public awareness, strategies for addressing petrol hazard, allocation of land and finally the chapter provides a summary.

3.2Technological Hazards

Technological disasters can harm people and the environment, whether they are caused by natural or man-made risks (UNISDR, 2018). It is difficult to predict the occurrence of a technological disaster because it is rarely associated with early warning indicators. Worse, it has the potential to do significant damage in a short (Ta *et al.*, 2022).Technological disasters emerge as a result of technological hazards that can harm people and society; therefore, technological hazards must be effectively handled to avoid unfavourable outcomes (De Silva et al., 2017).

Technological dangers are more closely tied to exposure than long-term environmental degradation since they are related to rapidly occurring, high-impact events such as hazardous spills and explosions. The important aspect in the case of hazardous materials – chemical and

toxic waste leakage is exposure. That was the case in Bhopal, India, in 1984, when material escaped and formed a lethal cloud, killing and injuring thousands of people, the majority of them were from poor households who had been allowed to reside near the chemical plant. The disastrous consequences of this chemical discharge were directly tied to modernization efforts, which put a complicated and poorly managed industrial production system into an unprepared society. One of the most essential aspects of technological risks is that they are not restricted to urban-industrial society. Almost every modern product and procedure has reached the majority of countries and social settings (International Strategies for Disaster Reduction (ISDR), 2002).

3.2.1 Technological Accidents

Humans are exposed to three main dangers from major hazard installations: the risk of uncontrolled releases of harmful substances in the form of gases, liquids, or solids. Toxic gases are by far the most harmful of the three (Gupta, 2002; HSE, 2011).

From the international accidents demonstrated 3.8 History of Industrial Accidents above all of the accidents were caused by human error in the operation of the hazardous facility, a technology failure in the facility, or a design flaw in the facility. In all of these accidents, there were fatalities among community members, significant injuries, or long-term poor health consequences. All of the assets were severely damaged, resulting in financial and infrastructure losses, which had a devastating impact on the local and regional economy.

The importance of the intimate and critical relationship between persons (workers), communities (society), and technologically dangerous facilities is emphasised. The institution must constitute a societal health and safety concern caused by humans. The dangers must come from the facility's human design and construction/creation, as well as its human operation. To assist the study to make point in issues pertaining to major incidents and vulnerability of communities near the hazardous installation, the study looks at the South African legislation that governs the health and safety risks associated with major hazard installations Major Hazard Installation Regulations (2001), make use of the risk assessment methodology which focuses on the hazardous installation itself: the likelihood of a major incident and the consequence or severity of such an incident. On the basis of this information, a decision must be made about how other facilities in the vicinity of the hazardous installation will be affected by the expected major incident, as computed from the safety distances around the hazardous installation. Infrastructure, housing,

community structures, similar hazardous installations, production facilities, and places where humans may meet or be present may all be included in the surrounding facilities. The law does not cover an exogenous, outward-focused strategy in which communities in the vicinity of a hazardous facility are examined to determine their sensitivity to the predicted consequences of a significant disaster there. As advocated by WHO (2002); Turner II et al. (2003a); Birkmann (2005), in that case a vulnerability assessment should incorporate the impacted communities coping capacity and resilience. The absence of community vulnerability assessment in existing legislation is due to the fact that it is mostly based on legislation produced in the United Kingdom under the direction of the Health and Safety Executive (HSE). Their legislation does not put into consideration community risk. This is a problem that exists across the European Union (EU). The second challenge is that it is fragmented and dispersed over numerous government offices, diverting attention away from community health and safety vulnerabilities as well as the facility owner. One of the unavoidable consequences of this fragmentation is that government agencies avoid taking responsibility in the belief that the problem will be solved by another department. Eventually, no one does it, and communities' vulnerabilities are ignored.

Third, under the current Major Hazard Installation Regulations, it is fully up to local governments to decide whether a new hazardous installation should be permitted near existing facilities or whether new land development should be permitted near an existing hazardous installation (MHI Regulations, 2001). When communities are at danger, these are pressing problems for all local authorities in South Africa, especially as they lack land-use standards, which are inextricably tied to community health and safety vulnerability.

Schmidt-Thome (2005) employs a systems approach to assess community risk from a spatial planning perspective, concluding that when it comes to the health and safety hazards provided by major hazard installations, a multi-hazard risk assessment approach must be used: the vulnerability of communities around large hazard installations must be considered as part of the overall risk assessment technique. Schmidt-Thome (2005) defines vulnerability as a combination of hazard exposure and coping capacity. Risk assessments should not just address natural disasters, but also technology disasters, because the two are linked: Natural disasters may result in technical (Natech) failures at significant danger sites.

3.2.2. Major Hazards Risks

A hazard is described as a potentially hazardous incident that could result in death, injury, or other health consequences. destruction and loss to property, infrastructure, livelihoods, and services, and social repercussions Technological disruption, economic disruption, and/or environmental damage (UNISDR, 2009). Technological hazards are defined as a dangerous event caused by technology invented, developed, manufactured, and utilised (UNISDR, 2009; Hughes, 2004).UNISDR (2009) further points out that this could include collapses, transportation accidents, manufacturing explosions, pollution, radioactive radiation, hazardous waste, fires and chemical spills in gas stations and can result in death, injury, sickness, or other health consequences, property damage, loss of livelihoods and services, as well as social and economic consequences environmental harm and/or disruption.

3.3 Petrol as a Hazard

According to the Health and Safety Executive (HSE) (2015), petrol is a dangerous liquid that is extremely flammable and can produce vapour at room temperature that can easily be ignited, even at low quantities. So, if not handled properly, it has the potential to produce a major fire and/or explosion. Therefore, it puts people, the environment, and property at risk. Petrol is stored in containers made specifically for that purpose. The petrol storage containers are developed and built according to the following principles: have a normal capacity, must meet UN container standards, which means they shall be made of metal and suited for storing gasoline and be labelled with the UN seal of approval (Health and Safety Executive (HSE), 2015).

In this context, petrol storages pose a health and safety risk, particularly because of the toxicity and flammability of the liquid and gaseous products (Australia Retail Association (ARA), 2009). As a result, petrol storages are one form of technical creation that poses a risk to individuals, society, and the environment (Cutter, 1993). This study examines the public awareness of risks posed by petrol storage in Maseru, the extent to which this is taken into account in land-use planning, and the implications for urban public safety.

3.4 History of Industrial Accidents

Historical evaluation of accidents of storage tank in industrial processes reveals that about 242 storage accidents occurred internationally in industrial facilities over the last 40 years. According to the findings, 74 percent of incidents happened in petroleum refineries, oil terminals, or storage

facilities. 85 percent of the accidents are caused by fire or explosion. There were 80 incidents (33%) caused by lightning, and 72 (30%) caused by human faults, such as bad operations and maintenance. Equipment failure, sabotage, crack and rupture, leak and line rupture, static electricity, open flames, and other factors were also factors (Chang and Lin, 2006). This part of the study will evaluate a few accidents that occurred, as to enhance the literature review.

3.4.1 Flixborough in Britain (1974)

This was the scene of a significant chemical disaster that occurred on June 1, 1974, which influenced global process safety regulations (Jenson, Lawford, Norman, & Ogden, 2019). The Process safety regulations are essential for the protection of workers, the general public, and the environment. As a result, worldwide regulations were examined in order to assess the scope of process safety regulations in the United States, the European Union, the United Kingdom, China, and India (Besserman & Mentzer, 2017).

As the most plausible immediate cause Jenson, Lawford, Norman, and Ogden (2019), mentions that the 20-inch theory was adopted. It stated that the shear forces encountered caused the makeshift connecting pipe to fail. This resulted in the release of 10 to 15 tonnes of boiling cyclohexane; the ensuing vapour cloud then ignited, culminating in a massive explosion. The force of the explosion has been estimated to be between 15 and 280 tonnes of trinitrotoluene (TNT). The weak culture surrounding process safety at Flixborough, which was widespread throughout the chemicals sector, was a crucial underlying reason. Due to the insufficient safety analysis performed on the temporary plant modification, the probability of a failure and its potential implications were not considered. There was also relatively little information about vapour cloud explosions accessible at the time. As a result, the magnitude of such a tragedy was unknown.

According to Jenson, Lawford, Norman, and Ogden (2019), lessons were learned and outcomes once the causes of the Flixborough incident were determined, steps were taken to limit the likelihood of a repeat occurrence. Flixborough ushered in a societal shift in how people saw safety. Hazard and risk analysis become a key factor while executing designs. Since Flixborough, industry-led good practice guidelines have been established, emphasising the use of the hierarchy of controls and the risk assessment process to mitigate risks to humans in buildings on high-hazard sites.

In the late 1970s, stated by Jenson, Lawford, Norman and Ogden (2019), a guide for designing and placing buildings around a chemical process was released. Since Flixborough, the regulations in place have proven to be extremely successful. Certainly, the necessary changes in management and safety practices would have had a significant impact. The impact of the necessity for interdepartmental communication may still be seen today in management structures. As processes have expanded and developed, so have safety protocols as a result ofFlixborough. Many European countries recognised the significance of the post-disaster actions.

The magnitude of the Flixborough accident, as well as other large incidents in the 1970s, forced a significant shift in process safety. Not only in the UK, but throughout the developed world, its legacy affected legislative reform. Flixborough's principal effect may be observed in the Management of Change, which has become more frequent in industry (Jenson, Lawford, Norman, & Ogden, 2019).

3.4.2 Seveso in Italy (1976)

Cited in (Eskenazi et al., 2019) (Mocarelli 2001; Pocchiariet al. 1979; Signorini et al. 2000) explains that on July 10, 1976, a chemical reactor at the ICMESA factory in Meda, near Seveso, Italy, exploded. The factory was producing 2,4,5-trichlorophenol, a cosmetics and pharmaceutical intermediate. Over an 18-km2 region, a runaway chemical reaction released an aerosol cloud including sodium hydroxide, ethyleneglycol, sodium trichlorophenate, and an estimated 15 to 30 kg of TCDD (di Domenico et al., 1980). Residents in the aerosol cloud's path experienced nausea, headaches, and eye irritation, and 19 children with skin lesions were brought to nearby hospitals. In the weeks that followed, the area saw severe animal and plant death, as well as almost 200 occurrences of chloracne among inhabitants, particularly among children.

The disastrous tragedy prompted European Union legislation known as Seveso I, which aims to prevent accidents in specific businesses that use hazardous substances, limiting the impact on employees, the general public, the environment, and property. It stated that businesses that keep hazardous compounds must prepare interior and exterior protection as well as emergency plans that include risk assessments. There were more than 130 serious accidents in Europe when the Seveso I was adopted. As a result of technical improvements, new threats have evolved. The European Commission then introduced the Seveso II directive in 1996 in response to the additional risk. The directive divides plants into three categories: ineffective, low risk, and high

risk. These levels are classified based on the amount of harmful compounds present. Seveso II was changed into Seveso III in order to improve the protection levels of persons, property, and the environment (Greiving et al., 2006; Ta *et al.*, 2022).

3.4.3. Bhopal in India (1984)

According to Berger and Mohan (1996), India's Bhopal Gas leak, the greatest chemical industrial disaster in history occurred in 1984. A total of 520,000 people were exposed to the fumes, with an estimated 8,000 deaths in the first few weeks. At least 100,000 people have been permanently injured. The disaster has become a symbol of global businesses' disregard for human life. As a result, it has been used as a warning. Despite this, industrial disasters continue to occur in India as well as the rest of the world. Despite the fact that they are not as large as Bhopal, chemical risks are widespread enough to be deemed a public health issue. Companies frequently reject their own role in the accidents and devalue the incidents' health consequences. Companies have also been hesitant to financially compensate the victims. Different people have different ideas about what caused the Bhopal disaster and who was to blame. The incident was a sabotage by an unhappy employee. The idea of 'the accident process,' which includes pre-event, event, and post-event stages, is utilised in injury analysis. There have been numerous models devised to assess the severity of injuries.

3.4.4. Enschede in the Netherlands (2000)

On Saturday, May 13, 2000, a massive fireworks accident happened near the Dutch-German border in the city of Enschede (152,000 inhabitants). Exploding pyrotechnics in a fireworks storage and trade company sparked the disaster. One of the concrete storage tanks caught fire. A tremendous and fatal explosion occurred, destroying the central storage facilities and blowing up several metal containers full of pyrotechnics. Environmental measurements taken shortly after the disaster by the National Institute for Public Health and the Environment (RIVM) indicated that people were unlikely to have been exposed to dangerous concentrations of various fireworks and fireworks-related substances such as cadmium, strontium, and lead. There were 22 patients with rather high levels that required clinical toxicological follow-up, but these were considered chance observations because there was no evidence that the elevated levels were linked to disaster-related exposures. The poll also aimed to raise awareness of mental and physical health

issues, as well as foster a sense of social support and a caring government (Velden, Yzermans, & Grievink, 2012).

3.4.5. Toulouse in France (2001)

Description and consequences of the accident outlined by Dechy, Bourdeaux, Ayrault, Kordek and Le Coze (2004), stating that the explosion occurred in a warehouse for AN (am-monium nitrate) that was located between process parts, storage, and packaging sections. It was used to store downgraded AN temporarily. The warehouse was managed by the dispatch department and had no gas supply, no steam pipes, and only natural light. The transportation of these reduced AN to storage was handled by three different subcontracting organisations, however no one was in the storage warehouse at the time of the explosion. An estimate of 390–450t of downgraded AN was stored before the incident, allowing retracement of the entries on September 21, 2001. The explosion killed 30 people (22 employees and 8 members of the general public) and injured up to 2242 others. In addition, 5079 persons were treated for stress.

The plant was in the outskirts of Toulouse, and the damage was extensive both on and off site, with insurers estimating a cost of 1500 million Euros. Land use planning (LUP) in the past and after the accident. During the last century, due to the tenfold increase in the population of Toulouse (750 000 in 2000), residences and human activities grew increasingly close to the factory. Safety investigations began in 1983 after the Seveso disaster, and the LUP was approved in 1989. There were 1130 people in the deadly impact zone for LUP (900 m) and 16000 in the irreversible effect zone (on September 21, 2001). The type of the product was placed on top of the AN storage minutes and hours before the facility was located in the suburbs of Toulouse, and the level of damage was very big both on the inside and outside of the plant. At a cost of 1500 million Euros, according to insurers (Dechy, Bourdeaux, Ayrault, Kordek & Le Coze, 2004).

3.4.6. Buncefield in Britain (2005)

On December 11, 2005, a large explosion occurred at the Buncefield fuel storage near Hemel Hempstead, UK. The major explosion was a vapour cloud explosion (VCE) caused by unleaded gasoline spilling from a storage tank. Buncefield fuel depot, which has over 20 tanks, is one of the UK's largest storage facilities, with 35 000 m3 held on site on December 11th (Powell, 2006a). The overflow culminated in a total overflow of almost 300 tonnes at the time of the

explosion (Powell, 2006c). Before the explosion, a vapour cloud formed over an area of approximately 80 000 m2 with a thickness of 1–7 m. The blast is believed to be the greatest in Europe since World War II. There were 43 people hurt in total. The explosion was followed by a 36-hour fire that consumed the remaining fuel (Ottemoller & Evers, 2008).

3.4.7. Regional Accident of Sasol South Africa (2000 and 2004)

This focuses on Sasol in South Africa, down from the historic international review to the regional incident. In 2004, a massive gas explosion occurred at the Sasol petrol facility in Secunda, Mpumalanga, killing six people and injuring more than 100 more (South African History, 2004). According to accounts, incidents involving the Zamdela community in Sasolburg have occurred. Three large chlorine gas leaks at the Sasol polymers plant in 2000 resulted in the hospitalisation of more than 200 persons, the majority of whom were young people from a neighbouring school (Peek, 2000). When inhaled in sufficient quantities, chlorine gas can cause significant harm and even death and the Environmental Protection Agency (EPA) strictly regulates its use.

Dhara (2000) discusses the variables which contribute to factors of human exposure and are: The distance of residence from the plant, duration of exposure, and activity during exposure. The distance between the homes and the plant increases chemical exposure. Mortality and morbidity were reduced by increasing distance from the plant in the instance of Bophal. Concerning duration of exposure again in the Bophal case, activity during gas exposure was undoubtedly a substantial dosage controlling element. In the case of Zamdela, the chlorine gas was discharged as a vapour, and most of the affected students from the local school were outside, inhaling huge amounts of it (Peek, 2000).

3.5 Importance of Disaster Risk Reduction in Addressing Technological Hazards

Disaster Risk Reduction (DRR) is the systematic development and application of policies, techniques, and practises to reduce community vulnerabilities and disaster risks to avoid (prevention) or limit (mitigation and preparedness) the harmful effects of hazards, all within the context of long-term development (Disaster Management Authority, 2011). Traditional disaster management practices focused on preparedness for response, but as stipulated by International Strategies for Disaster Reduction (ISDR) (2002), the focus shifted to risk reduction, and continued to show that it is most important to sustain efforts to reduce all costs of disasters,

including social, economic, and environmental costs. Furthermore, risk is now given more weight because disaster, development, and environmental challenges are all linked. Communities must become more resilient to the effects of hazards to lessen disaster losses, according to this understanding. The cost of disasters, on the other hand, is quantified in lives lost, livelihoods lost, property lost, and damaged environment. Currently, the holistic approach to risk reduction is focused on risk and vulnerability; this strategy encourages people to value their property, lives, and livelihoods even before they are lost or threatened. Protective and saving techniques should receive more emphasis. The Yokohama Strategy and Plan for Action for a Safer World (1994) added to the strategy by emphasising that each and every country must bear primary responsibility for protecting its people and property from disasters, and that human actions can minimise community vulnerability to hazards (International Strategies for Disaster Reduction (ISDR), 2002).

Disasters can be significantly decreased if people are fully informed about the steps they can take to lessen vulnerability and are motivated to take action (International Strategies for Disaster Reduction (ISDR), 2005). All disaster reduction programmes, according to Twigg (2004), should incorporate communications and awareness-raising as a core, continuing aspect, with a clear plan for doing so. Information is critical; for the poorest people, it may be the only type of disaster preparedness they can afford (International Federation of Red Cross (IFRC), 2005).

United Nations International Children's Emergency Fund Lesotho (UNICEF) (2011)mentions that integrating the disaster risk reduction into the school curriculum helps encourage awareness, which shows the importance of awareness. Risk awareness and assessment(which includes hazard analysis and vulnerability/capacity analysis); forms part of the disaster risk reduction framework, further showing the importance of risk awareness in disaster risk reduction. Risk awareness is mostly determined by the quantity and quality of available information as well as individual risk perceptions. We want to be mindful of how we perceive risk, danger, and vulnerability. When people are unaware of the dangers that threaten their lives and possessions, they are more vulnerable. The curriculum has since been out to work in 2016 (Ministry of Education and Training, 2016).

Also, Disaster Management Authority (2011), highlights the African Regional Strategy for Disaster Risk Reduction (ARSDRR) laying forth a strategy of having accomplished the following six goals:

- Political commitment to disaster risk mitigation has grown.
- Improved disaster risk reduction knowledge management
- Public awareness of disaster risk reduction has grown.
- Institutions for disaster risk management have improved governance.
- Disaster risk reduction is integrated into emergency response management.
- Improved disaster risk identification and assessment.

Increased public awareness being among the achieved objectives symbolises how important it is. The policy further states that lack of information and awareness, underemployment/unemployment, remote and inaccessible settlements, inadequate government programme execution, and inefficient service delivery all contribute to disaster vulnerability. Additionally, inadequate capacity in terms of both resources and equipment, such as fire fighting equipment, exacerbates vulnerability.

Moreover, United Nations Development Programme (UNDP) (2008), mentions that Lesotho has all the plans to increase disaster risk reduction awareness with frameworks in place but has seemed to be weak. Lesotho's disaster risk reduction lacks knowledge in management. Disaster Management Authority's key tasks and functions, such as training, public awareness, and education, are not being planned and implemented in a systematic way, although the initial plan is that all structures and stakeholders should prioritise disaster risk management training programmes.

3.6 Disaster Risk Assessments

Risk assessment identifies the type and severity of risks by investigating potential hazards and assessing existing vulnerability conditions that may have an impact on exposed individuals, their homes, properties, livelihoods, and the environment on which they rely (Jordaan, 2019). Karageorgos (2017) further explains risk assessment as the process of finding, analysing, and evaluating the risk posed by hazardous installations, with the primary goal of preventing and reducing any accidents. The process is divided into three phases: 1. hazard identification, which

is the process of identifying and recording hazards, 2. analysis, which entails developing an understanding of the hazard and making information available for evaluation, and 3. evaluation, which is concerned with comparing the hazards levels estimated with predetermined criteria to determine the significance of the hazard level together. As a result, according to International Strategies for Disaster Reduction (ISDR) (2002), risk assessment is a critical stage in developing appropriate and effective disaster reduction policies and actions.

The risk assessment progress diagram below outlines the 3 phases of risk assessment as stated above and in the end if there are impacts then there is probable risk (Ready, 2022). Concerning information available on the risk assessment, Global Facility for Disaster Reduction and Recovery (GFDRR) (n,d) states that agencies across sectors can proactively respond to disaster risk by upgrading buildings, adopting new land-use planning rules, designing financial protection measures, and equipping and training emergency.

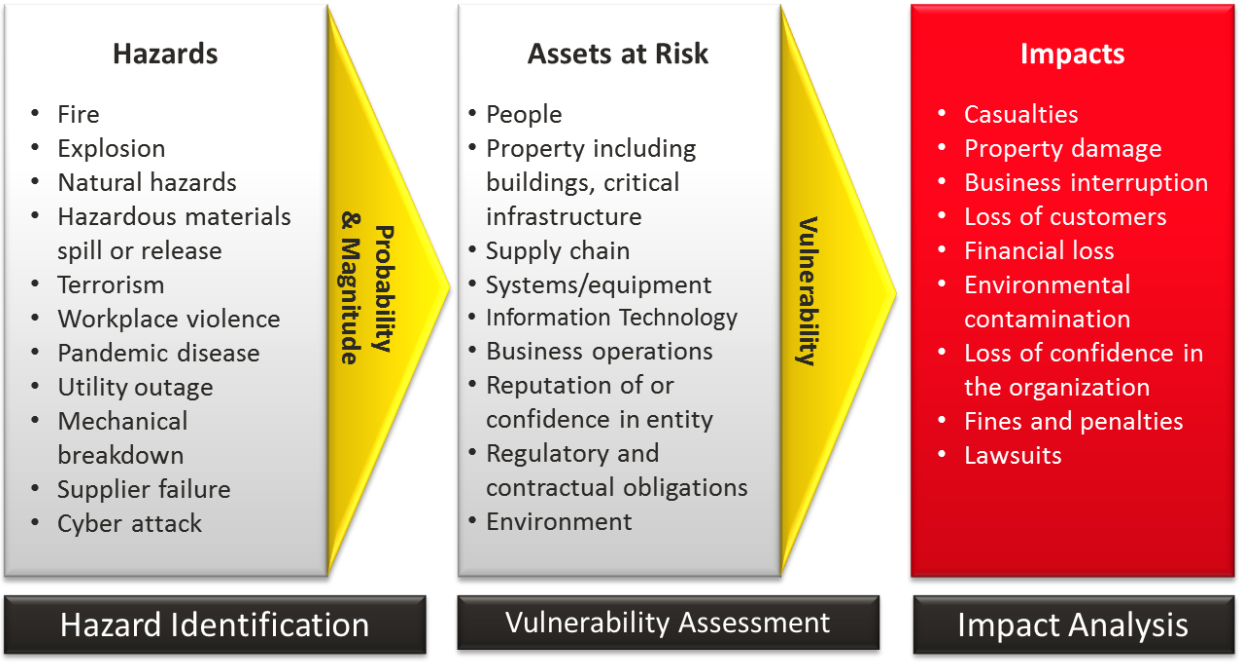

Figure 3. 1 Risk Assessment Progress Diagram
Source: (www.Ready.gov, 2022)

3.6.1 Chemical Incident Assessment and Response in Maseru

Regarding the petrol storage in Maseru Industrial Area, there was a single incident of a petroleum tank explosion in the 1980s. This was quite confined and had no effect on the general public because it was of small magnitude and intensity. Aside from that, there has never been a situation that has deserved national attention as an emergency. This is not to say that there are no risks which still pose a great risk (Ministry of Tourism Environment and Culture, 2010).

The Ministry of Tourism Environment and Culture (2010) makes clear that any incident should be recorded as thoroughly as possible, and a follow-up should be conducted in order to prevent or mitigate future incidents. The requirements for workplaces in the Labour Code provide for this, yet in most situations, nothing is in place or practised. Globally, disasters have sparked good practises, prompting governments to recognise the severity of the problem and the necessity for strict regulations and enforcement. Lesotho has not seen a major level of risk. As a result, the country has no actual experience with major hazardous risks, and they appear to be too far-fetched to justify any consideration at this time.

3.7 Public Awareness

Public awareness should be defined as more than just providing information to the general public; it should also include actual learning that leads to people being willing to take steps to improve their safety. Public awareness is a broad phrase that refers to a continual exchange of information between authorities and the general public. Active participation in hazard mitigation by vulnerable areas is vital, and illustrates that vulnerability patterns and mitigation activities are local. Because they have a mission to guarantee their safety and welfare, local communities are more likely to be the first responders in the case of a disaster. As a result, public awareness should be used to help communities prepare for disasters (Wisner et al., 2006). Public knowledge, followed by informed action, is the cornerstone prerequisite for lowering vulnerability and establishing resilient households, communities, and societies, according to (Wisner et al., 2006), citing (Handmer and Penning-Roswell, 1990).

Risk awareness is mostly determined by the quantity and quality of available information as well as individual risk perceptions (International Strategies for Disaster Reduction (UNISDR), 2002). The Strategy further continues to state that when people are unaware of the dangers that threaten

their lives and possessions, they are more vulnerable. Moreover, people, communities, agencies, and governments all have different levels of risk awareness based on their own perceptions of risk, knowledge of hazards and vulnerabilities, as well as the availability of accurate and timely information.

Through public awareness campaigns the goal of DRR role-players is to inspire people to participate in actions that lessen the dangers to which they are exposed (UNISDR, 2004). Chagutah (2009) also mentions that through communication interventions, all regional and global disaster risk reduction frameworks ask for increased public knowledge of disaster risk reduction and the creation of a culture of risk avoidance.

The National Disaster Management Framework for South Africa (NDMF) demands for the deployment of effective public awareness programmes to raise community awareness of the dangers they face and the risk-reduction actions they can take. Chagutah (2009) further emphasised the need of providing information and improving understanding among at-risk communities, which above all shows the importance of awareness of people at risk.

Disasters can be significantly decreased if people are fully informed about the steps they can take to lessen vulnerability and are motivated to take action (UNISDR, 2005). All disaster reduction programmes, according to Twigg (2004), should incorporate communications and awareness-raising as a core, continuing aspect, with a clear plan for doing so. International Federation of Red Cross (IFRC) (2005) highlights how information is critical; for the poorest people, as it may be the only type of disaster preparedness they can afford.

Ardalan, Linkov, Shubnikov and LaPorte (2008) posts that increasing public knowledge through education has long been considered as a foundation for minimising disaster risk. They further discussed building disaster networks through an educational strategy that takes advantage of the rising public interest in hazard and risk information to teach and uncover national and worldwide expertise. The Hyogo Framework for Action 2005–2015 as articulated in chapter 2 above emphasises the importance of having formal and non-formal education and raising awareness as a major component of risk mitigation efforts.

Previous experience, studies, and programmes have proven that education has immensely good benefits on disaster risk reduction and management. Children and adults who have been taught

how to react in the event of a disaster, community leaders who have learned to warn their people in a timely manner, and entire social players who have been taught how to prepare for hazards have all contributed to better mitigation strategies and the dissemination of information on the dangers of hazards. People have been given skills for reducing vulnerability and improving their lives through education and information (Shaw, Takeuchi & Rouhban, 2009).

In application to the study conducting public awareness to the general public, more especially to the people located near the petrol storage, then they will be more aware and prepared so that in case of a disaster at the petrol storage, there will be less impact. They will be fully aware of how to mitigate the effects, respond to disaster and recover from it.

- **Awareness of Chemical Safety Issues in Lesotho**

Chemical Management Committee (CHEMAC) members and key stakeholders according to the Ministry of Tourism Environment and Culture (2010), they expressed a general view that public awareness of environmental issues is quite poor. There is, however, a caution to this statement, in that people are aware of the possible hazards posed by recognised substances, but there are no immediate concerns because there is no known national tragedy that has occurred.

In relation to time, the Ministry of Tourism Environment and Culture (2010) added that awareness-raising techniques are ineffective. The messages that are sent out are frequently unclear and do not always convey the intended meaning. It is necessary to create communications that do not have many meanings and can be understood by the target audience. Another challenge derived by the Ministry is that, despite the importance of the sector of information dissemination, many people take it for granted. It is a common misconception that because it is not a specialised subject, anyone can try it. Technical jargon is widely used, particularly in print media. This results in messages that are not always understandable to the average person, despite the fact that they would have been quite valuable if plain language had been employed. Again the issue of time when it comes to information dissemination comes into play. Failing to meet people's needs at the appropriate moment. Some messages are critical at specific times, however there have been many instances of delays in getting messages to clients when they are most needed and thus becoming problematic.

While the general public and workers are aware of the dangers posed by some known chemicals, there is still a tendency for people to disregard health and safety norms in order to support their livelihoods. People will also watch out for themselves because there are no restrictions protecting them from employer misconduct that could endanger their safety and health (Ministry of Tourism Environment and Culture, 2010).

3.8 Strategies for Addressing Petrol Hazards

According to Fuentes-Bargues, Gonzalez-Cruz, and Baixauli-Perez (2017), risk management systems were urgently needed following all of these disasters that created enormous difficulties and serious damages. The chemical industry employed four strategies to increase process safety and environmental protection: inherent safer design, risk assessment processes, usage of instrumented safety systems, and installation of safety systems management systems. The HAZOP approach (hazard and operability) is the technique most commonly used to identify risks by means of risk assessments. HAZOP is defined by Crawley and Tyler (2015), as a thorough approach for systematic analysis of a well-specified process or operation, whether planned or existing. A HAZOP analysis can be used to search for potential operating problems in addition to identifying safety, health, and environmental (SHE) threats. The approach has been used in a variety of ways in the process industries, which is not surprising. HAZOP can significantly reduce accidents. The Bhopal and Flixborough disasters, for example, could have been avoided if HAZOP had been used. Before an accident occurs, hazards must be identified (Kletz, 1999).

3.9 Allocation of Land in Lesotho

Leduka, Ntaote, and Takalimane (2018) explains that in Lesotho all urban and rural municipalities, as well as the state-owned Lesotho Housing and Land Development Corporation (LHLDC), are direct beneficiaries of land purchased for subdivision, servicing, and final disposition under part IX of the Land Act 2010. After being serviced, such land is usually marketed for sale, and any member of the public is allowed to apply for such advertised parcels. The most common criteria for distribution are proof of applicants' ability to pay for the land, with first-come, first-served selection. The LHLDC's land allocation methods are briefly highlighted, as compared to local councils, it has a comparatively well-documented set of procedures.

The Land Administration Authority (LAA) (2010) states on its website that they do not provide or assign land. Local land allocation bodies; municipal and community councils are responsible

for providing State land to individuals and enterprises who seek it. The Land Administration Authority is responsible for converting all such urban land allocations and commercial land allocations in rural regions into leases. Other land allocations in rural areas may not require conversion, although they cannot be handled in the same manner as leasehold title can (e.g. transferred, mortgaged, inherited). Land under leasehold title registered with the Land Administration Authority is becoming more common in urban areas.

3.10 Linking Environment to Disaster Risk Reduction

Greiving, Fleischhauer and Lückenkötter (2006) state that in an effort to link environment and disaster risk reduction several outcomes emerged such as assessment of environmental concerns in relation to hazard, grounded on credible sources of available information. Environmentally sensitive areas are mapped, their environmental characteristics and development trends are described, their impacts are evaluated, and further data is required. Monitoring to offer data for decision-making, such as preventing the development of disaster-prone land (land-use plans enable local governments to gather and analyse information about the suitability of land for development, so that policymakers, potential investors, and community residents understand the limitations of hazard-prone areas).

Further, Greiving, Fleischhauer and Lückenkötter (2006), make mention of Regulatory (zoning, subdivision regulations, building codes, special ordinances), incentive (tax incentives, transfers of development rights, easements, land purchases, voluntary agreements, donations, leases, covenants, charitable deductions), programme, hazard control and mitigation, environmental tools for disaster reduction. These linkages bring about the connection of environment and disaster risk reduction and proper connections can yield proper land use planning and thus reduce disasters in a huge way.

3.11 Land Use Planning and Dealing with Risks

Future land-use decisions have long-term consequences as stated by Greiving, Fleischhauer and Lückenkötter (2006), such as on physical structures like buildings or infrastructure, and are frequently irreversible. Furthermore, risks are unavoidable anytime such decisions are made. As a result, planning must always consider the consequences of planned activities. This reduces uncertainty about future effects while increasing confidence in the legitimacy of the democratic decision-making bodies involved. This is particularly true when making decisions about

hazardous industrial infrastructure. Spatial planning, which is responsible for making long-term decisions for specific geographic locations, must take into account all spatially relevant sectors.

This is because spatial planning is in charge of a specific spatial area (where the total of hazards and vulnerabilities determines the overall spatial risk) rather than a specific object. As a result, in order to deal adequately with risks and hazards in a spatial context, spatial planning must use a multi-hazard approach (Greiving, 2002; Schmidt- Thome, 2005).

The recognition that risk potentials are expanding and that risk policies should not be limited to the response phase of the emergency management cycle is one of the key reasons for this current shift in attitude. Rather, mitigating hazards is an essential prerequisite for promoting sustainable development, a task for which spatial planning must develop adequate instruments. As a result, methodological tools for estimating the hazard intensity, vulnerability, and total risk of a specific geographic area must be established (Greiving, Fleischhauer & Lückenkötter, 2006).

Preventionweb (n.d) discusses that by promoting sustainable land use and urban development methods, land use planning can help to reduce disaster risks. However, understanding the mechanisms that form disaster vulnerability and approaches to integrate risk reduction into land use planning procedures are required for a risk-sensitive land use planning practice. Unfortunately, there is a lack of understanding, motivation, and resources at the local level to incorporate risk reduction into existing planning and management methods. As a result, disaster risk reduction is frequently implemented in a reactive manner after a big disaster. However, land use planning, in the form of comprehensive plans, zoning, and construction rules, presents a chance for proactive risk reduction through location-based and/or structural measures. Land use planning that is based on systematic risk assessment techniques, applied strictly, and regularly monitored has the ability to reduce current, future, and residual risks.

Integrating disaster risk concerns into land use planning practices by expanding awareness of urban disaster vulnerability and the processes that go along with it. The goal is to encourage more risk-aware urban development and land management policies, regulations, and technologies aimed at disaster risk reduction and mitigation (Preventionweb, n.d).

Moreover Kontic and Kontic (2009), express that the setting of sufficient distance between hazardous installations and residential areas is the most effective preventive technique for

decreasing the consequences of industrial accidents. Proper distances should be ensured by land-use planning (LUP): one of the standards of the Seveso II Directive is that risk assessment results be considered in land-use planning in order to minimise the effects of accidents.

The goal is to reduce off-site public damage from significant incidents by establishing standards for determining the placement and layout of new installations, developing existing installations, and land developments near existing installations. Land use planning is an important component of major hazard control since it helps to reduce adverse effects from disastrous industrial accidents. The primary idea is to provide effective isolation of facilities that pose severe hazards, reducing the public's exposure to the repercussions of serious industrial accidents (Khakzad & Reniers, 2017; Pak & Kang, 2021).

To further emphasise on the better situation of major hazardous installations Christou, Amendola and Smeder (1999), articulate that there is no doubt that establishments capable of causing major accidents with consequences that extend beyond their borders should be kept at a safe distance from residential and commercial areas. Separation distances should, in theory, be sufficient to protect the safety of persons and sensitive environments. Land, on the other hand, is an economic good that is generally scarce. As a result, appropriate separation distances must be established that adhere to some sustainability principles.

Disaster Management Authority (2011) show how poor or unplanned land use, unregulated settlements, and a lack of enforcement of building regulations all contribute to land use planning as a vulnerability factor in Lesotho, among many others and also how human activities and urbanisation are perpetuating developmental and environmental concerns. Thus resulting in greater risk to the nearby land users.

3.12 Chapter Summary

In summary the purpose of the chapter was to review literature on areas relating to the study. Firstly, the chapter defined and explained the concepts that supported the study. Secondly, the chapter provided the historical view of past industrial disasters to show that indeed major hazardous industries can cause disasters internationally, regionally and locally which is in Maseru Industrial Area. Nevertheless, through the past disasters there are lessons learned and the global regulations formulated to ensure that risk is lessened. To further lessen the risk, the land

use planning tools are viewed and the conclusion is that if properly deployed then greater risk can be reduced.

Chapter 4

Research Methodology

4.1 Introduction

This chapter outlines the research approach and methodology used to achieve the study's goal and objectives. It discusses the chosen research philosophy, approach, and strategy. The approach to data gathering and analysis are also described in the chapter. The chapter concludes with a discussion of ethical concerns and limitations pertaining to the research.

4.2 Research Overview

According to Sahu (2013), research in a domain of knowledge is defined as a scientific procedure of gathering and analysing information to gain a better understanding of a phenomenon the researcher is interested in, whereby new facts, concepts, and theories can be established or proven. The goal of any research project is to find answers to the questions posed by the researcher. The goal of every investigation is to uncover the truth that has been hidden for so long. Any study can have one or more objectives that are relevant to the study's aim.

In addition, Rajasekar, Arts, and Veerapadran (2006) explain that many other sources of information can be used to obtain information, including personal experience, interpersonal interactions, books, journals, and nature. The body of knowledge may grow because of a study. Research is the only way to advance a field. Research makes use of study, experiment, observation, analysis, comparison, and reasoning. We are surrounded by research. Finding predictions for events as well as the ideas, relationships, and explanations underlying them is the goal of research. Drawing from these definitions, research is a planned activity aimed at obtaining new facts and knowledge about a specific phenomenon. The research process begins with the discovery of a specific problem or area of interest, followed by the translation of that problem into a research problem, data gathering, data analysis, and publishing the study findings.

Moreover, an appropriate approach to data collection aids the researcher in ensuring that the data gathered is reliable and valid. This is also known as the research design. It needs to be selected with careful consideration. When research is created and founded on a proper research plan and

the proper technique is used, a theory or research question is usually tested. De Vaus (2001) explains the research design as a general approach the researcher takes to bring together the many parts of the study in a logical and convincing way, assuring that the researcher will successfully solve the research problem. It serves as the guide for gathering, measuring, and analysing data. It is critical to keep in mind that the research challenge, not the other way around, dictates the type of design chosen.

4.3 Research Process

To clarify research design and methodology concepts, Barbour *et al.* (2018) define research design as real entities, not only a plan for the research but also the real conceptualizations and practices engaged in the study, which may be different from the intended design. The suitable framework for the investigation is provided by Research Design. Most importantly, it is about deciding on the study approach, as this determines how information will be gathered. Data gathering tools are utilised to obtain the information (Sileyew, 2019).

According to Creswell (2014), study approaches are research strategies that involve everything from broad hypotheses to specific methods for data collection, analysis, and interpretation. Creswell (2014) also emphasises that this plan requires several decisions, none of which can be made in the order that is logical or that is described here. Which approach to choose to research a topic is ultimately up for debate. This choice should consider the researcher's philosophical presuppositions, the methods of inquiry (often referred to as research designs), and the particular research methodologies for data collection, analysis, and interpretation. A research approach is chosen after considering the audience, the nature of the study topic or issue, and the researchers' personal experiences. Research designs are types of inquiry within qualitative, quantitative, and mixed methodology techniques that give specific guidance for procedures in a research design (Creswell, 2014). A mixed design was chosen for this study because mixed methods offer the most insightful, comprehensive, fair-minded, and practical research findings (Johnson & Onwuegbuzie, 2007).

The term methodology refers to the umbrella of research methods. Methods are the procedures for selecting instances, measuring, and examining social life characteristics, gathering, and analysing data, and finally producing and presenting the results. Methodologies and methods are

intertwined and mutually dependent. The techniques through which a study can be conducted are described in research methodology. Experiments, surveys, tests, and other processes are applied in research. On one side, research methodology, includes examining the several measures that can be utilised in the carrying out of research as well as experiments, surveys, tests, and important studies (Goundar, 2013; Neuman, 2006).

4.3.1 The Research Onion as a Model for Research Methodology Development

The conceptual model in Figure 4.1 below shows how the research question developed from the research literature. A clear rationale for the best relevant methodology was sought in order to address the research question. A clear framework for the most appropriate research method and strategies was required to solve the research questions indicated above, which was found by considering the conceptual model and each layer of Saunders et al. (2009) research onion model.

The research onion model first urged the researcher to choose an acceptable research philosophy. The research philosophy encourages people to think about how knowledge should be generated to solve the research issue. Following the selection of an appropriate research philosophy, various methodological factors were evaluated.

According to Ellis and Levy (2009), the research onion is a tool that helps students to conduct a research in the right format by following each stage of approaches that aid in producing research outcomes. Philosophies, methods, strategies, options, time spans, methodologies, and procedures are the six divisions of the research onion. Each layer of the research onion is explained in order to clarify why each element was chosen and how it contributed to the research questions being answered.

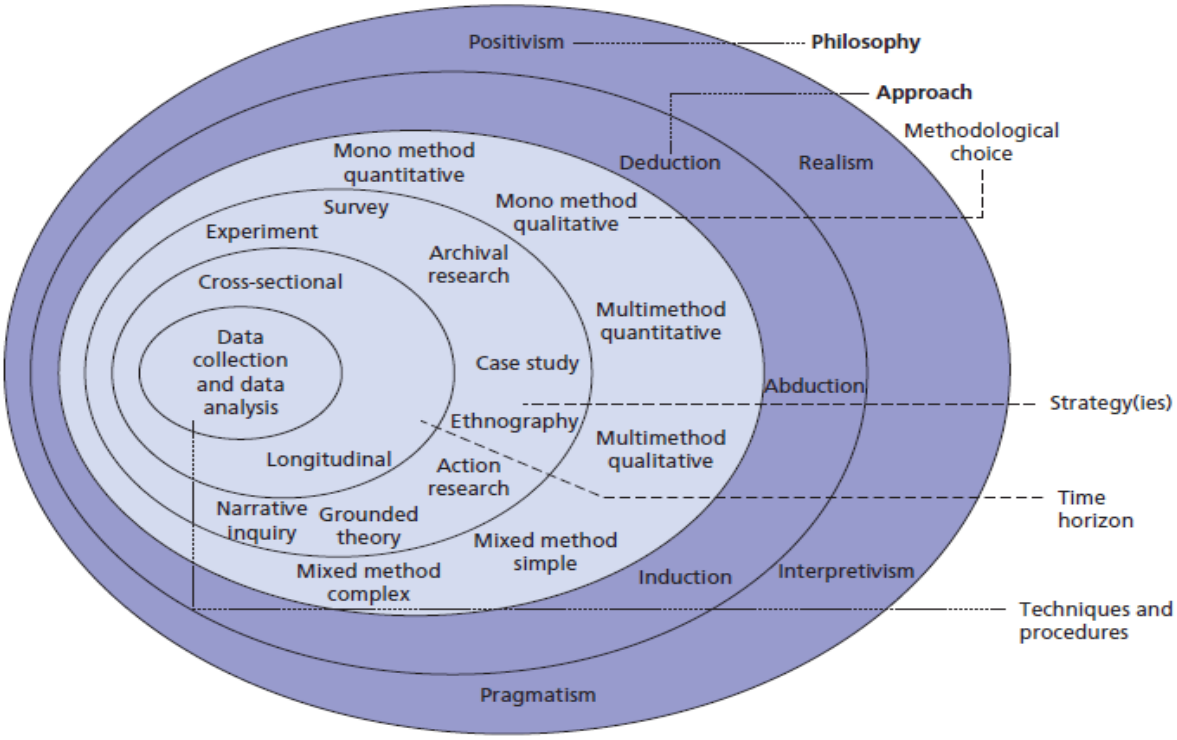

Figure 4. 1 The Research Onion Shape
Source: (Saunders, Lewis and Thornhill, 2009)

4.3.2 Research Philosophy

Saunders, Lewis and Thornhill (2019) point out that an arrangement of beliefs and assumptions concerning the generation of knowledge is referred to as research philosophy. Saunders, Lewis and Thornhill (2019) further cite that a believable research philosophy will be built on a well-thought-out and consistent set of assumptions that will guide the methodological choices, research plan, data collection methodologies, and analytic procedures. This will enable the researcher to create a coherent research project in which all research parts are integrated.

A traditional research methodology is founded on a philosophical theory that subsequently entails research strategies and techniques (Nweke & Orji, 2009; Saunders et al., 2016). According to Creswell (2014), the research philosophy is represented by the outer layer of the research onion, illustrated in figure 4.1 above. In this research, a pragmatism philosophy was chosen, as it is one that is not bound by any particular ideology or reality, allowing the researcher to choose the processes that best suit their goals. This method considers the what and how of

research in terms of its intended outcomes. Rather than focusing on methodology, researchers weigh in on the research problem and employ all possible methodologies to comprehend the issue. Regarding this research, the problem is the petrol storage that is located within other land uses and may pose a threat to those nearby land uses. Looking further, the question is whether the nearby land uses are aware of the risks posed by the petrol storage. What is the level of awareness of the risks posed by petrol storage to the people, properties and environment near this installation as shown in chapter 1?

Pragmatism philosophy, according to Rorty (1991) (cited in Parvaiz, Mufti and Wahab, 2016), is defined as alleviating and improving man's condition, making humans happier by enabling them to cope more successfully with the physical environment and with one another. As a result, a pragmatist's main focus is to figure out what works and what makes it possible to solve problems. Parvaiz, Mufti, and Wahab (2016) state that according to a pragmatist, the mission of science is not to discover truth or reality, whose existence is continually contested, but to make human problem-solving easier.

In terms of ontology and epistemology, pragmatism is not constrained by any particular philosophical or reality theory. Since reality is actively created when people interact with the world, it is always evolving, based on human experience, and geared toward finding solutions to practical issues (Frey, 2018). Towards integrating practices, empirical ways are valued above idealistic approaches in pragmatism (Frega, 2011). Pragmatism encourages researchers to focus on the two methods of inquiry rather than categorising post positivism and constructivism as two distinct ontological and epistemological positions (Morgan 2014b). That is why this research will combine inquiries. The goal of pragmatism is to provide practical solutions that will inform future practice. For combining perspectives and techniques, pragmatism is a well-developed and appealing philosophy. This is because it provides a rationale and an epistemic basis for combining approaches and procedures (Johnson, Onwuegbuzie & Turner, 2007). This research used pragmatism philosophy because the structure is both qualitative and quantitative as it accommodates both methods. It turns out to solve problems which in this research the problem stems from the petrol storage being located within other land uses and thus can affect the land uses in the case of an accident.

4.3.3 Research Approach

The second layer of the research onion model, according to Saunders (2009), is related to the research approach. Research approaches highlighted are: deductive, inductive, and abductive and according to Trochim (2006), deductive and inductive approaches are two widely used techniques of reasoning. Trochim (2006) mentions that arguments based on experience or observation should be articulated inductively, while arguments based on laws, rules, or other commonly accepted principles should be expressed deductively. That is why, in this study, the two approaches will be combined thus forming an abductive approach.

As Creswell and Plano Clark (2007) put it, deductive research employs a top-down approach, moving from a theory by means of hypotheses to findings that support or refute the theory. In contrast, an inductive approach is a set of straightforward processes for evaluating qualitative data that yields accurate and reliable results, whereas inductive advances from specific to general, which is the bottom-up approach. Inductive approach offers a straightforward, basic strategy for drawing conclusions in the context of focused evaluation questions, even though it is less effective than other analytical procedures for theory creation. For many researchers, employing a general inductive technique to analyse qualitative data presents less difficulties than utilising other methodologies (Thomas, 2006). Again, Creswell (2014) indicates that inductive reasoning is more applicable to constructivism-based studies.

Abductive reasoning is characterised as a retroductive process (instinctive reason's spontaneous conjectures) of identifying or developing hypotheses that might give explanation of unexpected fact or an unanticipated observation (Patokorpi, 2006). When using pragmatism, Morgan (2007) outlines that the researcher would usually use an abductive thinking method, which alternates between inductive and deductive reasoning. The abduction approach has a number of connections to grounded theory.

This research employed an abductive method in order to obtain knowledge and understand phenomena by engaging in extensive literature review and participating in both quantitative and qualitative data collection and analysis. Which also makes it exploratory in terms of research classification. An exploratory strategy is the study of multiple prospects, and the exploration of potential developments is the goal of the exploratory strategy. And for this nature, it anticipates

upcoming events and their potential effects on oneself and those around one; it chooses a current course of action while considering potential future events; it strikes a balance between immediate and long-term interests to achieve objectives; it identifies and addresses the root causes of significant events; and it increases motivation, assuming that the situation can be improved (Melnikovas, 2018).

4.3.4 Research Strategy

The third layer is concerned with choosing an acceptable research style that will aid in discovering data collection and data analysis sources, as well as how the researcher will handle the information acquired in the report (Sanders et al., 2009). Among the seven research approaches existing are experiment, survey, case study, action research, grounded theory, ethnography, and archive research which are accessible to the researcher. According to Melnikovas (2018), a research strategy is a general approach that guides a researcher on deciding on main data collection methods or combinations of procedures in order to solve the research question and attain the research objectives.

This study applied a case study strategy. A case study is an empirical investigation that explores a current occurrence in its actual setting, particularly when the distinctions between the object of study and the setting are not clear. It deals with the technically unique situation in which there will be many more variables of interest than data points, and as a result, it relies on multiple sources of evidence because data must combine in a triangulating manner. It also benefits from the earlier development of theoretical propositions because they serve as a guide for data collection and analysis (Yin, 2003).

Case studies represent a type of qualitative research, but quantitative research can also be represented. They are different from other types in that they are intensive analysis and descriptions of a single unit or system bounded by space and time. Individuals, events or groups are often examined in case studies. Through case studies researchers hope to gain in-depth understanding of situations and meaning for those involved. While case studies are sometimes criticized for lack of generalizability (Merriam, 2001), Yin (2018) suggests that insights gleaned from a case study can directly influence policy, procedures and future research. Although case studies are discussed extensively in the literature and employed frequently in practice, little has

been written regarding the specific steps one may use to successfully plan, conduct and share the results of a case project (Hancock, Algozzine & Lim, 2021). Case studies have been used to address important research questions and advance theory and knowledge in many different disciplines. Each method begins with identification of questions to be answered (based on what is already known) and ends with documentation of answers grounded in systematic analysis of information gathered using appropriate methods (Hancock, Algozzine & Lim, 2021).

Some people portray case study research as a completely exploratory approach in which nothing can be demonstrated, most frequently by emphasizing the claimed inability to generalise (Dul & Hak, 2008). According to Yin (2003), the issue of generalisation can be resolved, and theories can therefore be evaluated in ideally many case studies.

For this research therefore, a case study is used that addresses a question that focuses on discovering the level of public awareness of the businesses/ companies in Maseru Industrial Area nearby the petrol storage. As the businesses can be similarly affected by the petrol storage accident if it occurs. Data is gathered by interviews whereby the respondents give details of their events.

4.3.5 Research Choice

The fourth layer of the research onion concept is concerned with the study's character and is strongly linked to the research kind (Saunders et al., 2009). It is accepted that the nature of research can be divided into three categories. These components can be qualitative, quantitative, or a mix of the two. The level of research in these types of studies varies, as does the approach, depending on the nature of the study (Barrett et al., 2011).

The quantitative method is concerned with the utilisation of numbers, with statistical techniques being given specific priority. Qualitative research, on the other hand, deals with people's opinions, cognitive processes, and feelings. Mixed research is a type of research in which a researcher combines qualitative and quantitative research methods (Johnson et al., 2007). This study employs the mixed technique, which is a combination of qualitative and quantitative techniques.

4.3.6 Time Horizon

The fifth layer is linked to the length of time it takes to complete the research. There are two different types of time horizons: cross-sectional and longitudinal. The shorter time is covered by cross-sectional data, which measures the same sample over a short period of time and gives out conclusions, whereas the longer term is covered by longitudinal data, whereby the same sample of a population is measured repeatedly over a long period of time to find meaningful association (Saunders, 2007; Robinson, Schmidt, & Teti, 2005). Due to the nature of the study being once off, a cross-sectional study design was used in collecting data in this study.

4.3.7 Sampling Strategy

Probability and non-probability sampling are the two basic types of sampling. Non-probability sampling entails selecting participants in a non-randomized fashion, whereas probability sampling entails selecting participants in a random manner. For instance, volunteers could be chosen based on their accessibility (this is called a convenience sample). The best sampling strategy is largely determined by the goals of the research, specifically, if the researcher is attempting to develop findings that can be applied to a sizable number of individuals. Reality and resource constraints also play a major role here, since gaining access to correctly random samples might be difficult (Crossley, 2021).

The type of sampling engaged in this study is probability sampling in a random manner. Whereby, sample was randomly selected from a total population of 104 plots in the Maseru Industrial area at a 500m range from the petrol storage. Note that the majority of plots are business plots and within them can consist of several businesses. A sample of only 37 plots was selected. From 37 plots, 73 businesses were selected.

4.3.8 Data Collection and Data Analysis

The identification of an acceptable way of data collection is required for every research project to achieve its goal (Sarantakos, 1998). The data collection and data analysis tools are the last layers of the research onion model. The researcher makes choices here about which collecting and analytic tools are most suited. Interviews were conducted by the researcher face-to-face, to obtain primary data from land uses located nearby the petrol storage, and questions were outlined

on a questionnaire pre-designed for the study. The participants were randomly selected from 37 plots that falls within the range of 500m from the petrol storage. 73 respondents participated in the study and land users identified were office spaces(government offices), hardwares', small informal businesses, wholesales, logistics businesses, milling, street vendors, warehouse & storage, insurance & financial institutions, construction companies, factories, gas supply and petrol stations.

Convergent parallel analysis is used to analyse the data in this study. In convergent parallel analysis, both qualitative and quantitative data are collected at the same time, analysed separately, and brought back together and compared (Edmonds and Kennedy, 2017). The responses were coded and analysed using IBM SPSS Statistics 22 software and Microsoft Excel Spreadsheet 2007.

4.4 The Limitations and Delimitation

4.4.1 Limitations

The researcher aimed to approach 100 companies nearby the petrol storage, but due to challenges and the hesitation of other companies, the number was brought to 73. Participants were asked questions face-to-face by the researcher, and the questionnaire solemnly leant on the research questions as stated in chapter 1 above. The hesitation comes from some people not liking to participate in research studies due to past experiences of researchers using data in a manner that puts them at risk with the authorities. Other challenges were derived from the management of companies being busy and not being able to take part in the study, some delegating other people to take part and not being able to answer most questions, especially in the demographics section. Those questionnaires were discarded.

4.4.2 Delimitation

Only the petrol deposit was studied. There may be other hazardous materials in the study area that were not examined. Besides, there could be storages of other hazardous materials in Lesotho or even in the Maseru district which were not covered under this research.

4.5 Ethical Consideration (s)

The General/Human Research Ethics Committee (GHREC) of the University of the Free State provided an ethical clearance (see Appendix C). In order to conduct the research about petrol storage in Lesotho, permission was requested from the Ministry of Energy and Meteorology (see appendix B). The goal of the study was adequately explained to the target respondents, who were then offered clarification as needed. Every respondent underwent the necessary informed consent processes. Each interview started off with the respondent giving consent to participate in the research. Plagiarism was avoided and a Turn-it-in report is provided as Appendix D.

4.6 Chapter Summary

The research questions provided in Chapter 1 were addressed, and a complete understanding of them, using the selected research methodologies and analytical techniques. The research plan methodologies employed in this study have generally been thoroughly discussed in this chapter, along with any potential limitations and ethical concerns. The next chapter presents the research results and analyses.

Chapter 5

Data Analysis and Presentation of Results

5.1 Introduction

From the previous chapter, a comprehensive explanation and description of the methodology used in the study was provided, leading to the analysis of the data collected. This chapter consists of eight sections, beginning with the introduction, which serves as a road map for the chapter, then one of each theme, namely; demographic variables, assessing the hazards that can occur from the petrol storage, evaluation of the vulnerability of people, properties, and livelihood of people near the petrol storage, determining the various land uses around the petrol storage facility, determining suitable land zoning for petrol storage, recommending ways to reduce the impact of petrol storage industrial accidents on surrounding communities and the environment, and in closing, the chapter summary.

From the first research question: what are the hazards and risks posed by petrol storage to the surrounding land uses? The data collected addresses all hazards and risks known to land uses that can occur or affect them. Has the company ever experienced any form of disaster? If they think they are vulnerable to risks posed by the petrol storage what measures do they take to ensure their health and safety?

The second research question is to identify the various land uses near the petrol storage facility. The data gathered assessing the various land uses and determining whether, in an ideal world, it is ideal for petrol storage to be located within the various land uses or should ideally be segregated. The third research question is, how can land-use zoning improve the health and safety of vulnerable people to hazardous installations in the area? The data collected found out if land zoning can improve the health safety of land users near petrol storage, bearing in mind that it is from the viewpoint of the land users nearby and from the answers provided, the majority did not know about land use zoning. This demonstrates a lack of awareness in that regard.

The fourth and final research question is: how can the government ensure that hazardous installations are managed in an effective way? We addressed the viewpoint of companies and or

residents nearby the petrol storage about how they can be assisted to ensure the proper management of the petrol storage to minimize risk.

5.2 Demographic Variable

5.2.1 Response Rate

To identify the response rate, the number of respondents was divided by the originally planned sample size and multiplied by 100.

Table 5. 1 Response Rate

Sample size	Number of respondents	Spoiled questionnaires	Non-respondent percentage	Response rate percentage
73	73	0	0	100%

Source: (Survey, 2022)

The study conducted interviews with73 participants within a radius of 500m buffer from the petrol storage in Maseru Industrial Area, outlined in table 5.1 above, and were all successfully interviewed, which gave a 100% response rate. The 100% participation is an ideal response rate as it covers the selected sample as according to Taherdoost (2016), 50% is the minimum limit to proceed with analysis.

5.2.2 Age Groups of Respondents

Table 5. 2 Age Groups of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-35	26	35.6	35.6	35.6
	36-55	40	54.8	54.8	90.4
	56-65	5	6.8	6.8	97.3
	More than 65	2	2.7	2.7	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The ages of the respondents were grouped to disaggregate the respondents by age. The outcome showed in table 5.2 that the age group 36-55 had the majority of responses at 55%. followed by the age group 18-35 at 36%. Then 7% of the age group 56-65 and 3% of the age group over 65.

This implies that the majority of people who responded are part of the economically active population and are found in various economically active activities.

5.2.3 Gender of Respondents

Table 5. 3 Gender of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	45	61.6	61.6	61.6
	Female	28	38.4	38.4	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

Table 5.3 shows the gender indicated by the respondents while Figure 5.1 presents a cross tabulation of age and gender of the respondents.

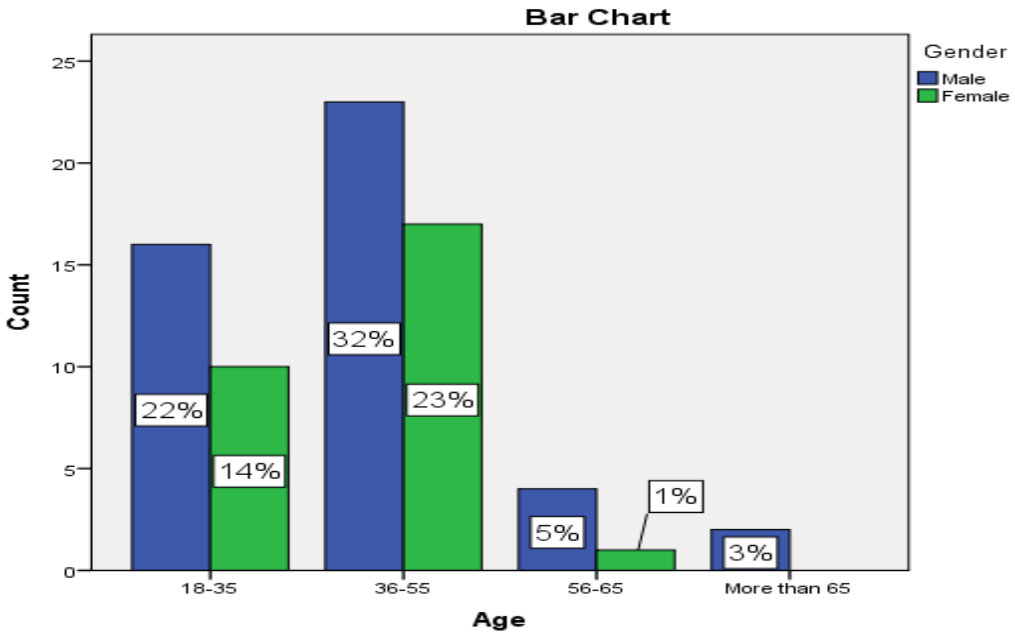

Figure 5. 1 Age and Gender
Source: (Survey data, 2022)

Gender in relation to age reveals that, in every age group represented in the study, the male gender seems to be more than the female gender. The highest male gender was at age 36-55 with 32%. Followed by 22%. Then there is age group 56-65 at 5% and age group above 74 years 3%, with male gender still outnumbering female gender. The conclusion is that males in the

communities are the most economically active and, in this study, the male population found in Maseru industrial area, within the 500m buffer zone, is about 62% while the females, which is 38% lower than males (see table 5.3 above).

5.2.4 Position of the Respondent in the companies/businesses

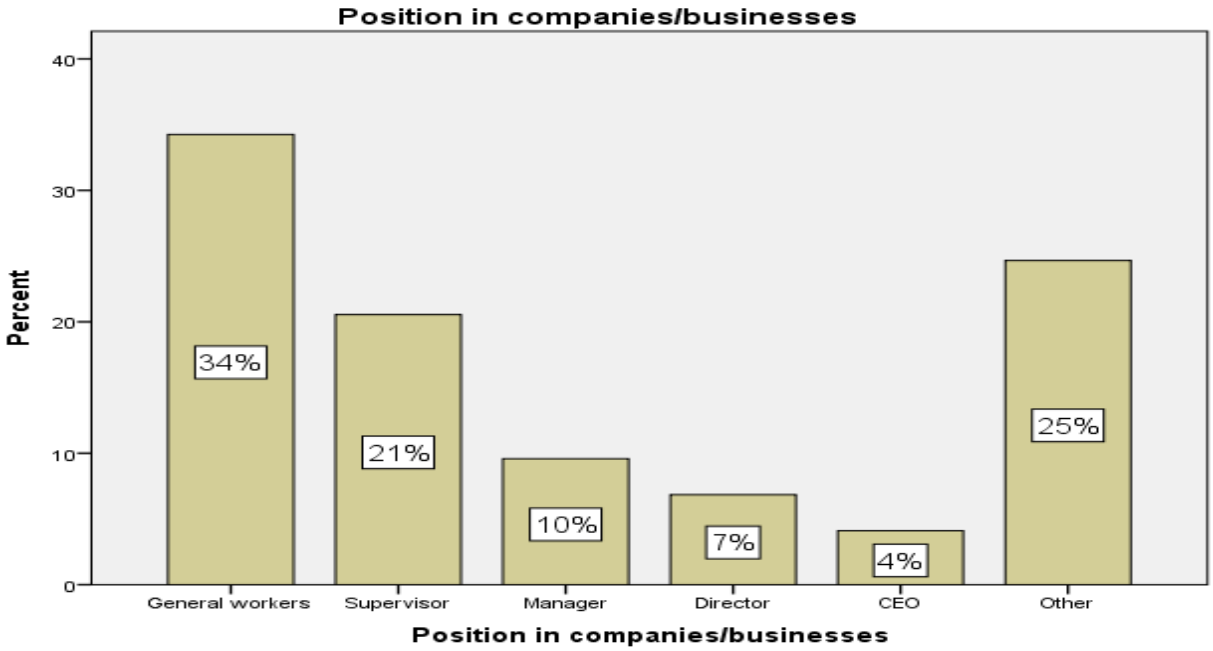

Figure 5. 2 Position of Respondents on the Companies/Businesses
Source: (Survey, 2022)

The position of respondents reveals that general workers make up the majority who took part in this study at 34%, followed by other positions at 25%, then supervisors at 21%, managers at 10%, directors at 7%, and lastly, Chief Executive Officers (CEOs) at 4%. This can be due to the busy schedule of managing positions, who delegated the people in lower positions to take this study interview.

5.2.5 Years a Respondent Worked for the Companies/businesses

The number of years the respondents worked for the company/business, aimed to reveal the experience of the respondents. The higher the experience, the more time they have been working near the petrol storage area, revealing the likelihood of having experienced disasters and or accidents. In other words, many years will represent better chances of having experienced with the petrol storage facility.

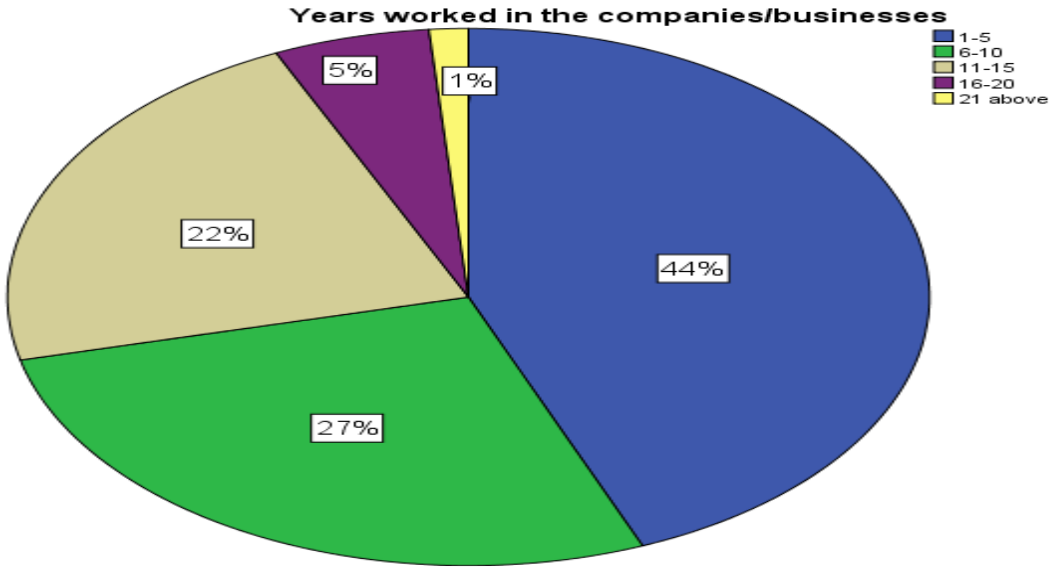

Figure 5. 3 Years Respondents Worked for the Companies/Businesses
Source: (Survey, 2022)

The pie chart above shows how the results came out. The respondents with 1–5 years of working with the company formed the majority of respondents at 44%, followed by 6–10 years at 27%, then 11–15 years at 22%, then 16–20 years at 5%, and last 21 years and above at 1% The pie chart shows that the people with the least number of years or experience are the most frequent respondents. Judging from their experience in a small location, it can be concluded that they might not have experienced any accidents from the petrol storage and they have not even thought of accidents occurring. As reviewed in the literature in chapter 3, the only recorded accident occurred in the 1980s at the petrol storage. Of those surveyed by the Ministry of Tourism, Environment and Culture (2010), none of the respondents had experienced the accident at the petrol storage.

5.2.6 Level of Education

The level of education determines the understanding of the surroundings of respondents. The inclusion of disaster risk reduction in the education curriculum as of 2016 from primary level will assist the communities to be aware and have knowledge of disaster issues in the future. However, since DRR was only incorporated in the primary curriculum in 2016, the current economically active population or people at the presented age groups may not have that information (Ministry of Education and Training, 2016; United Nations International Children's

Emergency Fund Lesotho (UNICEF), 2011). Education level has an impact on risk perception and awareness. The education level of the respondents is presented in Figure 5.4 below.

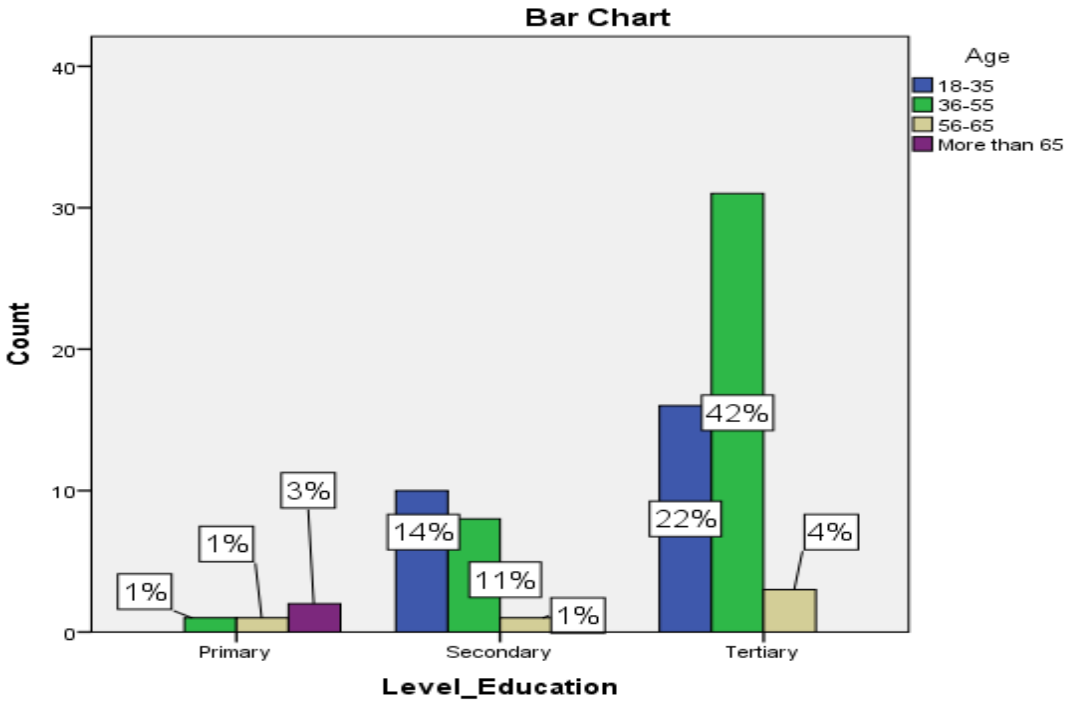

Figure 5. 4 Age Group of Respondents with Relation to Level of Education
Source: (Survey, 2022)

The level of education for this analysis was cross-tabulated with age groups to further understand which age groups achieved what level of education. By showing the bar chart (figure 5.4) above at 42%, the age group 36–55 was the most common in tertiary education. It is evident that a number of respondents near the petrol storage area have or can have a clear understanding of what is at stake. The age group 18-35 also has a tertiary level of education, as does a small portion of the age group 56-65, which also has a tertiary level of education.

Heading to the secondary level of education, whose frequencies follow the tertiary level, reveals that age group 18-35 has 14% secondary education level, followed by age group 36-55, presenting 11% secondary education level, and age group 56-65 at 1%.The final level of education categorised in this study, which is the primary level, shows the highest frequency of 3% in the age group older than 65, followed by 1% in both age groups 36-55 and 56-65. The

older respondents therefore had lower levels of education and this may need community education and risk awareness campaigns from Lesotho DMA.

5.2.7 Number of Employees

The number of employees was derived from the notion that the higher the number of employees, the greater the risk in a case of disaster.

Table 5. 4 Number of Employees

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-50	39	53.4	55.7	55.7
	51-100	20	27.4	28.6	84.3
	101-150	2	2.7	2.9	87.1
	151-200	2	2.7	2.9	90.0
	301-400	3	4.1	4.3	94.3
	401 and above	4	5.5	5.7	100.0
	Total	70	95.9	100.0	
Missing	System	3	4.1		
Total		73	100.0		

Source: (Survey:2022)

The number of employees table outlines the number of employees with the highest frequency, being the 0-50 group at 56%, followed by the 51-100 group at 29%. Then the 401 and above with 6%, then the 301-400 with 4%, and the two remaining groups of 101-150 and 151-200 tying at 3%.

The study compares the number of employees with the function of the company to try to determine the vulnerability to loss of lives. Considering that the companies with high numbers are at great risk and should be located further away from the petrol storage. From the literature in chapter 3, it was revealed that when risk assessment is conducted, humans are an important element or subject whose vulnerability should be assessed. So where there are many people involved, the level of risk becomes high (Major Hazard Installation Regulations, 2011). Also Wisner et al. (2004) state that a disaster happens when a large number of people are vulnerable to

a hazard and are exposed to serious harm, and they are affected so much that they cannot recover on their own.

5.2.8 Function of the Companies/businesses

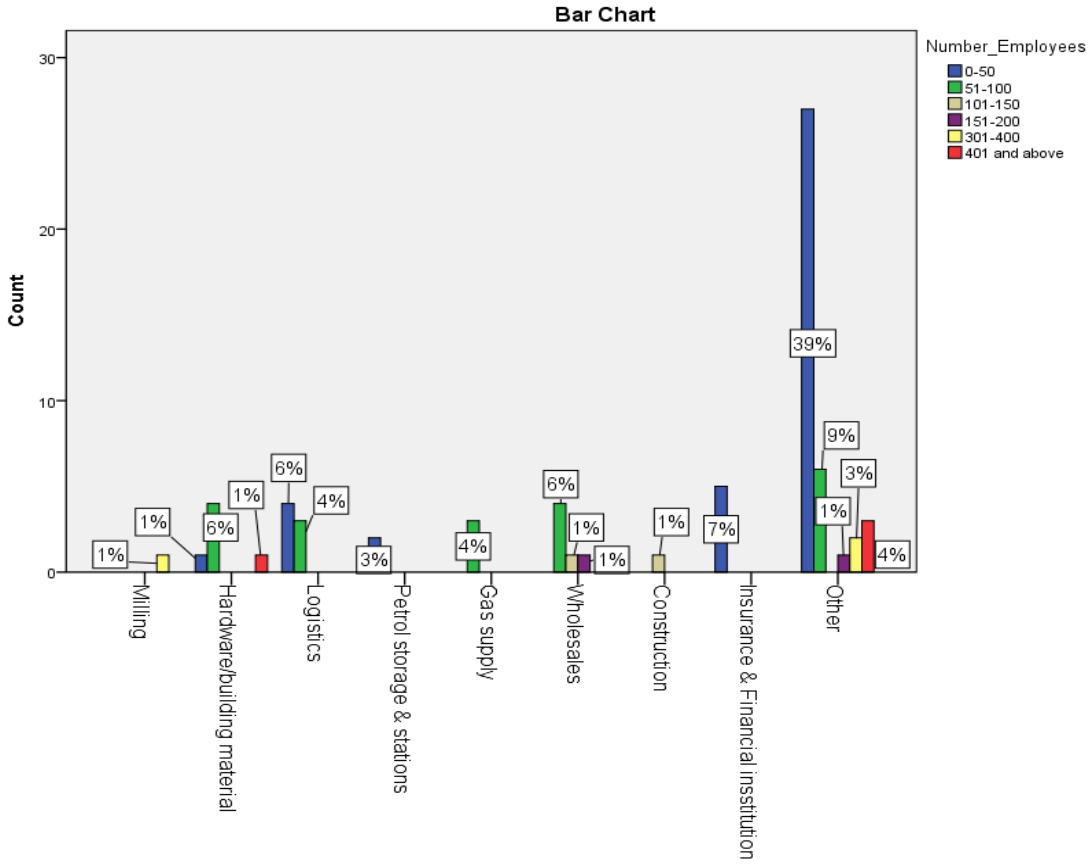

Figure 5. 5 Function of the Company in Relation to Number of Employees in the Companies/businesses
Source: (Survey, 2022)

The functions or activities of the main companies/businesses, which were included in the survey were government offices, street vendors, small retailers, and other companies. This means companies with 0–50 employees identified above as being in the majority fall within this category. Other companies, such as factories and other hardware, portray the number of employees with high numbers at around 301 and above, so in a case where the companies/businesses are affected by an accident from nearby petrol storage, especially during working hours, many people will be affected.

The most frequent, at 39%, is the other function of the companies/businesses with 0–50 as the number of employees. Followed by other functions of companies with 51-100 employees at 9%. Insurance and financial functions of companies with 0-50 employees at 7%. Logistics, wholesale, and hardware functions of companies with 0-50, 51-100, and 51-100 employees having equal frequencies at 6%. Other logistics, gas supply, and construction with 51-100, 51-100, and 401-400 employees having equal frequencies at 3%, and the final functions with the least frequencies at 1%.

5.3 Section B Hazards that can occur from the petrol storage

Table 5. 5 Hazards that Can Affect the Companies/Businesses

		Responses		Percent of Cases
		N	Percent	
Hazards affecting company	Floods	35	9.2%	47.9%
	Heavy Rains	33	8.7%	45.2%
	Storms	27	7.1%	37.0%
	Snow	8	2.1%	11.0%
	Fires	60	15.8%	82.2%
	Explosions	55	14.5%	75.3%
	Riots	26	6.8%	35.6%
	Human errors	24	6.3%	32.9%
	Electric shock	26	6.8%	35.6%
	Environmental pollution	37	9.7%	50.7%
	Oil spill	27	7.1%	37.0%
	Other	22	5.8%	30.1%
Total		380	100.0%	520.5%

Source: (Survey, 2022)

The question aimed to determine the hazards that could affect the businesses in the area. As a multiple-response question, where a single respondent could choose as many hazards as possible that they believed could affect them. So, the most frequent hazard was fire with 16%, followed by explosions at 14%, then environmental pollution at 10%, then floods with 9%, then heavy rains with 9%, then with the same frequency of 7% are storms and oil spills, then riots and electric shock, also sharing the same frequency at 7%, human error follows with 6%, then others with 6%, and the last one being snow with 2%.

5.3.1 Companies/businesses experience with disasters within past five years

Table 5. 6 Companies/Businesses that Experienced Disasters

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	19	26.0	26.0	26.0
	No	54	74.0	74.0	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The majority of respondents had experienced no disaster in the past five years 74% saying “No” to the question while about 26% responded "yes."

From the 19 respondents who answered Yes in table 5.6 above, the prevailing disasters that affected the companies were COVID-19 and floods. They affected daily operations in that, during the COVID-19 state of emergency lockdown in 2020, companies that did not provide essential services were not allowed to operate at all (Lesotho Government Gazette, 2020), resulting in loss of business, retrenchment of staff members, and the loss of perishable goods (Lesotho Government Gazette, 2020). During the heavy rains that resulted in floods (2021), there were other functions of companies that could not work because the location they worked at was flooded with water. Some lost their stock and properties, like tables used by street vendors.

According to the analysis, companies that responded yes have been affected by COVID-19 and floods in the last five years but have not been affected by fire, explosion, or oil spill from the

petrol storage facilities in the Maseru industrial area. Even the literature in chapter 3 above supports that the fire that once occurred from the petrol storage facilities occurred a long time ago in the 1980s and occurred on a very small scale that did not cause much harm to lives, property, or livelihoods of people.

5.3.2 Threats Posed by Petrol Storage

Table 5. 7 Petrol Storage Pose a Human Induced Health and Safety Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	68	93.2	93.2	93.2
	No	5	6.8	6.8	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The question posed to the respondents was to find out whether the petrol storage poses a human-induced health and safety risk to nearby land uses. From the responses the majority responded yes, (68), while 5 responded no.

From the 68 respondents that said yes in table 5.7 above, the respondents highlighted the human-induced health and safety risks that are posed by petrol storages to the nearby land users, such as risk of fire from human-induced errors (from machine failure, maintenance gone wrong, and if the storage is not managed well).

A question in Section B to assess the hazards that could occur, revealed that the majority of respondents believe there are risks such as fire hazards, explosions and mechanical failure. From the literature review, it was highlighted that, fire was experienced in the past but on a small scale. Learning from the occurrence, if things get out of control and explosions occur, there might be major health and safety issues to deal with, necessitating adequate disaster preparedness. Health and safety issues to the public have to be detected in extremely vulnerable areas to these risks, through a thorough multi-hazard risk assessment, which is good for the spatial risk management process (Greiving et al., 2006).

5.3.3 Necessity of Risk Assessment

Table 5. 8 Necessity of Risk Assessment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	62	84.9	84.9	84.9
	No	11	15.1	15.1	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The question about the necessity of risk assessment for the company was posed, and the majority responded yes (62 respondents), This implies that the majority understand the need for their companies to do risk assessments though they are still located in high risk areas with no risk assessment done.

From the 62 people who responded yes to the question on the need for a risk assessment, some outlined that it is necessary because small companies are put at risk by large petroleum storage and need to know what those risks are and the degree of potential damage. The Asian Development Bank (2016) indicated that the petrol storage poses a high risk, as the land use pattern is mixed, where the infrastructure with businesses and residential areas. The businesses and the urban population and their assets end up being vulnerable. The employment of better land-use management and zoning could mitigate such risks.

5.3.4 Impact Analysis for Companies

Table 5. 9 Impact Analysis to Quantify Losses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't know	6	8.2	8.2	8.2
	Yes	8	11.0	11.0	19.2
	No	59	80.8	80.8	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The question on whether the companies do impact analysis to quantify the losses in the event of any form of disaster; revealed the majority of respondents responding negatively (81%), while (11%) were in affirmative, and the remaining (8%) respondents did not know whether the impact analysis is conducted or not as presented in table 5.9 above.

From the 11% of respondents who responded "YES" to the question, on doing impact analysis, these companies do the impact assessment for the insurance claim to see what their financial losses are. Evens (2019) made mention of risk transfer such as insurance, which compensates with money for losses incurred during a disaster. As a result, companies near the major hazardous installations ought to have been insured, as much as they believe they are vulnerable to hazards that can occur from the petrol storage. Unfortunately only few companies were aware and mentioned the insurance aspect.

5.4 Section C:Vulnerability of People, Properties and Livelihood of People Near the Petrol Storage

5.4.1 Vulnerability of Company in a Case of Disaster

Table 5. 10 Companies/Businesses Vulnerability in a Case of Disaster

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't know	4	5.5	5.5	5.5
	Yes	62	84.9	84.9	90.4
	No	7	9.6	9.6	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The companies or businesses were asked about their vulnerability in a case of an accident at the petrol storage and 85% responded that they were vulnerable; 10% responded no, and 5% were unsure.

From the 85% of respondents who said "yes" to the question about company vulnerability in the event of a disaster caused by storage; they explained that they are vulnerable because of the fire that can come from the petrol storage and because of the short distance can affect them. Again,

some explained that because the storage is of a large size, this can mean great impact if the fire occurs on their businesses and recovery from such disasters will be difficult especially since many were not insured. This continues to suggest the importance of insurance so as to mitigate the losses they will incur if an accident happens at the petrol storage, as stated by Evans (2019). The results suggest that the majority believe that they are vulnerable. Further, the International Strategy for Disaster Risk Reduction (2002) makes mention that when people are not aware of risk, they are more vulnerable, so raising awareness can help reduce vulnerability to risks posed by the petrol storage in the area.

5.4.2 Losses Incurred

Total responses amounting to 162 is derived from the fact that it was multi response answer, Each response being cumulated over 73. Meaning a single participant could answer on all three options provided, which increased the total responses.

Table 5. 11 Losses Incurred by the Company

		Responses		Percent of Cases
		N	Percent	
Losses incurred	Property losses	59	36.4%	84.3%
	Lives	61	37.7%	87.1%
	Livelihoods	42	25.9%	60.0%
Total		162	100.0%	231.4%

a. Dichotomy group tabulated at value 1.

Source: (Survey, 2022)

Asked the type of potential losses that they may incur, the loss of lives was the most frequent response with 38%, followed by property losses with 36% and then the livelihoods at 26%. This is demonstrated in literature review (chapter 3) where historical accidents highlighted there was loss of life and injury to people, properties were damaged, resulting in financial costs that impacted on the regional and local economy.

5.5 Section D:Land Users Around the Petrol Storage Facility

5.5.1 Land Uses that can be Located Near Petrol Storage

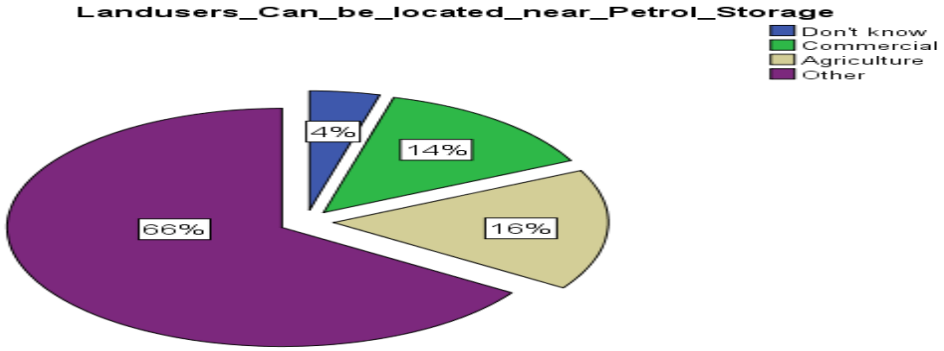

Figure 5. 6 Land Uses that Can be Located Near Petrol Storage
Source:(Survey, 2022)

The question about land uses the respondents think can be located near petrol storage was asked and many respondents' responses were other uses at 66%, followed by those who said agriculture land use with 16%, commercial at 14%, and finally, 4%, did not know the response to this question. Preventionweb (n.d) makes use of measures aimed to reduce disaster risk, and land management is one of them, which can be suitable for locating the hazardous installation. Also, the World Bank group (2015) added land zoning to determine the size, location, density, and use of buildings in order to allow complementary uses. Even within industrial zones where hazardous installations are located, there will be different types of industries. Like the clothing factories, will be in one section and hazardous installations will be in the other. Mixing Hazmat industries and other ordinary industries is not advisable in land use planning.

5.5.2 Understanding of the Health and Safety Impacts that the Petrol Storage can have on Employees, Livelihoods and Properties

Table 5. 12 Understanding on Health and Safety Impact

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Don't know	3	4.1	4.1	4.1
	Yes	45	61.6	61.6	65.8
	No	25	34.2	34.2	100.0
	Total	73	100.0	100.0	

Source: (Survey, 2022)

The respondents were asked to indicate whether petrol storage facility had health and safety impacts on employees, livelihoods, and property The majority responded "yes" at 62%, followed by no with 34%, and the one that did not know made up 4%.

The same question on whether the respondents understood the health and safety implications of petrol storage on employees and property, 62% of respondents were in affirmative (see table 5.12). Some of the safety reasons included fire-burning employees can result in injuries or deaths; burning property will result in loss of property and cost the company a lot of money; as well as loss of jobs for employees if a building is burned. In support of these statements, International Strategies for Disaster Risk Reduction (2002) outlines the cost of disaster being quantified by lives lost, livelihoods lost, property lost, and environmental damage.

5.6 Section E:Determining Suitable Land Zoning for Petrol Storages

5.6.1 Suitable Location of Petrol Storage

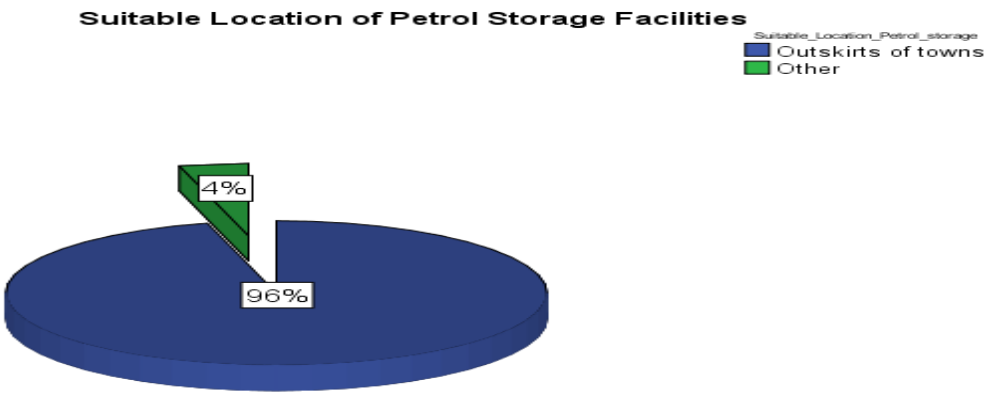

Figure 5. 7 Suitable Location of Petrol Storage
Source: (Survey, 2022)

The question was posed to the companies located near the petrol storage, which asked where they thought the petrol storage facilities should be located. The majority of responses, 95%, thought they should be at the outskirts of town, followed by other locations, with 4%. The rest of the other land uses were not chosen by respondents. From the literature reviewed, Greiving

(2002); Schmidt- Thome (2005) make use of spatial planning as being important in dealing with risks and hazards adequately, and with proper planning, the risks and hazards will be reduced. As a result, locating major hazardous installations on the outskirts of town on their own can significantly reduce risk.

A question which tested the respondent's comprehension of land zoning, showed that the majority of respondents did not know or did not want to attempt to answer the question. Some gave their understanding presented in the donut chart below (see figure 5.8). 93% said they didn't know, 3% said laws and regulations were included, 2% said segregation of other companies, and 1% said putting same companies together to avoid risk and putting same companies in one zone. The larger number of respondents who did not know or even did not attempt to answer the question was not shocking, as the term "land zoning" is somehow a technical term used by town planners. However Literature shows that land zoning as a regulatory tool can bring in proper land use planning and reduce disasters in a huge way (Greiving et al., 2006).

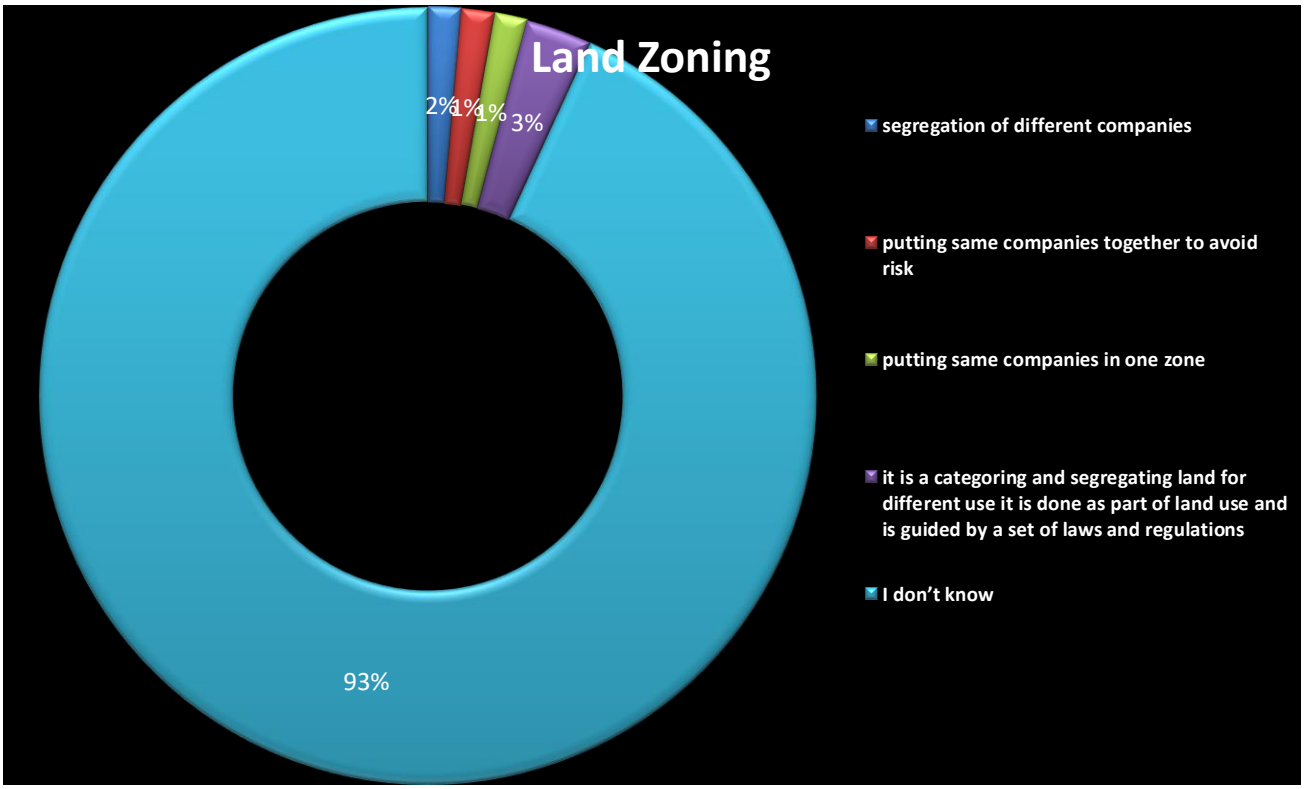

Figure 5. 8 What is Land Zoning Responses
Source: (Survey, 2022)

A question on how land use guidelines can be incorporated into existing legislation to reduce the health and safety vulnerability of nearby land users showed some respondents mentioning that the guidelines might already exist in regulations but the problem was implementation. Others suggested having strict enforcement of existing regulations to see if there is a need for more; having a department that works on land use planning to minimise vulnerability; by accepting that communities are vulnerable and working on reducing vulnerability; by the government being aware of business vulnerabilities and acting accordingly were some of the answers. The majority responded that they do not know. Khakzad and Reniers, (2017); Pak and Kang, (2021) highlight land zoning as being an important aspect of major hazard control. With the aim of isolating major hazards from the general public to decrease the incidence of accidents.

5.7 Section F:Recommended Ways to Reduce the Impact of Petrol Storage Industrial Accidents to Surrounding Communities and the Environment

A question on what could be done to reduce the impact of possible disasters that can occur from the petrol storage revealed that some respondents still did not know what can be done, others thought they should have health and safety officers at their businesses, locate petrol storage far away and enforce laws as strictly as possible.

One respondent stated; "government ensure that the storage is operated in a safe manner, for safety of nearby company."

Another stated; " move the petrol storage for where they will not affect other businesses."

And another mentioned; " have health and safety officers on board."

The Labour Code Order No. 2 (1992) also encourages all businesses to have a safety and health officer on board for ease of risk management or control.

5.8 Chapter Summary

The purpose of the chapter was to interpret and analyse the data collected so as to draw conclusions from the study. Using the demographic variables and the five research objectives, namely; to assess the hazards that can occur from the petrol storage; to evaluate the vulnerability

of people, properties, and livelihoods of people near the petrol storage; to determine the various land users around the petrol storage facility; to determine suitable land zoning for petrol storage; and to recommend ways to reduce the impact of petrol storage industrial accidents on surrounding communities and the environment. The data was analysed quantitatively and qualitatively using IMB SPSS statistics 22 and Microsoft Excel spreadsheet 2007. The next chapter presents conclusions and recommendations.

Chapter 6

Conclusion and Recommendations

6.1 Introduction

The preceding chapter dealt with data analysis and the presentation of results. The purpose of this chapter is to conclude and recommend based on the findings of the study. The chapter is set off with the introduction, which works as a guide to the chapter content, followed by the overview of the study, which summaries the preceding chapters as a highlight of what the research is all about, followed by the findings from the data, and lastly, the chapter will make conclusions with the recommendations for further research.

6.2Findings from the Study

The research results for this study are summarised in this section. The overall objective of the study was to assess awareness of risk factors concerned with the location of petrol storage within several other land uses in the industrial area of Maseru, Lesotho. The objectives were addressed in chapter 5. By checking all responses, which in the end revealed little to no awareness of risks posed by petrol storage.

6.2.1 Demographic Results

Respondents from age groups ranging from 18 to more than 65 were represented in the study. From the findings, the dominant age group that responded was age group 36–55 and was of the male gender. The most responses also came from the general worker position, which has little experience at the company. Since the study was targeting higher positions like CEO, directors, and managers groups, this affected the study in that some people did not know some answers and it was difficult to find the true essence of the questions. This demonstrated that top management are busy groups and hard to access. Most respondents had a high level of education, indicating a good understanding of their surroundings. The companies with low numbers of employees seemed to be more frequent, meaning the loss of lives will not be high in the event of an accident that occurs during working hours. Other companies with a function of 0-50 employees

(characterized by retailers, government offices, and street vendors) (see Figure 5.5) seemed to be most companies in the area.

6.2.2 Potential Hazards from Petrol Storage

Results from the study to assess the hazards that can occur from the petrol storage showed that fire is the main hazard that can affect the respondent businesses, followed by explosions, which are hazards that can occur from the petrol storage. Most respondents have not experienced any disasters in the last five years, indicating that the risk of disasters at petrol storages is rare, leading to a tendency to ignore risks.

The majority say that the petrol storages do pose human-induced health and safety risks to nearby land users, stating that the risk of fire in the event of an accident can affect them and that can occur resulting from failure or errors from tanks, the maintenance going on and not managing the storages well. This statement speaks to the petrol storage management's following precautions properly to prevent such accidents, which has proven to be working up to this point. The majority of respondents showed that risk assessments are necessary, as their companies are at risk and they will incur losses in the event of accidents at petrol storage. This shows that people have a bit of understanding of risk assessment.

The majority of respondents responded no to the company's impact analysis to quantify the losses in the case of any form of disaster. This revealed the lack of knowledge, or little knowledge, of the importance of impact analysis and having insurance to help with recovery costs, as they can be major resulting from hazardous installation.

6.2.3 Vulnerability Assessment of People, Properties, and Livelihoods in Land Uses Near a Petrol Storage Facility

According to the findings, the majority of respondents believed that their businesses were vulnerable to disasters caused by petrol storage due to their proximity to the storage. The companies are more susceptible to fire hazard if it spreads or if there is an explosion, and because of the large size of the storage, the impact will be great. In a case of loss, the companies will incur losses in all three elements; property, lives, and livelihood were fairly presented, but the majority leaned over to the lives of people, revealing that the companies may be located near

the petrol storage but are aware of the risks they may face in the event of a disaster at the petrol storage.

6.2.4 Determine the Various Land Uses Around the Petroleum Storage Facility

In determining land uses which can be located near the petrol storage, the majority selected other land uses. Other land uses, such as similar major hazardous industries, can be situated on the outskirts of towns. Considering that there are health and safety issues surrounding the petrol storage impacts on the lives of employees, properties, and livelihoods of nearby land uses, the understanding is that during an accident at the petrol storage, the fire might affect the nearby people and cause injuries or deaths, affecting them together with the properties, which will result in creating loss, and due to damaged property, there will be loss of employment.

6.2.5 Determine the Best Land Zoning for Gasoline Storage

Locating petrol storage facilities on the outskirts of towns seemed to make sense to the respondents. In coming to define land zoning, it can fairly be said that the majority did not know what it was. Which is understandable given that the term is technical and used by town planners, but the expectation that the town is planned may have revealed knowledge of the term. When it comes to the guidelines incorporation into existing legislation to ensure health and safety vulnerability of nearby land uses is minimized, there is a need to educate the people, even if it is just for a little bit, so that when by chance they are located near hazardous locations, like it is at Maseru industrial area, the people are able to take mitigation measures that will protect their lives, properties and livelihoods or avoid risk entirely by not locating near hazardous installations and choosing where there is less risk.

6.2.6 Recommend Ways to Reduce the Impact of Petrol Storage Industrial Accidents on Surrounding Communities and the Environment

To mitigate the effects of a disaster caused by petrol storage, respondents believed that prospective businesses should have a safety and health officer to assist with all health and safety issues, and can work as a qualified person being there to help assess and control dangerous situations and reduce vulnerability. With knowledge being provided to all the people near petrol

storage, they can be aware and be proactive. Some people who are unaware really need the information to act in their best interests.

6.3 Conclusion

In conclusion, this thesis assessed the public awareness of risks posed by petrol storage within the Maseru industrial area, based on a quantitative and qualitative analysis of companies' thoughts, understanding, and knowledge of the petrol storage as a major hazardous installation. It can be concluded that by the portrayed thoughts, understanding, and knowledge, there is a great need for more in-depth knowledge for companies located near petroleum storage to be in a good place to prepare, respond, recover, and mitigate the disasters that they are vulnerable to, as the disaster management cycle illustrates in chapter 2 above. Hazards are identified during the preparation stage, which can be derived from assessing the risks that can occur from petrol storage. Knowledge is power, and if the threat is known, it is easy to address it. For mitigation, determining suitable land zoning for petrol storage is as the aim is to build better. Mitigation strategies that will try to eliminate great risks are employed, such as separating major hazards installations, bearing in mind that both stages of preparedness and mitigation are in the pre-disaster stage. Further response and recovery, which takes place during or after a disaster, deals with ways to reduce the impact of the disaster, such as risk transfers (insurance) being applied, and people getting compensated to rebuild strategically to avoid great risk. From all this, awareness is not excluded, as through knowledge those steps will be achieved adequately.

6.4 Recommendations Based on Research Findings

To assist the companies near the petrol storage to better prepared for disasters that can occur from the petrol storage the following recommendations are portrayed by the study:

- Increase awareness of disaster risk reduction so that people know the risks they are faced with. Because DRR is currently taught only in primary schools, it should be expanded to high schools and even tertiary schools so that people will avoid locating their business or residence in high-risk areas such as near gas storage.

- There is a need for preparedness and awareness programmes for communities located near the petrol storages at Maseru industrial area. By the Petrol Storage owners,

coordinated by the Disaster Management Authority to ensure effective planning and implantation.

- There should be strict enforcement of regulations that assist in risk reduction to ensure the safety of people.

- Lesotho has been focusing more on natural disasters and tends to neglect manmade disasters such as petrol storage fires. It is high time a multi-hazard approach is considered.
- There should be proper land-use management and zoning to reduce risk
- Lastly, risk transfer especially insuring businesses both small and large scale should be encouraged.

6.5 Recommendation for Further Studies

The study can go beyond this and collect data from all relevant authorities such as DMA, LAA, MCC and LMPS to inquire on their challenges in dealing with risks surrounding the businesses/companies near petrol storage and how they are planning or working on reducing the vulnerability as it only explored the views and understandings of the land uses near the petrol storage, overlooking those. of authorities who are assigned the mandate to ensure their safety.

Conduct the risk assessment to determine the extent of risk the petrol storage poses to nearby land uses.

The research should further seek to know the level of preparedness in a case of disaster from the petrol storage.

6.6 General Summary of the Study

This study examined the public awareness of risks posed by the petrol storage in Maseru Industrial area. The 73 participants engaged in both qualitative and quantitative interviews. The interviews and data analysis were informed by the theories.

The literature on technological hazards and the record of fires at petrol stations globally and

locally highlights a need to ensure urban public safety through risk-aware development. Internationally, good practice prevents development near petrol stations, especially of hospitals, health centres, schools and old people's homes and housing. Land-use planning must play an important role in risk reduction.

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Appendix A: **Questionnaire**

Introduction

My name is Puleng Edith Sehloho, Pursuing my Masters Degree in Disaster Management at the University of the Free State. I am conducting a survey on the public awareness of risks posed by petrol storage within Maseru Industrial Area: Lesotho. The research aims to highlight if there are possible risks in the case of an accident that can occur since the petrol storage is located within other land users. From this research the surrounding land users will be aware of the possible dangers thus embark on measures that will prevent or minimize possible impacts.

I therefore humbly request your utmost attention and all honesty in responding to the questions. The information provided please note that it will be confidential and will be used strictly for the purpose of this study. Please note that participation in the survey is voluntary, your are free to decline your participation at any point or leave out any question that you are uncomfortable to answer. Please also note that there will be no monetary compensation but I will share my research findings with the local community.

Thank you in advance!

Puleng Sehloho

Email address: pulengspg@gmail.com

Cell number: (+266) 59083152

Section A Demographic Variable

1. **What is your Age?**

a) 18-35

b) 36-55

c) 56-65

d) More than 65

2. **What is your Gender?**

    a) Male

    b) Female

3. **What is your Position in the company/business?**

    a) General Worker

    b) Supervisor

    c) Manager

    d) Director

    e) CEO

    f) Other, Specify……...

4. **How many Years have you been working for the company/business?**

    a) 1 to 5

    b) 6 to 10

    c) 11 to 15

    d) 16 to 20

    e) 21 and above

5. **What is your Highest level of education?**

    a) None

    b) Primary

    c) Secondary

    d) Tertiary

6. **What is the Number of employees in the company/business?**

    a) 0-50

    b) 51-100

    c) 101-150

    d) 151-200

    e) 201-300

    f) 301-400

    g) 401 and above

7. **What is the function of the company/business?**

    a) Milling

    b) Warehouse & Storage

    c) Hardware/building material

    d) Logistics

    e) Petrol storages and stations

    f) Gas supply

    g) Wholesales

    h) Construction

    i) Insurance & Financial institutions

    j) Other, specify_____

Section B To assess the hazards that can occur from the petrol storage

8. What are the Hazards that can affect your businesses/companies? Please tick all that are applicable

a) Floods

b) Heavy rains

c) Storm

d) Snow

e) Fires

f) Explosions

g) Riots

h) Human- error disaster

i) Electric shock

j) Environmental pollution

k) Oil spill

l) Other, specify_____

9. **Have the companies/businesses experienced any disaster within the past five Years?**

a) Yes

b) No

10. **If** Yes**, please explain what kind of disaster and how did the disaster affect the daily operation of the companies/businesses?**

_____

11. **Does petrol storage pose a human-induced health and safety risk to nearby land users?**

a) Yes

b) No

12. **If yes which?_____**
13. **Can you say risk assessment is necessary for the companies/bussinesses?**

a) Yes

b) No

14. **IF Yes why?_____**

15. **Does the companies/businesses do impact analysis to quantify the loss in case of any form of disaster?**

a) Yes

b) No

16. **If yes, why?_____**

Section C To evaluate the vulnerability of people, properties and livelihood of people near the petrol storage

17. **Do you think your companies/businesses are vulnerable in a case of any disaster that can occur from the storage?**

    a) Yes

    b) No

18. **If yes, why?_____**
19. **What are the Losses your companies/businesses will incur?**

a) Property loss

b) Lives

c) Livelihoods

Section D To determine the various land users around the petrol storage facility

20. **Which land users do you think can be located near petrol storages?**

    a) Commercial

    b) Residential

    c) agricultural

d) Other specify_____

21. **Do you fully understand the health and safety impacts that the petrol storage could have on your company's/business's employees and property?**
    a) Yes
    b) No
22. **If Yes what's your understanding?_____**

Section E To determine suitable land zoning for petrol storages

23. **Where do you think the petrol storage can be suitably located?**
    a) In Town
    b) Within residential area
    c) Industrial area
    d) outskirts of town
    e) Other specify_____
24. **What is your understanding about land zoning ?**

    _____
25. **How can guidelines for land-use be incorporated in existing legislation to ensure health and safety vulnerability of nearby land users is minimised?**

    _____

Section F To recommend ways to reduce the impact of petrol storage industrial accidents to surrounding communities and the environment

26. **What do you think can be done to reduce the impact of the disaster that can occur from the petrol storage?**

    _____

Appendix B: Permission from the Ministry of Energy and Meteorology

LESOTHO

Department of Energy
Old Agric Bank building
Private Bag A91
MASERU 100

23 August 2021

MEM/D/28

Dr. Johanes A. Belle
Acting Director
Faculty of Natural and Agricultural Science
University of the Free State
REPUBLIC OF SOUTH AFRICA

Dear Dr. Belle

RE: PULENG SEHLOHO'S RESEARCH

Reference is made to your letter date 06 August 2021 regarding the above-mentioned subject matter.

Kindly note that permission is granted for Ms Puleng Sehloho student No. 2018576237 to conduct research on the topic 'Assessing Public Awareness of Risk Posed by Petrol Storage within Maseru Industrial Area'. We have studied the research proposal availed and we are convinced that recommendations of the study will provide useful information in the future for public awareness dissemination strategy of the petroleum products.

This is granted on the understanding that a copy of the final report will be made available to the Department.

Yours sincerely.

Mokhethi Seitlheko
Director of Energy

CC: PS – Energy and Meteorology

Appendix C: Ethical Clearance

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

09-Mar-2022

Dear Ms Puleng Sehloho

Application Approved

Research Project Title:
Assessing Public Awareness of Risks posed by Petrol Storage within the Maseru Industrial Area; Lesotho

Ethical Clearance number:
UFS-HSD2021/0258/22

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis
Chairperson: General/Human Research Ethics Committee

Dr Adri du Plessis
Digitally signed by Dr Adri du Plessis
Date: 2022.03.10 14:06:36 +02'00'

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Appendix D: Turn-It-In Plagiarism Report

Assessing Public Awareness of Risks Posed by Petrol Storage within the Maseru Industrial Area

ORIGINALITY REPORT

18%	10%	4%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of the Free State Student Paper	4%
2	Scholar.ufs.ac.za Internet Source	1%
3	hdl.handle.net Internet Source	1%
4	Submitted to Segi University College Student Paper	1%
5	Submitted to Stadio Holdings Student Paper	1%
6	www.mona.uwi.edu Internet Source	1%
7	nelga.org Internet Source	<1%
8	www.ukessays.com Internet Source	<1%
9	Submitted to University of Bradford Student Paper	<1%

Appendix E:Letter from the Editor

Bokamoso Suite

Level / Block 4

Old Europa, Maseru

30th July 2022

The University of Free State

Faculty of Natural and Agricultural Sciences

C/o Prof. Johannes Belle

Bloemfontein, SA

RE: Accreditation of Language Editing for Puleng Edith Sehloho

Student Number 2018576237

This confirmation letter serves as proof that the above-mentioned student who is studying towards a master's degree in Disaster management with your prestigious University has had her thesis proof read and language edited by Alimea Media and Admin Ltd. Pty. The title of the thesis is ***"Assessing Public Awareness and Risks Posed by Petroleum Storage within the Maseru Industrial Area".***

The thesis went through a dual processing where it was screened under the Quillbot screening and was further proof read and checked by a linguist and communication specialist to ensure that it meets the academic standards of a Master's degree dissertation. Kindly reach out to the undersigned if and when need arises concerning Ms. Sehloho's dissertation.

Kind Regards,

Ms. 'Mampati Ramakhula,

Founding Partner

Linguist , Civic Educator, Public Policy Expert , Youth Development Worker, Project Manager

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