Developing a framework for the management and rehabilitation of abandoned mines in South Africa

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Acronyms and Abbreviations

AGSA	Auditor General of South Africa
AMD	Acid Mine Drainage
AMD	Acid Metalliferous Drainage
AML	Abandoned Mine Land
ASM	Artisanal and Small-Scale Mining
BL01	Business Leaders
CS01	Councillors
D & O	Derelict and Ownerless
DMP	Department of Mines and Petroleum
DMR	Department of Mineral Resources
DMRE	Department of Mineral Resources and Energy
EMP	Environmental Management Programme
EMIs	Environmental Management Inspectors
EMPR	Environmental Management Programme Report
FM01	Former Miners
GDP	Gross Domestic Product
ICMM	International Council on Mining and Metals
MCA	Mineral Council of Australia
MCMPR	Mineral Council of Mining Petroleum and Resources
MPRDA	Mineral and Petroleum Resources Development Act
NAOMI	National Orphaned and Abandoned Mines Initiatives
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation

NWA	National Water Act
O & A	Orphaned and Abandoned
PAIA	Promotion of Access to Information Act
SA	South Africa
SADMR	South Africa Department of Mineral Resources
SCL01	Senior Community Leaders
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Education Scientific and Cultural Organisations

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Declaration

This thesis, Developing a framework for the management and rehabilitation of abandoned mines in South Africa: A case study of North West province is submitted for the degree of Doctor of Philosophy in Economic and Management Sciences, School of Business and Governance. To the best of my knowledge, I, Edward Kuipa, declare that this is my own work and that all material contained herein has been duly acknowledged.

Kuipa E	**November 2022**
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Surname & Initials	**Date**

Abstract

The focus of this study was to develop a framework for the management and rehabilitation of abandoned mines in South Africa using the North West province of South Africa a case study. To this end, specific working objectives were formulated to explore gaps in the implementation of the existing legislative frameworks for the management of abandoned mines in South Africa. In the study, a mixed research approach (quantitative and qualitative) was followed. Data was collected from a total of 200 respondents of which 20 participants were key stakeholders interviewed for qualitative data and 180 respondents surveyed for quantitative data. Descriptive, thematic and exploratory factor analysis methods were used to analyze data. The study found that, the existing management frameworks for abandoned mines in South Africa compared to those of other mining countries around the world do not explicitly state the processes to be followed when rehabilitating a mine. Furthermore, the management and rehabilitation of abandoned mines are constrained by costs and confusion as to which stakeholder is responsible for disused mines rehabilitation. The study also found that, there is lack of clearly assigned responsibility in the absence of explicit criteria and standards of rehabilitation. Findings also reveal that, stakeholders do not adhere to the existing legislative frameworks and legal instruments to rehabilitate disused mines and hence, abandoned the mines despite the high risks associated with their non-rehabilitation. The study concludes that, mines today and in the past are a major contributor to the Gross Domestic Product (GDP) of South Africa. Despite their contribution, abandoned mines remains a costly legacies of confusion in policies and legislations and poses a major risks to the environment and communities that live around these abandoned mines.

Keywords: Framework, management, rehabilitation, abandoned mines, South Africa

CHAPTER ONE
OVERVIEW OF THE STUDY

1.1. Introduction

The management and rehabilitation of abandoned mines world-wide has resulted in socio-economic and environmental problems which need immediate attention. The increasing number of abandoned mines in Africa is worrisome and a concern to the environment, humans and animals. Failure to act will result in serious challenges that will be difficult to solve. Mine closure forms part of the mine's long-term planning (Kloppers, Horn, and Visser, 2015) and aims towards the creation of sustainable living outcomes through the minimization of environmental, social, and economic impacts on host communities once mining has ceased (Logan, Murphy, and Beale, 2007). South Africa is not spared in the concern of management and has the plethora of abandoned mines that have even threatened the safety of many residents, whom many perceive as xenophobic. These tools come in very handy in South Africa with so many ills or alleged social ills. These continue to aggravate living conditions, with no economic growth, high and exponential unemployment, and serious challenges to the state of democracy, and freedom.

The purpose of this study was to develop a framework for the management and rehabilitation of abandoned mines in the North-West Province of South Africa. Mines today and in the past have been a major contributor to the Gross Domestic Product (GDP) of South Africa. Despite their contribution, abandoned mines are costly legacies of poor policies decisions characterized by inadequate, insufficient, non-existent mine closure framework in South Africa. In a report by the United Nations Environment Programme (UNEP, 2019:13), it was argued that the potential costs (externalities) of rehabilitation, the lack of context-based framework with clearly assigned responsibilities, the absence of uniform criteria and standards for rehabilitation and other related factors delay stakeholders, governments and communities to rehabilitate mines after they reached their lifespan in South Africa.

Furthermore, the changing developmental patterns and mining operations in South Africa compels mine stakeholders to respond quickly and rehabilitate these mines once their lifespans is reached (World Bank, 2019:17). But the changes in developmental patterns in South Africa since 1994 at the social, economic, and political levels have led to many disused mines being abandoned without being rehabilitated. As a result, the number of abandoned mines in South Africa is on the rise and poses serious concerns (Watson, 2019:1) as the challenges of poverty; inequality and unemployment reach unprecedented levels. Mhlongo and Amponsah-Dacosta, (2018:414) opined that, despite the increasing number of cases of non-rehabilitated mines, increasing social and economic challenges in communities around these mines, little focus has been given to ensure rehabilitation of disused mines across South Africa. Furthermore, the lack thereof of an explicit framework for the management and rehabilitation of disused mines poses severe environmental challenges such as Acid Mine Drainage (AMD) and air pollution (van Druten & Bekker, 2017: 486).

Though literature on the management and rehabilitation of abandoned mines in South Africa is limited, the existing mining charter used in South Africa defines abandoned sites as “mines where mining leases or titles no longer exist; and the responsibility for rehabilitation cannot be allocated to any individual, company or organisation responsible for the original mining activities.” This definition is borrowed from the Minerals Council of Australia (MCA 2010:259). Furthermore, there is no official global inventory of abandoned mines, but countries such as Canada, Brazil, Germany, and Australia are leading the way in the creation of an abandoned mines inventory (Unger, Lechner, Kenway, Glenn, & Walton, 2015:1-10). A review of literature suggests that very few mine sites have been successfully relinquished to any competent authority or post-mining land user globally (Blommerde et al., 2015:15; de Jesus & Sánchez, 2013:364).

In South Africa, the existing management frameworks for mines compared to those of the leading mining countries around the world do not explicitly state the processes that must be followed in the rehabilitation of abandoned mines (Unger et al. 2020: 104). This is the case despite Sections 28 and 24 R (1) of the National Environmental Management Act 107 of 1998 (NEMA) and Section 34(a) of the Mineral and Petroleum

Resources Development Act 28 of 2002 (MPRDA) stating, “the mining right holder retains responsibility for abandoned mines until the Minister of Mineral Resources (MMR) issues them with a closure certificate” (Klopper & Wessel, 2017:2). These sections stipulate that the mining right holder takes responsibility for environmental liability, pollution, ecological degradation, and the management thereof but not the socio-economic (externalities) liabilities posed by these mines to surrounding communities (Alberts et al, 2017:267). Furthermore, these legislations fail to explicitly specify the management processes and the timeframe for which the responsible stakeholders must rehabilitate mines after the lifespan is reached before a certificate of closure is issued.

This chapter focuses on the background to the study to establish existing gaps in literature. The background is followed by a statement of the research problem, research objectives and questions. The motivation, significance, limitations, and contributions of this study to the body of knowledge are also contextualised in this chapter.

1.2. Background to the study

According to Kodir *et* al., (2017:27) and Favas et al., (2018:3) the impact of disused mines on the environment can be reduced or eliminated through proper management and rehabilitation processes. Moreover, abandoned mines in South Africa contribute significantly to physical and environmental hazards, exacerbating the current socio-economic challenges that the communities around these mines face. There is no doubt that the national economy largely depends on mining (Unger, 2017; Unger et al., 2020:105), but there is also the need to avert the dangers posed by abandoned and disused mines. Alberts et al., (2017: 153) opined that, South Africa's legal framework for the management of closed mines and their rehabilitation remains weak in several respects. Although there have been recent reforms, the guidance provided by the multiple ministries and agencies as stakeholders have resulted in legislations being confused, complex and hard to implement.

Furthermore, the Auditor General Report (AGSA, 2009:6) of South Africa found 5 906 abandoned mines across South Africa as of May 2009. This number has increased to

approximately 6 000 as of 2020 according to the recent AGSA's report. But an analysis of documents obtained from the Promotion of Access to Information Act 2 of 2000 (PAIA) shows that only 787 closure certificates were issued across South Africa between 2011 and 2016. Of the 787 closure certificates issued, only 17 % of these certificates were dispensed to large scale mining operators. The remaining 83 % went to prospecting rights, mining permits or borrowed pits as well as work associated with highway construction. Whether the large-scale mining operators who received 17 % of the closure certificates rehabilitated the mines after their lifespan was reached before closure certificate is not known.

Klopper and Wessel (2017:1) explain that, a data-driven investigation from the Department of Mineral Resources and Energy (DMRE) found that approximately R60 billion was allocated for mine rehabilitation, but these funds have remained unused because mines were not legally closed. The current South African mining regulatory framework makes no provision for the management and rehabilitation of abandoned mines; neither does the Mineral and Petroleum Resources Development Act 28 of 2002. Furthermore, the Mineral and Petroleum Resources Development Act 28 of 2002 makes no provision for an approved strategic plan for the rehabilitation of abandoned mines in South Africa before certificate of closure is issued.

In an article published by the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2019:19), "abandoned mines are rich in minerals that make the land around them suitable for agriculture. These mines, if properly managed and rehabilitated, can contribute positively towards the economic growth and productivity of communities around these mines". In addition, Genesis Analytics and Digby Wells Environmental Report (2015:32) found that the current Environmental Management Framework used for the management and rehabilitation of abandoned mines in South Africa is based on extracts and theories adapted from the Australian, Canadian, and German frameworks and does not align to South Africa's context.

The Constitution of the Republic of South Africa (1996) and the Common Law, Minerals Act No 50 of 1991, the National Water Act (NWA) No 36 of 1998, the Mine Health and Safety Act No 29 of 1996 as well as the Mineral and Petroleum Resources

Development Act (MPRDA) 28 of 2002 are the main pieces of legislation for mine closure currently existing in South African (Swart, 2019:2). These pieces of legislations do not specify time frames, processes and how mines that have reached their lifespan should be managed and rehabilitated. While post-apartheid South Africa has seen changes in the implementation of these mine-related legislations and charters such as the National Environmental Management Act (NEMA) 107 of 1998, there is still no framework specifying the management process for mine closure as evident in the 2018 amendments documents.

Therefore, it is important for individual mining operators to develop a management framework for the rehabilitation of mines when they reach their lifespan in South Africa. The framework must be in line with the timeline of the evolution of environmental governance in the South Africa mining Sector as shown in Figure 1.1.

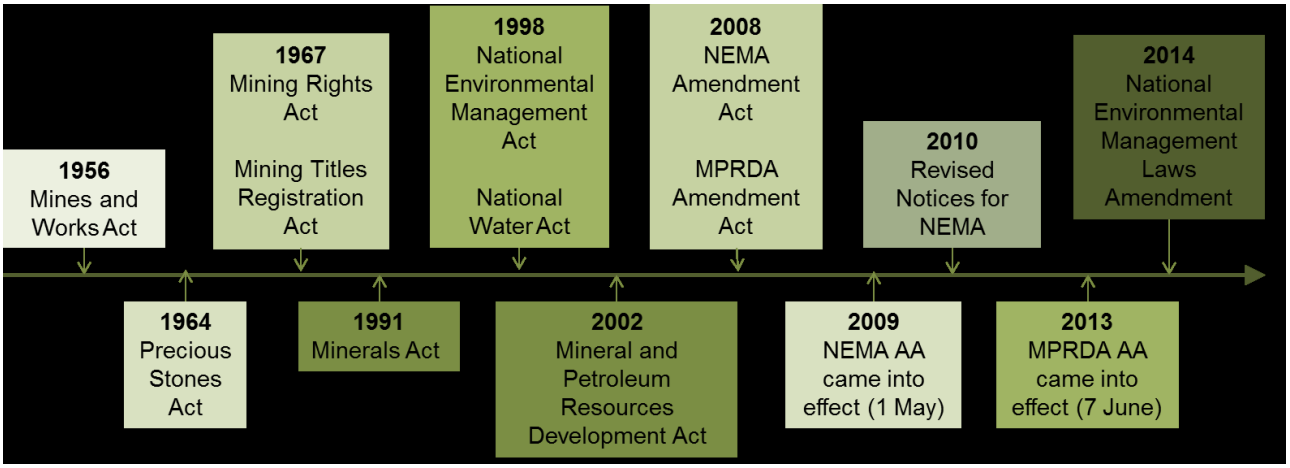


Figure1.1: Timeline of the evolution of environmental governance in the South Africa mining sector

Source: Genesis, (2015:18)

The timeline of the evolution of environmental governance in the South Africa mining Sector led to the enactment of a Mining Charter in 2018. The charter was derived from the Mineral and Petroleum Resources Development Act (MPRDA) No. 28 of 2002. The charter acknowledges the negative environmental impact on communities around mines but, the same charter is not comprehensive as it does not provide directives for the management, budgetary allocation, and time frame for the rehabilitation of disused

mines. Moreover, though mining contributes to the socio-economic development of host communities (Mhlongo and Amponsah-Dacosta, 2016:279), but communities and mine owners as key stakeholders' inputs have not been incorporated into the charter for it to be comprehensive.

Matshusa and Makgae, (2017:156) are of the view that existing mine owners and host communities are central in the management processes and rehabilitation of mines after the lifespan is reached. As such, any management framework for the rehabilitation of abandoned mines must substantially address concerns raised by these key mining stakeholders (owners and communities). Mining organisations leave dumps, synchrony, polluted ground water, and effluent which are externalities to host communities, destroying fertile agricultural land and degrading the environment (Basu and van Zyl, 2006: 300; Carvalho, 2017:61). Once the lifespan of a mine is reached, the economic activity of the community decreases leading to poverty and shortage of employment opportunities. The development of a comprehensive management framework for the rehabilitation of abandoned mines may provide realistic solutions for the mitigation of challenges arising from disused mines in the North-West province of South Africa.

1.3. Statement of the problem

The Auditor General South Africa Report (AGSA, 2009:6) noted that, there were 5 906 abandoned mines across South Africa as of May 2009 and the number has increased to approximately 6 000 as of May 2020 as reported by the Department of Mineral Resources and Energy (DMRE, 2020). The increasing number of abandoned mines is an indication that the existing management framework for the rehabilitation of abandoned mines in the country is not comprehensive and implementation is challenging.

There is a growing evidence of the after-effects of abandoned mines on the socio-economic conditions of people living in communities close to disused mines. Furthermore, the current situation in old mining towns is characterised by poverty, hunger, poor housing conditions and, an increasing disease burden coupled with the influx of illegal miners searching for minerals through open shafts (Zama Zama). There

is inadequacy of existing management frameworks in the rehabilitation of abandoned mines. The non-rehabilitation of mines after their lifespan presents both socio-economic and environmental threats to communities living around these mines in South Africa. Ledwaba and Mutemeri (2017:10) state that in South Africa, approximately 347 lives were lost between 2012 and 2016 due to the collapse of abandoned mine shafts that are still being mined by illegal miners. These 347 are the reported incidents: there could be more that go unreported. Furthermore, approximately 20 bodies of illegal miners operating in obsolete shafts around the North-West Province were found in 2021 as reported by the Department of Mineral Resources and Energy (DMRE, 2021) statement.

Promotion of Access to Information Act (PAIA, 2020) indicates that 787 closure certificates were issued across the country between 2011 and 2016. Only 17% of these closure certificates were issued to mainstream mining companies and 83% went to prospecting rights, mining permits or borrow pits as well as other work associated with highway construction. Whether these closure permits were issued after disused mines were rehabilitated cannot be established as the number of such abandoned mines is on the increase. A data-driven investigation from the Department of Mineral Resources and Energy (DMRE) shows that about R60 billion was budgeted for mine rehabilitation but the funds remain unused today because mines were not legally closed. The increasing number of abandoned mines in South Africa may indicate concerns around the existing mining framework and the escalating costs for the management and rehabilitation of mines once they have reached their lifespan (Brown, 2007:31; Nzimande & Chauke, 2012:208). Mhlongo and da Costa, (2016:279) add that abandoned mines without rehabilitation escalate physical and environmental problems in their immediate communities. According to UNESCO (2019:5), R 60-billion ($43 Billion USD) has been reserved for the rehabilitation of more than 6 000 abandoned mines in South Africa. However, the absence of a comprehensive management framework that specifies clear rehabilitation standard, prioritisation criteria, costing and presence of Artisanal and Small-Scale mining (ASM) actors hinder effective rehabilitation efforts.

Genesis Analytics and Digby Wells Environmental (2015:44) suggest that the current management framework for the rehabilitation of mines has been undergoing constant

iterations and amendments. These processes appear to be never ending as they pose significant challenges for the implementation of legislation about mine closures. One such example was the deletion of Sections 38 to 42 of the Mineral and Petroleum Resources Development Act (MPRDA) of 2002 which dealt with environmental governance. These sections were deleted with the intent to replace them under National Environmental Management Act (NEMA) but were eventually omitted leaving a major gap in the environmental legislation. The current gap in existing management frameworks for the rehabilitation of abandoned mines in South Africa forms the foundation on which this study is conceived.

1.4. Aim of the study and objectives

This study aims to develop a comprehensive framework for the management and rehabilitation of abandoned mines in South Africa. The motivation emerges from gaps identified in the current frameworks. The study focuses on purposively sampled abandoned mines in the North-West Province of the country and excludes abandoned mines in other parts of South Africa. The focus on this province stems from the fact that it is one of the leading provinces in terms of mining activities nationally. Equally, it has a high number of abandoned mines. Based on the aim of this study, the specific objectives of this study were designed to:

- To explore gaps in the implementation of the existing legislative frameworks for the management of abandoned mines in South Africa.
- To conduct a critical review of literature on theories underpinning the existing management frameworks for the rehabilitation of abandoned mines in South Africa.
- To describe the implementation strategies of the existing management frameworks for the management and rehabilitation of abandoned mines in South Africa.
- To propose an alternative management framework for the rehabilitation of abandoned mines in South Africa.

1.5. Research questions

Based on the research problem identified and the aim of this study, the main research question was:

"Are the existing legislations and management frameworks for mines when they reach their life-span sufficient in addressing challenges related to the rehabilitation of mines in South Africa?" From this research question, the sub-research questions are designed as follows:

- What gaps exist in the implementation of legislation and management frameworks relating to abandoned mines in South Africa?
- What do the literature and theories underpinning the current management frameworks for the rehabilitation of abandoned mines in South Africa exhibit on managing abandoned mines?
- What implementation strategies are enforced in the existing management frameworks for the rehabilitation of abandoned mines in South Africa?
- What suitable management framework could be developed for the rehabilitation of abandoned mines based on findings from this study in South Africa?

1.6. Justification of the study

There is a growing evidence of the after-effects of abandoned mines on the socio-economic conditions of people living in communities close to disused mines. Furthermore, the current old mining towns are characterised by poverty, hunger, poor housing conditions, an increasing disease burden and influx of illegal miners searching for minerals through open shafts (Zama Zama). Most of the abandoned mines have not been rehabilitated after their lifespan was reached. This reality presents both socio-economic and environmental threats to communities living around these disused mines in South Africa. This study seeks to establish why these mines have not been properly managed, rehabilitated and closed after they reached their lifespan.

South Africa has witnessed an ever-increasing number of illegal activities in unsafe abandoned mines shafts. There have been reports of an increasing number of deaths in

abandoned mines shafts. There have also been constant iterations and amendments in the current management frameworks for the rehabilitation of mines. In a nutshell, abandoned mines nationwide constitute real threats to citizens and the environment to the extent that there is a dire need to relook at the existing frameworks and suggest a robust alternative. There is no doubt that there are escalating costs that go with the management and rehabilitation of disused mines. This background justifies the logic in undertaking this study to find some solutions to the management and rehabilitation challenges of abandoned mines in the North West Province in South Africa.

1.7. Scope of the study

This study is in the domain of management policies, mining legislation as well as socio-economic frameworks. The study engages socio-economic and environmental management with a sharp focus on the management and rehabilitation of abandoned mines. Data for this study was collected from 180 strategically selected miners and 20 conveniently selected mine managers, mine supervisors, technocrats, clerks, communities members, business leaders, senior community leaders, councillors and former mine workers from the North West Province. The study focuses on selected abandoned mines in the North-West Province of South Africa, namely Stilfontein Gold Field, Orkney, Hartebeesfontein, Buffelsfontein and Machavie gold mine. The North West Province of South Africa has the oldest mining towns and the second highest number of abandoned mines with a total 1 040 out of 6 000 as detailed in the DMRE Report (2020).

A total of 347 illegal miners lost their lives in disused gold mines from 2014-2016 and 20 illegal miners reportedly died at Orkney mine in 2021 according to a report by the DMRE. These are the cases reported in the public domain, although there could be unreported cases. With respect to delimitations, this study does not cover other provinces of the country that should have contributed to the development of a more robust framework for management and rehabilitation of abandoned mines in South Africa. A year timeframe allocated to collect data and movement restriction imposed by the South African government due to Covid-19 pandemic seriously dented the scope of

this study. Despite the scope limitation, mining in this province and its socio-economic challenges are guided by the same legislations, policies and frameworks as prescribed by the national government. The data collection instruments used was the same for all respondents in the sample for this study. The theoretical underpinnings and methods were tested for reliability and validity and such a sound process ensured the credibility of findings. The data collection instruments were survey questionnaire and an interviews guide and the approach was a mixed method.

1.8. Significance and contribution of the study

The significance of this study is embedded in its contribution to understanding of the theory, concepts and methodology guiding the development of an effective management framework for the rehabilitation of abandoned mines. Though frameworks in this domain exist in developed countries but even in those countries, the number of mines that are abandoned after they reached their lifespan is just as confounding. In such a situation, it must be acknowledged that these frameworks are context-based, and their adoption by the South African DMRE has not resolved the challenges but has rather seen the number of abandoned mines increasing. It is not just the increase in numbers that is worrisome, but the more immediate impact of this dereliction on communities and the environment.

As a result, a modified framework for the management and rehabilitation of abandoned mines in South Africa may assist companies to minimise the damage to the environment, respond to economic and social challenges in mining communities after mines have reached their lifespan. Once developed and properly implemented, beneficiaries would include the Department of Mineral Resources and Energy (DMRE), mining communities, surrounding environment, mine owners and other stakeholders involved in mining. The drive in the framework is in minimizing the risks associated with abandoned mines. The study intend to identify the existing gaps in policies, legislations, processes, implementation and strategies to manage disused mines across the North West Province in South Africa.

Findings from this study may guide government on how to enhance the management thereof and rehabilitation of abandoned mines nationwide. Findings may also address the health, safety, and environmental challenges within communities around abandoned mines across South Africa. The study proffers a basis for future academics and researchers to extend studies on the management and rehabilitation of mines in general. This study adds value to policy, mining companies, communities living around abandoned mines and other interested stakeholders.

This study contributes towards the development of a practical management and rehabilitation framework of abandoned mines in South Africa from a philosophical, theoretical and policy perspective. The theories used are founded on existing frameworks which are deemed insufficient to close the theoretical gaps in current frameworks. From a practical perspective if all mining companies would adhere to the legislative frameworks and rehabilitation of disused mines during and after their lifespan, South Africa would be a better place to live. On policy contributions, the study assists in resolving social, economic, and environmental concerns related to the professional management of abandoned mines.

1.9. Conceptualisation of the study

Abandoned mines could be defined as spaces where mining activities have stopped because of incomplete mining closure. They are also characterised by improper rehabilitation (Issaka et al., 2021). The reasons for the existence of abandoned mines could range from inadequate frameworks for environmental protection agency compliance policy by mining operators. Furthermore, there is no encompassing and common definition of what constitutes abandoned mines. As such, the United Nations Environment Programme (UNEP, 2018) defines abandoned mines as those that are no longer operational, actively managed, or rehabilitated. Abandoned mines therefore cause significant environmental or social problems for which no one is currently accountable because certification and maintenance are inordinately compromised.

The Government of Western Australia Department of Mines and Petroleum, (DMP) defines abandoned mine sites as “areas of land impacted by former mining activities for which no individual, company or organisation can be held responsible for their rehabilitation. In this definition, an abandoned mine site is characterised by land or site features such as open and disused mine shafts, mineral waste dumps harping on the obsolete activities, and abandoned equipment. These features could be identified in one or several other places that may or not be adjacent to each other” (DMP, 2015).

Mineral Council of Mining Petroleum and Resources/ Mineral Council of Australia MCMPR/MCA (2003:6) define abandoned mines as locations where mining leases or titles no longer exist. In this regard, the responsibility for rehabilitation cannot be ascribed or attributed to any individual, company or organisation. The company, individual or individual responsible for the original mining activities can no longer be traced, or if at all, the dereliction of responsibility cannot be enforced due to loopholes in the framework and/or legislation.

This study adopts the definition above where mining operations have ceased. There could be partial operation but then leases or titles no longer exist. By extension, the sole responsibility for rehabilitation cannot be ascribed to any individual, company or organisation. The cessation of activities by the original mining company, organisation or individual means that such sites are ‘derelict’, ‘orphaned’, or ‘former’ mines (Minerals Council of Australia, 2010:6). In South Africa, the Department of Mineral Resources (SADMR: 2020) defines derelict and ownerless mines as sites where the owners or mining rights or lease holders have abandoned operations. In such circumstances, the owner or company or individual has ceased operations. They no longer manage nor maintain the disused mine. Consequent challenges in the non-operation of such mines arise and manifest in the form of associated safety, health and environmental impacts. When such gross irresponsibility becomes evident and the culprits can no longer be traced, we have serious consequences regarding ownership, responsibility, and maintenance of the disused mines.

The management of mine rehabilitation is the process of backfilling the void created by extraction, re-vegetation and rehabilitation of fauna on the site (UN Environment,

2018:68). It is against this background that the management and rehabilitation of abandoned mines needs to be planned. In the Canadian context, rehabilitation has been the widely accepted option (Marshall, 1982) and lies within the concept of site stability and a degree of ecological integrity as outlined in Figure 1.2 below.

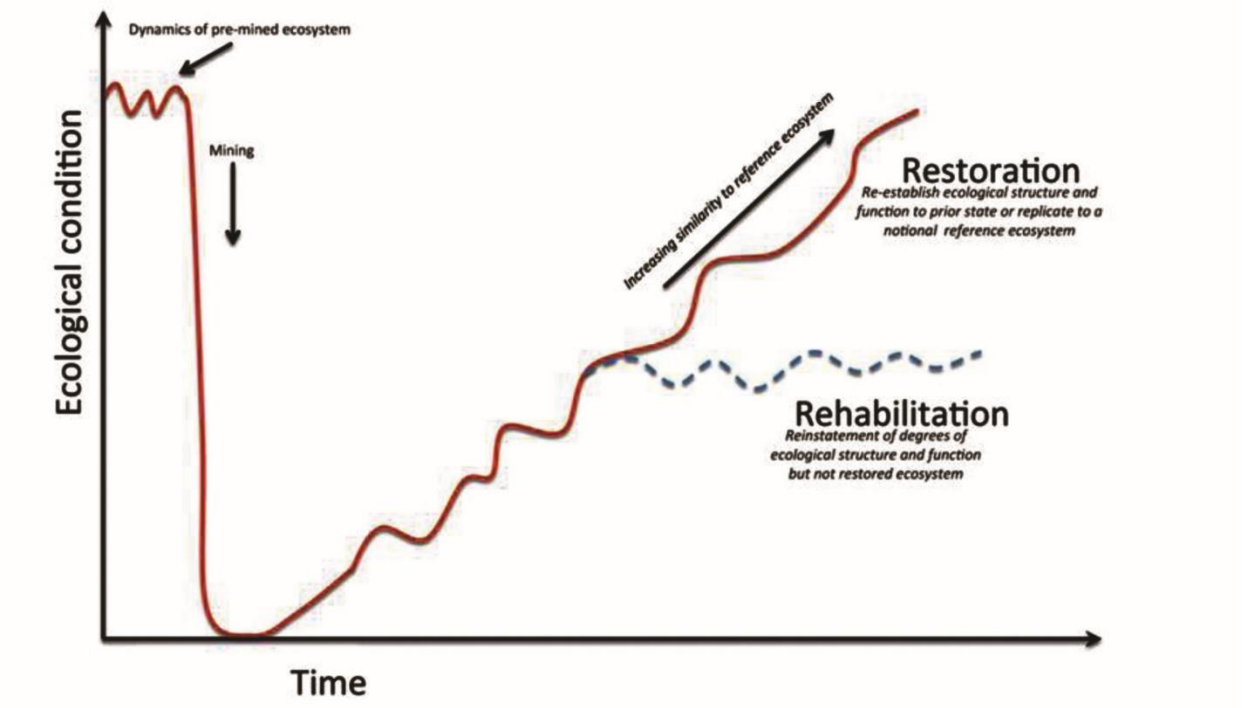


Figure 1.2: Transition concept of rehabilitation (from Standards Reference Group SERA (2016). Source: After Bradshaw (1987)

Literature and classic mine operations demonstrate that mine management and rehabilitation are mandatory protocols. The intention is to return the site to a safe state. This means that management and operators are expected to rehabilitate the mine to a secure, non-polluting state. According to Watson and Olalde, (2019) rehabilitation entails a rejuvenation of the ecosystem to its near-original status. The environmental and social impacts of mining depend largely on the commodity mined, its location, and the type of mining practiced. Acid mine drainage (AMD) is a major concern in the gold mining sector in the North-West Province South Africa. The management of abandoned mines assists to transform disused mines to their original condition through coordinated supervision (Dale et al., 2000:640).

1.10. Outline of the thesis

This thesis is presented in seven chapters: overview of the study, literature review, research design and methodology, quantitative data presentation and interpretation, qualitative data presentation and interpretation, proposed framework for abandoned mines, conclusions and recommendations.

Chapter one – Overview of the study

The chapter provides an overview of this study, a background to the study, statement of the problem, the aim and research objectives, main and sub research questions; justification for this study, scope and significance of the study. The chapter also outlines the contribution of this study to the body of knowledge in terms of theoretical, practical and policy perspectives. The chapter closes with operational definitions, summary of chapter one and a preamble to the next chapter.

Chapter two – Literature review

The literature review focuses on the associated conceptual and theoretical frameworks for the research, gaps in the implementation of existing rehabilitation frameworks, management frameworks in South Africa, literature frameworks and theories underpinning the study, management frameworks for mine rehabilitation globally, abandoned mines management frameworks from a national perspective and a summary leading to the next chapter on research methodology.

Chapter Three – Research Methodology

Research methodology commences with an illustration of the research onion model. The model depicts the different elements constituting a structured methodology chapter that ensures completeness. The chapter presents the research strategy and design, population, sampling techniques, data collection methods, the data collection procedures, the data capturing, coding process, the research instruments and the statistical techniques used in analysing data. The chapter also discusses the validity and reliability of the instruments, ethical considerations and the summary. It terminates

by giving highlights of the next chapter on qualitative data presentation and interpretation.

Chapter Four – Qualitative data analysis and interpretation

Data obtained from interviews is discussed in this chapter. The interviewees gave in depth responses and assessments through the interviews. The patterns were grouped into themes for subsequent analysis. The researcher adopted the five phases of qualitative thematic analysis which include reading the data intensively, building the coding frame, coding the data, analysing the coded data and presenting the results.

Chapter Five – Quantitative data analysis and interpretation

The chapter focuses on data analysis and interpretation. It outlines how semi-structured questionnaire data was collected and analysed. The data is presented in graphical, pictorial formats, tables. The Statistical Package for Social Sciences was used to analyse the data. Exploratory factor analysis was used to explain the variables in the research in terms of testing hypotheses.

Chapter Six – Proposed framework for management and rebailitation of abandoned mines

The chapter presents and explains the proposed conceptual framework for the management and rehabilitation of abandoned mines. The framework highlights eight stages from the results of the study namely; research information, development of mine closure and process rehabilitation, developing predictions based on options, evaluation/guidelines, submission and review by competent bodies, rehabilitation of abandoned mine programmes, monitoring and reporting and abandonment.

Chapter Seven – Chapter summary, discussion, conclusions and recommendations

The study concludes with answers to the research questions. This penultimate chapter maps the contribution of the study to the government under theoretical, methodological and policy. The researcher also suggests areas for future research.

1.11. Chapter summary

This concluding chapter offers a comprehensive overview of the whole research, through the problem statements, objectives, and questions, the justification, and the significance of the study, which are all aligned with the research title and the problem raised. Further, this research chapter has also conceptualized the study. The research contributions and assumptions of the study are also explored in a bid to contextualise the final contributions to South Africa's management and rehabilitation of mines once their lifespan is reached. It is upon this background that the researcher develops a framework for the management and rehabilitation of abandoned mines in South Africa to assist the government in minimizing management effects.

The next section scrutinizes the literature review relevant to the research objectives and problem to offer theoretical answers to the problem raised by this project and examine legislative frameworks for the management of abandoned mines in South Africa. Theories underpinning the current management frameworks for the rehabilitation of abandoned mines in South Africa are examined for their application and utility in this study. Ultimately, the chapter interrogates strategies in the implementation of frameworks for the management and rehabilitation of abandoned mines in North West Province, South Africa and proposes an alternative management framework for the rehabilitation of abandoned mines.

CHAPTER TWO
OVERVIEW OF LITERATURE REVIEW

2.0. Introduction

The previous chapter establishes the gaps as explained in the background of this study, the statement of the study, the objectives, and justification of the scope of the study. The present chapter reviews literature in the context of the research objectives, the conceptual and theoretical foundation of the study. In this study, the conceptual framework identifies the gaps in the existing management framework. The conceptual theories selected for the study explore how a management principle applies in the mining rehabilitation discourse in the phase of increasing challenges with abandoned mines. The study evaluates, compares the views of various key stakeholders on the management and rehabilitation challenges of abandoned mines. According to Webster (2010:50), the literature review chapter explains and clarifies concepts that were applied in this study, as well as establishing link between the study and preceding ones in abandoned mines literature.

The management and rehabilitation of mines occurs at the point where the development and revenue costs of the mining operation approach zero value and the remediation cost becomes evident (Turton, 2008). According to Mhlongo and Amponsah-Dacosta (2016: 279), the major reasons why mines are abandoned after they reach their lifespan in South Africa is the absence of a clear framework that assigns responsibilities as well as criteria and standards for rehabilitation. A study by the Auditor General of South Africa (AGSA, 2009); found that the disruptive nature of mining causes adverse environmental and social effects on the communities once they reach their lifespan. As such, the rehabilitation of mines should form part of a mine's long-term planning (Kloppers, Horn, & Visser, 2015). Such an itinerary must be directed at creating sustainable living outcomes even after the lifespan of a mining venture is reached as depicted in the conceptual design in Figure 2.1.

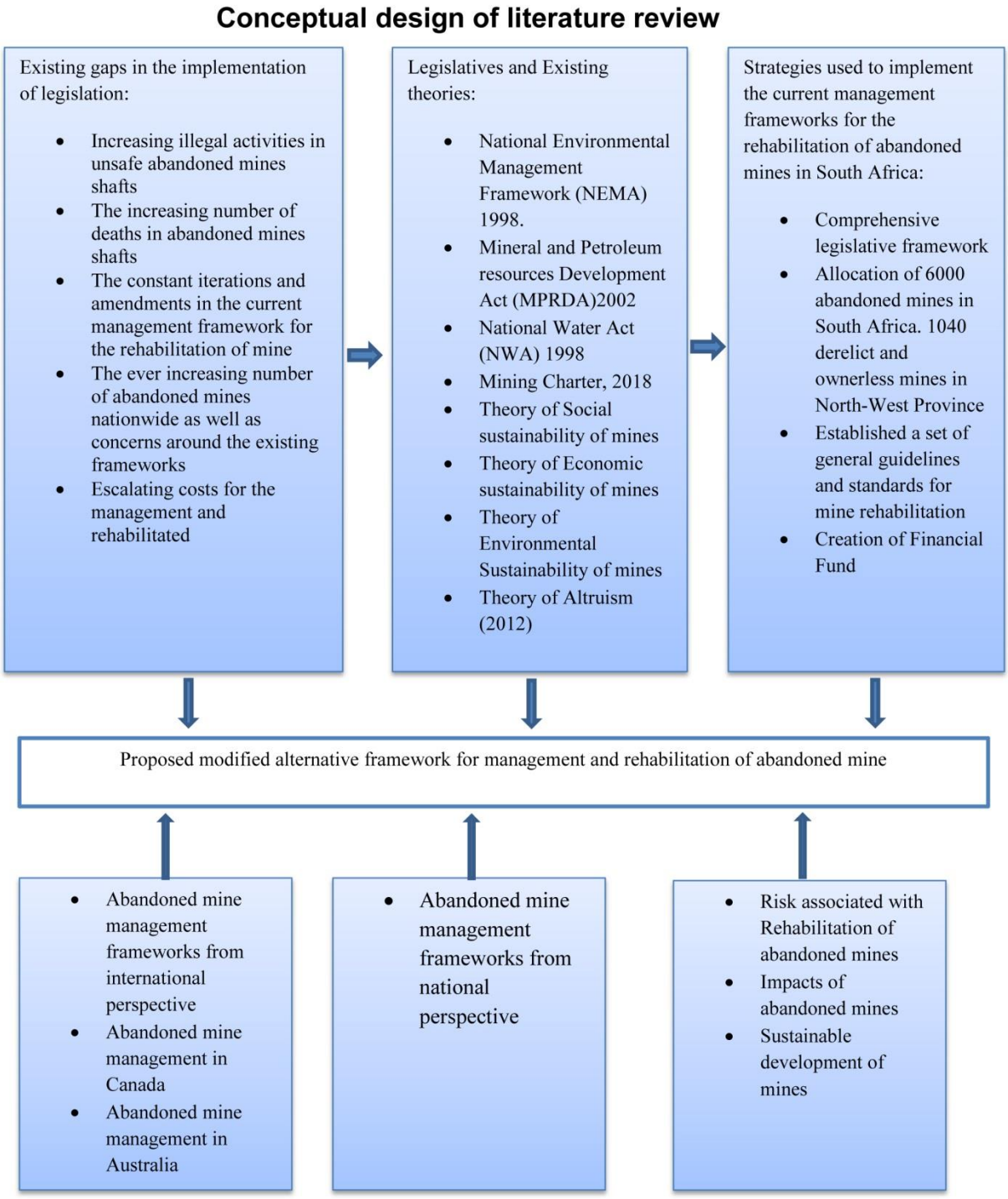


Figure 2.1: Conceptual design of literature review
Source: Own researcher's modification

2.1. Conceptual and theoretical framework for abandoned mines

South Africa's abandoned mines are sites with adverse consequences on communities. This negative potential has led to an increase in mining regulations intended to avert the legacy of abandoned mines. The concepts and principles surrounding mine closure are rapidly evolving in terms of the supposed scope and responsibilities of the major groups involved. These groups include government, industry, impacted communities and other stakeholders such as non-governmental organizations (NGOs), financial institutions and other components of civil society (Lima & Curi, 2002:146). A modified conceptual framework is thus required to help systematize and prioritize specific rehabilitation tasks.

Many guidelines, standards and policies have been compiled globally, aiming to guide or strategically focus mining-related rehabilitation and mine closure planning. Most of these guidelines have been compiled by key industry role players such as mining houses, supporting financial institutions, or governing bodies such as the International Council on Mining and Metals (ICMM). Apartheid-era mining operations used outdated mining methods with no regard for environmental protection and management or rehabilitation of abandoned mines. Inadequate and inefficient mine closure policies, inefficient legislative controls, and reckless past mining practices have resulted in a legacy of abandoned and derelict mine sites, which have substantial impacts on environmental liabilities and mine rehabilitation costs. Abandoned mines may pose unique and complex challenges, often leaving negative impacts such as safety and health hazards for people and animals (Bennet: 2016:1).

This study is underpinned by concepts in management but applied in the rehabilitation of abandoned mines in South Africa. The study aim at employing an integrated resources management approach in the decision-making process aimed directly to stakeholders in the identification, data collection and analysis as well as the selection of alternatives at various levels of the rehabilitation process of mines (Armour, 1990:51) as shown in Figure 2.2.

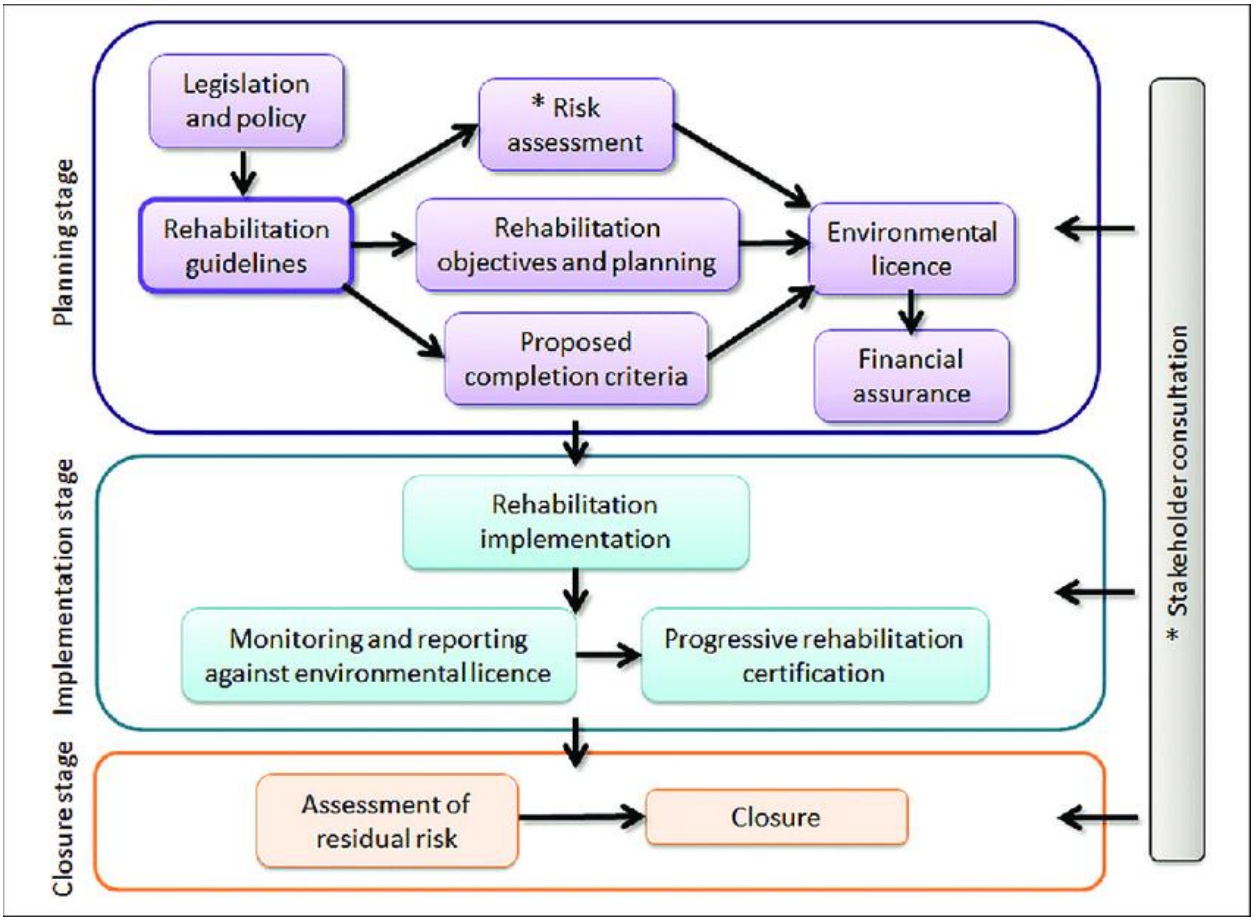


Figure 2.2: Conceptual framework for abandoned mines from Australia

Models are derived from cases that have provided workable solutions to problems at hand, where rehabilitation implementations are paramount and focused on developing a management framework with specific reference to the rehabilitation of abandoned mines.

The flow chart shows that the rehabilitation of abandoned mines is a cost intensive undertaking calling for the collaboration of all stakeholders. The ways and means to effect sustainable mine rehabilitation must encapsulate the logistical resources, financial and human capital, both short- and long-term plans, proactive strategising to achieve the desired ends. As such, for a management framework to be effective, the involvement of government at the highest political level, public-private partnership and other stakeholders such as non-governmental organizations (NGOs), the community, environmentalists, financiers, and insurance service providers is a prerogative. As such,

only when such a broad range of actors are involved would there be a possible generation of an all-encompassing blueprint for the rehabilitation of abandoned mines.

Planning for mine closure should aim to alleviate or mitigate environmental damage, achieve productive use of the land, and provide for social and economic benefits from mine development and operations (Smith 2007:5). Current mining legislations (NEMA and MPRDA) have focused on the concept of avoiding future abandoned and derelict mines, which occurred during the apartheid era. The reality is that it is not practical to rehabilitate all abandoned emerging from the abandoned mines. Many disused mines discharge a trickle of acid and metalliferous drainage (AMD) and this makes rehabilitation of all abandoned mines impossible. There is a need to develop guidelines and standards for mine closure planning, where best practice guidelines and mine closure procedures are enforceable and regulated by mining legislation (Smith 2007:6). Du Plessis (2006) contextualises the responsibilities created by a mine closure application through the constitution at national, provincial, and local levels which leads to misalignment among the hierarchical reporting structures. This result in all three spheres of government is being 'distinctive, interdependent and interrelated', and all of them sharing environmental responsibilities during a closure and rehabilitation application.

2.2. Gaps in the implementation of existing rehabilitation frameworks

Existing gaps in the implementation of the current legislative frameworks for the management of abandoned mines in South Africa pose challenges in the rehabilitation of abandoned mines in the country. Prior to the passing into law the Minerals Act 1991, many mining companies “used irresponsible mining methods with no regard towards protecting the environment and had often shirked their responsibility towards environmental rehabilitation by leaving an area unrehabilitated prior to them being liquidated or leaving the country” (Swart, 2003).

There is also an increase in the number of deaths in abandoned mines shafts. The non-rehabilitation of mines after their lifespan presents both socio-economic and environmental threats to communities surrounding these mines in South Africa.

Ledwaba and Mutemeri (2017:10) state that in South Africa, approximately 347 lives were reportedly lost between 2012 and 2016 due to the collapse of abandoned mines shafts that are still being mined by illegal miners. Furthermore, approximately 20 dead bodies of illegal miners operating in obsolete shafts around Orkney and Stilfontein in North-West Province were found as reported by the Department of Mineral Resources and Energy (DMRE 2021 statement). This clearly shows that mines continue to claim lives and immediate attention is needed to rehabilitee such abandoned mines in South Africa.

This study responds to the constant iterations and amendments in the current management framework for the rehabilitation of mines. The deletion of Sections 38 to 42 of the Mineral and Petroleum Resources Development Act (MPRDA) of 2002 which dealt with environmental governance were supposed to be replaced under National Environmental Management Act (NEMA) but were eventually omitted, leaving a major gap in environmental legislation. If the government continues to ignore this error, there are bound to be detrimental effects on the communities, hence the management and rehabilitation of abandoned mines cannot be achieved. The point remains on the urgent need to minimise the challenges posed by abandoned mines.

United Nations Environment Programme (UNEP, 2019: 13) stresses that the potential costs of rehabilitation, the lack of clearly assigned responsibilities, the absence of criteria and standards of rehabilitation and other factors have delayed action by all parties - industry, governments and communities in the past given the changing developmental patterns in South Africa. According to UNESCO (2019:5), R60-billion ($43 Billion USD) has been reserved for the rehabilitation of more than 6 000 abandoned mines in South Africa. However, the absence of a management framework that specifies clear rehabilitation standards, prioritization criteria, costing and presence of artisanal and small-scale mining (ASM) actors hinders effective rehabilitation efforts.

Furthermore, the number of abandoned mines nationwide, as well as concerns around the existing frameworks, is also concerning. The Auditor General Report (AGSA, 2009:6) of South Africa noted that there were 5 906 abandoned mines across South

Africa as of May 2009 and the number has increased to approximately 6 000 as of 2020 according to the recent AGSA's report. This indicates that the existing management framework for the rehabilitation of abandoned mines in the country is not comprehensive.

The MPDRA Amendment Bill, 2013 regulatory framework makes no provision for cases of abandoned mines, nor does the legislation delegate due responsibility or have an approved strategic plan for their rehabilitation. The mine rehabilitation system has come under increased scrutiny following the acid mine drainage crisis, several judgments pertaining to post-closure liability (Stilfontein Gold Mining, 2006); (Kebble, 2007); (Harmony Gold 2012); (Harmony Gold, 2014); (MPRDA Amendment Bill, 2013). A lot of consideration in the framework has been given to the financial provision, the duration of liability without attending to the management and rehabilitation of abandoned mines in the country.

Several mining companies only comply with the minimum requirements with regards management and rehabilitation. An additional challenge in governing mine closure is the fact that the impact from mining crosscuts the authorities of several government departments, all of whom are bound to play an important role in the management of legacies (van Tonder et al, 2009:2)

MPRDA regulations require the submission of closure objectives as part of the draft, in terms of the closure plan; MPRDA gives leeway to the Environmental Management Programme (EMP)/Environmental Management Programme Report (EMPR), the conjoined twins that are a pre-requisite for DMRE to issue the appropriate mineral rights, all things being constant. Nonetheless, submission of the closure plan together with the Environmental Risk Report for the application of the afore-mentioned closure certificate has inherent loopholes for the fact that in the latter process it would be a blueprint of the updated of the original in conjunction with the respective mine site's subsequent rehabilitation and development process. The area of concern is the capacity and competence of government to implement legislation. The shortage of relevant mine closure skills and knowledge within the regulator is a major key contributor to

unsuccessful closure and this is a major gap in the management and rehabilitation of abandoned mines in South Africa. Corruption Watch (2017) indicates that positions in the regulator have been frozen for many years, leading to a shortage of staff and that unqualified individuals have been appointed.

The mining legislature also does not define sustainability in the context of the management framework for the rehabilitation of abandoned mines. This omission is a failure in providing a holistic definition of the type of sustainability standards in question. This has not been addressed by the new legislation detailed. NEMA of 1998, only defines, “sustainable development as the integration of social, economic and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations”.

The Mining Charter III has also become a regulatory instrument rather than a document aimed at promoting socio-economic changes in the industry and the management and rehabilitation of abandoned mines (Moodley, 2019:8). The mining charter does not provide policy implementation, budgetary and timeframe for the management of abandoned mines. It leaves serious gaps because it fails to make provision for time results in delaying the rehabilitation programme and this consequently has a negative effect in the rehabilitation of abandoned mines in South Africa.

2.3. Frameworks and theories underpinning the study

There are two main frameworks enacted by the government designed to combat the problems associated with the management of mines in South Africa. NEMA and MPRDA best fit for controlling mining operations. The researcher proposes a modified suitable management and rehabilitation framework as perfect fit to minimize the dangers and gaps of abandoned mines in South Africa. The following are existing legislations in detail.

2.3.1. The National Environment Management Act (NEMA) 107 of 1998

The NEMA Act provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state. It provides for certain aspects of the administration and enforcement of other environmental management laws, and provides for matters connected therewith (NEMA, 1998:2).

It is in this legislation that the minister is mandated to make regulations consistent with mine closure requirements and procedures, the apportionment of liability for mine closure and the sustainable closure of mines with an interconnected impact resulting in a cumulative impact. Section 24 of NEMA provides the framework and principles for sustainable development and sets national norms and standards for Integrated Environmental Management. Section 28 of the Act imposes a duty of care and remediation of environmental damage on every person who causes, has caused or may cause significant pollution or degradation from occurring, continuing or recurring, or in so far as such harm to the environment is authorized by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

National Environmental Management Amendment Act, 2003 (Act No. 46 of 2003), deals with compliance and enforcement and provides for Environmental Management Inspectors (EMIs). National Environmental Management Amendment Act, 2004 (Act No. 8 of 2004), streamlines the process of regulating and administering the impact assessment process, procedures with which the Minister or MEC must comply before listing or delisting an activity. National Environment Laws Amendment Act, 2008 (Act No. 44 of 2008), amends the National Environmental Management Act, 1998, so as to clarify any uncertainty in the Act; authorises the Minister of Water Affairs and Forestry to designate persons as environmental management inspectors; provides for environmental management inspectors to be regarded as peace officers as contemplated in the Criminal Procedure Act, 1977; and amends the National

Environmental Management: Air Quality Act, 2004, so as to substitute Schedule 1 of that Act.

National Environmental Management Amendment Act, 2008 (Act No. 62 of 2008), empowers the Minister of Minerals and Energy to implement environmental matters in terms of the National Environmental Management Act, 1998, in so far as it relates to prospecting, mining, exploration or related activities. It aligns environmental requirements in the Mineral and Petroleum Resources Development Act (MPRDA), Act 28, 2002, with NEMA (1998), by providing for the use of one environmental system and environmental management programmes; and further regulates environmental authorizations. National Environment Laws Amendment Act, 2009 (Act No. 14 of 2009), amends the Atmospheric Pollution Prevention Act, 1965, so as to adjust the penalties provided for in the said act, the Environment Conservation Act, 1989, so as to adjust the penalties provided for in the said act, the National Environmental Management: Air Quality Act, 2004, so as to provide for a processing fee to review a licence, and to include directors or senior managers in a juristic person for the criteria for a fit and proper person.

All NEMA amendments (2003, 2004, 2008 and 2009) concentrate on environmental conservation. The framework does not specify the management framework processes for mine closure and how these effects can be solved in the context of the impact that an abandoned mine has on the surrounding communities and the government. In this legislation, stakeholder engagement and networks are not maintained after the policy formulation process is complete. This would have assisted in highlighting some challenges caused by the negative presence of abandoned mines. A policy framework is necessary to develop a robust, effective and fair mine development, mine closure, rehabilitation and long-term care regulatory system and to minimize the accrual of abandoned mine features which is a cause of concern in South Africa.

The locus standing of section 32 of NEMA is that any person or group of persons may seek appropriate relief in respect of any breach or threatened of any provision of this Act, or any provision of a specific environmental management Act, or of any other statutory provision concerned with the protection of the environment or the use of

natural resources. This act has been substituted by section 6 of Act 46 of 2003 hence it has not been utilized to initiate legal actions against environmental offenders.

2.3.2. Mineral and Petroleum Resources Development Act 28 of 2002

A lot of amendments have been made in the MPRDA whose mission is to provide for equitable access to sustainable development of the nation's mineral and petroleum resources. According to Swart (2003) the MPRDA, 2002 provides a holistic cradle-to-grave approach to prospecting and mining, fully internalising economic, social and environmental costs to achieve sustainable development of SA mineral resources.

The MPRDA contains a set of objects and requires that 'any reasonable interpretation' consistent with these objects be preferred over any reasonable interpretation that is inconsistent with such objects' (Section 4 (1) of MPRDA, 2002). The most significant principle and object introduced by the MPRDA is custodianship, which means that mineral and petroleum resources belong to 'the nation' and the role of the state is to act as a custodian, using its regulatory authority over licensing and other matters to ensure the benefits from mineral wealth are shared by all (Sections 2 (b), 3 (1), 3 (2) of MPRDA, 2002).

Section 45 of the MPRDA provides that if any prospecting, mining, reconnaissance, or production operations causes or results in ecological degradation, pollution or environmental damage which may be harmful to the health or well-being of anyone and requires urgent remedial measures, the Minister of Environmental Affairs and Tourism, may direct the holder of the relevant right or permit in terms of the Act to:

- Investigate, evaluate, assess, and report on the impact of any pollution or ecological degradation, or any contraventions of the conditions of the environmental authorization.
- Take all necessary measures as may be specified in such directive; in terms of this Act or the National Environmental Management Act, 1998 as Section 57 of the act sets out the requirements for an application for a closure certificate and provides that such application must be completed in accordance with Form P. Form P

requires information pertaining to the name of the applicant applying for a closure certificate the number of the permission, permit or right the region within which the relevant mine occurs the type of permission, permit or right type of mineral(s) details of land, area or offshore licence block; and the reason for the application for a closure certificate13.

- Form P must be accompanied by the following documentation: a closure plan contemplated in Regulation 62 of the Regulations; an environmental risk report contemplated in Regulation 60 of the Regulations; a final performance assessment report contemplated in Regulation 55(9) of the Regulations; and a completed application form contemplated in Regulation 58(1) of the Regulations to transfer environmental liabilities and responsibilities, if the transfer of such liabilities has been applied for.

However, MPRDA does not provide a comprehensive set of directives for management, budgetary allocation, and timeframe for the rehabilitation of disused mines. This study intends to close the gap by developing a comprehensive management and rehabilitation framework for abandoned mines in South Africa to mitigate the challenges faced by surrounding communities and other stakeholders.

2.3.3. National Water Act, 1998 (Act No of 1998)

The availability of water act in the management and rehabilitation of mines enhances the flow of the process. The protection of water resources is fundamental to use, development, conservation, management, and control. The National Water Act, 1998 ensures that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways that take into account, amongst other factors: meeting the basic human needs of present and future generations; promoting equitable access to water; facilitating social and economic development; protecting aquatic and associated ecosystems and their biological diversity; reducing and preventing pollution and degradation of water resources; meeting international obligations; promoting dam safety; managing floods and droughts. In this regard, the Water Act establishes sustainable institutional mechanisms and modalities to ensure appropriate community, racial and gender representation.

The National Water Act, 1998, contains wide provisions particularly related to responsibility for the integrity of water resources. The basis of water management at mines is therefore the responsibility of the mine water management hierarchy. This hierarchy is based on a precautionary approach and sets the following order of priority for mine water management actions such as pollution prevention; water re-use or reclamation; water treatment and discharge. Managing water is one of the most important management considerations at mining operations. The most common uses of water in mining are in processing ore (e.g., grinding, flotation) and in watering mining roads to suppress dust (Stevens, 2010:322). One of the weaknesses in the implementation of the act has been the failure to stick to and speedily implement decisions taken in the operation of the National Water Authority (NWA). As a result, difficulties are encountered in the management and implementation of set down rules to provide enough water for the mine rehabilitation project. The catchment management agencies assist in storing, provision and cleaning of water for use by the residents and some end users. Water is stored in well protected tanks or sealed reservoirs to protect the contamination of water from abandoned mines and any other spillages from chemical waters.

2.3.4. Mining Charter, 2018

The Mining Charter, 2018, was derived from the Mineral and Petroleum Resources Development Act, 2002, (Act No. 28 of 2002) (MPRDA). The MPRDA's primary objective was to provide for transformation of the mining and minerals industry for the benefit of all South Africans. Section 100(2) (a) and (b) of the MPRDA mandated the Minister of Mineral Resources to develop the Mining Charter to ensure transformation within the mining and minerals industry.

The Charter is an important contributory instrument in creating governance certainty, sustainable growth and changed mining industry. As such, South Africa in the face of its long-term objectives of eliminating poverty, reducing inequality, and creating jobs requires the mining industry to implement the following elements: “ownership, mineral beneficiation, procurement, supplier and enterprise development, human resources

development, and mine community development." Employment equity, principles for housing and living conditions standards, a regime for junior miners and licenses as well as permits granted in terms of the Precious Metals Act, 2005 and the Diamonds Act, 1986. However, the charter fails to handle the issue of the management and rehabilitation of abandoned mines but provides for procedures and processes for issuing of licenses and beneficiation in South Africa. The charter does not provide policy implementation, budgetary and time to work on the rehabilitation of disused mines.

2.3.5. Theory of social sustainability underpinning this study

The legislations discussed above do not consider the tenants of social sustainability of communities long after the mines have seized operations. Social sustainability theory posits that the alleviation of poverty should neither entail environmental destruction nor economic instability. Legislations must aim to alleviate poverty within the existing environmental and economic resources base of the society (Kumar, Raizada and Biswas, 2014:4; Scopellite et al., 2018:970). Therefore, the South African government must play a leading role in the rehabilitation of disused mines to avoid further threats to human life and well-being.

In this study, social responsibility is an aspect of social sustainability of communities surrounding disused mines. This social aspect entails that, "every mining company and management should consider and develop a comprehensive framework for social sustainability of the communities long before the lifespan of the mine". According to Kolk (2016:23) social sustainability is not about ensuring that everyone's needs are met but rather aims at providing enabling conditions for everyone to have the capacity to realize their needs, if they so desire (Mensah 2019:10).

2.3.6. Theory of environmental sustainability mines

The theory of environmental sustainability focuses on the natural environmental and how it remains productive and resilient to support human life after the end of the mine lifespan (Mensah, 2019:10). Environmental concerns include biodiversity loss, emissions into the air, energy use, global warming and other environmental impacts,

land use, management and rehabilitation, resource use and availability (Chikktur et al., 2009). The current rate of biodiversity loss around mines exceeds the natural rate of extinction (UNSD, 2018c). The rush and exploration activities of minerals without proper recognition of statutes and negative consequences to the communities and environment is concerning. The implication is that natural resources must be harvested no faster than they can be regenerated while waste must be emitted no faster than it can be assimilated into the environment (Diesendorf, 2000:19-37; Evers 2018:515-554). The nonattainment of environmental sustainability in the process of mining is further exacerbated by the abandonment of these mines without any rehabilitation once their lifespan is reached has compounded the social sustainability crises around mining communities in South Africa.

2.3.7. Theory of economic sustainability of mines

The theory of economic impacts on communities and individual can be linked to issues such as a loss of the productive land, loss of groundwater, pollution of surface water by sediments, air pollution from toxic gases or risk of falling into shafts. Resources for cleaning up abandoned mines are very limited in the country. Economic sustainability implies a system of production that satisfies present consumption levels without compromising future needs (Lobo, Pietriga & Appert, 2015:3573). Economic sustainability therefore requires that decisions are made in the most equitable and fiscally sound way possible, while considering the other aspects of sustainability (Zhai & Chang, 2019:369). Economic growth needs to be sustained about planned production volumes, and in meeting the needs of customers, as well as achieving economic efficiency obtained from the sale of the excavated minerals and rehabilitated land. Three main activities that are carried out in an economy are production, distribution, and consumption but the framework used to guide and evaluate the economy about these activities grossly distorts values and this does not augur well for society and the environment (Cao, 2017:84). Disused and abandoned mines may pose unique and complex challenges, often leaving negative impacts such as safety and health hazards for people and animals, neglected mining heritage and other assets, in addition to economically depressed communities.

2.3.8. Theory of altruism (2012)

Altruism towards others involves some self-sacrifice, with the intention of benefiting others. Altruism towards others is a person's drive to develop other people regardless of the returns (Choongo et al., 2016:1). According to Kaufmann, Panni and Orphanidou (2012:50), the theory of altruism suggests that pro-environmental behaviour becomes more likely when an individual is aware of the damaging consequences to others and when that person takes the detrimental influence of individualism in this context. Borden and Francis (1978) hypothesized that, any person with strong selfish and competitive orientation is less likely to act ecologically and manage a disused mine. People who have satisfied their personal needs are more likely to act ecologically because they have more resources (time, money, and energy) to care about bigger, less personal social and pro-environmental issues. Thus, the South African government should work in the best interests of improving the welfare, sympathies and empathise with poor people and strive to improve the management of disused and abandoned mines which threatened the livelihoods of communities. Altruistic inclinations towards others usually elicit an understanding of the societal grief and the environmental condition that stimulates their intention to find sustainable opportunities.

The above-mentioned theories are appropriate for this study as a foundation for the development of a strategic management framework but in terms of implementation, there may be challenges in fulfilling these gaps, therefore this study goes beyond closing these gaps through literature review and data collected and analysis. The researcher intends to develop an alternative management framework for disused and abandoned mines in South Africa. The framework once developed may serve as an extension to the existing framework because in this new framework the researcher closes the gaps in the existing framework and proposed improvement strategies on the existing framework.

2.4. Strategies and management frameworks for mine rehabilitation

A strategic framework for disused and abandoned mines in Northwest Province of South Africa considers socio-economic and environmental issues on a regional basis

that pose threats and challenges towards rehabilitation of these mines. The South African government adopted a holistic approach in the drafting of a comprehensive legislative framework by addressing disused mine hazards and challenges bedeviling the nation. Although work is in progress to close and rehabilitate some of the abandoned mines in South Africa, Unger (2012:262) supports the notion that, a well-developed strategic management framework would encourage a strategic approach to this persistent problem. As such, the framework may provide mines management with a tool to promote efficiency, sustainability, innovation and consideration of the unique assets and community values for individual mines. The framework once developed may provide guidelines and processes toward addressing the problems posed by disused and abandoned mines at national and community levels.

The current management frameworks assisted in the identification of 6 000 abandoned mines in South Africa of which 1 040 are derelict and the owners cannot be traced but need closure and rehabilitation. In this study, the focus is on disused and abandoned mines in North West province. The SA government established a set of general guidelines and standards for the mine rehabilitation that needs must be followed in addressing the principles of stakeholder involvement, planning, and financial provisions. The Department of Mineral Resources and Energy (DMRE, 2010), indicates that a comprehensive database was developed in South Africa and provided detailed records of disused and abandoned mines. The database is an initial step allowing for the systematic management of environmental and safety problems. The South Africa's national mineral research organisation (Mintek) was appointed as the responsible organisation for the rehabilitation of all disused and abandoned mines in the country (DMRE: 2018). However, since the commission of this responsibility to the South Africa's national mineral research organisation (Mintek) which is one of the world's leading technology organisation specializing in mineral processing, extractive metallurgy and related areas, there is no management framework developed for disused and abandoned mines in South Africa.

2.5. Management frameworks for mine rehabilitation globally

Internationally, there is a well-established expectation by mining stakeholders (industry, financiers, and practitioners) that mine closure planning and rehabilitation should be an intrinsic element of the entire life cycle of the mining from initial project design to assessment for mining approval purposes, continuing through implementation, decommissioning, and final closure and rehabilitation (Sweeting & Clark, 2000; MMSD, 2002; ICMM 2008).

2.5.1. Framework for the management of abandoned mine in Canada

The Canadian framework for federal and provincial abandoned mine management programme was initiated by a multi-stakeholder advocacy group. Multi jurisdictions composed of Federal Government which regulates mining, the provinces that regulate within their borders and the Jurisdictions responsible for management of orphaned and abandoned mine sites. The Canadian government pledged C$2.2 billion (US$1.66 billion) to advance a long-term plan to remediate eight abandoned mine sites in the Yukon and North West Territories, (Mining Magazine, 2019:1). Manitoba province established the orphaned/abandoned mine site rehabilitation programme in 2000 to address public safety and environmental health concerns associated with orphaned or abandoned mine sites.

The Auditor General Crown of Canada reported that, though the province has not developed adequate processes to identify and remediate its own contaminated sites, the report found that it was due to legislation that was not clear regarding the Province's responsibility and liability for orphaned and abandoned sites. In September 2018 the report by Auditor General established a $70 million provincial account for orphaned and abandoned mines. Since 2002, over $1billion Canadian dollars has been spent on orphaned and abandoned mines.

The federal jurisdiction proposed a four-point plan to best address the problems of abandoned mines. According to Ungers et al., (2012:260), in the absence of complete and reliable data sets, the urgency for national and provincial inventories of sites was identified, followed by a need to verify the hazards posed by these sites through

physical and chemical assessments. Thirdly, the report recommended that once the scale and nature of the problem were better understood, clean-up of the worst sites be funded and prioritised along with research. Finally, it was found that inadequate bond requirements and/or bankruptcies had left the government with millions of dollars in clean-up costs. As such recommendations were that, a funding mechanism be developed to recover the attendant costs from the mining industry.

Furthermore, the Canadian's National Orphaned and Abandoned Mines Initiatives (NAOMI) was formed in 2016 to examine the legislative, policy and programme framework in Canada for addressing Orphaned/Abandoned mines. The aim was to identify obstacles or barriers to progress, identify best practices towards remediation and influence decision makers in arriving at informed choices. The organisation (NAOMI) action plan provides tools to remediate existing orphaned and abandoned properties and to prevent the occurrence of new orphaned and abandoned mines in the future.

The organisation's (NAOMI) partnered with the provincial government programmes assisted in undertaking rehabilitation. As such, over $192 million was spent on contaminated sites (2003-March 2016). In Manitoba, as of March 31, 2016, $214.8 million was also spent on Orphaned/Abandoned mines (O&A). Ontario spent $142.4 million on rehabilitating the highest priority Crown-held mine sites (September 1999 to March 2016) and Nova Scotia invested $760 000 on remediation of abandoned mine opening (2001-December 2015), (Tremblay et al, 2016:27).

Furthermore, the United States of America Abandoned Mine Land (AML, 2015) programme managed by the Bureau of Land Management defines abandoned mine "as those lands, waters, and surrounding watersheds contaminated or scarred by the extraction, beneficiation or processing of coal, ores, and minerals. Abandoned mine lands include areas where mining or processing activity is determined to have ceased."

While Unger et al., (2012:260) used examples of Canada and US frameworks to explained disused abandoned mines rehabilitation programs, central leadership, clear roles and responsibilities, commitments to safety, health, environmental restoration,

biodiversity were key to the successful implementation of the frameworks. Furthermore, complete inventories of jurisdictions to identify sites and the accessibility of spatial data to the public via a national mine land inventory was crucial in the development of their framework. There is strong evidence that there has been a substantial increase in action in the case of South Africa when compared to the substantial amount spent for rehabilitation of disused and abandoned mines across provinces in Canada.

2.5.2. Management of abandoned mines in Australia

Australia also has a legacy of abandoned mines that have not been rehabilitated, and need effective management strategies and framework to rehabilitate these mines. Mining in Western Australia (WA) started over 150 years ago and have results in a legacy of over 50,000 disused and abandoned mines. Given this scale, there are calls for these mines to be rehabilitated and restored across states. Pepper et al. (2014) have identified National Orphaned and Abandoned Mines Initiatives (NOAMI) used in Canada as a good framework that can be adopted in Australia for leadership and coordination in the rehabilitation of disused abandoned mines since 2003. However, there is little evidence in Australia for a comprehensive framework for the management and rehabilitation of disused abandoned mines.

Furthermore, despite a non-legally binding national policy on mine rehabilitation, there is also no national government agency with statutory responsibility for remediating abandoned mines (Bennett, 2016:245). As a result, states or territories are independently responsible for disused abandoned mines and private landholders are responsible for disused abandoned mines even on freehold land. Although there are some abandoned mines that are the responsibility of the Australian Government (Bennett, 2016:245), the territory government and the state of Australia have the responsibility of rehabilitating those mines. Furthermore, rehabilitation of mines is a lengthy and costly process and many disused abandoned mines existed before the environmental obligation required for rehabilitation.

A review from the Centre for Mined Land Rehabilitation, presented at the 2012 Life of Mine Conference suggests that Australia draws upon leading practices in Canada

where the National Orphaned and Abandoned Mine Initiative provides support across federal and provincial jurisdictions through an advisory panel of industry, government, and the community (Unger et al, 2012). In Canada and the US, there are projects specifically focused on addressing legislative obstacles for disused abandoned mine rehabilitation (Unger et al, 2012).

The Abandoned Mine Working Group convened from 2006 to 2011 and developed a "*Strategic Framework for Managing Abandoned Mines in the Minerals Industry*" (MCMMPR/MCA, 2010). The working group comprised representation from the Minerals Council of Australia (MCA) and abandoned mines managers. The Strategic Framework was aimed to encourage a strategic approach to abandoned mines management which promotes efficiency, sustainability, innovation and consideration of the unique assets and community values for each mine. The framework was envisaged to provide the first move towards addressing disused abandoned mines in Australia collectively at the national level (Unger et al, 2012:262).

At a national level, the Strategic Framework (MCMPR and MCA 2010) was prepared to encourage convergence of state and territory jurisdictions on the following aspects: site inventories and data management, improved understanding of liability and risk relating to abandoned mines, improvement in performance reporting, standardisation of processes and methodologies, knowledge and skills sharing across jurisdictions.

Unger et al., (2014:261) noted that "very few jurisdictions have up-to-date inventories that are publicly accessible and nor do they have a transparent process to assess risks and prioritize sites at a jurisdiction-wide level. Performance reports on completed jurisdictional programmes are hard to find. However, it is possible to find reports on specific abandoned mine sites and rehabilitation projects in some jurisdictions. Hence, Australia has no suitable national inventory for abandoned mines to date. However, such an inventory is critical to assess Australia's mining legacy, analysing cumulative impacts, estimating rehabilitation costs and prioritising disused abandoned mines for rehabilitation (Unger et al, 2012:262).

2.5.3. Management of abandoned mines in South Africa

South Africa is endowed with vast mineral resources which go as far back as the 1860s. As a result of the rush for mineral resources and mining ventures, the country was left with a legacy of disused abandoned mines which pose social, economic and environmental threats to communities around these mines. According to Genesis Analytics and Wells (2015: 1), the Minerals Act of 1991 was passed and a more determined approach to environmental regulation enforced. The National Environmental Management Act, 1998 (NEMA Act No. 107 of 1998) was enacted as a framework governing the mining sector matters in terms of environmental management. This legislation does not mention the management and rehabilitation of abandoned mines specifically but is inferred in Section 28 and 24R (1) of NEMA act. Figure 2.3 therefore shows a concentration of disused abandoned mines in each province across South Africa.

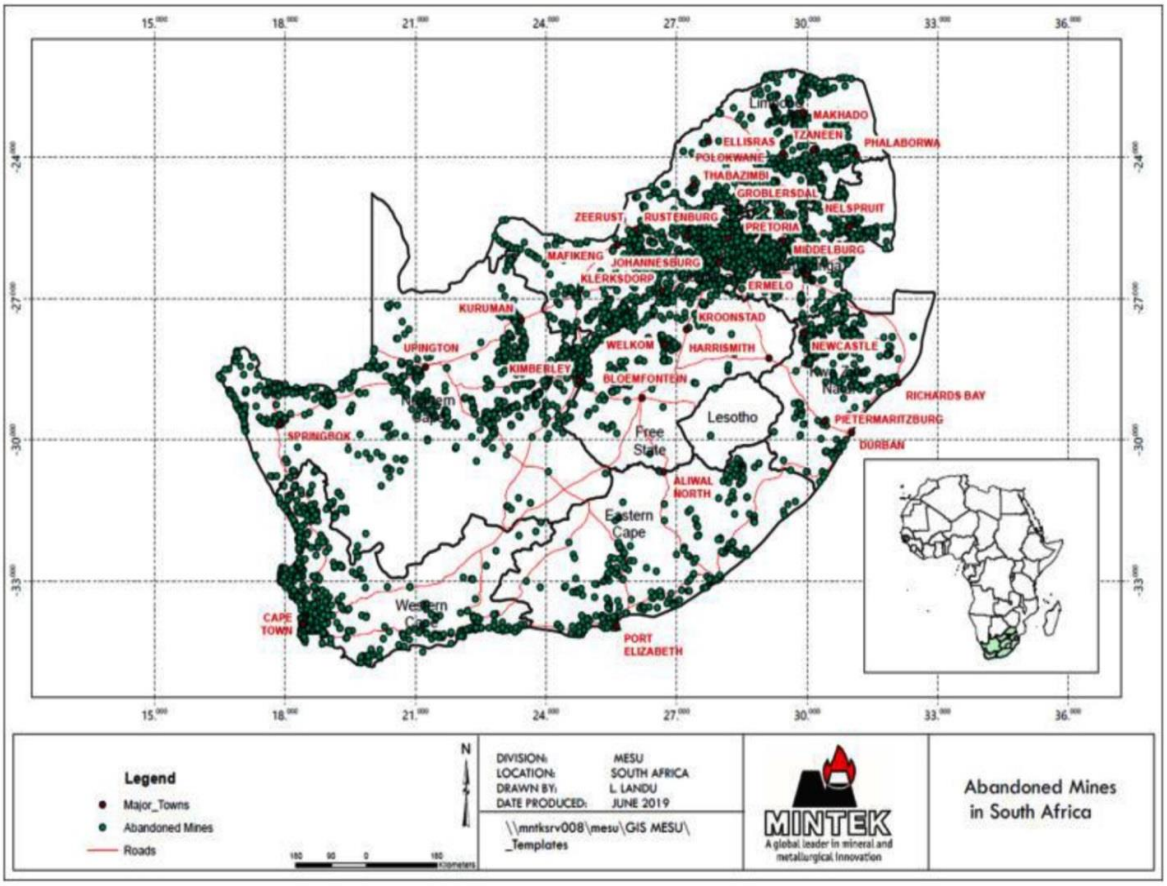


Figure: 2.3. Abandoned mines in South Africa
Source: Mintek (2019)

In 2002, the Mineral, Petroleum Resource Development Act (MPRDA Act No. 28 of 2002) was passed. The framework stated that a mining right holder remains liable for a disused abandoned mine, sustainable rehabilitation and closure thereof before a closure certificate is issued by the Minister of Mineral Resources. The Department of Minerals and Energy (DME) and the Department of Mineral Resources (DMR) consider all holders of mining rights responsible for their disused abandoned sites. The shared responsibility among departments created a gap in terms of the rights on who is responsible for regulating the mining industry from an environmental perspective. The DMR was given the right to regulate on mining issues, while the granting of environmental approvals, health, and safety rests with the Department of Environmental Affairs (DEA). The discussion in the legislation concentrates on existing mines without focusing on the management and rehabilitation of disused abandoned mines. This is a weakness in legislation because failure to attend to disused abandoned mines leaves a serious gap in resolving the social, economic, and environmental threats posed by disused abandoned mines. In 2009, the DMR proposed the National Strategy for the Management of Derelict and Ownerless Mines in South Africa (DMR, 2009:5). The framework provided a strategy through which the state implements management measures, including undertaking the rehabilitation of derelict and ownerless mines through a proposed action plan that addresses challenges related to these mines.

But Section 8 of the NEMA-Regulations (South Africa, 2015) only provided for financial guarantee and trust fund system to ensure financial provision for mine closure. There was no policy in place to rehabilitate disused abandoned mine sites (Klopper & Wessel, 2017:5). Though NEMA, MPRDA and Mining Charter III constitute a strong basis for environmental management issues in the mining sector, they have serious shortcomings such as the constant iterations and amendments to the framework, insufficient financial provision guidelines and closure certificates that are seldom issued resulting in the increase of disused abandoned mines in South Africa.

2.6. Risk associated with the rehabilitation of abandoned mines

Several types of risks must be considered from the perspective of designing a strategic management framework, closure plans and planning for closure of disused abandoned mines in South Africa.

Regulatory risk: This includes concerns that the rule might change during the development and life of the mining project. Such changes could subject the project to more strict regulations with consequent financial burdens which the operation cannot withstand.

Financial risks: These risks include calculating future costs when variables such as interest rates, inflation rates, taxation rates and other factors in time. Changes to other risk factors can cause unpredicted downstream inflation of costs as well, for example changes in water monitoring frequency or compliance limits.

Environmental risks: These include risks related to environmental factors such as climate change effects, which alter the predictability of certain events for instance many technical calculations for water management may be based upon the predictability and impacts of certain natural events such as storms.

Technical risk: This risk is related to engineered structures which may have inadequate information required for the necessary design, inadequate designs, and most importantly inadequate quality assurance during construction.

Risks related to social issues and stakeholder concerns must be anticipated and mitigating activities commenced well in advance of pre-feasibility studies. The risk assessment process identifies abandoned mine features that present the highest safety and environmental risk for consideration in the prioritisation assessment. The goal is to deal with the hazards in a cost effective and efficient manner utilising accepted best practices and established adequate closure plans to minimize future risk when the rehabilitation process has been completed. According to Cowan (2010:11), risk assessment assists in decision making from the perspective of potential risk to ultimate site owners/responsible parties.

Major risks in the closure plan process include inconsistencies in political intervention, overlooking of contamination possibilities, failed technologies, and bankruptcy of proponent, inadequate long-term institutional controls, inadequate input from other agencies and loss of access to site. However, the only approach to deal with these major risks entails monitoring, use of internal working groups, regular updating of closure plans and good communication and consultation with the various parties concerned.

2.6.1. Impacts of disused abandoned mines in South Africa

South Africa has a plethora of abandoned mine sites that pose management challenges to communities. The impact of abandoned mine sites is significant in many areas of post mining such as in groundwater regimes, contaminated soils, aquatic sediments, land degradation, desertification, deforestation, bio-diversity loss, unused pits, and shafts, altered landscape and extreme vulnerability to climate change (UNEP, 2018:30). UNEP (2018:30) stresses that mining has particularly strong environmental and social impacts on communities living in areas near disused mine sites. Mining also leaves a legacy of long-term environmental damage in the absence of good planning and management during mining operations and after closure. Swart (2003:489), states that mining closure leaves severe negative legacies that relate to the long-term residual effects on the social, health and environmental well-being of the communities residing in the vicinity of these mining areas. In South Africa, these negative legacies of disused abandoned mines are so severe that the government is under pressure from communities to managed and rehabilitate these mines as illegal mining is on the rise. Dales and Ramsay (2019:5) opined that, the continued release of mine pollution contaminates land, water and air, leading to significant costs in terms of lost productivity due to illness (burden of disease), healthcare, environmental damages and loss of ecosystem services.

Furthermore, detrimental environmental impacts are emerging on a continuous basis when disused abandoned mines are left for a long period without rehabilitation. As such, the mining industry today have recognised that to gain access to future resources, there

is a need to demonstrate an effective management and closure of mine plan with the support of the communities in which they operate (Bennet, 2016:241). There is need to continue to work together on a national and international scale to address problems associated with disused abandoned mine sites and minimise the effect on communities.

Land degradation *per se* emanates from abandoned mines that have lain fallow over a protracted timeframe. For instance, wanton land degradation, open excavations, disused shafts and quarry sites are illustrations of the myriad challenges emerging post the closure of mining activities (Kumar et al. 2017:158-65). Due to geophysical instability resulting from hollowed out through subsurface mineral extraction coupled with slurry/emission abandoned mines have fallen prey to earth movements and collapse. Degradation or failure of a pillar left in place to support the mine may lead to overexerted pressure on the remaining pillars until the integrity of the land is undermined, leaving a death trap for any curious adventurer who dares go near these sites (Bell et al 2000:135). A recent DMRE 2021 statement reported that 20 illegal miners perished at Orkney abandoned mine in the North West Province as a result of these pressures and rock bursts. Abandoned mines create habitat fragmentation, limiting the range and mobility of some species (Kumar et al. 2017:158). This may also lead to hazards during developmental stages and damage of property and infrastructure (Mishra et al 2012:52). Dales and Ramsay (2019:5) illustrate that land degradation is a result of physical soil disturbance; open mine shafts, drifts, and unfilled holes; slope instability; soil erosion; soil contamination; metal accumulation in crops, shrubs, and trees; loss of agricultural land; and regional crop contamination becoming the biggest threat in abandoned mines.

Water contamination occurs when acidified mine effluent, also termed Acid Mine Drainage (AMD), drains and pollutes water flows. Mhlongo (2016) recognised that changes in ground and surface water regimes, contaminated soils and aquatic sediments, subsidence, changes in vegetation cover, derelict sites with compacted soil, and burning coal waste dumps and workings. Operating and abandoned mines can have long-term impacts on the water infrastructure causing problems for humans and animals (Choudhury et al. 2017: 345; Howladar, Deb, & Muzemder 2017: 23). Acid and

metalliferous drainage (AMD), also known as acid mine drainage, is one of the negative environmental impacts on water quality that can result in a subsequent loss of biodiversity. AMD impacts can occur from underground workings, open pit mine faces, waste rock landforms, and storage areas that were left exposed to the elements or inadequately rehabilitated, resulting in the contamination of water with dissolved metals and acidity (Bennet,2016:241).

Bell et al (2001) and Yager (2013:37) report that gold tailing dumps have been a feature of the landscape around large gold mining towns since mining began and have been discharging polluted water for decades. High levels of mercury have been found in fish species due to exposure to polluted aquatic systems. Some mines such as Krugersdorp, West Rand, Gold, and Uranium pose potentially harmful elements (PHEs) and Acid Mine Drainage (AMD) poses chemical and biological hazards to wildlife. Water contamination though prevalent in South Africa, is akin to the rest of the world with abandoned mines that have not been reclaimed. Abandoned mines are sources of harm for the people and ecosystems. According to Dales and Ramsay, (2019:5), river diversion; sedimentation; drinking and groundwater contamination; leaching of chemicals from tailing ponds, and waste rock impoundments; acid mines drainage; nutrient loading; pH changes; and contamination of wetlands, aquifers, lakes, and rivers, causes diseases such as cholera, tuberculosis, and deaths of communities.

Air pollution contaminates soils and underlying aquifers, making them difficult to remove. Thus, humans and wildlife living near abandoned mines are exposed to harmful substances and toxic heavy metals if sites are not assessed and decontaminated (remediated) before rehabilitation and mine closure (Dales and Ramsay, (2019:8). When disturbed, abandoned mines can emit dust containing a variety of hazardous air pollutants, including arsenic, lead, and radionuclides. Abandoned mines compete for priority with a variety of other polluted sites. The management and rehabilitation of abandoned mines help to restore forest and life to the affected area. Dales and Ramasamy (2019:5) stated that deforestation and forest degradation reduce native plant cover; illegal timber harvest; loss of carbon sinks, climate regulation, nutrient cycling, water, and air purification; and reduced maintenance

of wildlife habitat and biodiversity, is rampant. If abandoned mines are not attended to, serious consequences will be experienced hence affecting the socio-economic life of people living around abandoned mines. This study intends to develop a framework for management and rehabilitation of abandoned mines in South Africa to assist the government in minimizing risk and impacts to communities as depicted in Figure 2.4.

Figure 2.4: Pillars of sustainable development in mines
Source: Rosen & Kishway, (2012)

2.6.2. Sustainable development of mines

The concept of sustainable development has attracted a lot of attention that other development concepts lacked and is poised to remain on the development paradigm for a long time (Scopelliti et al., 2018: 970; Shepherd et al., 2016: 429) in the discourses of disused abandoned mines. Sustainable Development (SD) of mines is imperative since decision-makers need not only to keep data on disused abandoned mines but information on the linkages among the principle stakeholders to enhanced the understanding of linkages and implication thereof for future action in the interest of human development (Abubakar, 2017:547; Hylton, 2019:515).

In an MPRDA Report (2002:15), it was argued that sustainable development means the integration of social, economic and environmental factors into planning, implementation and decision making so as to ensure that mineral and petroleum resources development serves present and future generations. Ukaga, Maser, and Reichenbach, (2011) stresses that, sustainable development aims at achieving social progress,

environmental equilibrium, and economic growth. The concept can be seen as a process of continually striving for a dynamic balance between people, planet, and prosperity in using and protecting the physical and natural environment and resources. Furthermore, the concept of sustainable development is used to ensure equitable and sustainable use of natural resources now and in the future in creation of an equitable and viable economic system from an ethical viewpoint. The concept can also be used to ensure economic growth with greater equity and self-reliance while acknowledging and guiding social and cultural systems with values towards greater equity, responsibility and human well-being as well as improving health, income and living conditions of the poor majority.

2.7. Chapter summary

This chapter reviewed literature and legislation on developing a framework for the management and rehabilitation of abandoned mines in South Africa. The literature commenced with conceptual and theoretical engagements for this study by examining existing gaps in the management and rehabilitation of abandoned mines, legislative frameworks and theories underpinning the current management frameworks for the rehabilitation of abandoned mines in South Africa, strategies in the implementation of frameworks for the management and rehabilitation of abandoned mines in South Africa and proposed an alternative management framework for the rehabilitation of abandoned mines in South Africa.

The chapter also discussed abandoned mine management frameworks from the international perspective. This covered Canadian and Australian frameworks as leading giants in the management and rehabilitation of abandoned mines. What has been clarified and verified in the literature review is used in the development of an alternative modified management and rehabilitation framework of abandoned mines in South Africa. An overview of abandoned mines management framework for national perspective was also discussed in this study. Post-apartheid mining used outdated methods with no regard to environmental concerns, leaving a legacy of approximately 6 000 abandoned mines. Several types of risks considered from the perspectives of

proponents in designing closure plans and planning closures was discussed. These risks include financial, regulatory, environmental, technical and management. Every project faces different types of risk therefore the management and rehabilitation of abandoned mine will not be spared.

Chapter three of this study focuses on the research methodology and justification for selecting the methods used. The research methodology reviews existing knowledge. The chapter is organized according to the following main sections: research philosophical assumptions, epistemology and ontology for the interpretation of the research problem under study, research approach to the research questions, research design, population, sampling techniques, data collection techniques, analysis, validity and reliability of data as well as ethical considerations.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0. Introduction

The previous chapter provided an extensive review of literature on the conceptual and theoretical discourse on frameworks for the management of disused abandoned mines from global perspectives to national perspectives. This chapter focuses on the research methodology adopted for this study to achieve the objectives as outlined in chapter one. The chapter explains the design to be followed in developing a strategic management framework for the management and rehabilitation of abandoned mines in North West province of South Africa. Rajasekar et al. (2013:5) describe research methodology as "the procedures by which researchers go about their work of describing, explaining and predicting phenomena."

The chapter commences by discussing the research philosophy which guides the thinking of the researchers, the research design, research approach, population, sampling techniques in selecting respondents and participants, data collection procedures, the data capturing, coding process and the techniques used in analysing data. Furthermore, the validity, reliability and trustworthiness of the instruments used to collect data were explained. Neumann (2000) explains that, the validity of the research results depends on the quality of the data collected and the methods analysis chosen to answer research questions, aim and objectives.

The research methodology chapter is divided into three sections: namely, the quantitative research methodology, the qualitative research methodology and strategic alignment of quantitative and qualitative methods (mixed methodology). The study was exploratory and follows a sequential mixed research design. Creswell and Clark (2014:12) opined that mixed method research provides positive benefits and is characterized by a clear research design and philosophical assumptions which form a basis for the methodology regarding data collection and analysis (Gunasekare, 2013:361). The methodology provides the researcher with a clear path on the alignment

of results in order to develop the framework as shown in Figure 3.1 illustrating the methodological design followed in this study.

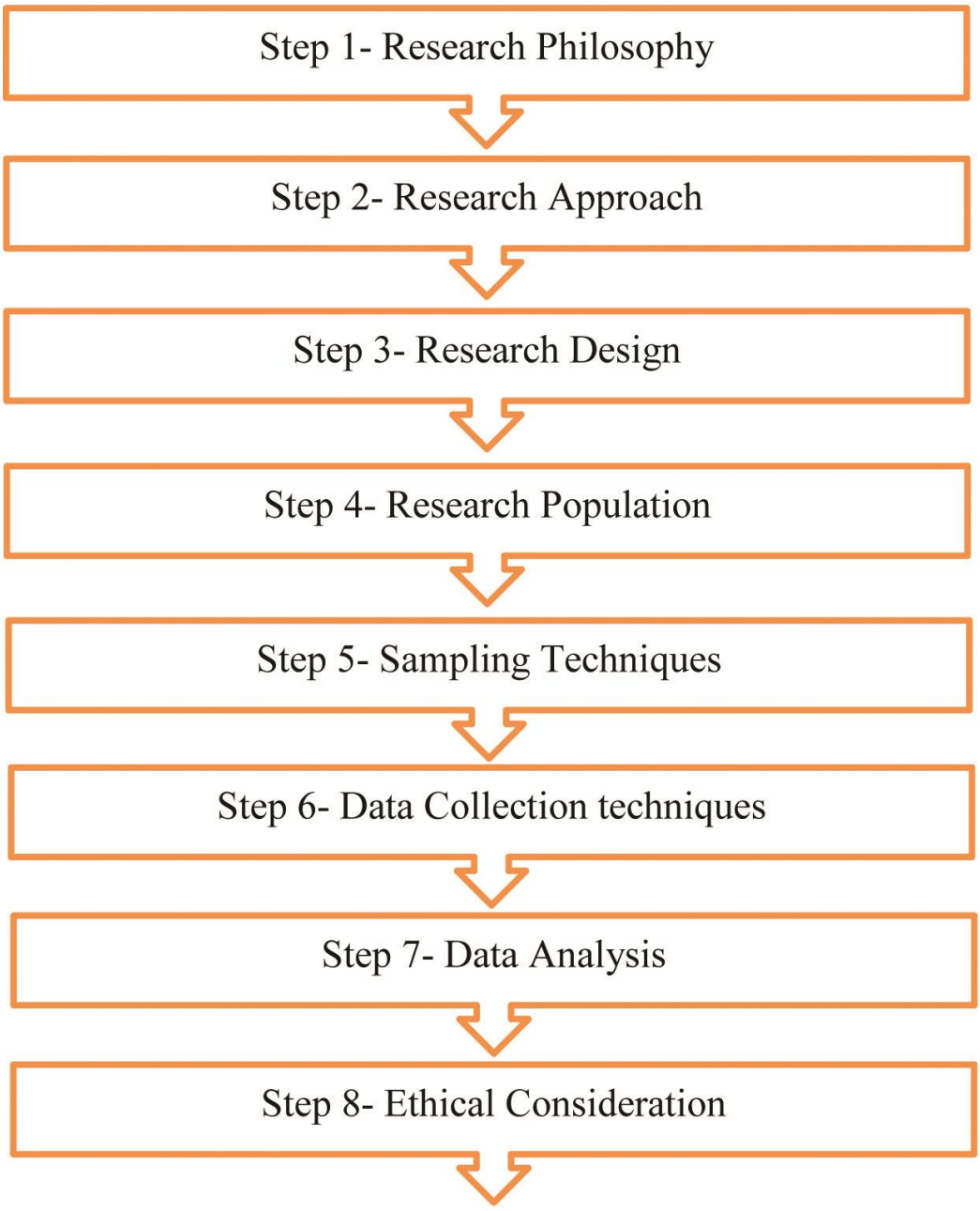


Figure 3.1: Methodological design for this study

Source: Own Source

3.1. Research Philosophies

This section discusses the philosophies adopted for this study in order to develop a framework for the management and rehabilitation of abandoned mines in the North West Province of South Africa. Saunders (2015:124) states that research philosophy is a system of beliefs and assumptions about the development of knowledge. Philosophy is regarded as the bedrock of any research, the core that guides the researcher's thinking in deciding on the approach, strategy, data collection techniques as well as procedures to follow in answering the research questions.

The study is guided by the pragmatism paradigm. Lor (2011:5) refers to a paradigm in social and organisational theory as the philosophical view on how to position research. Pragmatism is applicable to mixed method studies because it draws from both quantitative and qualitative assumptions (Tashakkori & Teddlie, 2010:271). According to Lincoln et al. (2011:91-95) paradigm refers to the philosophical assumption that guides the actions and defines the worldview of the research. Creswell and Plano-Clark (2011) and Tashakkori and Teddlie (2011: 271) argue that, studies link to pragmatism philosophy research assumes that there is no single way to explain phenomenon.

Therefore, the philosophical assumptions that form part of answering the research question and resolving the research problem are ontology, epistemology and methodology. Karley (2013) is of the view that the philosophical assumptions are based on research questions driven by the statement of the problem. Therefore, this study is premised on epistemological view (positivism and Interpretivism) point in the collection of data in the development of a framework for the management and rehabilitation of abandoned mines. The researcher utilises existing literature as a foundation for determining constructs that are key when developing a framework for the rehabilitation of disused abandoned mines. In this study both positivism and interpretivism research paradigm was applicable.

3.1.1. Positivism

Positivism is an epistemological position that advocates the application of methods of natural sciences in the study of social reality (Bryman & Bell, 2015:10). Positivism research focuses on gathering numerical data and generalising findings across groups of people or in explaining a particular phenomenon (Babbie, 2013:15). Therefore, quantitative research attempts to establish if significant relationships exist among variables when addressing the research questions by measuring, describing and it is based on objective measurement as well as observation. Positivism is concerned with correlation and causation (Hamer & Collinson, 2014:18). In the natural science, positivism is based on existing theories that formulate laws which have been tried and tested and universally accepted to apply to a population, and that explain the causes of objectively observable and measurable behaviours (Morgan & Smircich, 1980:493). This study measures the gap between the actual knowledge and tacit knowledge. Therefore, in this study positivism research philosophy was utilised to establish the relationship between stakeholders and management constructs on the rehabilitation of abandoned mines in the North West Province.

3.1.2. Interpretivism

Interpretivism deals with the collection and analysis of qualitative data or data in words as well as propositions (Creswell & Clark, 2007, Creswell, 2017; Teddlies & Yu, 2007). Interpretivism strives to arrive at an understanding of how people with commonalities think and feel on a given phenomenon (Northcutt & McCoy, 2004:7). Taking an interpretative stance, the researcher generates in-depth data that may assist the government of South Africa in minimising threats caused by disused abandoned mines. Makrakis and Kostoulos-Makrakis (2016:144) state that qualitative research is a rational approach to phenomenological events. The meaning of qualitative research is more important than the measurement or testing of a hypothesis. Phenomenology as a qualitative approach strives to develop new understandings of human life experiences with reference to abandoned mines.

Mixed methods involve combining or integration of qualitative and quantitative research approaches and using both data in words and quantities to find answers to the research questions. The core assumption in this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than a single approach (Tashakkori & Teddlie, 2010:273). Positivism paradigm may not provide enough solutions on its own, hence the need for a combination of two paradigms. Therefore, this study combines the two paradigms, positivism and Interpretivism, in order to arrive at the objective and subjective answers of the worldviews on the management and rehabilitation of disused abandoned mines in North West Province as depicted in Figure 3.2.

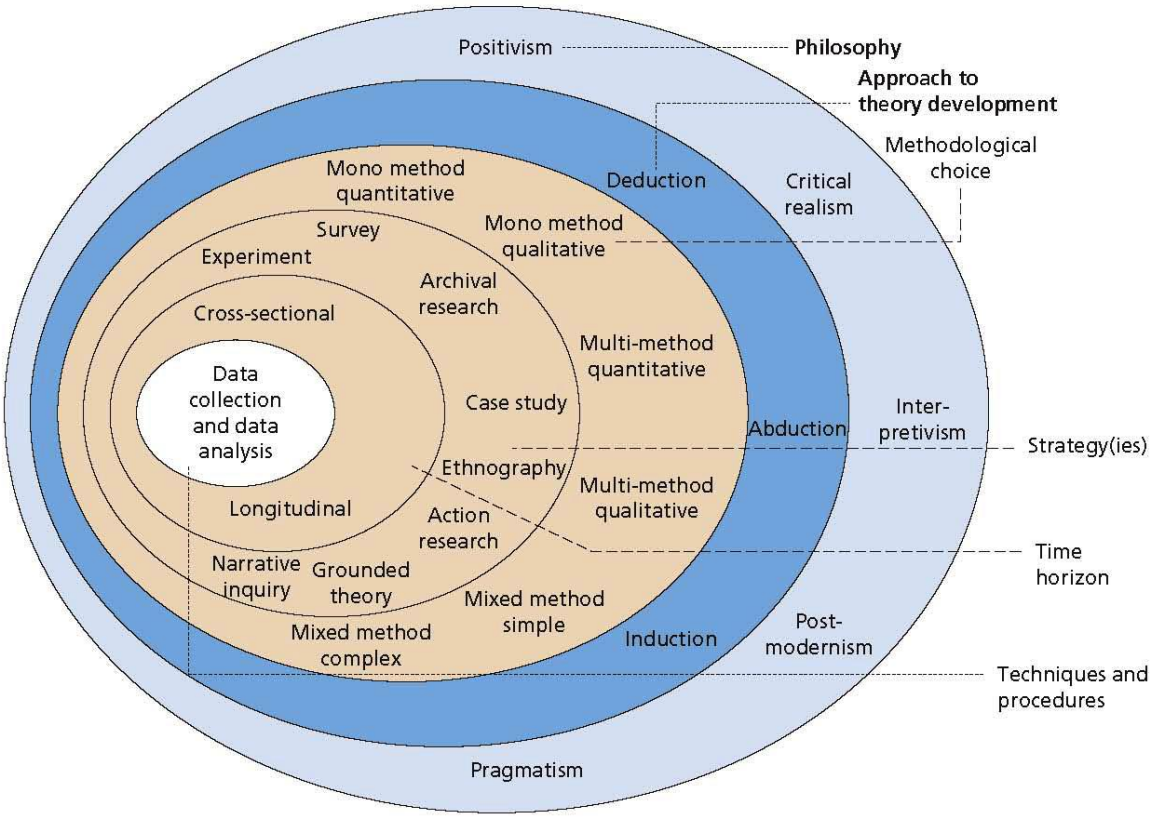


Figure 3.2: The research 'Onion'

Source: @2015 Mark Saunders, Philip Lewis and Adrian Thornhill

The study was guided by research philosophies as depicted in the research “onion” which by Saunders, Lewis and Thornhill (2015:124), linked it to the research objectives and questions as explained in Figure 3.2. Various approaches are clearly illustrated in the Onion Model as deductive, inductive, and adductive research approaches which support the researcher’s methodological and design path followed in Figure 3.1. The pragmatic philosophy is suitable for a study this since the gap to fill was the development of a strategic management framework for the rehabilitation of disused abandoned mines. The next section focuses on the research approach used to address problems in relation to disused abandoned mines in South Africa.

3.2. Research approach

In this study, a mixed method research approach was employed. Leedy and Ormrod (2016:329) opined that, research problems associated with management and development of frameworks are complex in nature and need both quantitative and qualitative dimensions to be fully addressed. This applies to the current study that examines the rehabilitation of disused abandoned mines. The study uses a pragmatic approach which is both quantitative (deductive) and qualitative (inductive) data collection to develop a framework for rehabilitation of disused abandoned mines based on the analysis. Creswell and Creswell (2017:26) argue that a mixed method research approach is an approach of inquiry involving collecting both quantitative and qualitative data and integrating the two forms of data. Bryman and Bell (2015:18) assert that, “quantitative research emphasises quantification in the collection and anaylsis of data and entails a deductive approach to the relationship between theory and research, in which the emphasis is testing of theories”. This takes a view of social reality as an external, objective reality. By conducting a survey, a large number of questionnaires were distributed electronically and in hard copy, providing the researcher an opportunity to gain an accurate picture of the perceptions and experiences of the sample (Brewerton & Millward, 2001:52). The quantitative methodology shares its philosophical foundation with the positivist paradigm, and is based on rigid rules of logic and measurement, truth, absolute principles, and prediction (Halcomb & Andrew, 2005: 71).

In a qualitative approach, the researcher emphasises words and an inductive approach to the relationship between theory and research. Qualitative research helped to fill the gaps left in the explanations and interpretations of the results of the quantitative research by providing in-depth and rich information on the issues that were investigated. Creswell and Clark (2011:214) were convinced that a single approach may not be adequate to understand the nature and extent of problems affecting abandoned mines. The purpose of collecting qualitative data is to empirically add in-depth information and interpretation to the preliminary conclusions, drawn after analysing the primary data collected.

The problem of increase in the number of disused abandoned mines, increase in deaths, alterations of existing frameworks and an increase in illegal miners (Zama Zama) in abandoned mines are suitable for both quantitative and qualitative data hence this study utilizes a mixed-methods research. Mitchel (2018:106) argues that mixed method approach draws from the strengths and minimises the weakness of a more traditional single approach. Mixed method research is important in the study because of the complexity of problems addressed and the practical need to gather multiple forms of data for diverse audiences (Gunasekare, 2013:364). Creswell (2015:5) defines research strategy as plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis. In this study, a pragmatic approach is used because it allows the researcher to interact with the participants and places importance on the researcher's value system. The researcher's rationale for adopting mixed methods research in this study is that, both approaches provide a more comprehensive account of the concept being investigated. The next section discusses the research strategy.

3.3. Research design

The research design that was used in this study is exploratory sequential design. A research design is utilised to structure the research, indicate that all the major elements of the research are designed to work together (Clinton & Guest 2013:548). Creswell (2018:31) observes that studies are either qualitative, quantitative, and mixed methods design to provide specific direction to attain the research objectives.

A design typology is “a set of different possible mixed method designs that attempt to convey the range of design options available” (Plano Clark & Ivankova, 2016:111). According to Bryman and Bell (2015:27) research design relates to the criteria that are employed when evaluating research. A design is therefore a framework for the generation of evidence that is suited for both applicable to a certain set of criteria and the research question in which the investigator is interested. This study adopts a mixed-method research design. The following section discusses the rationale and justification for the adoption of the mixed-method research design for this study as shown in figure 3.3.

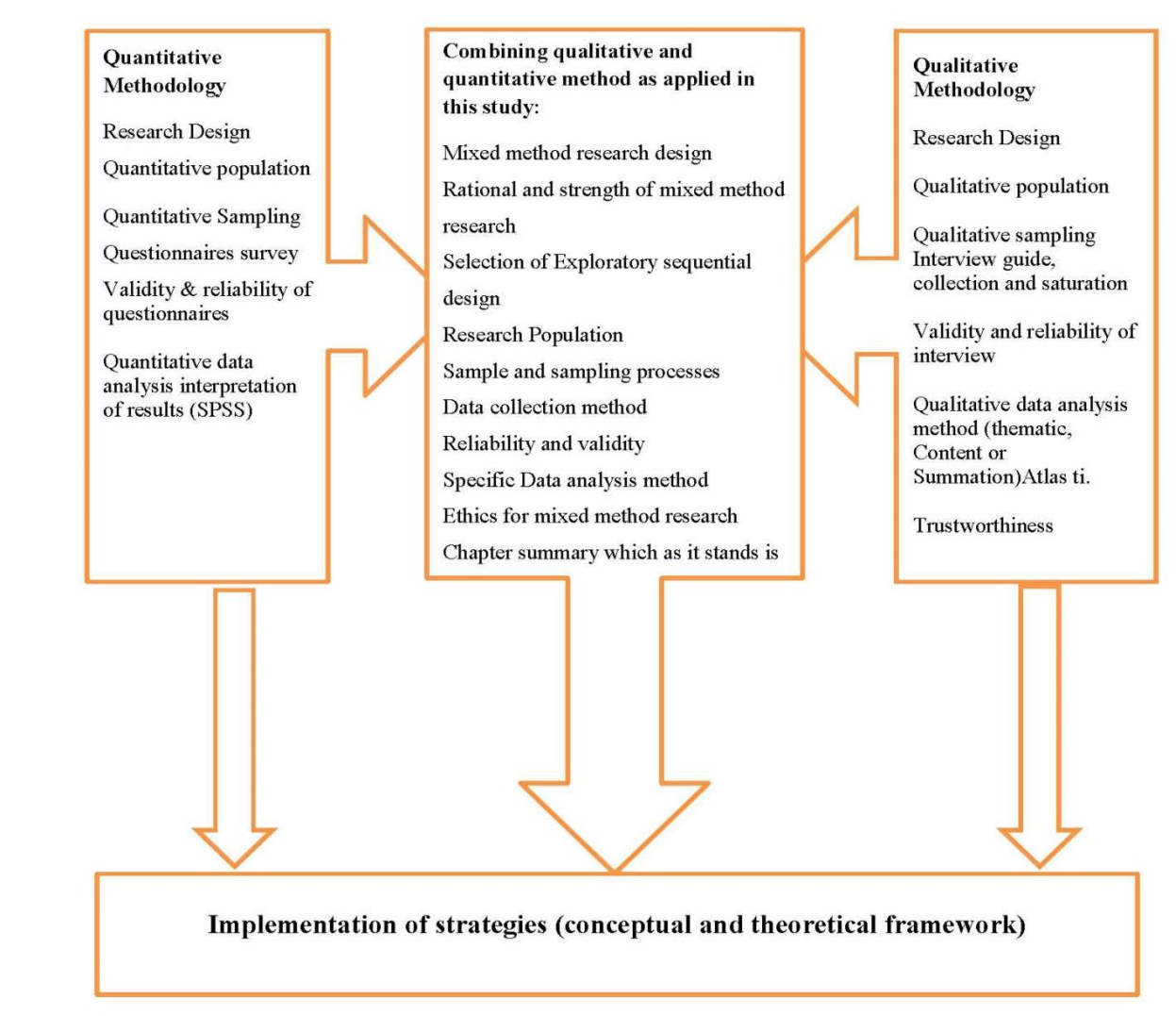


Figure 3.3: Tentative framework for research methodology
Source: Own Source

3.3.1. Mixed method research design

The method entails the collection, analysis and integration of qualitative and quantitative methods to gain a better understanding of the research problem (Fischler, 2018). The mixed method approach provides a realistic link between quantitative and qualitative studies. This allows the researcher to choose the method best suited for the study from across paradigms. The intensity of gaps, shortcomings in the frameworks and a surge in the number of disused abandoned mines encouraged the researcher's choice of mixed method research. The core assumption of this form of inquiry is that the integration of qualitative and quantitative data yields additional insight beyond the information provided by either the quantitative or qualitative data alone (Creswell & Creswell, 2017:26). Hence, this makes the generalizability of the results more applicable stated Cameron and Molina-Azorin (2011) argues that the rationale use of both quantitative and qualitative design is to offset the weaknesses of one method by another and offered a better way of examining the same phenomenon from two perspectives. Mixed method helps to think creatively and outside the box, enhance and extend the logic of qualitative explanation (Gunasekare, 2013:363).

In developing a framework for the management and rehabilitation of abandoned mines in South Africa, both strands of data amplify the conundrum such that the envisaged framework is robust. Creswell and Plano Clark (2011) describe six major mixed-method designs, namely, "the convergent parallel design, explanatory sequential design, exploratory sequential design, embedded design, transformative design and the multiphase design." The most significant three designs among these are the exploratory design, convergent parallel design and the explanatory design. In this study, an exploratory sequential mixed method research (MMR) design was selected to broadly explore and understand human practices, behaviours, and preferences of stakeholders in the mining industry with regards to abandoned mines in South Africa.

3.3.2. Rationale and strengths of mixed methods

A mixed-methods design offers the best chance of answering research questions by combining two sets of strengths while compensating at the same time for the weaknesses of each method (Johnson & Onwuegbuzie, 2004:14-26). Mixing two

methods (quantitative and qualitative) helps to produce a more complete picture of divergent views (Teddlie & Tashakkori, 2009). Quantitative data brings breadth to the study and qualitative data provides depth in the research.

In this study, the depth and breadth of two methods assist in the development of an alternative framework for the management and rehabilitation of disused abandoned mines. A mixed-methods design offers several benefits in approaching complex research issues as it integrates philosophical frameworks of both post-positivism and interpretivism (Fetters, 2016:3-11) views in explaining these challenges. Mixed-methods research (MMR) is a research methodology that incorporates multiple methods to address research questions in an appropriate and principled manner (Bryman, 2012; Creswell, 2015; Creswell and Plano Clark, 2011), which involves collecting, analysing, interpreting and reporting both qualitative and quantitative data.

The mixed method research approach offers a logical, methodological, flexibility and an in-depth understanding of smaller cases (Maxwell, 2016:12-27) and helps generalize findings and implications of the researched issues to the whole population. The rationale behind the use of mixing the two methods is “to develop more effective and refined conclusions by using the results from one method (qualitative or quantitative) to inform or shape the use of another method” (Plano Clark & Ivankova, 2016:86). Mixed method research approach helps “to overcome the epistemological differences between quantitative and qualitative paradigms and to provide a royal road to true knowledge” (Bergman, 2008:4). Indeed, a principled combination of the two methods supports researchers in developing an in-depth and comprehensive understanding of a research phenomenon.

In this study, data triangulation in a mixed-methods study was generally accepted as a strategy for validating results obtained with the individual method (Bergman, 2008:24). The researcher makes a more convincing case if both quantitative and qualitative data lead to those conclusions. However, collecting diverse types of data offers greater insights into a phenomenon that the methods individually cannot offer, and therefore,

provides more valid and stronger inferences than a single method (Teddie and Tashakori, 2009) as shown in Table 3.1.

Table 3.1: Tentative framework for mixed method research design

Purpose for mixed methods based on several sources

Purpose	Description
Complementarity	Mixed methods are utilized in order to gain complementary views about the same phenomenon or relationship. Research questions for the two strands of the mixed study address related aspects of the same phenomenon.
Completeness	Mixed methods designs are utilized in order to make sure a complete picture of the phenomenon is obtained. The full picture is more meaningful than each of the components.
Developmental	Questions for one strand emerge from the inferences of a previous one (sequential mixed methods), or one strand provides hypotheses to be tested in the next one.
Expansion	Mixed methods are used in order to expand or explain the understanding obtained in a previous strand of a study.
Corroboration/Confirmation	Mixed methods are used in order to assess the credibility of inferences obtained from one approach (strand). There usually are exploratory and explanatory/confirmatory questions.
Compensation	Mixed methods enable the researcher to compensate for the weaknesses of one approach by utilizing the other. For example, errors in one type of data would be reduced by the other (Johnson and Turner, 2003).
Diversity	Mixed methods are used with the hope of obtaining divergent pictures of the same phenomenon. These divergent findings would ideally be compared and contrasted.

Note. This table was constructed on the basis of several
Sources: Greene et al. (1989), Patton (2002), Tashakkori and Teddlie (2003a), Creswell (2003), and Rossman and Wilson (1985).

Ventakesh et al., (2013:54) add that, findings from mixed-methods research offer a holistic view of a phenomenon and provide additional insights into different components of a phenomenon which might help in generating substantive theories. In this study, the researcher believes that results from one method does not produce enough evidence to draw conclusion hence, the use of quantitative results to develop qualitative follow-up exploration (potentially through interviews, and observation) to explore why certain factors are significant.

3.3.3. Justification for exploratory sequential mixed methods design

The researcher used the sequential exploratory mixed-method research design to explore participants' views on the concept of strategic management and rehabilitation of abandoned mines in South Africa. According to Creswell (2009:200), in sequential exploratory design, the quantitative approach is integrated into the qualitative method to assist with the interpretation of qualitative data. Exploratory sequential design begins by exploring the topic through qualitative methods and then builds to a second quantitative phase where the initial results may be tested or generalized.

Morgan (2007:48) argues that “exploration is needed when the measures or instruments are not available, constructs are unknown and when there is no guiding framework or theory”. The researcher used an exploratory sequential mixed methods research design to identify and classify negative abandoned mine legacies, and challenges faced in the management of abandoned mines. This study allows for a deeper analysis and the development of a robust plan to implement research data from mixed methods to meet research objectives as outlined in Chapter one of this study. The diagram 3.4 illustrates an exploratory mixed method design by Creswell and Clark showing conceptual steps of the methodology design.

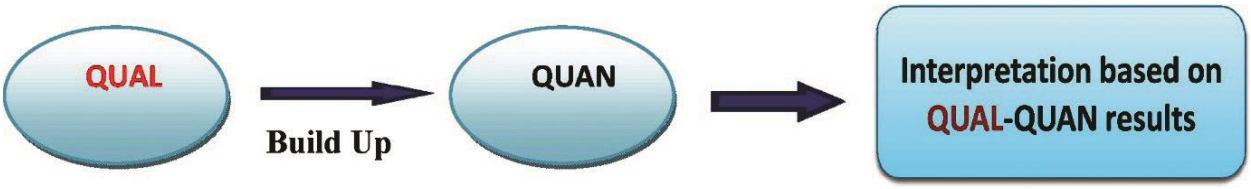


Figure 3.4: The exploratory mixed methods design
Source: Creswell & Clark, (2007)

The researcher is convinced that the design is necessary in this study where insufficient information is known about the phenomena. This helps to get more information and enhances the generation of new ideas (Zikmund, 2003). The qualitative phase may be used to build an instrument that best fits the sample under study, to identify appropriate instruments to use in the follow-up quantitative phase, to develop an intervention for an experiment, or to specify variables that need to go into a follow-up quantitative study (Creswell & Creswell, 2017:34).

The qualitative data sources for this study were semi-interviews and document analysis from government enclave. In phase two, which is the quantitative phase, the study built on the qualitative phase, which established the population size and the nature of the population for the proper application of sampling procedures. Exploratory research is destined to discover ideas and insights. This is the most appropriate research design for those projects addressing a subject about which there are high levels of uncertainty and ignorance such as on management and rehabilitation of abandoned mines.

3.4. Target population of the study

The targeted population was all stakeholders who are involved in disused selected abandoned mines. The research population is the entire group of stakeholders that the researcher desires to investigate. Poll and Hungler (1999:37) suggest that population refers to an aggregate or totality of all the objects, subjects or members that conform to a set of specifications. COMZ (2019) observes that in the mining sector, there are four stakeholder groups, namely, managers, professionals, technocrats, and general employees whose skills are generic. It therefore follows that managers are professionals who are responsible for the daily operations of the organisation. They

have technical expertise and management, leadership, and supervisory skills to run the organisation.

The total population comes from seven (7) disused abandoned mines across areas in the North West Province, namely; Mafikeng, Potchefstroom, Klerksdorp, Rustenburg, Kuruman, Vryburg, and Zeerust as depicted by the following Table: 3.2. The sample stakeholders from some selected mines were interviewed. Statistics South Africa (2019) defines population as a group that is studied or from whom information is collected for data driven decisions. The chosen sample must be a true representation of the population to which the researcher can make inferences and or generalisations about the entire population. The table below shows 200 respondents selected from different areas in the North West Province out of a total population of 220.

When a population is too large for a research study, sampling becomes vital but the sample must be a true representation of the population under investigation. The sample must reflect the characteristics of the entire population from which it is drawn. The researcher used stratified sampling method because the population has different groups (strata) and the analyst needs to ensure that those groups are fairly represented.

Table 3.2: Selected town in the North-West Province

Towns Selected	Total population
Mafikeng	55
Potchefstroom	30
Klerksdorp	40
Rustenburg	50
Kuruman	10
Vryburg	20
Zeerust	15

Total Population	220

Source: Own Research

Alvi (2016:20) argues that stratified sampling is used when population is heterogeneous for example every element of the population does not match all the characteristics of the predefined criteria as depicted in Table 3.2. The researcher identified relevant strata and their actual representation in the sample. The strata in this study were based on sixty (60) environmental consultants representing 30% of the population, ten (10) Auditor General South Africa personnel, forty (40) Government officials, thirty (30) land barons and sixty (60) community representatives from seven (7) mining towns in Table 3.3. The mentioned bodies have vast experience and first-hand information on what could be important in mine rehabilitation.

Table 3.3: Targeted groups for the research

Groups	Number selected	Percentage (%) representation
Environmental management Consultants/Managers	60	30%
Auditor General/Professionals	10	5%
Government Officials/General employees	40	20%
Land Barons/Technocrats	30	15%
Communities	60	30%
Total Sample	**200**	**100%**

Source: Own Research

3.5. The study area

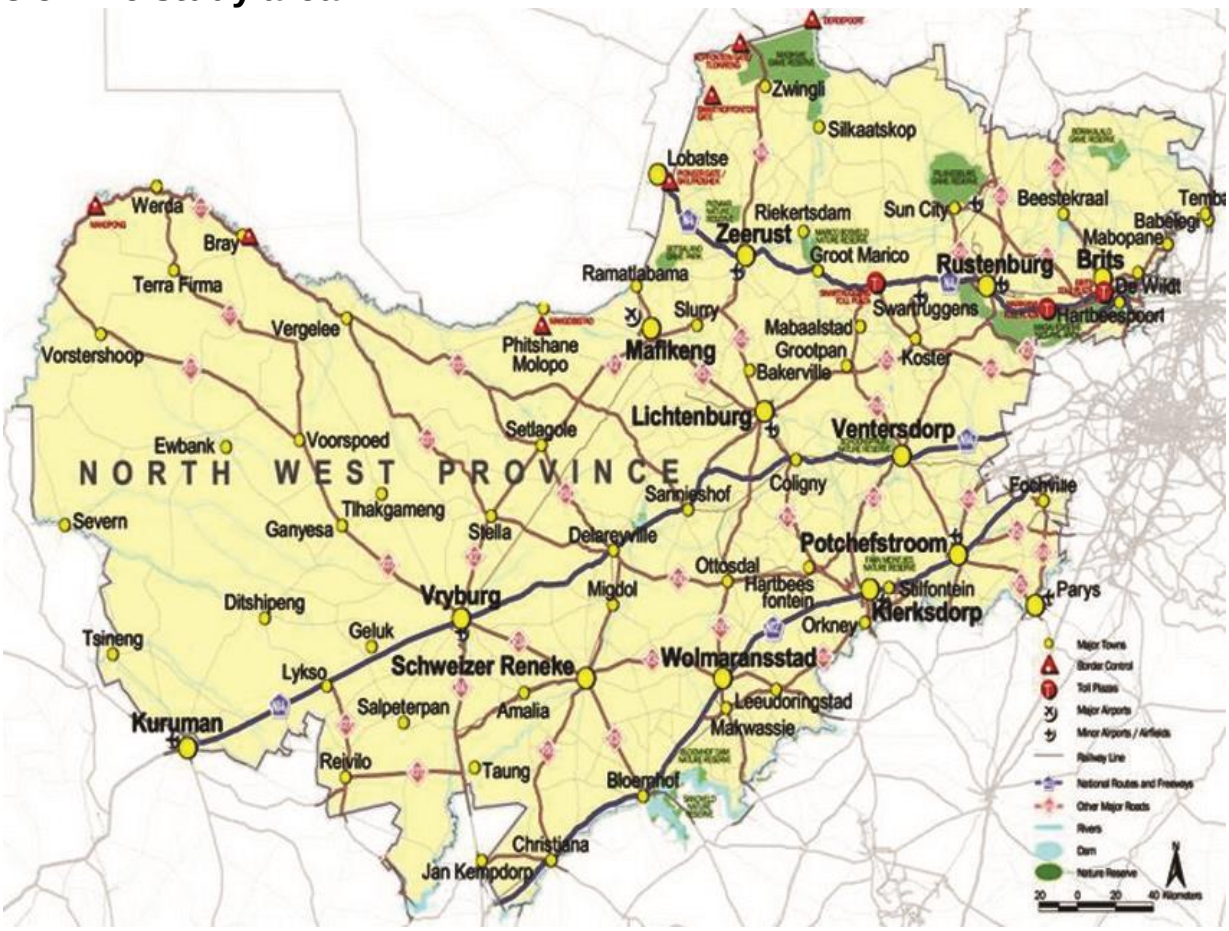


Figure 3.5: North West Province Map
Source: www.practicegroup.co.za

The study was conducted in the North West Province, South Africa. The main areas of study were Mafikeng, Potchefstroom, Klerksdorp, Rustenburg, Kuruman, Vryburg and Zeerust. Department of Mineral Resources (DMR: 2018) indicates that North West has the second highest number of abandoned mines with 1 040 out of 6 000 in South Africa. This is 17% of the total abandoned mines in the country. Department of Mineral Resource and Energy (DMRE, 2021) reported 20 bodies of suspected illegal miners commonly operating in obsolete shafts in Orkney and Stilfontein in North-west Province were found and this is an indication of one of the risks associated with disused abandoned mines in the country and Table 3.4 shows the distribution of derelict mines across provinces in South Africa. The table indicates that there are more abandoned

mines in North West than Free State and Eastern Cape because the gold green belt lies along the northern part of the country. There was a lot of mining concentration seeking for precious minerals such gold along the northern belt. This caused the myriad of abandoned mines after mining had ceased.

Table 3.4: Estimated Derelict and Ownerless Mines in South Africa

Derelict and Ownerless (D&O) Mine Sites Distribution

Province	Total Number of D & O's
Eastern Cape	326
Free State	226
Gauteng	360
KwaZulu Natal	410
Limpopo	886
Mpumalanga	794
North West	1040
Northern Cape	1065
Western Cape	866
Total	5976

Source: Department of Mineral Resources and Energy (DMRE) South Africa (2019)

3.6. Time Horizon

Saunders et al (2015) suggest that, next to the inner core of the research onion model is "time horizons" that can be classified as cross-sectional and longitudinal. Cross-sectional studies focus on a particular phenomenon at a particular time while a longitudinal study gives a representation of events over a period. In this study, the time horizon was cross-sectional and data collection was once off. Proper management strategies are necessary in tackling the negative legacies of apartheid mining activities.

Due to the time constraints in conducting this study project, a cross sectional approach was adopted.

3.7. Sampling techniques

There are two broad methods used to draw sample in a research study and these are probability and non-probability. The sizes of the quantitative and qualitative samples are unequal given the nature of quantitative research to generalize findings to a population whereas the qualitative sample provides an in-depth understanding of a small group of individuals. In this study, a stratified random sampling was used for the quantitative part of the study because the population had different strata and the researcher needed to ensure that the groups are fairly represented in the sample. Alvi (2016:20) argues that this type of sampling method is used when a population is heterogeneous, and every element of population does not match all the characteristics of the predefined criteria. The population was first divided into strata. A stratum is a subset of the population that shares at least one common characteristic. These strata were based on job specification and availability. Yin, (2014:42), argues that the language of sampling implies a desire to achieve statistical generalisability, and understanding that would be consistent with the common dictionary definition. The sample represented permits the researcher to make inferences and generalisations and to draw conclusions about the entire population. Mixed methods sampling requires an understanding and acknowledgement of the sampling strategies that occur in qualitative and quantitative research.

3.7.1. Qualitative sampling (Phase 1)

A carefully considered representation of former mine workers and experts in the mining industry specializing in abandoned mines was chosen for qualitative interviews. The non-probability convenience sampling of 20 participants was used for structured interviews. This method relies on the availability of interviewees by virtue of their accessibility and willingness to participate. This method of sampling is the least expensive, least time consuming and most convenient until saturation plus two was reached. The convenient sampling technique provides valuable information related to

the research questions. Non-probability sampling is the most helpful for exploratory stages of studies such as a pilot survey. Qualitative studies in social research tend to utilize non-probability sampling. The issue of sample size in non-probability sampling is rather ambiguous and needs to reflect a wide range of research-specific factors in each case (Dudovskiy, 2016:15). Non-probability sampling is a technique in which each unit in a population does not have a specifiable probability of being selected (Bryman & Bell, 2015:135).

3.7.2. Quantitative sampling (Phase 2)

The target population of this study was all mining stakeholders from different towns in the North West province. The study followed the exploratory sequential design, and a stratified sampling method was used because the population was divided into segments called strata. According to Dawson (2009:9) the use of a stratified sampling technique provides more precision than simple random samples of the same size. A population of n=180 respondents were approached and a semi-structured questionnaire by electronics means due to Covid-19 protocols. Virtual meeting was scheduled with respondents and a total of n=160 respondents completed the survey instrument out of the scheduled n=180 targeted respondents.

The number of constructs established in the qualitative analysis was determined by the size of the sample for factor analysis. Exploratory factor analysis (EFA) aims to identify underlying constructs (latent variables) that are either unknown and cannot directly be measured (Hamid 2014:10). Costello and Osborne (2005:5) are of the view that, “factor analysis is a technique for the identification of groups and clusters of variables”. This technique has three main uses, namely, to understand the structure of a set of variables, to construct a questionnaire to measure an underlying variable and to reduce a dataset to a more manageable size while retaining as much of the original information as possible.

3.8 Data Collection Instruments

A total of 200 semi-structured questionnaires and interviews were administered by the researcher to collect both quantitative and qualitative information from participants. To ensure a high response rate, respondents' schedules were stretched over 30 days period for both quantitative survey and qualitative interviews. A follow-up was made, and the responds rate was approximately 90%. The questionnaires covered a broad spectrum of what the researcher desired to achieve in solving management problems of rehabilitation of abandoned mines in North West Province, South Africa. The semi-structured questionnaires (quantitative) and interviews (qualitative) provided greater scope for discussion and learning about the problem, opinions, and views of the respondents. The study considered related studies by other scholars such as Florio & Leoni, (2017:61); Gagoitseope & Pansiri, (2012:56); Hoyt & Liebenberg, (2011:803); Pansiri & Temtime, (2008:255).

3.8.1 Research instrument in qualitative research (Phase 1)

The research instruments used in this phase 1 include interview schedules, virtual face-to-face interviews and telephone calls to the interviewees as the means of administration. The questions were designed by the researcher, included open ended questions and follow up on questions that focused on the research objectives as developed in chapter one. The interviews provided direct insights and an in-depth understanding of research problems under investigation. Interviews were conducted with key informants who have vast experience in the mining industry, particularly abandoned mines. These were people who once worked in mines, senior communities' leaders, councillors, and business leaders. The interview guide assisted in establishing constructs to measure the phenomenon of interest (disused abandoned mines).

The researcher developed the interview guide based on the set of themes generated through extensive review of literature and aligned with the research objectives. Once the interviews were conducted, they were transcribed verbatim and data were then coded, and themes grouped. The interview questions were grouped into four sections namely, perception and knowledge, strategies with regard to rehabilitation of

abandoned mines, financing and government policies. The study followed Adelowotan's (2013) procedure to increase the response rate during the data collection period as follows:

- The researcher sought permission and informed consent (see Annexure A) from the participants in the study. The researcher sent written invitation letters to the respondents explaining the purpose of the study. The letters were sent a month before the interviews.
- The researcher guaranteed and reassured participants of confidentiality and anonymity and that the data collected would be used solely for the purpose of this study.
- The duration for the answering questions was 30-40 minutes to enable respondents to adjust their schedules and plan their activities without causing inconvenience.
- The researcher clearly stated the reasons for conducting the study and explained why the specific respondents were chosen and what would happen to the interview data.
- Respondents were encouraged to ask questions to help establish rapport with the candidate.
- The researcher sought consent to take notes during the interviews, as the participants did not give consent to be recorded.

3.8.2 Research instrument in quantitative research (Phase 2)

The researcher designed and developed semi-structured questionnaires that were administered to the sample population. The questionnaires were administered via online platforms such as email, and LinkedIn to the respondents. Due to Covid-19 restrictions, the researcher ensured that no physical contact was made with participants. However, contact with participants was made using virtual means and telephone. The study used sequential exploratory design. All questions were aligned to the research problem and questions as set in chapter one. A 5-point Likert scale rating was utilised for the study because it gave respondents alternatives. Cooper and Schindler (2011) argue that "a structured questionnaire provides responses that could be sectioned as dichotomous,

multiple-choice, checklist, rating or ranking." Section one of the study elicited data on demographic profiles from participants. Section two of the research questions the 'gurus' opinions on abandoned mines in South Africa. Section three examines the impacts of mining and section four focussed on financing for rehabilitation of abandoned mines.

Collection of data from relevant sources assisted in finding answers to the research problem and assist in the development of the framework. The outcome of both qualitative and quantitative data also assisted in crafting the proposed framework for the rehabilitation of abandoned mines in South Africa. The following procedure was followed to elicit responses from participants:

- The researcher sought permission and informed consent (see Annexure B) from the participants to participate in the study.
- Participants were assured of the utmost confidentiality.
- Participation was voluntary and no money was paid for participation.
- The respondents were given the opportunity to ask for clarification in places where they were not certain of the question.
- The survey took 30-40 minutes to complete and this assisted participants to plan their time in answering the questionnaires.
- Information gathered during the research was used solely for the purpose of this study.
- Data gathered was captured in a database and statistically analysed for research purposes only.
- Collection of data was through LinkedIn, WhatsApp and Email.

This method was quick as the respondents completed the questionnaires within the time allocated. To minimize non-return of questionnaires, the researcher made a follow up and the response rate was 82%. This was quite a remarkable response given the restrictions imposed by Covid -19.

3.9 Reliability and Validity

The study used questions and frameworks from literature review to construct the questionnaire (See Annexure A) for the quantitative phase 2. A five-point Likert - scale was used to develop the questionnaire with the following ranges: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The study provided instructions to the participants on specific sections to answer in the questionnaire during the survey. Cronbach's alpha tests for reliability and consistency were used to test the reliability of the questionnaire. Valid and reliable findings and interpretation thereof were supported by statistical analysis, discussed in detail in the chapter on the presentation of results. Babbie (2013:25) confirms that reliability and validity are imperative in ensuring the credibility of research. Reliability is the extent to which a measurement of a phenomenon provides stable and consistent results over time and place (Taherdoost, 2016:29). If we attain the same results repeatedly, then the measure is considered reliable. It refers to the extent to which results are constant over time and provide an accurate representation of the total population under study. Scholars such as Cortina, (1993:99); Vaske, Beaman,and Sponarski, (2017: 165) argue that an instrument is reliable if it is consistent each time it is used to measure the same subject under the same conditions. The generally acceptable level of Cronbach alpha is 0.6 to 0.7, while 0.8 to 0.95 are considered to be perfect scores. However, scholars such as Vaske et al., (2017:165) recommended 0.6 as acceptable reliability.

Validity, on the other hand, ecompasses the experimental concepts and establishes whether the results obtained meet all the requirements of the scientific research methods and how truthful the results are. Validity is concerned with the integrity of the conclusions that are generated from research (Bryman & Bell, 2015:540). Reliability and validity ensure the accuracy of the study so that the results may enhance full understanding on the topic. The concepts used in this study are management and rehabilitation of abandoned mines. The researcher is confident that the method used in this study generated correct and truthful results in compliance with the institution standards.

3.10 Data presentation, analysis and interpretation

This section focuses on how the data was collected, analysed, interpreted and the findings disseminated in the study. The process of data analysis involves arranging and bringing logical order to the huge amount of data collected. An analysis of the results crystallises the validity and reliability of the data used. The logic behind was to answer the research questions in line with the objectives of the study. Lawrence and Tar (2013:29) define data analysis as the process of exploring and categorizing the data by themes to develop an informed understanding of the study. In this study, qualitative and quantitative analysis methods were employed.

3.10.1 Qualitative data analysis (Phase 1)

Qualitative analysis method focused on the qualities of phenomena studied rather than their numeric measurement. Qualitative data collected through semi-structured interviews were analysed and interpreted using thematic analysis.

3.10.1.1 Thematic analysis

Thematic analysis was used to explore questions about participants' lived experiences, perspectives, behaviours and practices, the factors and social processes that influence and shape particular phenomena, the explicit and implicit norms and 'rules' governing particular practices, as well as the social construction of meanings and the representation of social objects in particular texts and contexts (Braun et al, 2019: 589). This method emphasizes on both organization and rich description of the data set and theoretically informed interpretation of meanings.

In qualitative data, the researcher read the data intensively from the interviews and coded it. The coding process generated categories of relevant data bits. The coded data was analysed on an on-going basis. The researcher used ATLAS.ti for the qualitative analysis of large bodies of textual, graphical, audio and video data. Open-ended questions allowed the researcher to conduct in-depth interviews with the respondents (Creswell & Plano Clark, 2011:119). This interview protocol provides the researcher with

an in-depth knowledge of the possible relationship between the independent variable and the dependent variable in this research.

Qualitative data analysis gave the researcher an opportunity of understanding the interviewees' perceptions, and feelings about the impact of abandoned mines in South Africa and how they have brought untold suffering in their lives. The researcher created relationships with the participants and made them secure, confident and relaxed to speak their minds. This helped the researcher to solicit more useful information from the participants. The data analysis part therefore answered the basic questions raised in the problem statement, "developing a framework for the management and rehabilitation of abandoned mines in South Africa." Below is an illustration of Braun and Clarke's thematic analysis approach for developing themes from qualitative data.

Strategic measures to ensure the quality of the data collected: Trustworthiness of qualitative and quantitative data

Credibility: The researcher shared and discussed with the respondents how best they could assist in the study, the purpose of the research and the full assurance on confidentiality and anonymity of the respondents.

Dependability: The researcher ensured dependability in this qualitative study, as the researcher remained diligent and thorough in conceptualising the study, gathering the data, deducing the findings and recording the results. The term dependability in qualitative research can be defined as data consistency over a period of time and circumstances. This is an evaluation of the quality of cohesive procedures of data collection and analysis of data.

Trustworthiness: An attempt was made by the researcher to provide reassurance that their details would not be disclosed to other parties thereby guaranteeing their personal data. The provision of background data was used to establish context of study and detailed description of phenomenon in question allowed degree to which findings are transferable.

Confirmability: This is the degree to which the outcomes could be verified or substantiated by other researchers. The researcher detailed the data collection process, analysis and a full explanation of the research findings.

Authenticity: All relevant information gathered in the course of the field work was carefully recorded and transcribed as shown in Figure 3.6.

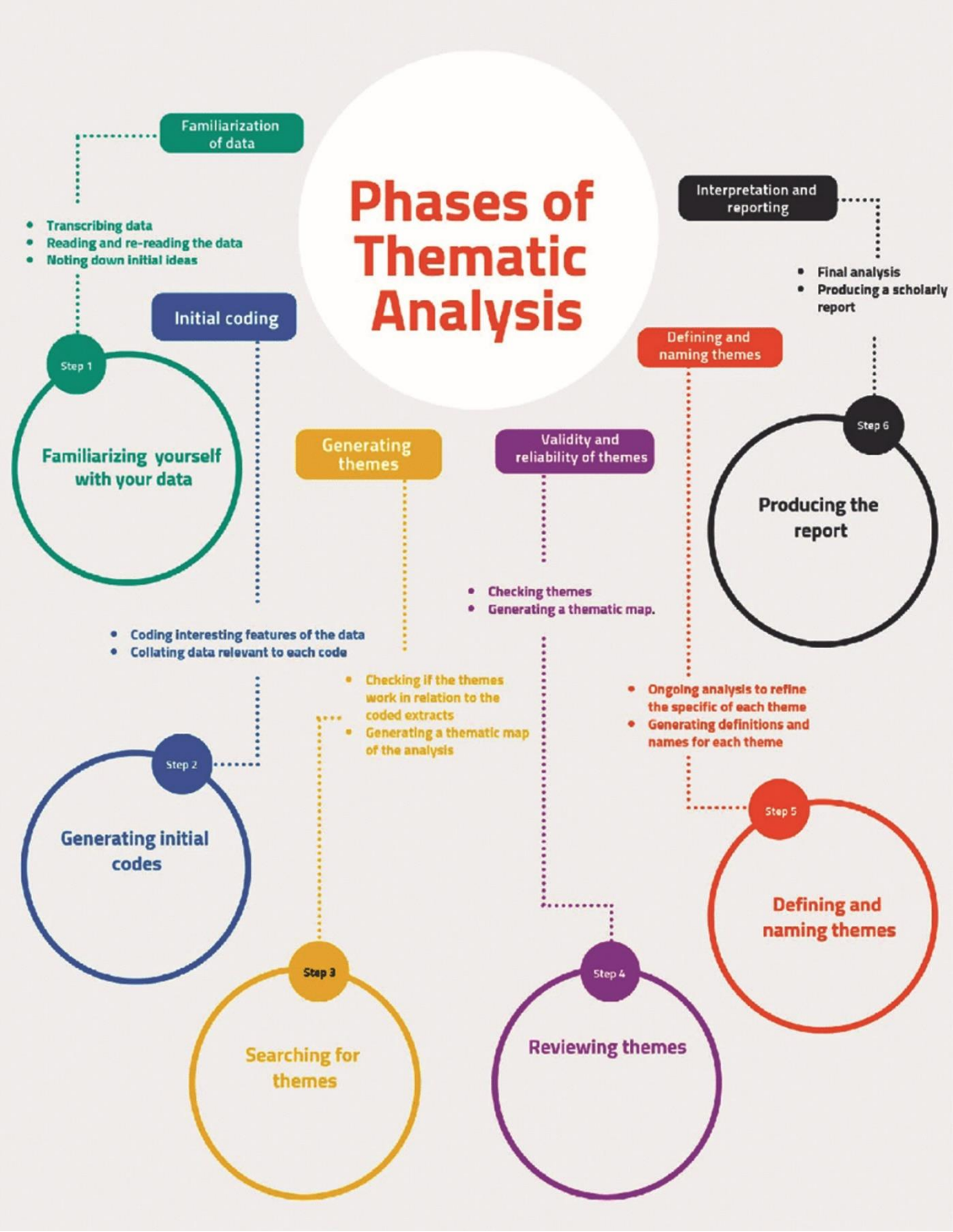


Figure 3.6: Braun and Clarke's thematic analysis approach for developing themes from qualitative data
Source: (adapted from Braun & Clarke, 2006:87).

There are six-phase processes for thematic analysis based on the work of Braun and Clarke and their reflexive approach to thematic analysis (Braun et al, 2012: 57) as shown in Table 3.5. Thematic analysis provides a flexible method of data analysis and allows for researchers with various methodological backgrounds to engage in this type of analysis. Clarke and Braun (2013) posit that the main objective of the thematic approach is to establish themes, i.e. patterns in the data. These themes are then used to address the research problem. This study adopted the thematic framework consisting of six steps from the moment the data was collected to the last level when a report was extracted.

Table 3.5: Braun and Clarke's six phases of thematic analysis

Phase	Process	Result	Reflexivity Journal Entries
Phase 1	Read and re-read data in order to become familiar with what the data entails, paying specific attention to patterns that occur.	Preliminary "start" codes and detailed notes.	List start codes in journal, along with a description of what each code means and the source of the code.
Phase 2	Generate the initial codes by documenting where and how patterns occur. This happens through data reduction where the researcher collapses data into labels in order to create categories for more efficient analysis. Data complication is also completed here. This involves the researcher making inferences about what the codes mean.	Comprehensive codes of how data answers research question.	Provide detailed information as to how and why codes were combined, what questions the researcher is asking of the data, and how codes are related.
Phase 3	Combine codes into overarching themes that accurately depict the data. It is important in developing themes that the researcher describes exactly what the themes mean, even if the theme does not seem to "fit". The researcher	List of candidate themes for further analysis.	Reflexivity journals need to note how the codes were interpreted and combined to form themes.

	should also describe what is missing from the analysis.		
Phase 4	In this stage, the researcher looks at how the themes support the data and the overarching theoretical perspective. If the analysis seems incomplete, the researcher needs to go back and find what is missing.	Coherent recognition of how themes are patterned to tell an accurate story about the data.	Notes need to include the process of understanding themes and how they fit together with the given codes. Answers to the research questions and data-driven questions need to be abundantly complex and well-supported by the data.
Phase 5	The researcher needs to define what each theme is, which aspects of data are being captured, and what is interesting about the themes.	A comprehensive analysis of what the themes contribute to understanding the data.	The researcher should describe each theme within a few sentences.
Phase 6	When the researchers write the report, they must decide which themes make meaningful contributions to understanding what is going on within the data. Researchers should also conduct "member checking". This is where the researchers go back to the sample at hand to see if their description is an accurate representation.	A thick description of the results.	Note why particular themes are more useful at making contributions and understanding what is going on within the data set. Describe the process of choosing the way in which the results would be reported.

Source: Braun and Clarke's six phases of thematic analysis (2006:87)

3.10.2 Quantitative data analysis (Phase 2)

On the other hand, quantitative method focused on data that was collected and recorded numerically or in the form of categories. Through this quantitative method, the researcher analysed, interpreted the data, and presented the findings in tables, graphs and pie charts for easy analysis. The presentation of data in graphical and pictorial formats promoted effective communication and understanding of the information by participants. The researcher coded the data. Neumann (2000) defines coding as a

system of marking/labelling something with letters/symbols so that facts about it can be understood. The Statistical Package for the Social Sciences (SPSS) Version 22 was used to analyse the data through various functions statistically and tested the hypothesis. This involved the following:

Firstly, descriptive statistical techniques were used to analyse the demographic characteristics of the respondents. The result were presented in the form of frequency distribution, tables, cross-tabulations, pie charts and histograms was used to illustrate the age, sex, and educational level of the respondents. Secondly, inferential statistics were used and the results were presented in the form of means, mode and standard deviations. Teddlie and Tashakkori (2009:22) argue that inferential statistics are used to confirm or disconfirm descriptive findings between groups and relationships between variables. Pearson Cronbach's Alpha was used to determine the reliability of the quantitative data. The researcher used logical regression analysis to determine relationship and also use factor analysis to explain other factors that can also influence the relationship between the main variables of the research.

According to Loeb *et al*., (2017:2), descriptive statistics are a short description of measurements that sum up a given dataset, which could be either a picture of the whole or a sample of a population. The study was quantitative and used data that was changed into a readable format by SPSS software. The process starts with data coding where codebook contains outlined description of each variable in the study that is measured numerically through five-point, seven-point or any other kind of scale that use Likert scale. After the data is formatted into a numerical format, it can be entered into an Excel spreadsheet that was exported into SPSS program.

Challenges such as missing values, are unavoidable in research but should be noticed earlier during pre-test and corrected before the data gathering process commence. In the event of data entry, missing values may be shown as blank entries by some statistical programs, while other missing values need to be entered with numerical values like -1 or 999 to reflect as missing values. Statistical programs, like SPSS and SAS, can eliminate biases of missing values by replacing them with an approximation

value through an exercise called imputation. Where an average of other respondent's responses to the item is used as an imputed value.

The coder must ignore bad data, like reverse-coded items and responses that are the same throughout the research instrument regardless of the content. The coder must also modify data, in the case of reverse-coded items and same answer throughout the questionnaire, before it can be correctly interpreted. According to Jiang (2018:95), the correlation coefficient is an arithmetical estimate of the soundness and trend of the relationship between the comparative movements of two variables. The commonly used correlation coefficient is Pearson correlation which quantifies linear correlation that exists between two variables situated in the (X) and (Y) axis. Pearson correlation is unable to express non-linear relationships between two variables nor distinguish between dependent and independent variables.

The strength of the correlation coefficient is between -1 and +1 values. If the value is positive, it means the relationship between variables is strong. When the value is negative, again the relationship between variables is weak. Also, when the value is 0, it means there is not a relationship between variables. The p-value of 0.05 suggests the association among variables is significant. The course of the association is determined by either a positive or negative sign of movement of variables. If both variable increase or decrease together, the coefficient is positive and the line representing the slope of the correlation coefficient moves upwards. However, if both variables are moving the opposite direction, where one is increasing and the other decreasing, the correlation coefficient will be negative and the line of the slope moves downwards.

As a result, when one variable changes, it does not mean it is caused or affected by the other variable, in this case, there is a need to conduct a properly controlled experiment to determine the cause of the change in a relationship. Pearson correlation coefficient is sensitive to very high or very low data values, and causes of such extreme values should be identified and measurement errors corrected. Some variables have a non-linear relationship, as a result, depict a low Pearson correlation coefficient, and this does not mean there is no relationship between variables is concerned.

According to Watkins (2018:220), exploratory factor analysis (EFA) is when an applicable group of variables indicates an inter-dependence to realize the latent factor are grouped to observe internal reliability. EFA is often suggested when there is no hypothesis concerning the fundamental factor design of the scale. As a result, when the researcher does not have a hypothesis, EFA should be adopted to observe variables that are not directly noticed but are rather deducted from variables that are noticed. EFA assumes there is a linear relationship between variables and factors need to have about three (3) variables. However, a factor that has two (2) variables may be considered reliable if the variables have a high correlation among themselves were ($r > 0.70$) but are not correlated with other variables. The researcher is encouraged to use EFA when the sample size is more than 300 respondents and factor analysis has between five (5) and ten (10) observations, because with large sample size error in data lessens.

The older methods using the Kaiser criterion is a preselected option in SPSS, where variables that have Eigen values under 1.0, are not included by a researcher to work with factors that have confidence interval more than 1.0. The Cattell scree test has had a criticism of dropping all elements from the one beginning on the elbow because it is easily controlled by the researcher. The other challenge is the researcher unwillingness to use resources to maintain 90% of the variation, where standard could be 50% low.

However, a modern model by Monte-Carlo matches the noted eigenvalues with the one acquired from uncorrelated normal variables. In this model, a factor is kept only when eigenvalue is greater than the 95% of the spread of eigenvalue achieved from unsystematic data. EFA is an interdependence model where there are no dependent variables, independent variables or causality. It undertakes that data rating can be reduced to a significant magnitude because some characteristics of variables are connected. The advantage of EFA is that both objective and subjective characteristics can be utilized on condition that subjective characteristics can be changed into scores, and it can recognize latent theories that straight analysis may not. However, a

limitation of EFA is that the named factors may not correctly indicate the variable that is within a factor, because variables may correlate but reflect no meaning for the factor. The results from EFA may be hard to reproduce and the researcher should survey a large sample in a specific time to reduce the margin of error in the data.

3.11 Ethical considerations

The researcher was aware of the need to adhere to sound ethical practices that lend credibility to the study. Ethical issues are important in qualitative and quantitative research. Neumann, (2000) defines ethics as a set of moral principles suggested by an individual or groups which are widely accepted, and offers rules and behavioural expectations about the most correct conduct towards experimental subjects and respondents. Consequently the study was guided by the following fundamental ethical considerations. In this study, participants were given adequate information on the aims of the research, procedures, credibility of the research and how the results were to be used (See Annexure A). According to Van Zyl (2014:115) participants are given enough information pertaining to the study before data collection. The researcher ensured the participants that there was no harm as a result of their participation in a research (Zikmund, Babin, Carr and Griffin, 2012: 92: Collis and Hussey, 2013:32) and information obtained was private and was not passed onto others. The researcher ensured participants that they would remain anonymous to protect their identities in the research hence the use of codes to represent them. The researcher obtained permission from relevant ministry to carry the research. University‘s ethical committee (Annexure C) issued a clearance to sanction the anonymity and confidentiality of the research participants and for the protection of the researcher‘s reputation. No incentives were given to participants.

3.12 Limitations of the study

The study was limited by the reluctance of some of the respondents to complete the questionnaires and those who failed to complete them at all. 22% of respondents did not respond at all. Their participation would have added a lot to the knowledge gap in the management and rehabilitation of abandoned mines. Timing of the study also hampered the study. The outbreak of deadly Covid-19 contagion affected the results

because movement and contact with participants was not encouraged. The study only concentrated on North West Province and did not examine other parts of the country. A larger coverage of mining and rehabilitation would have contributed hugely to the outcomes of the study.

3.13 Chapter summary

This chapter focused on the choice of methodology used to conduct the study of developing a framework for the management and rehabilitation of abandoned mines in South Africa. The research focused on 200 participants and a stratified sampling was selected for quantitative analysis and a convenience method was also selected for qualitative data. Stratified sampling helps to overcome the problem in which simple random sampling results in some members of the population being under or over represented. The researcher used sequential exploratory mixed method design in this study. This allowed the researcher to design and develop data collection instruments. The chapter discussed the research paradigm, research approach, design, justification for exploratory sequential design, study population, sampling methods, data collection instruments, validity and reliability of the study, data analysis and ethical issues followed in carrying this study. Limitations of bias were also explained in this chapter. The next chapter presents qualitative data findings and thematic analysis to interpret the results.

CHAPTER FOUR
QUALITATIVE DATA ANALYSIS AND INTERPRETATION

4.0. Introduction

The previous chapter outlined the research methodology and discussed issues such as the study's research philosophy, design, population, sampling, and data collection techniques. It also explained the mixed-method research approach and the sequential exploratory design of the study. This chapter presents qualitative data, executes an analysis and discussion of findings. The chapter discusses the themes that emerged from semi-structured interviews conducted with key informants who have vast experience of working in the mines and who bore the brunt of the daily challenges and difficulties of living in and around abandoned mines. The key informants are classified as Former Miners (FM01), Councilors (CS01), Business leaders (BL01) and Senior Community Leaders (SCL01). These granted the researcher consent to carry out the study and the interviews were recorded and transcribed. The interviews provided direct insights and an in-depth appreciation of the study's questions.

Themes were derived from the research objectives and research questions based on the participants' perceptions and views on developing a framework for the management and rehabilitation of abandoned mines in South Africa. The problems faced by communities around abandoned mines are so severe that the government's intervention is needed to minimise the impact that abandoned mines have on the population and other inhabitants. Braun and Clarke (2006) state that, "thematic analysis was used to explore questions about participants' lived experiences, perspectives, behaviour and practices, the factors and social processes that influence and shape particular phenomena, the explicit and implicit norms and 'rules' governing particular practices, as well as the social construction of meanings and the representation of social objects in particular texts." In developing the basic themes, rigorous analysis of the textual data was collected from the interviews. A web-like thematic network starting from the basic themes and working inwards towards organising themes and a global theme were

established respectively. Furthermore, Braun and Clarke (2006:87) submit that “an analysis should provide a concise, coherent, logical non-repetitive and an interesting account of the story the data tells within and across themes.”

4.1. Participants

The non-probability convenience sampling of 20 participants was used for structured interviews. This method uses the availability of interviewees by virtue of their accessibility and willingness for them to participate in this study and this would generate useful data for the research. Convenient sampling technique provides valuable information related to the research questions. These participants were assigned codes as Former Miners (FM01), Councilors (CS01) and business leaders (BL01) and Senior Community Leaders (SCL01). This assisted in keeping participant’s names anonymous as per ethical conduct.

Table: 4.1. Coding key system of participants

Group Name/Category	Code assigned
Former Miners	FM01
Councilors	CS01
Business Leaders	BL01
Senior Community Leaders	SCL01

Source: Own Source

4.2. Interview structure

This segment of the results chapter was structured into four sections. The first section focused on perception and knowledge of management of abandoned mines. The second section focused on financing and strategies to be implemented in the rehabilitation of abandoned mines in South Africa. The third section deals with government policies in eradicating the dangers and harm caused by negative legacy of abandoned mines. The fourth section examines implementation, checks and balances as well as recommendations to curb the challenges posed by abandoned mines in South Africa. The following is an outline of interview questions asked during the final interview and extracted from Annexure B.

Section one: Perception and knowledge of management of abandoned mines.

a. How long have you been staying around this abandoned mine?
b. What are the challenges relating to abandoned mines and how have they affected your daily lives and business operations?
c. What do you think are the causes of abandoned mines?
d. How much do you know about abandoned mines?
e. Do you feel the public are empowered with knowledge to make informed decisions about rehabilitation of abandoned mines in South Africa?
f. How much assistance are you receiving from both Government and Non-Governmental Organisation (NGO) in solving these challenges?

Section two: Financing and strategies implemented in the rehabilitation of abandoned mines in South Africa

a. What do you think should be done to control the problems that the communities are facing?
b. Tell us about strategies in place that have been implemented in the rehabilitation of abandoned mines in South Africa?

Section three: Government policies in eradicating the dangers and harm caused by negative legacy of abandoned mines

a. Do you feel the government has the fiscal muscle to implement adequate policies to minimise the problems associated with rehabilitation of abandoned mines?
b. How much community support exists for the rehabilitation of abandoned mines in South Africa?
c. What are the shortcomings in practice in relation to abandoned mines management and rehabilitation of abandoned mines in South Africa?
d. Does the mine rehabilitation identify all possible domains?
e. What lessons has the government learnt in the handling of abandoned mines in South Africa?

f. What policies and strategies have been put in place to make sure that current miner would not fall into the previous miners disused mines death traps??

Section four: Implementation, checks and balances as well as recommendations to curb the challenges posed by abandoned mines in South Africa

a. With due regard to the above-mentioned challenges concerning the rehabilitation of abandoned mines, what do you think would be the way forward to generate sustainable solutions to the problem?
b. How should responsibility and costs of abandoned mines be shared between the government and other stakeholders?
c. Who do you think is responsible for the high costs of rehabilitation of abandoned mines in South Africa?
d. Do you feel the estimated R 60 billion allocated to rehabilitate all 6 000 abandoned mines in South Africa is sufficient given the socio-economic, environmental and political challenges facing the country in the wake of COVID-19 pandemic. Briefly explain?
e. What successes have been made in the rehabilitation of abandoned mines in South Africa?
f. If all stakeholders including government were taken on board to roll out initial planning, given the Finance Act, would their input add value to the implementation of the rehabilitation of abandoned mines as a best practice of finding out an amenable solution?
g. What recommendations do you have for the rehabilitation of abandoned mines in South Africa?

All questions above were answered by the participants and their responses were used in development of a modified framework for management and rehabilitation of abandoned mines.

4.3. Qualitative analysis

Qualitative analysis is a rigorous and logical process through which data is examined to establish variegated meanings. Qualitative data provide rich descriptions and explanations that demonstrate the flow of events as well as often leading to opportune (chance) findings. In qualitative data, the researcher read the data intensively from the interviews and coded the data. The coding process generated categories of relevant data bits. The coded data was analysed on an on-going basis. Creswell and Plano Clark, (2011:119) state that, "qualitative research presents data in descriptive narrative with texts, words and attempts to understand the meanings of a phenomenon in natural settings". Open-ended questions in the questionnaire instrument allowed the researcher to conduct interviews with the respondents (Creswell & Plano Clark, 2011:119). Qualitative data analysis gave the researcher an opportunity of understanding the interviewees' perceptions, and feelings about the impact of abandoned mines in South Africa and how they have brought untold suffering in their lives. The researcher created relationships with the participants and made them more secure, more confident and more relaxed to speak their minds. This helped the researcher to elicit useful information from the participants. The data analysis part therefore answered the basic questions raised in the problem statement, "developing a framework for the management and rehabilitation of abandoned mines in South Africa." Qualitative data analysis pay attention to the 'spoken word', context, consistency and contradictions of views, frequency and intensity of comments, their specificity as well as emerging themes and trends.

Strategic measures to ensure the quality of the data collected: Trustworthiness of qualitative and quantitative data

Credibility: is the use of persistent observations; triangulation (of data, methods, theories and investigations); member checks (where data and interpretations are tested with research participants. The researcher shared and discussed with the respondents how best they could assist in the study, the purpose of the research and the full assurance about confidentiality and anonymity of the respondents.

Dependability: The researcher ensured dependability in this qualitative study, as the researcher aimed to remain thorough in conceptualizing the study, gathering the data, deducing the findings and recording the results. The term dependability in qualitative research can be defined as the use of audit trails through the data.

Trustworthiness: An attempt was made by the researcher to provide reassurance that their details would not be disclosed to other parties thereby guaranteeing their personal data. The provision of background data was used to establish context of study and detailed description of phenomenon in question allowed degree to which findings are transferable.

Confirmability: This helps the researcher with proper checks, showing the acquaintances between data and the researchers' interpretations. The researcher detailed the information collection process, analysis of the data and a full explanation of the research findings.

Authenticity: All relevant information gathered in the course of the field work was carefully recorded and transcribed.

4.4. Thematic data analysis

The researcher was guided by steps in thematic analysis. The main thrust of the thematic analysis was to generate domains (Braun et al., 2014:118). This implies that qualitative data should be comprehended first as it provides core skills useful for conducting many other kinds of data analysis (Clarke & Braun, 2013:121). Thematic analysis offers researchers flexibility with respect to: (a) the type of research questions it can address, from personal accounts of people's experiences and understandings to broader constructs in various social contexts; (b) the type of data and documents examined; (c) the volume of data analysed; (d) the choice of theoretical and/or epistemological framework applied; and (e) the ability to analyse data with an inductive, data-driven approach or a deductive, theory-driven approach (Clarke and Braun 2013: 120-123). It is a powerful method for analysing data that allows researchers to

summarize, highlight key features of, and interpret a wide range of data sets. Under thematic network method the researcher closely examines the data in order to identify common themes. According to Braun and Clarke (2013:123), while there are various approaches to conducting thematic analysis, the most common form of thematic analysis involves a six-step process, as depicted by figure 4.1 below.

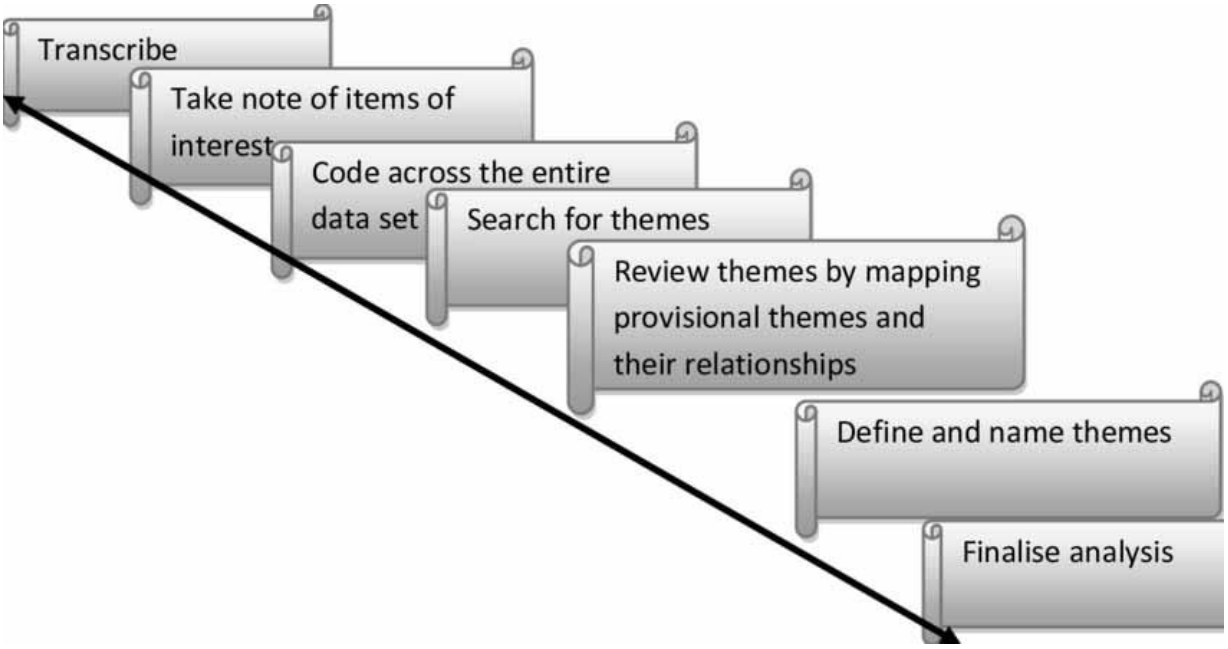


Figure 4.1: Steps in thematic analysis
Source: Adapted from Braun and Clarke (2013; 2006)

The interview was guided by the research objectives and the interview outcomes were related to the opinions and perceptions towards an adoption of a modified management and rehabilitation framework. Table 4.2 below shows comments on objectives answered and number assigned to each research objective.

Table 4.2: Research objectives (Matrix)

Number	Research objectives	Number assigned
1	Explore gaps in the implementation of the existing legislative frameworks for the management of abandoned mines in South Africa	1
2	Conduct a critical review of literature on theories underpinning the existing management frameworks for the rehabilitation of abandoned mines in South Africa.	2
3	Examine the implementation strategies of the existing Management Frameworks for the management and rehabilitation of abandoned mines in South Africa.	3
4	Propose an alternative management framework for the rehabilitation of abandoned mines in South Africa.	4

Source: Own Source

Table: 4.3. Thematic analysis from coding of themes

Description of Process	Themes	Themes with recommendation	Assign number from Table 4.2
Period of stay around abandoned mines	✓ Economic, social, and environmental challenges on lives. ✓ Crimes, prostitution, robbery and murder a daily occurrences.	✓	1
Challenges related to abandoned mines and how they have affected daily lives and business operations	✓ Mine pollution and toxic chemical contaminate water sources and air. ✓ Acid drainage causes health hazards. ✓ Lack of cooperation by stakeholders. ✓ Changes in legislation. ✓ Inadequate funding and cash flow. ✓ Robbery and theft instances	✓ Enhance forensic auditing.	1
Causes of abandoned mines	✓ Job losses and unemployment. ✓ Inadequate finances to rehabilitate.	Government intervention needed	1
Knowledge about abandoned mines in South Africa	✓ Conversant with hazards of abandoned mines. ✓ Partly knowledgeable		1,2
Public empowerment to make informed decision about rehabilitation of abandoned mines	✓ They empowered. ✓ Agreed.		3
Assistance received from both Government and	✓ No tangible proof.		3

Non- governmental organisations			
Description of Process	**Themes**	**Themes with recommendation**	**Assign number from Table 4.2**
Measures to control problems communities' faces	✓ Government to expedite rehabilitation process. ✓ Government commitment.		3
Strategies to manage and rehabilitate abandoned mines in South Africa.	✓ Government drafted legislative framework. ✓ Government allocated R60 billion for closure and rehabilitate abandoned mines. ✓ Identified approximately 6000 abandoned mines. ✓ Designed generic concrete plug to seal abandoned open shafts.	Government to enforce the legislative framework laws.	2,3
Government fiscal muscle to implement adequate policies to minimise the problems	✓ Do not have. ✓ Government lacked funding. ✓ Lack of commitment at highest political level		3
Extent of community support from Authorities	✓ Sealing of open shafts and trenches. ✓ Reduction in TB cases	✓ Rehabilitated surrounded areas should be used for agriculture and tourism.	3
Shortcomings in practice of management and rehabilitation of abandoned mines	✓ Lack of community consultation. ✓ Inadequate social impact assessment (SIA). ✓ Monitoring of post closure activities	✓ Need for Community-Based-Consultative process. ✓ Emphasis should be on	1,3

	and viable options. ✓ Dearth of information about monitoring socio-economic conditions	surrounding communities than environment.	
Description of Process	**Themes**	**Themes with recommendation**	**Assign number from Table 4.2**
Identification of possible domains	✓ Loopholes in tackling management and rehabilitation of mines. ✓ Community engagement loopholes	✓ Requires immediate attention for comprehensive closure and rehabilitation	1,3
Lessons learnt on handling abandoned mines in South Africa	✓ Lack of community engagement ✓ Slow response towards abandoned mines. ✓ Late auditing of abandoned mines.		3
Policies and Strategies in place	✓ Drafted legislative frameworks(NEMA &MPRDA ✓ Established Council for Geoscience		1,3
Solutions and way forward to challenges of rehabilitation of abandoned mines	✓ Follow environmental legislative to the letter ✓ Enough budget and legal instruments ✓ Team work by stakeholders ✓ Strategic decisions related to management and rehabilitation		1,3
Responsibility and cost sharing between government and Stakeholders	✓ Government to play a bigger picture	Overarching authority	3

Who is responsible for the costs of rehabilitation value	✓ Collective ideas brings results	Ignite supportive effort	3
Description of Process	**Themes**	**Themes with recommendation**	**Assign number from Table 4.2**
Estimated R60 billion allocated for rehabilitation of 6000 abandoned mines	✓ Fell short of actual amount	Boost needed	3
Success on management and rehabilitation of abandoned mines	✓ Developed programme of management of derelict and ownerless (D&O) of mines ✓ DMRE enforcement strict measures for closing of abandoned mines ✓ Rehabilitated some mines and sealed 268 dangerous mine openings ✓ Issuance of closure certificates ✓ Design methodology of sealing off entries to abandoned mines ✓ Database of D &O mines ✓ DMRE prioritization and ranking of abandoned mines		3
Value input to the implementation of abandoned mines as best practice	✓ Collective ideas and efforts always bring results ✓ government partnership form the first line of human contact		
Recommendations	✓ Speedy up pace		1,3,4

for management and rehabilitation of abandoned mines	✓ Prioritize risk areas ✓ Transparent on financial dealings and operations ✓ Proven method ✓ Clear roles and responsibilities of contracted companies		

Source: Own Source

The above data was obtained from the interview conducted by the researcher and the interviewees. The detailed data above emanates from the interviews conducted and conversed in line with the objectives and literature review conducted in this study. Below is a full explanation of the data and how the interviews were conducted.

4.1 Period of stay around abandoned mines

The existence of many abandoned mines that have not been rehabilitated in South Africa is a major concern as it has socio-economic and environmental ramifications for the country. They also act as hives of illegal activities for the people living around abandoned mines. Abandoned mines tend to become hot spots for small scale and illegal mining operations that create both environmental and social challenges.

4.1.1 Common theme

The question posed to the interviewees was: **May you tell us how long you have been staying around abandoned mines?**

The following were the common responses according to the participants:

Code: SCL01 said: *"We have been staying around abandoned mines for thirty years and have been facing social, economic and environmental challenges every day of our lives."* Code: FM01 said: *"We have been staying around abandoned mines for ten years and life has not been easy because of environmental problems as a result of abandoned mines. Crimes, prostitution, robbery and murder are daily occurrences."* Code: CS01 said: *"I have been staying in this place for over thirty years now. It has*

been a challenge growing up because of the daily problems that we are facing without solutions." Code: BL01 said: *"I have been operating business in this area for more that twenty-five years, but this is not a good environment so to speak. A lot of criminal activities take place day in and day out."*

4.1.1.2. Interpretation of data set

In summary, there is some consensus among people living in and around abandoned mines in South Africa that they are facing various challenges. Mhlongo and DaCosta, (2016:279-294) confirms this observation by citing that, "abandoned mines especially gold mines degenerate into hot spots for illegal and small-scale mining operations that create environmental and social challenges such as waste disposal facilities, changes in ground compaction, unused pits and steep shaft slopes and these have become death traps to surrounding communities". It is encouraged that the government should provide amenities in those places to assist people surrounding abandoned mines.

4.2. Challenges related to abandoned mines.

The challenges faced by government and stakeholders around abandoned mines are similar to the challenges faced by those that responded in Question 4.1

4.2.1. Common themes

The following were the common submissions by the participants when they were asked **"What are the challenges relating to abandoned mines and how have they affected your daily lives and business operations"**

Code SCL01 said: *"In my view the challenges that we are facing as a community include mine pollution and toxic contaminated water sources and air. People are drinking contaminated water and this is dangerous to the residents. Acid mine drainage from these abandoned mines is changing the water quality and cause health hazards to humans, animals and fish destroying our livelihood."* Code FM01 said: *"There is a challenge of cooperation by stakeholders, government, industry, communities and environmental groups in creating a lasting solution to manage and rehabilitate*

abandoned mines in South Africa." Code CS01 said: *"In my opinion I think there are challenges of changes in legislation as well as an exodus of senior management from the mining ministry to other places looking for greener pastures. This is affecting the way projects of rehabilitation take place."* Code BL01 said: *"There is inadequate funding and cash flow management which is a major challenge to the management and rehabilitation of abandoned mines. There is also poor management in the handling of rehabilitation financial resources resulting in corruption cases and this is affecting us as businesses in a mighty way. Another challenge here of abandoned mines management is to implement effective rehabilitation with limited resources, prolonging effective rehabilitation."*

4.2.1.2. Interpretation of range of data sets

In summary, pollution was cited as the order of the day and the interviewees indicated that exposure to dust remained a major problem. It is the principal environmental issues related to water pollution, soil erosion and soil contamination. Most of these complications and challenges come at a considerable cost to environmental authorities who are expected to make the sites safe, and prevent further pollution. It was discovered that communities were seldom cohesive and were not capacitated to make informed decisions. Miralas et al (2014) confirmed that, "the participation of all stakeholders in mine closure speaks to a broader inadequacy in strategic planning, technical capacity and a cooperative/regional approach all underpinned by sustainability principles". Concerning the exodus of senior management, the government contracts Mintek a private entity formed in 1934 to carry the responsibility of rehabilitation of abandoned mine sites as attested in the MPRDA Act of 2002.

With regard to cash flow management, there was need for the government to enhance forensic auditing to make sure that there was financial prudence. The surge in challenges associated with abandoned mines affected people's daily lives because when tremors occur, they endanger human safety. The researcher developed an impression that cases of corruption and misuse of Rehabilitation Fund is high in the ministry, and this delays the implementation of set rehabilitation projects.

4.3. What causes mines to fall into disuse and dereliction?

The existence of disused mines causes indescribable suffering to surrounding communities, animals and government in meeting sustainable development goals of the country.

4.3.1. Common themes

The question posed to the stakeholders was: **"What do you think are the causes of abandoned mines?"**

Code SCL01 said: *"The causes of abandoned mines depend on the circumstances for example when there is a depletion of mineral resources, mine life is terminated."* Code FM01 said: *"In my opinion the cause of abandoned mine is the exhaustion of minerals. Former miners left the mining areas unclosed to required standards."* Code BL01, said: *"There is an inadequate finance to rehabilitate the mine, undue care by previous miners to commit to environmental sustenance and rehabilitation best practices are causes of abandoned mines."* Code SC01 said*: "There continuous presence of illegal miner in the area who temper with sealed mines is a major problem affecting communities living in the vicinity of abandoned mines."*

4.3.1.2. Interpretation of range of data sets

In sum, the researcher verified that inadequate finances to rehabilitate the mines, exhaustion of minerals, undue care by previous miners to commit to best practices in environmental sustenance and rehabilitation are causes of abandoned mines.

4.4. Knowledge about abandoned mines

Abandoned mines exist because the mineral resources are depleted, the profit margins are less than investment on returns, or the outdated previous mining methods were executed without due diligence and care of human life and sustainable activities. The question posed was: **"How much do you know about abandoned mines in South Africa?"** The following were vignettes submitted by the participants:

4.4.1. Common themes

The following are some of the quotes:

Code FM01 said: *"Abandoned mines are disused mines which endanger human and animal lives."* Code CS01 said: *"These are old mines left by former miners which cause health hazards to people surrounding these mines."* Code BL01 indicated that: *"These are unused and old dated mines which cause environmental hazards and affect human lives. They pollute and release Acid water which contaminates water sources."* Code SCL01 said: *"Abandoned mines cause health hazards and untold sufferings to people surrounding them. They are the main causes of theft, prostitution, rape cases and robberies by Zama-Zamas in the area."*

4.4.1.2. Interpretation of range of data sets

The response demonstrates that groups of participants were conversant with the negative impact emanating from abandoned mines. Abandoned mines were cited as sources of health hazards, prostitution, rape cases, theft, and robberies. It was indicated that they pollute and release acid water which contaminates water bodies and endanger human and animal lives.

4.5. Public empowerment the rehabilitation of abandoned mines

The interviewees indicated that there is relationship between stakeholders' involvement and management framework for the rehabilitation of abandoned mines.

4.5.1. Common themes

The question posed to the stakeholders was: **"Do you feel the public is empowered with knowledge to make informed decisions about the rehabilitation of abandoned mines in South Africa?"** The following were some of the submissions from the participants:

Code FM01 said: *"We are not empowered with knowledge to make informed decisions on the rehabilitation of abandoned mines"* Code CS01 said: *"I think the system does not*

empower us though that is our wish. We will benefit in a mighty way if we are empowered to make decision regarding the way rehabilitation run." Code BL01 said: *"The word empower is news to us. We have been fighting the government for a long time to no avail."* Code SCL01 said: *"We do not have a say on the rehabilitation of mines. We just see government people doing what they want. We are not even recognized or consulted."*

4.5.1.2. Interpretation of range of data sets

The analysis shows that the public is not allowed to make informed decisions about the rehabilitation of abandoned mines.

4.6. Government and NGOs responses to abandoned mines

The government is dragging its feet by not barricading some of the disused pits to the extent that they remain a real and present danger in the communities.

4.6.1. Common theme

The question posed to the stakeholders was: "**How much assistance are you receiving from both the government and NGOs in solving these challenges?"** The following were some of the observed experiences.

Code FM01, said: *"The NGOs sometimes assist with medication and mosquitoes' nets to protect us from mosquitoes."* Code BL01 said: *"There is no tangible proof that the government is addressing the challenges of landscape degradation, unused mine pits and shafts in honest truth however, NGOs at times give a helping hand based on their budgets."* Code SCL01 said: *"The government is assisting us by arresting Zama-Zamas who are raping and robbing our citizens' broad day light"*

4.6.1.2. Interpretation of range of data sets

The thematic analysis suggests that there was no tangible proof that the government was addressing hazards associated with abandoned mines. The government was seen as dragging its feet by not barricading some of the unused pits to the extent that they

still remain a real danger to humans and animals. Some participants indicated that the government is assisting by arresting Zama-Zamas who are raping and robbing the citizens.'

4.7. Measures to control problems communities' faces

Progress made on any management and rehabilitation project should be shared to show high levels of transparency.

4.7.1. Common theme

The follow-up question posed was: **"What do you think should be done to control problems that communities face from abandoned and disused mines?"**

Code SCL01 said: *"The government as the sole authorities responsible for rehabilitation of abandoned mines should speed up the rehabilitation of abandoned mines through all stakeholders' consultation and engagement." Code BL01 said: "the government should deploy enough Law enforcement agencies to prevent crimes, prostitution, drug abuses, rape cases and robberies." Code SC01 said: "The government through other interested stakeholders should introduce education and awareness campaigns concerning disused and abandoned mines therefore the people will be able to make informed decisions concerning the problems."*

4.7.1.2. Interpretation of range of data sets

In view of the above theme, the government was identified as the sole authority responsible for engineering the process of management and rehabilitation of abandoned mines. The obligation is upon the government to expedite the processes through all stakeholders' consultation to control the problems faced by communities and business fraternities.

4.8. Strategies in place for the rehabilitation of abandoned mines

Pressing issues on the disruption of human lives and the environment should be dealt as a matter of urgency and strategies must be put in place to combat these problems.

4.8.1. Common theme

The statement posed to the stakeholders was: "**Tell us about strategies in place that have been implemented in the rehabilitation of abandoned mines in South Africa?"** The following were the common themes which the participants interpreted as follows:

Code CS01 said*: "The government adopted a holistic approach in the drafting of comprehensive legislative framework in addressing environmental hazards beginning with the risky affected abandoned mines in South Africa. Work is in progress!* "Code BL01 indicated: *"The government has allocated R60 billion for the closure and rehabilitation of abandoned mines in South Africa and to this end appointed Mintek as responsible for the rehabilitation of abandoned mine."*

4.8.1.2. Interpretation of range of data sets

In examining the strategies that have been implemented in the rehabilitation of abandoned mines in South Africa, the researcher found out that majority of interviewees indicated that the government adopted a holistic approach in drafting a comprehensive legislative framework that seeks to address environmental hazards beginning with risky affected areas. It was also indicated that government allocated R60 billion for the closure and rehabilitation of abandoned mines in South Africa.

4.9. Government ability to implement policies

Government as the overarching authority responsible for the negative legacies caused by outdated mining practices should have proper policies to minimise the problems associated with management and rehabilitation of abandoned mines in South Africa.

4.9.1. Common theme

The question posed to the participants was: **"Do you feel the government has the fiscal muscle to implement adequate policies to minimize the problems**

associated with the rehabilitation of abandoned mines?" The following were the common themes which the participants interpreted:

Code CS01 said: *"The government does not have enough resources to implement the policies given the costs associated with COVID-19 pandemic. If they had they should have long solved the problems we are currently facing."* Code BL01 said: *"The government lacks the funding to implement existing legislative frameworks due to inefficiency by responsible leaders. People in power are busy thinking about their pockets and forget people at grassroots level."*

4.9.1.2. Interpretation of range of data sets

In light of the above, the interviewees pointed out that the government does not have the fiscal muscle to implement adequate policies to minimize problems associated with the management and rehabilitation of abandoned mines given the costs associated with Covid-19 pandemic. Despite the fiscal deficit, the general consensus was that the introduction of the legislative acts was the best organic solution in eradicating risks associated with abandoned mines and their closure.

4.10. Extent of community support from authorities

The most affected party needs assistance to move from quagmire position to a safer zone.

4.10.1. Common themes

The question posed in this section was "**How much community support exists from the rehabilitation of abandoned mines in South Africa?"** The following are some of the quotes:

Code BL01 indicated that: *"The government is sealing open shafts and trenches. This is a welcome development to the communities because it is a giant leap in removing major risk to human and animal lives."* Code SCL01 said: *"I strongly feel that rehabilitated land surrounding abandoned mines should be used for agricultural and tourist*

attractions. This will assist in the creation of employment and solve some of the challenges we are facing." *Code SC01 said: "The sealing of open shafts will improve the safety of people and livestock."*

4.10.1.2. Interpretation of range of data sets

In summary the participants agreed that the government is in the process of sealing off open shafts, trenches and paying significant attention to some of the risks emerging from abandoned mines in the North West Province. This is an important development given the risks associated with abandoned mines and the challenges to human and animals. The support from government minimises the dangers associated with falling into disused mines and losing lives.

4.11. Challenges in the management and rehabilitation of mines

The issue of management and rehabilitation of abandoned mines is caused by the lack of clear legal and financing mechanisms and the unwillingness on the part of industry, governments and communities to form mutually beneficial partnerships.

4.11.1. Common theme

The question posed to the participants was: **"What are the shortcomings in practice in relation to abandoned mines management and rehabilitation in South Africa?"** The following are some of the quotes:

Code CS01 said: *"There are shortcomings that have been identified concerning the rehabilitation of existing mine closure practices in the country. These include lack of community consultation, and monitoring of post closure activities. To be honest communities have not been consulted to ensure their wholehearted contribution and participation in the management and rehabilitation process of abandoned mines."* Code BL01 said: *"There is inadequate social impact assessment, when it comes to rehabilitation of abandoned mines. More emphasis is placed on the environment than the surrounding communities. This highlighted a negation in the entire process of mine rehabilitation."* Code SCL01 said: *"There is lack of information about the monitoring of*

social and economic conditions in connection with the community to be affected by the abandoned mines."

4.11.1.2. Interpretation of range of data sets

The thematic analysis that there is dire need for the formation of community-based consultative process made out of community representatives, government and other stakeholders to ensure that all parties mentioned above are parties to the initiative. It was discovered that dearth of information about the monitoring of social and economic conditions needs enhancement. The monitoring of the roll out of the rehabilitation process measures enhances community capability to align with the requirements after mine closure and this forms an essential prerequisite. The emphasis should be on surrounding communities than the environment. Kabir et al (2015:154) argue that monitoring of social indicators is more difficult than those relating to the physical environmental.

4.12. Identification of possible domains

The objective of rehabilitation management is for the rehabilitated area to be self-sustaining and resilient, requiring no more management effort than surrounding undisturbed areas.

4.12.1. Common theme

The question posed was: "**Does the mine rehabilitation identify all possible domains?"** The following are some of the suggestions:

Code BL01 said: *"I have felt strongly that there are loopholes in the way government tackles the issue of rehabilitation of mines. Community engagement in the development of a mine closure, rehabilitation and decommissioning are some of the loopholes that require immediate attention for comprehensive closure and rehabilitation."*

4.12.1.2. Interpretation of range of data sets

The findings of the study demonstrate that ten interviewees felt strongly that there were loopholes in the way government tackled the issue of rehabilitation of abandoned mines. Community engagement in the development of mine closure, rehabilitation and decommissioning were cited as loopholes that call for immediate attention for comprehensive closure and rehabilitation.

4.13. Lessons learnt on handling abandoned mines in South Africa

There are many lessons we learn from the past mistakes that help us in molding our future. Likewise, the government is not spared when it comes to lessons on the professional management and rehabilitation of abandoned mines.

4.13.1. Common themes

The question posed to the participant was: "**What lessons has the government learnt in the handling of abandoned mines in South Africa?"** The participants responded as follows:

Code CS01 said: "*In my view lack of community engagement by the government is a major impediment to successfully handle and rehabilitate abandoned mines."* Code FM01, said: *"The government left rather late the issue of abandoned mines in South Africa. Former miners should have been tracked and held responsible for rehabilitation of abandoned mines."* Code SCL01 said: "*I think the government identified rather late risky mines and shafts which are a threat to animals and human. The slow rate of responding to affected areas results in loss of lives like what is happening at Orkney Mine. Illegal miners in seek of fortune are perishing and the government should move with speed to close these places for the safety of people."* Code BL01 said: *"I think the government learnt that late auditing and lack of political commitment at the highest level worsened the impacts of abandoned mines. The issue of abandoned mines should have been given first priority by the government because the problems we are facing have been there for decades without proper attention."*

4.13.1.2. Interpretation of range of data sets

In summary the government learnt that a Community-Based-Consultative process made out of community representatives, government and other stakeholders ensures that all parties contribute effectively towards the closure and rehabilitation of abandoned mines in South Africa. Former miners should have been tracked and held responsible for environmental impacts by abandoned mines. This should have at least solved the decade problems caused by the legacy of abandoned mines. The government should also enforce laws and pass heavy penalties against the offenders.

4.14. Policies and strategies in place

Policies and strategies assist in the way mine management and rehabilitation are handled. It is important that the authorities and responsible stakeholders adhere to set down policies in the fight to minimise the dangers caused by abandoned mines. It is the researcher's view that no mine or part of a mine should be abandoned until the mine plans have been brought up to date.

4.14.1. Common theme

The question read: "**What policies and strategies have been put in place to make sure that current miners would not fall into the previous miners trap?"** In response the participants had the following to say:

Code BL01 said: *"The government drafted two important legislative frameworks (NEMA Act and MPRDA act) that binds current miner in the environmental aspects concerned with the closure and rehabilitation. This a great leap in the fight to minimise abandoned mines. If properly followed with enough resources, the government will win this war against abandoned mines."* Code CS01 said: *"What I know is that the government of South Africa established the Council for Geoscience, scientific research contracted by the Department of Mineral Resources (DMR) to manage the ownerless and derelict mines database. This body should up the pace and make sure that all abandoned mines are closed and rehabilitated."*

4.14.1.2. Interpretation of range of data sets

The main aim of the study was crafted to develop a framework for the management and rehabilitation of abandoned mines in South Africa. This can only be achieved with proper policies and strategies in place to minimise the negative legacies of abandoned mines. It was verified that the government of South Africa drafted two important legislative frameworks (NEMA and MPRDA) as policies and strategies that bind current miners in the environmental aspects concerned with closure and rehabilitation of abandoned mines. It was also found out that Council for Geoscience was contracted by the Ministry of Mines to manage and rehabilitate ownerless and derelict mines.

4.15. Way forward to rehabilitation challenges of abandoned mines

The traditional weak mining regulation system by government post-apartheid era contributed to the high number of abandoned mines in the country. According to Swart (2003:2), "prior to the enactment of the Minerals Act, 1991 (Act 50 of 1991), mining companies used irresponsible mining methods with no regards towards protecting the environment and had often shirked their responsibility towards environmental rehabilitation by leaving an area unrehabilitated prior to them being liquidated or leaving the country".

4.15.1. Common theme

The question posed to the participants was: "**With respect to the above-mentioned challenges concerning the rehabilitation of abandoned mines, what do you think would be the way forward in order to come out with sustainable solution to the problem?"** The participants responded as follows:

Code BL01 said: *"In my view the only way to decipher these problems is to follow the environmental legislative framework (NEMA and MPRDA) to the letter and leave space for innovativeness in line with international best practices. Failure to adhere to environmental legislative framework will result in severe challenges looking at the way Zama-Zamas are infiltrating abandoned mines in search of fortune. You cannot blame them given the high unemployment rate in this country and the state of poverty."* Code FM01 asserted that: *"There should be enough budgets to counter the problems head*

on." Code CS01 indicated: "*I honestly feel aggrieved by these daily challenges. I think there should be team work by all stakeholders involved in order to come up with sustainable solutions rather than leaving everything in the hands of the government. It seems the burden is too much for the government and they have run out of ideas. Strategic decisions related to management and rehabilitation should come from all angles and implemented."*

4.15.1.2. Interpretation of range of data sets

The challenge of abandoned mines management is to implement effective rehabilitation with limited resources. The researcher found out that it is important to promote innovation and share experiences of success and failure. The government and all other interested stakeholders should collaborate in finding an amicable solution to combat abandoned mine problems and map the way forward. There is urgent need for a sustainable solution to the problem. Making strategic decisions related to rehabilitation is an important and complex issue and any mistake could be very expensive. It was indicated that stakeholders need to make decisions based on unbiased judgment and priorities should be given to high risk abandoned mines. The influx of Zama-Zamas in disused mines in search of gold and other precious minerals needs the full involvement of concerned stakeholders to seal and rehabilitate entrances to the mines. Morrison-Saunders and Pope (2013:212), argues that the sites pose social, environmental and financial challenges for the government, and a financial burden on taxpayers.

4.16. Cost sharing between government and stakeholders

4.16.1. Common theme

The question posed to the participant was: **"How should be responsibility and costs of abandoned mines shared between the government and other stakeholders?"** However, the participant's response was:

Code CS01, said: *"The government as the overarching authority should play a bigger role in management and rehabilitation of abandoned mines in South Africa."* Code BL01 said: *Government controls all the finances and has the fiscal muscle to implement*

decisions on the rehabilitation of abandoned mines hence should pay a bigger percentage despite the involvement of other parties." Code SCL01, said: *"The government controls everything that is happening in the country and should be responsible for the rehabilitation including the costs of closing all disused mines. Code FM01 said: "It is an open secret that the government of South Africa should be responsible for closing all open pits that are a danger to the people and its surroundings. This has been ongoing for a long time and they should have been closed decades ago. When it comes to cost sharing for the closure of abandoned mines, the government controls everything hence the greater share should come from them before other interested parties chip in."*

4.16.1.2. Interpretation of range of data sets

In summary, the researcher noted that there were mixed feelings on responsibilities and cost sharing of abandoned mines. Mine management and rehabilitation is a universal problem and not the responsibility of one entity though the whole responsibility lies in the hands of the government.

4.17. Who is responsible for the costs of rehabilitation?

Management and rehabilitation are costly projects that should be dealt with care and due diligence.

4.17.1. Common themes

The question posed was: "**Who do you think is responsible for the costs of rehabilitation of abandoned mines in South Africa?"** In response the participants stated the following verbatim statements.

Code BL01 said: *"In my view the management and rehabilitation of abandoned mines in South Africa is a complex issue given the time these abandoned mines have been in existence and lies in the hands of the government. It is the government prerogatives to make sure that all derelict and ownerless mines are closed to perfection."* Code CS01 said: *"As far as I know the government bears the financial responsibility since it is the institution that should have ensured that there are policies and regulations in place to prevent mine abandonment."* Code FM01 said: *"I strongly feel that the government's*

department of Mine Environmental Management through a programme called Mineral Policy and Promotion is responsible for the management and rehabilitation of abandoned mines in South Africa." Code SCL01 said: *"There is need for collaborative effort from all stakeholders than to let the government go at it alone. The minerals department could use other legislative tools to pursue previous holders of mining rights who caused environmental damage under the pre-MPRDA framework."*

4.17.1.2. Interpretation of range of data sets

The researcher found out that it is the sole responsibility of government to ensure that abandoned mines are managed, and rehabilitation undertaken. It has been noted that there is need for collaborative effort from all stakeholders to assist the government in the rehabilitation of abandoned mines. According to MPRDA Act 28 of 2002, Section 28, holds that, "Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorized by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment." Indeed, the government bears the financial responsibility since it is the institution that should have ensured that there are policies and regulations in place to prevent mine abandonment and their falling into dereliction.

4.18. Costs allocated for the rehabilitation of abandoned mines

Every project must be financed to kick start and it is noted in this regard that the government allocated R60 billion for the management and rehabilitation of abandoned mines in South Africa, (2018).

4.18.1 Common themes

The statement posed to the participants was: **Do you feel the estimated R60 billion allocated to rehabilitate all 6 000 abandoned mines in South Africa is sufficient given the socio-economic, environmental and political challenges facing the country in the wake of COVID-19 pandemic, briefly explain.?** The following are some of the responses.

Code BL01 said: *"The estimated amount for rehabilitation of abandoned mines fell short of actual amount because of inflationary consequences and fluctuations in the market prices. This amount of money would purchase very little if the project of rehabilitation of mines takes a long time."* Code CS01 said: *"I do not think so because the budget amount needs revisions upwards taking into account the inflation rate. This colossal amount is just a fraction of the whole R60 billion budgeted."* Code SCL, FM01 said: *"This is just a paper figure given the socio-economic and political problems bedeviling the country. There is not enough money to rehabilitate all abandoned mines in South Africa. A failure in the rehabilitation system of abandoned mines could have a knock-on effect to communities living next to abandoned mines."* Code BL01, CS01 and FM01 said: "*The corruption is at its peak in the country and there is no way that money would be accounted and made use without misappropriation of funds, as such, the beneficiaries would not benefit. It was an under estimation that the rehabilitation of abandoned mines would be done within a stipulated time with the stated budget. Rehabilitation of all abandoned mines would take a longer time than anticipated."*

4.18.1.2. Interpretation of range of data sets

As outlined in the financial provisions (2018) held for mine closure, North-West Province has the second largest allocation of R 11.9 billion. It was discovered that COVID-19 caused an unknown quantity in terms of expenditure and its toll, taking into consideration its contagion. Having other contingency plans would have had some budgetary fool proofing. Without a budget, it would not be enough to estimate whether all costs could be accounted. Notwithstanding if put to prudent use, there is no doubt that the rehabilitation would quick start. According to Minerals Council of South Africa 2020 Report, member companies of the mineral's council set aside a total sum of R60billion in various financial vehicles earmarked for rehabilitation of polluted and disused environment sites. This demonstrated the commitment and responsible behaviour by the current mining companies towards rehabilitation and overall management and to the citizens of the country, thereby making sure that mining matters to all South Africans.

The researcher found out that communities should also assist financially as the budget is not enough because they are the ones affected by ongoing pollution and health risks that these abandoned mines pose. In sum, it was also acknowledged that the full R60 billion is not a recurring annual provision, the quantum relative to mining GDP is evidence of the commitment by mining companies to their environmental obligation. The estimated 6 000 abandoned mines are too many for the South African government alone and it is not realistically clear whether the government would be able to fund rehabilitation of such magnitude. CER attorney Christine Reddell indicated, that the information provided about the costs of rehabilitation, and the companies' ability to cover costs, is inconsistent, unclear, in some cases unreliable, and not comparable.

4.19. Successes in the management and rehabilitation of mines

The rehabilitation of abandoned mines in South Africa is a thorny issue that needs collective effort from all stakeholders to gauge success. South Africa, like any other mining jurisdiction in the land, addresses physical threats to people and animals due to the large number of abandoned mines in South Africa.

4.19.1. Common themes

The question posed to the participants was: **What successes have been done on the rehabilitation of abandoned mines in South Africa?** The participant's response was:

Code BL01 said: *"In my view, the National Government of South Africa developed the programme for the Management of Derelict and Ownerless (D&O) mines of South Africa. It aims at proposing an action plan for a programme to address challenges related to abandoned mines and ensure that all D & O sites are rehabilitated to acceptable levels and helps in reducing the state's liability with respect to abandoned mines."* Code FM01 said: *"What we know is that DMRE enforces strict measures for the closing of abandoned mines, and they do not issue any closure certificates unless a mine is fully rehabilitated. This is a remarkable step given the dangers to health and animals due to abandoned mines."* Code BL01 said: *"The Department of Minerals and*

Energy developed a new strategy focusing on rehabilitation efforts in one or two areas…regions to maximize the impact of the rehabilitation programme as opposed to the previous way of rehabilitating or sealing shafts over a number of areas with small visible impact. This assists in closely monitoring progress of every project." Code CS01 said: *"DMRE managed to issue a closure certificate to Etruscan Diamonds (Pty) Ltd for mining right 38MR located at remaining extent of the farm Klipgat 18 IQ, Ventersdorp."* Code BL01 and CS01 said: *"Mine Health and Safety Council, commissioned a project to design a feasible methodology for sealing off entries to abandon and non-operational mines. Also chronic inhalation of Silica dust affects people and lower immune system. In this regard, a R 5 billion project to compensate ex-mine workers is currently underway in partnership with department of health."* Code BL01, SCL01 and FM01 said: *"The most important step by DMRE was to develop a database indicating 1 040 derelict and Ownerless mines in the North-West Province out of the estimated 6 000 abandoned mines country-wide and because of the intensity and gravity of the problem associated with abandoned mines, DMRE started prioritization and ranking of abandoned mines. Priority was given to the most dangerous and hazardous that posed the greatest risk to the people and the environment."*

4.19.1.2. Interpretation of range of data sets

In summary all participants highlighted that there is a remarkable success towards the rehabilitation of abandoned mines in South Africa. It was discovered that a comprehensive database was developed and provided detailed record of abandoned mines in South Africa, allowing systematic management of problems. The results indicated that a remarkable work was done in North West Province in respect to closing and rehabilitation of abandoned mines. The respondents gave an affirmative answer that there was negative legacy caused by abandoned mines hence the attention given by the DMRE and as a result of large number of sites, implementation of rehabilitation was started. The assessment of financial requirement started and a figure of approximately R40 billion was estimated for the State's liability due to abandoned mines in South Africa.

4.20. Value input to the implementation of abandoned mines as best practice

It is of great importance to have collective ideas towards the management and rehabilitation of abandoned mines.

4.20.1. Common themes

The statement posed to the participants was: "**If all stakeholders including government were taken on board to roll out initial planning, given the Finance Act, would their input add value to the implementation of abandoned mines as a best practice of finding out an amenable solution?"** The following are some of the quotes:

Code BL01, CS01 and SCL01 said: *"Collective ideas and efforts always bring results and solution to pertinent issues. Stakeholders (community, industry, private land owners, local governments, trade unions) and government partnership form the first line of human contact on the deleterious consequences on the environment."*

4.20.1.2. Interpretation of range of data sets

Delving deeper into the outcomes of government and stakeholder's combination in finding amenable solutions to abandoned mines, the researcher found that collective ideas and efforts bring results on pertinent issues. It was also found out that stakeholders and government partnership form the first line of human contact on the deleterious consequences on the environment. Definitely, government would possess the financial wherewithal and fiscal energy to get rehabilitation off the ground and ignite supportive processes.

4.21. Recommendations for management and rehabilitation of abandoned mines

In too many instances, mines have been abandoned in a highly toxic condition, with limited or no rehabilitation treatment. They are eyesores, can have destructive environmental impacts, and are an unwelcome legacy for governments and

communities to deal with. Participants in this study recommended a number of facts that should be taken into consideration by government and interested stakeholders.

4.21.1. Common themes

The question posed to the participant was: "**What recommendations do you have for the rehabilitation of abandoned mines in South Africa?"** The following are some of the quotes:

Code BL01, SCL01, CS01and FM01 said: *"The rehabilitation of abandoned mines was the only way to address environmental, health and safety challenges under one auspice. The government should speed up the pace and priorities especially the risk areas that pose dangers to humans and animal."* Code BL01, FM01 said: *"Without hiding behind the finger, the government, and responsible parties on rehabilitation of abandoned mines should be transparent in their financial dealings and operations. The government should report on stages undertaken during rehabilitation."* Code CS01 said: *"It is a legal requirement for all parties responsible for the management and rehabilitation to adhere to principles and regulations as outlined in the MPRDA and NEMA frameworks. There should also be proven methods available to address the problems encountered during closure and rehabilitation."* Code FM01 said: *"I think there should be clear roles and responsibilities of contracted companies to supervise and oversee the rehabilitation of abandoned mines. Without clear roles nothing will move as expected and it will be a waste of resources that are supposed to be channeled towards other developmental goals."*

4.21.1.2. Interpretation of range of data sets

In summary the researcher established that rehabilitation of abandoned mines was the only way to address environmental, health and safety challenges under one auspice. It was found that responsible parties on management and rehabilitation of abandoned mines should be transparent in their financial dealings, operations and adhere to principles and regulations as outlined in the MPRDA and NEMA frameworks. Mhlongo and Amponsah-Dacosta (2016), validates that, "the delay in rehabilitating abandoned

mines include a lack of clearly assigned responsibilities, the absence of criteria and standards of rehabilitation for these mines, and the priority for rehabilitation". Clear roles and responsibilities assist the government on the direction taken in respect to the management and rehabilitation projects.

4.22. Chapter summary

This chapter covered a broad spectrum of interviews with participants which could contribute to the development of a framework for the management and rehabilitation of abandoned mines. It described the findings obtained in Phase 1 of the research and provided a summary of each of the group's responses by common theme and code, aligned with the framework of the research. The next chapter presents the empirical findings from the research, summarizing the research's interpretation of the findings obtained through the questionnaires.

CHAPTER FIVE
QUANTITATIVE ANALYSIS, RESULTS AND DISCUSSION

5.0. Introduction

This study used a mixed method research approach with an exploratory sequential design of qualitative (QUAL) and quantitative (QUANT) research approach. The previous chapter presented qualitative results using thematic analysis. The qualitative results built a foundation for the quantitative phase of this study. Quantitative data was gathered using a questionnaire. This chapter presents the analysis and interpretation of the research findings through the use of tables, graphs, and figures. The data was collected through a five point Likert semi-structured questionnaire and interviews administered to a total of 180 Mine Consultants and Employees in South Africa whose job titles are related to Environmental Consultancy, Mine managers, Clerks, Technocrats, Supervisors mine/land rehabilitation and communities living in abandoned mine towns. The findings further provide a clear understanding of the phenomenon under study. This chapter is structured into four sections.

Section A focuses on the personal characteristics of respondents in North-West Province. Participants gave information about their gender, age, educational status and roles in the industry. Section B focuses on the opinions of key stakeholders with in-depth knowledge on abandoned mines in South Africa. Section C deals with the impact of mining in South Africa highlighting the most significant risk and threats posed by abandoned mines on health, safety, and the environment (SHE). Section D concentrates on financing the rehabilitation of abandoned mines. This section intends to establish effective ways of financing the rehabilitation of abandoned mines and whose responsibility is to rehabilitation these mines. Finally, the interpretation of the results, discussion of the results and their implications on abandoned mines closes the chapter.

In this study, data collected using survey questionnaires were capture for further analysis on MicroSoft Excel Spreadsheet and cleaned. The Excel data was transported to SPSS Version 26 as a tool for data analysis. The results output based on the capture responses were further cleaned and results were presented in the form of tables, charts

and graphs. Inferential analysis was further performed in the form of factor analysis. This design followed for qualitative analysis is depicted in Figure 5.1.

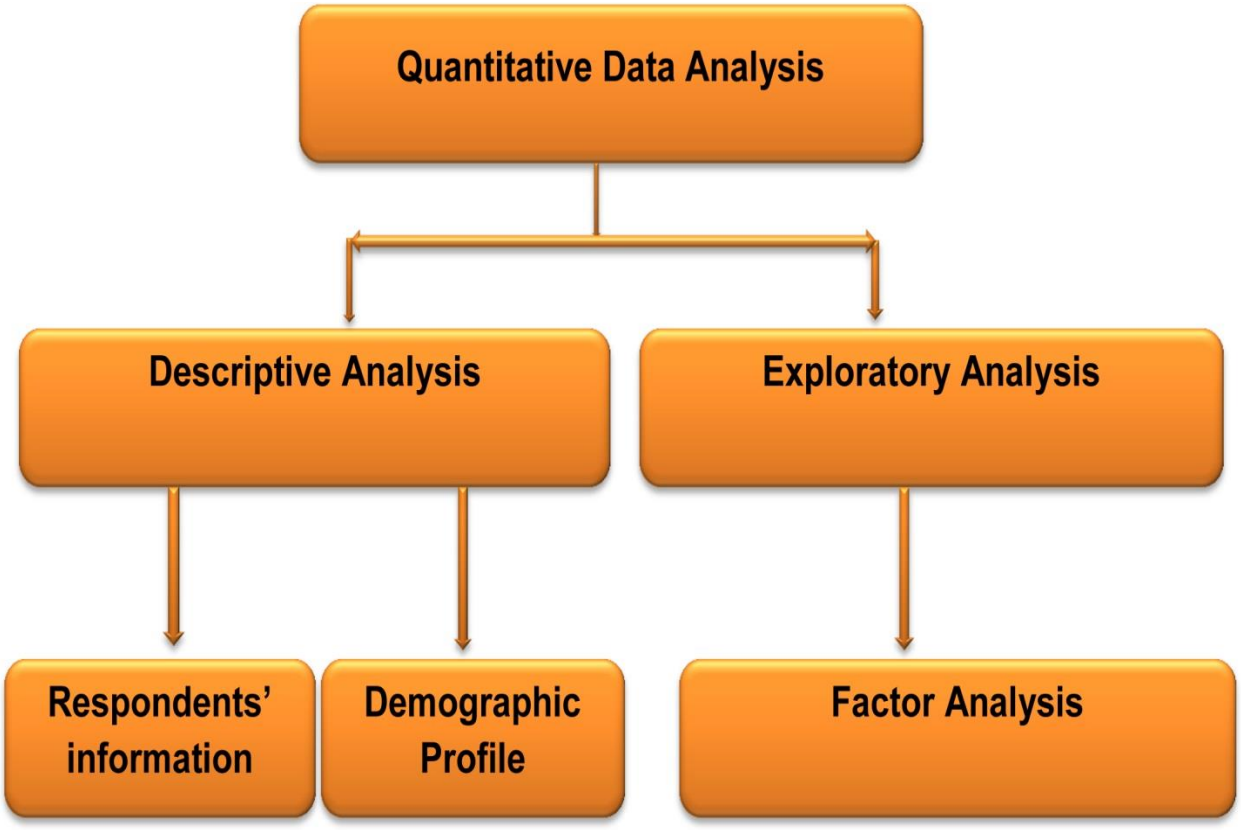


Figure 5.1: Quantitative data analysis processes
Source: (Own research)

5.1. Personal characteristics of the respondents

This section analyses the demographic characteristics of the respondents. Supporting tables and figures are provided. Table 5.1. is a summary of the personal characteristics of the respondents. The variables that were captured are gender, age, highest level of education, sector the respondent works in, duration of working in DRME, AGSA and abandoned mines, current position in DMRE and AGSA status, are all typical examples of demographics that are used in surveys.

Table: 5.1. Demographic Characteristics of the respondent

		Gender							
		Male		Female		Other		Total	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Age in Group	**18-30 years**	15	21.4	9	16.7	2	13.3	26	18.7
	31-45 years	11	15.7	31	57.4	11	73.3	53	38.1
	46-55 years	42	60	13	24.1	2	13.3	57	41.0
	Above 55 years	2	2.9	1	1.9	-	-	3	2.2
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**	**139**	**100.0**
Highest level of education	**Doctorate/Master's Degree**	9	12.9	5	9.3	4	26.7	18	12.9
Highest level of education	**First Degree**	45	64.3	36	66.7	6	40.0	87	62.6
	Diploma Degree	13	18.6	12	22.2	4	26.7	29	20.9
	High School Certificate	3	4.3	1	1.9	1	6.7	5	3.6
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**	**139**	**100.0**
Sector of work	**Public**	35	50.0	30	55.6	8	53.3	73	52.5
	Private	9	12.9	11	20.4	3	20.0	23	16.5
	Non-Governmental Organisation	5	7.1	6	11.1	2	13.3	13	9.4
	Resident	20	28.6	7	13.0	2	13.3	29	20.9
	None	1	1.4	0	0	0	0	1	0.7
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**	**139**	**100.0**
Duration of working in DMRE,AGSA, and abandoned mines	**1-5 Years**	21	30.0	17	31.5	4	26.7	42	30.2
	5-10 Years	17	24.3	17	31.5	8	53.3	42	30.2
	10-20 Years	31	44.3	19	35.2	3	20.0	53	38.1
	More than 20 Years	1	1.4	1	1.9	-	-	2	1.4
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**	**139**	**100.0**
Current Position in DMRE, and AGSA,	**Manager**	10	14.3	3	5.6	2	13.3	15	10.8
	Technocrat	16	22.9	8	14.8	3	20.0	27	19.4
	Supervision	12	17.1	7	13.0	4	26.7	23	16.5
	Clerical Officer	23	32.9	30	55.6	2	13.3	55	39.6
	Other	9	12.9	6	11.1	4	26.7	19	13.7
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**	**139**	**100.0**

Source: Own Source

5.1.1. Gender representation of respondents

Gender plays an important part as it is widely accepted and known through various studies that females are the ones who shoulder most of the responsibilities for communities (Mutyenyoka *et al*., 2017: Moodley *et al*., 2017). Figure 5.2 depicts the distribution of the respondents in terms of the variables and indicated that 50 % of the respondents were males, 39 % were females and 11 % were other gender. Out of a total of 180 respondents approached 139 responded.

Sample gender distribution

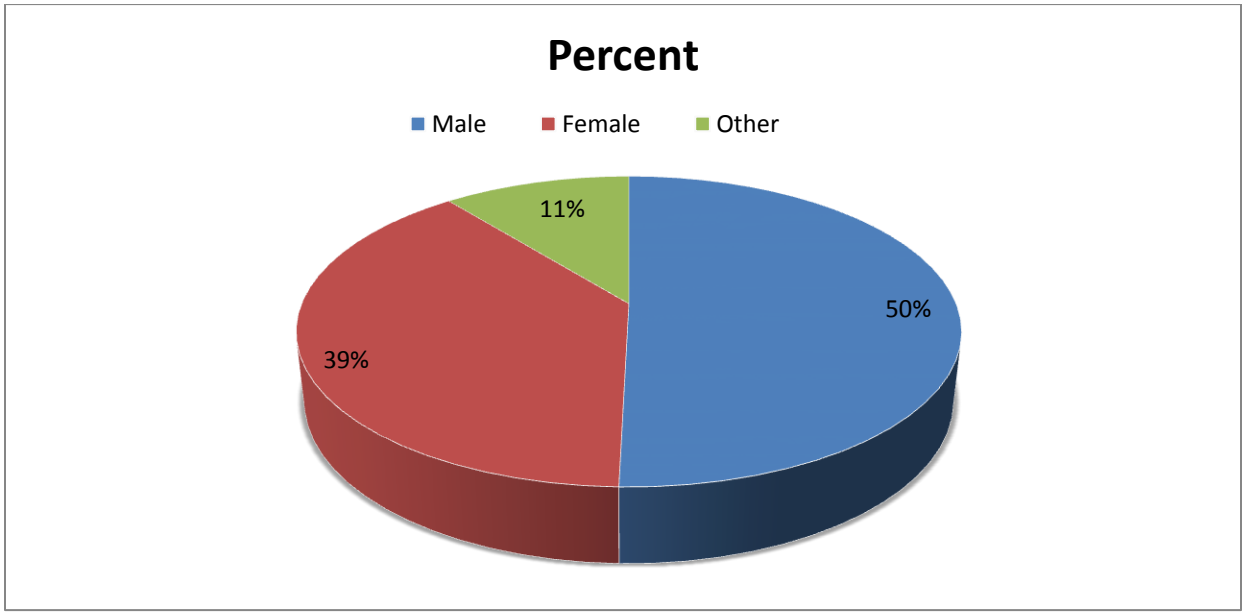


Figure 5.2: Gender of the respondents

The respondents were randomly selected through stratified sampling. The results show that males constituted a large number of workforces in the mining sector in comparison to females and other genders.

5.1.2. Age distribution of respondents

The age distribution of respondents were analysed and the results are presented in Figure 5.3. The results show that majority of respondents (41.0 %) of all genders were 46-55 years old, 38.1 % of them were 31-45 years old, and 18.7 % of them were 18-30 years old. Within gender, most of the female (57.4 %) and other (73.3 %) were between

the ages of 31-45 years, and majority of male (60.0 %) were between the ages of 46-55 years.

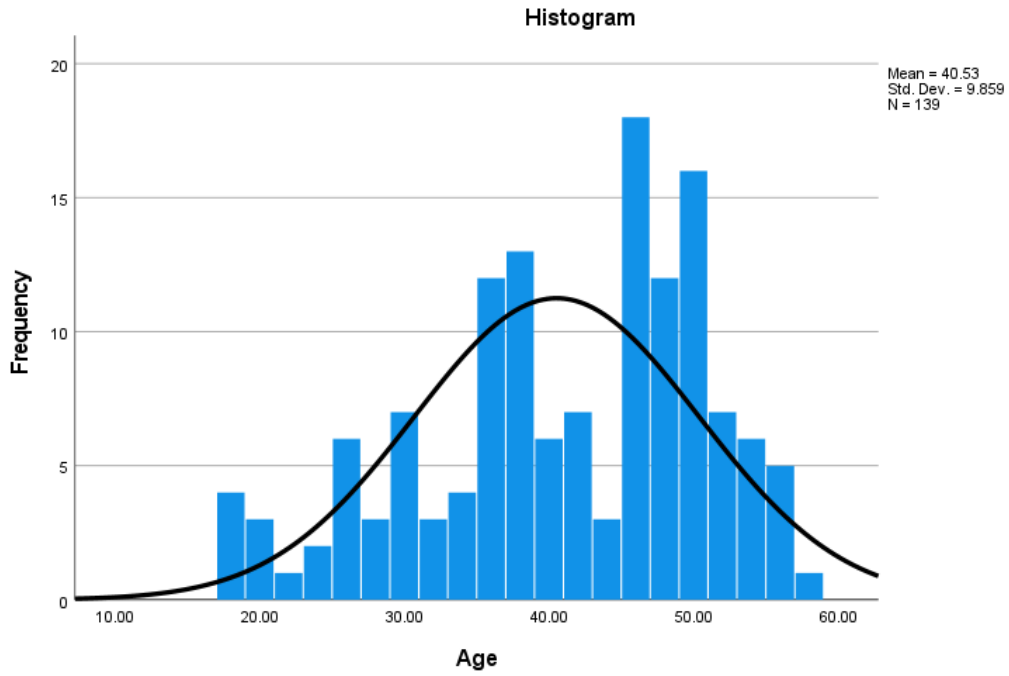


Figure 5.3: Age distribution of respondents in group

The age distribution of the respondents indicates that the average age is 40.5 years and the median age is 42 years. The age ranges from a minimum of 18 years to 57 years. The findings of this study imply that the median age of respondents was 42 years and the graph was normally distributed.

5.1.3. Educational level of respondents

The success of any leadership depends on the availability of the capacity of the human resource capital of the institution (Sergeant and Raet 2022; Barbosa Castro et al. 2022). Biswas and Mattheis (2022) reported that education plays an important role in the capacity of any role player in an institution. Vagas-Hermandez (2022) highlighted that building capacity establishes skills, attitude, capability, and procedures. This author also emphasized that the process of capacity building has an impact on the strategic direction of an organisation. In assessing the stakeholders educational capacity, Figure

5.4 demonstrates below the highest academic and professional qualifications possessed by the respondents.12.9 % of the respondents had a Doctorate / Master's Degrees, 62.6 % had First Degrees, 20.9 % had Diplomas and 3.6 % had High School Certificates.

Sample education level distribution

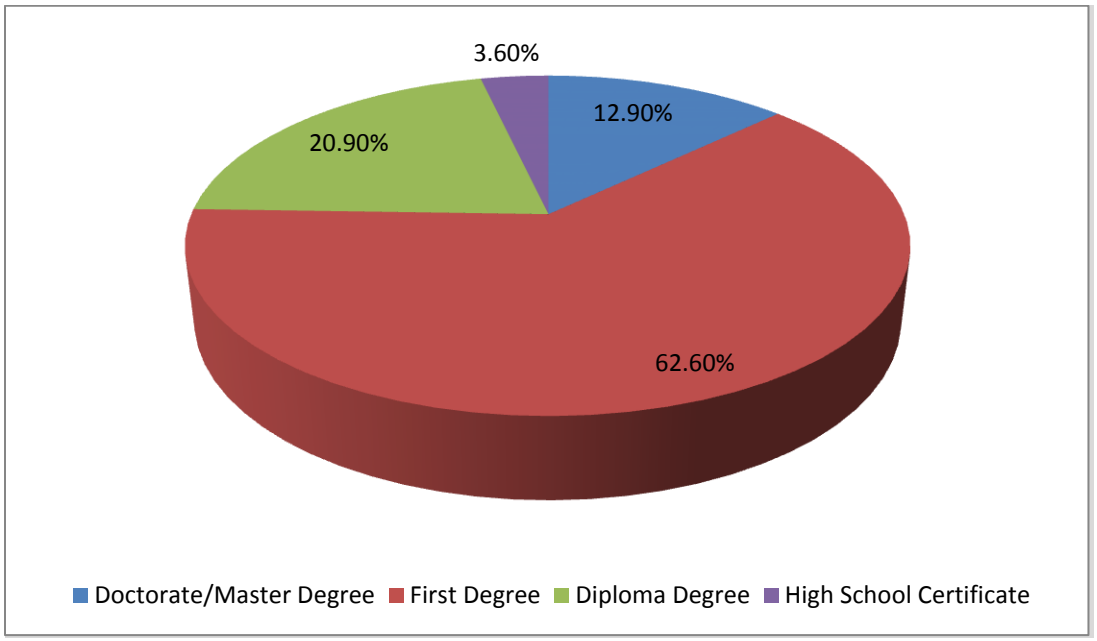


Figure 5.4: Highest level of education

Clearly, most respondents had a first degree and considering the responses, it can be concluded that the respondents were literate enough to understand the requirements of the study, and this plays a major role in enhancing the validity and reliability of the results of this study. The statistics confirm that DMRE and AGSA employ qualified personnel. The findings of this study show that though the Ministry does not compromise when it comes to educational quality, it fails to attract employees who hold postgraduate qualifications such as Doctorate and Master's. Remuneration plays a pivotal role in the attraction and retention of qualified employees who contribute to the growth of the business.

5.1.4. Employment sector of respondents

Employment status and how much one earns is very important in determining where an individual stays. As depicted on Figure 5.5: 52.5 % of the respondents were working with the public sector at the time of the survey, followed by participants (20.9 %) who were working as residents, 16.5 % of the respondents were working with the private sector, and 9.4 % work with non-governmental organization.

Sample activity sector distribution

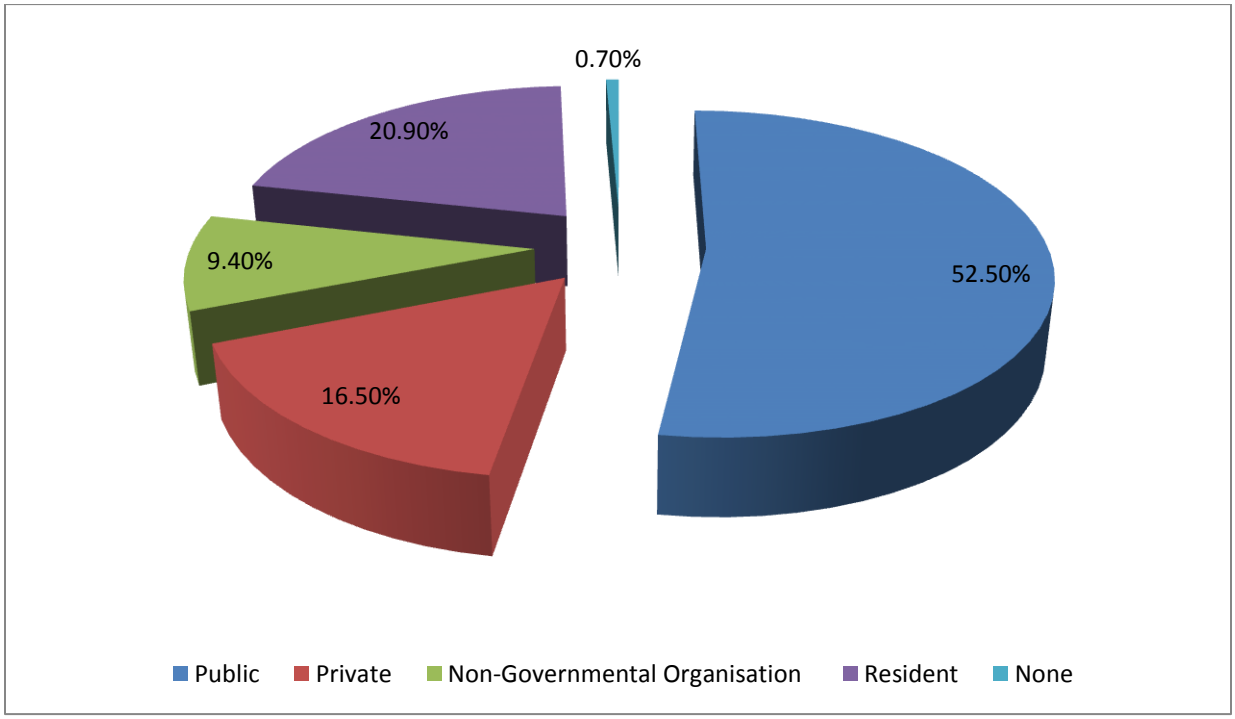


Figure 5.5: Sector you work in

The findings of this study show that the government is the highest employer in the mining industry as depicted by Figure 5.5 above, followed by the private sector with 16.5 %. These departments were a representation of respondents in the North-West Province.

5.1.5. Number of years of work in the Department mineral, Auditor General, and or mines

It is important for the organisation to have employees who will stay for a long period with an organisation. This brings trust, honest and experience hence a goodwill to the organisation. Employing new employees is cost effective and time consuming. In figure 5.6, the majority of the respondents (38.1 %) were working with Department of Mineral Resources or Environmental Affairs, Government, Auditor General of South Africa and abandoned mines for 10-20 years, 30.2 % of them had been with organisation between

Sample years of service distribution

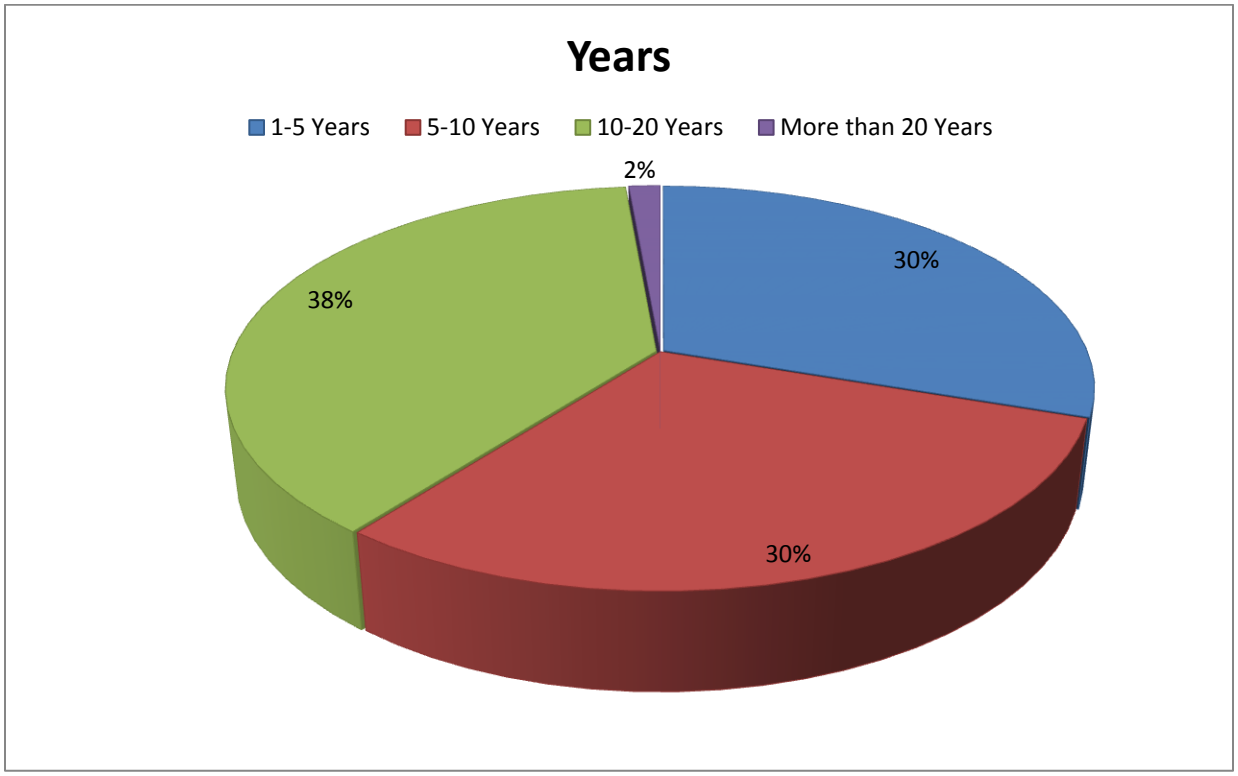


Figure: 5.6- Duration of working in DMRE, AGSA and Abandoned mines

5-10 years and another 30.2 % of them had been working with organisation between 1-5 years, and 1.4 % had been working with organisation for more than 20 years. Delving deeper into the figures, the researcher found out that the collective data (79.8 %) of the respondents or highest number of workers that had been working in the mining sector for more than five years and longer was higher.

5.1.6. Position in Department of Minerals and Auditor General

In any normal organisation clerical officers occupy the highest percentage of employees compared to their supervisors. Figure 5.7 indicates the positions occupied by the respondents as follows: 39.6 % were working as clerical officers, 19.4 % of them were technocrats, 16.5 % of them were in supervision, 10.8 % were managers, and 13.7 % of them were holding other positions.

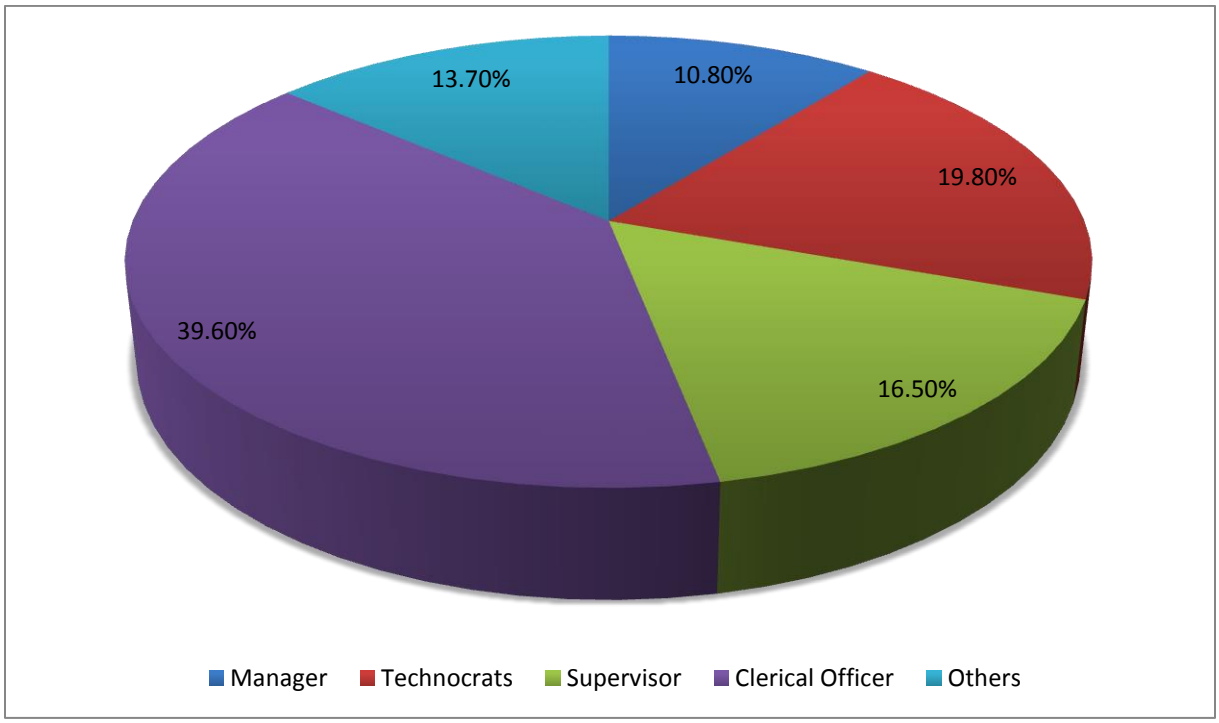


Figure: 5.7- Current position in DMRE and AGSA

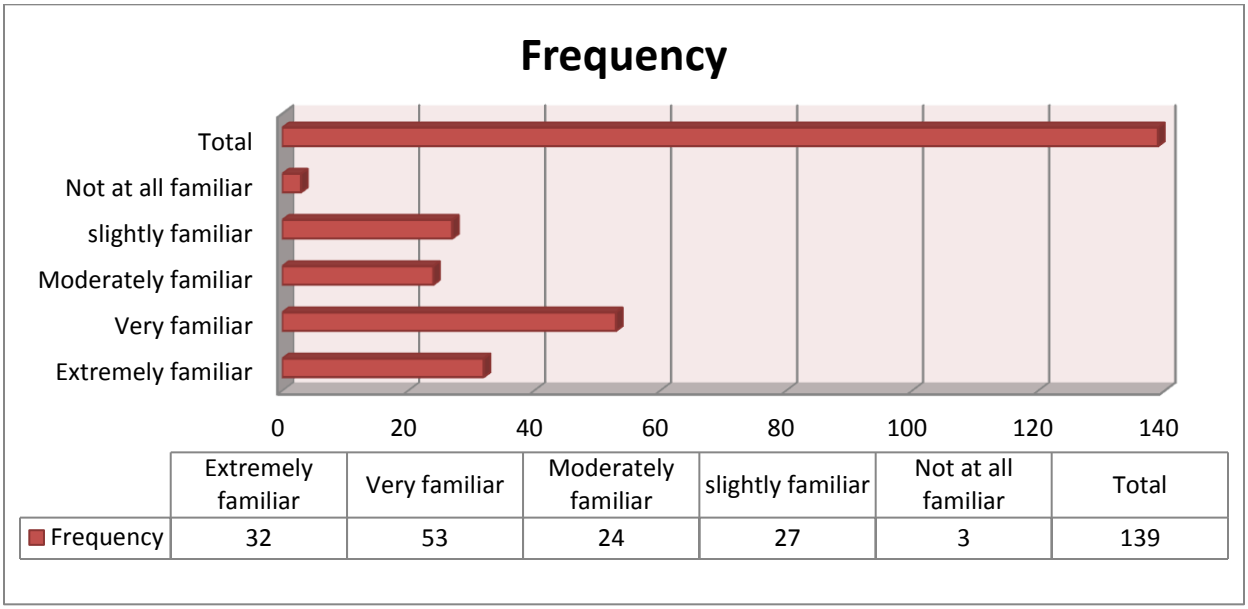
Clerical Officers recorded the highest respondents which showed that many people were employed at the lower level and this position required a lot of employees. The technocrats and supervisors came second and third, respectively. This shows that Technocrats and Supervisors were important in the organisation as they performed a variety of duties from day-to-day running of the ministry.

5.2. Public perception of abandoned mines in South Africa

Stakeholders and communities around abandoned mines have different perceptions regarding the negative impact disused mines have on the livelihoods of the people. Complains from communities emanate from daily challenges faced as a result of abandoned mines in the area. Expectations are always high by communities that the government and interested partners would quickly act and minimise the dangers of disused and abandoned mines.

5.2.1. Familiarity with abandoned mines and associated environmental challenges

Abandoned mines endanger public safety, pollute underground water, cause environmental degradation and create wasteland impeding agriculture or range land management.



	Extremely familiar	Very familiar	Moderately familiar	slightly familiar	Not at all familiar	Total
Frequency	32	53	24	27	3	139

Figure 5.8: Familiar with abandoned mines and associated environmental challenges

Most of the respondents (n=53) were very familiar with abandoned mines and their associated environmental concern, (n=32) of them were extremely familiar, (n=27) of them were slightly familiar, (n=24) of them were moderately familiar, and (n=3) of them were not at all familiar. Figure 5.8 depicts that 38.1 % of the respondents indicated that

they were very familiar with abandoned mines and their associated environmental concerns. 23 % of the respondents indicated that they were extremely familiar, 19 % of the respondents were slightly familiar, and 17.3% were moderately familiar.

5.2.2. Public Knowledge on decision making about the rehabilitation of abandoned mines.

People have different views on decision making about the rehabilitation of mines in South Africa. Figure 5.9 below represents public opinion on abandoned mines knowledge. Majority of them n=47(33.8 %) did not agree that own opinion about public were empowered with knowledge to make decisions about rehabilitation of abandoned mines, another n=47(33.8 %) of respondents disagree. In explaining the results, it can be inferred that the respondents were indifferent to make informed decisions about the rehabilitation of abandoned mines, n=29(20.9 %) respondents strongly disagree that public were empowered with knowledge to make informed decision about rehabilitation of abandoned mines and n=8(5.8 %) of them agreed and strongly agreed respectively.

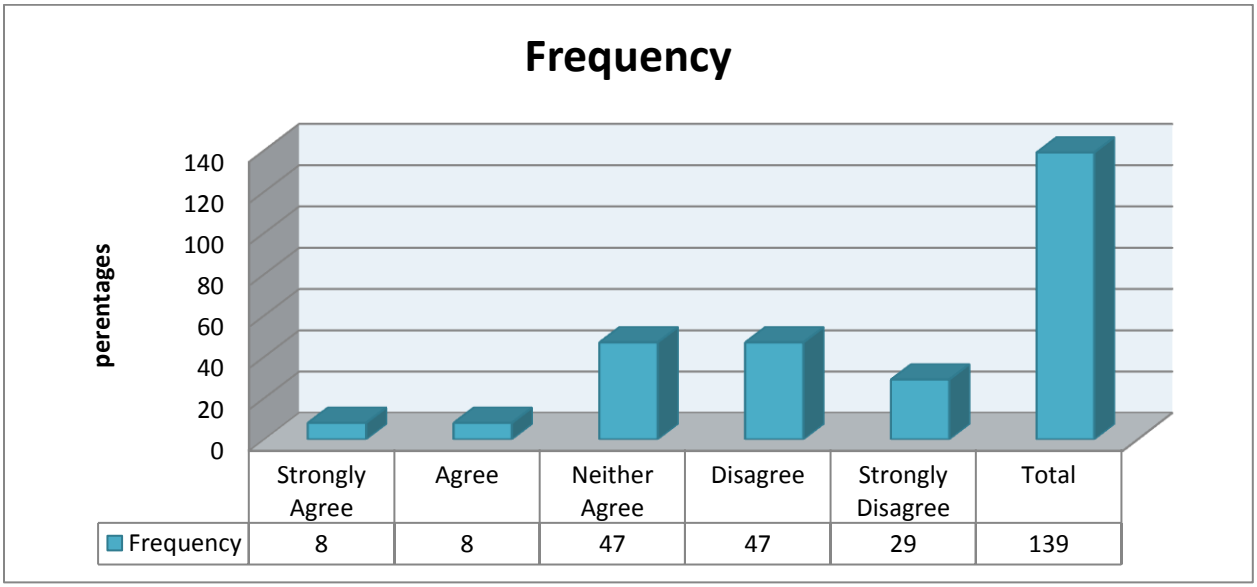


Figure 5.9: Public knowledge on decision making about rehabilitation of abandoned mines

The researcher deduced that the public were not empowered with knowledge to make informed decisions about the rehabilitation of abandoned mines. It therefore shows a

high level of indifference and no sense of belonging to the rehabilitation of abandoned mines.

5.2.3. Causes of illegal mining of abandoned mines in South Africa.

Illegal mining causes untold sufferings to the communities around abandoned mines. These were caused by old mining practices. Due to the high unemployment rate in South Africa, unemployed residents and foreigners resort to illegal mining activities as the only recourse of getting quick cash to sustain themselves and their families. Figure 5.10 indicates stakeholders and employees views with regard to the causes of illegal mining in South Africa.

Sample illegal mining motivation distribution

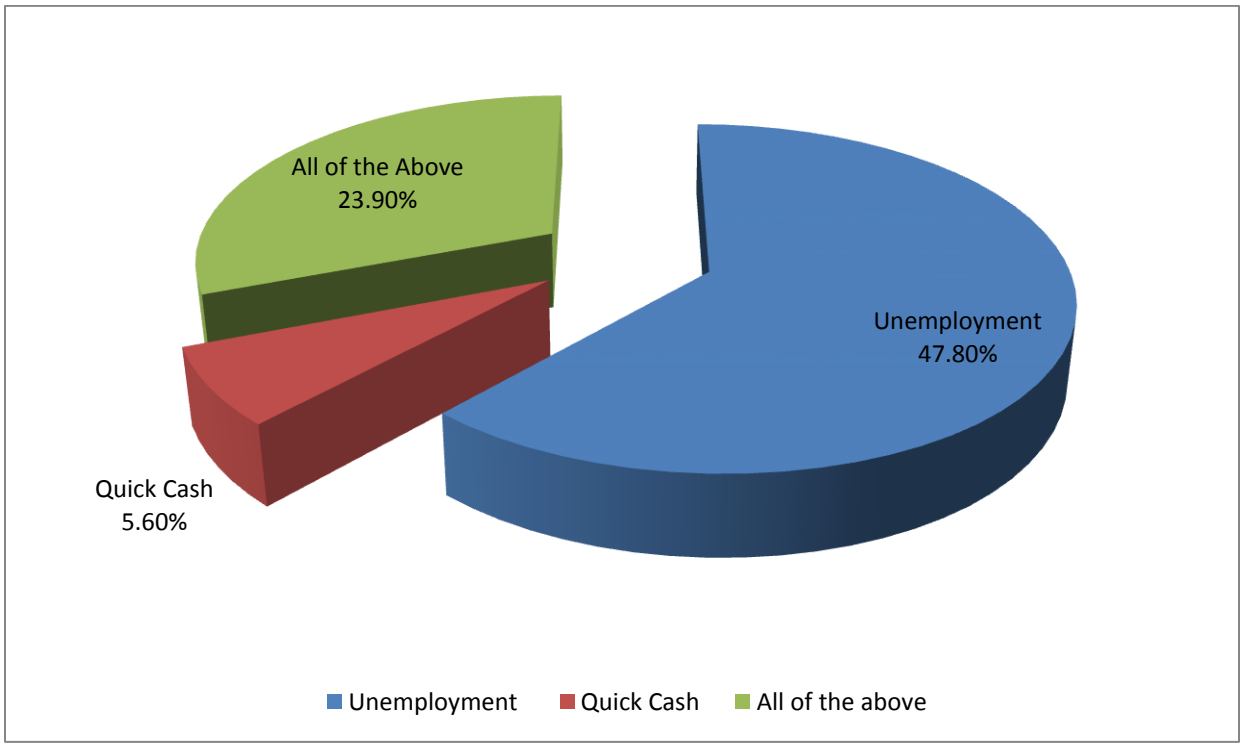


Figure 5.10: Causes of illegal mining in South Africa

It is clear from this figure above that the majority of the employees and stakeholders considered unemployment with 47.8 % of the respondents as the main cause of illegal mining in South Africa. Another 23.9 % of the respondents asserted that poverty, hunger, unemployment, and the need for quick cash all combined cause illegal mining

in South Africa. However, 5.6 % indicated that the need for quick cash was the cause of illegal mining.

5.2.4. Causes of abandoning mines without rehabilitation in South Africa

There are different reasons such as political, environmental, social and economic factors which cause miners to abandon mines before the end of the lifespan. Figure 5.11 below represents causes of abandoning mines in South Africa. Majority of them n=51,(36.7 %) believed that all of the mentioned factors (social, economic, environmental and political factors) were the causes of abandoning mines in South Africa, n=41,(29.5%) of the respondents believed environmental factors, n=20,(14.4 %) of them believed it was economic factors, n=15,(10.1 %) of them believed it was political factors and n=12,(8.6 %) of the respondents believed that it was social factors that causes miners to abandon mines in South Africa.

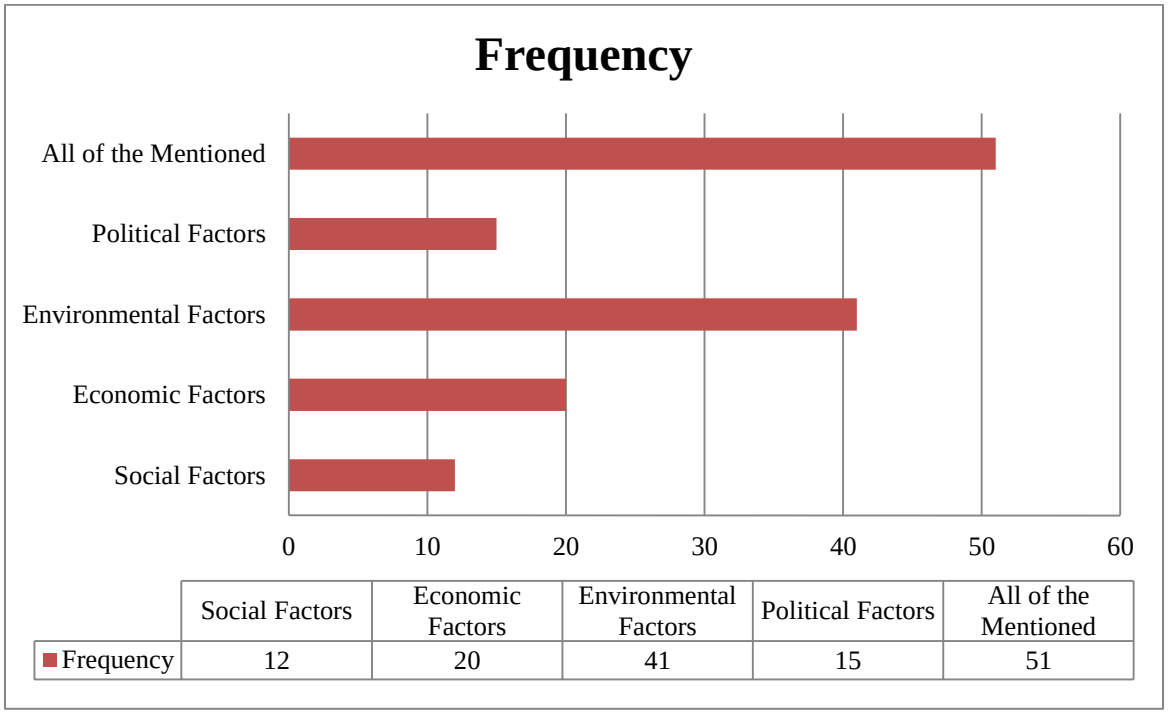


Figure 5.11: Causes of abandoning mines without rehabilitation in South Africa

The results established the fact that government should create opportunities to provide employment to the communities living within the precincts of mines.

5.2.5. Fiscal policies, community engagement and DMRE response to abandoned mines

The involvement of the national fiscus, the communities and the DMRE is a welcome development with the potential to minimise the hazards and challenges of abandoned mines. However, DMRE should play a leading role in ensuring policy conformity in minimising the harmful effects and in the ultimatum foster a user friendly environment.

Table 5.2: Fiscal policies, community support and DMRE response to abandoned mines

		Gender					
		Male		Female		Other	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Government has the fiscal muscle to implement NEMA, MRPDA and NWA acts effectively	**Strongly Agree**	9	12.9	12	22.2	4	18.0
	Agree	30	42.9	23	42.6	6	42.4
	Don't Agree	15	21.4	10	18.5	2	19.4
	Disagree	12	17.1	6	11.1	2	14.4
	Strongly Disagree	4	5.7	3	5.6	1	5.8
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**
Communities honestly support the rehabilitation of abandoned mines in South Africa	**Strongly Support**	5	7.1	10	18.5	1	6.7
	Somewhat Support	17	24.3	16	29.6	5	33.3
	Neutral	38	54.3	16	29.6	3	20.0
	Somewhat Oppose	7	10.0	6	11.1	5	33.3
	Strongly Oppose	3	4.3	6	11.1	1	6.7
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**
The DMRE in collaboration with government is doing enough to handle the issue of abandoned mines in North West Province, South Africa	**Strongly Agree**	17	24.3	13	24.1	3	20.0
	Agree	37	52.9	18	33.3	8	53.3
	Neither Agree	6	8.6	12	22.2	4	26.7
	Disagree	10	14.3	9	16.7	-	-
	Strongly Disagree	-	-	2	3.70	-	-
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**

5.2.6. Role of NEMA, MPRDA and NWA in eradicating abandoned mines in SA

The above frameworks hold the responsibility that will create a conducive environment that will ensure forthwith the eradication of abandoned mines in South Africa. From the 139 respondents in this survey, majority of male n=30, (42.9 %) agreed that Government had the fiscal muscle to implement NEMA, MRPDA and NWA effectively, n=23, (42.6%) of female also agreed and n= 6, (40%) of other gender agreed. For those who strongly agreed, most of them n=12(22.2%) were female, n=9, (12.9%) of them were male, and n=4, (26.7%) of them were other genders. Although some strongly disagreed, n=4, (5.7%) of them were male, n=3, (5.6%) of them were female, and only one was from other gender.

Table 5.3: Role of NEMA, MPRDA and NWA in SA

Table 5.3		Gender					
		Male		Female		Other	
Government has the fiscal muscles to implement NEMA, MRPDA and NWA acts effectively	Strongly Agree	9	12.9	12	22.2	4	26.7
	Agree	30	42.9	23	42.6	6	40.0
	Don't Agree	15	21.4	10	18.5	2	13.3
	Disagree	12	17.1	6	11.1	2	13.3
	Strongly Disagree	4	5.7	3	5.6	1	6.7
	Total	**70**	**100.0**	**54**	**100.0**	**15**	**100.0**

Source: Own Source

In summation, the majority of respondents agreed and felt that the introduction of the legislative acts came as the best solution of eradicating abandoned mine risks and closure. 18 % of the respondents strongly agreed that government had the fiscal muscle to implement the existing legislatives effectively. 19.4 % of the respondents indicated that they did not agree. 14.4 % of the participants disagreed that the government of South Africa had the fiscal muscle to implement the legislation effectively.

5.2.7. Effectiveness of the Environmental Management Framework in managing abandoned mines in SA

In view of this, it can be stated that insufficient and inadequate capacity within organs of state poses a threat to the successful development and implementation of Environmental Management Frameworks. The fragmentations of legislations additionally create management and governance problems, disallowing development to occur in a manner consistent with the principles of sustainability and considered planning. Figure 5.12 reflects the following results: majority of them (52 %) believes other, that is (31.9 % thinks this is ineffective, and 19.6 % thinks this is slightly effective), 21.7 % thinks this is moderately effective, 17.4 % of them believed that EMFs was effective, and 9.4 % thinks this was very effective.

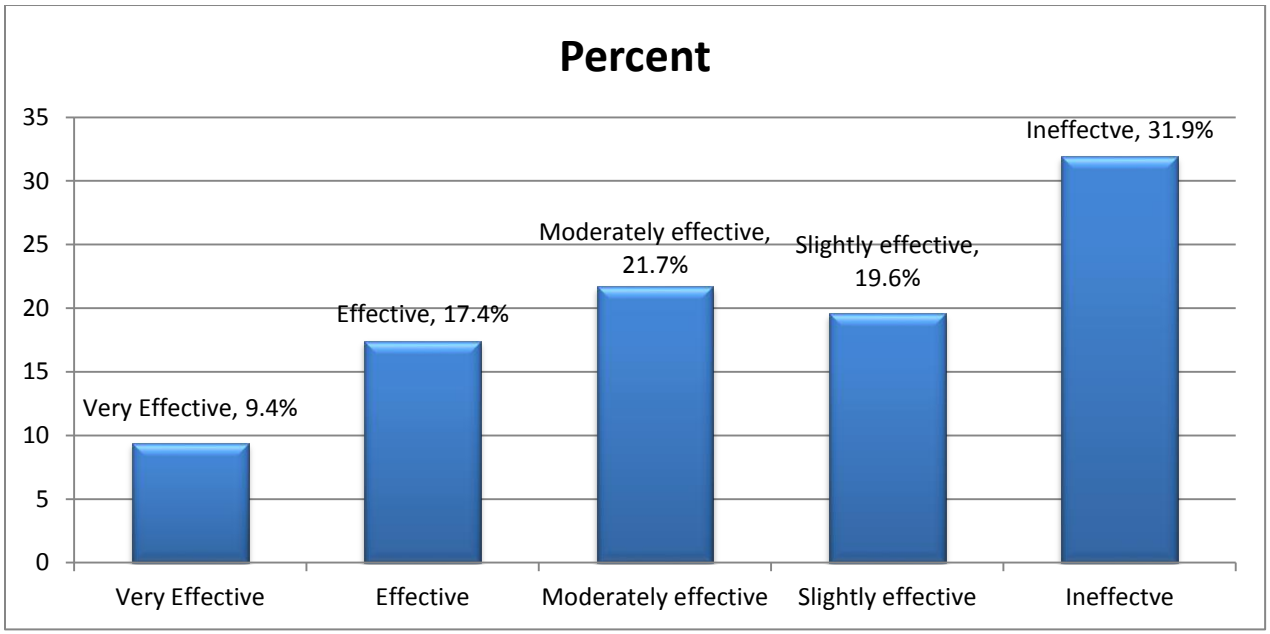
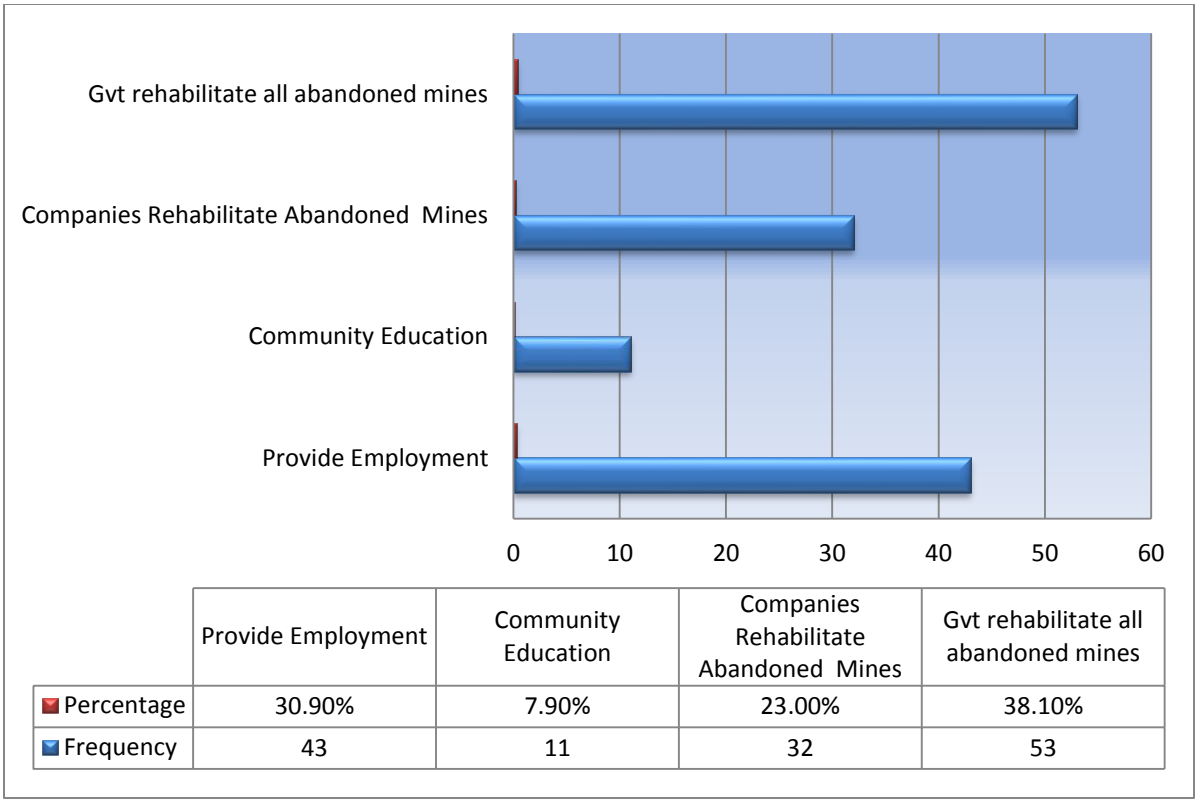


Figure 5.12: Effectiveness of the Environmental Management Frameworks in the management of abandoned mines in SA

The findings of this study verified that the majority of the respondents (74 %) indicated that Environmental Management Frameworks (EMFs) have not been effective.

5.2.8. How can the challenges of illegal mining in South Africa be managed?

It is the obligation of many stakeholders to make sure that the challenges of illegal mining activities in the country are minimised. Figure 5.13 shows the results of the perception of respondents on illegal mining. n=53, (38.1%) of the respondents indicates that government of South Africa should rehabilitate all abandoned mines to control or eliminate illegal mining in South Africa. n=43, (30.9%) of the respondents indicates that the government should provide employment in order to curb the influx of people in illegal mining in abandoned mines in South Africa. n=32, (23%) believes that companies should be responsible for the rehabilitation of abandoned mines. n=11, (7.9%) indicates that community education on dangers of abandoned mines and any environmental hazards is important.



	Provide Employment	Community Education	Companies Rehabilitate Abandoned Mines	Gvt rehabilitate all abandoned mines
Percentage	30.90%	7.90%	23.00%	38.10%
Frequency	43	11	32	53

Figure 5.13: Management of the challenges of illegal mining in South Africa

This creates awareness in the surrounding communities and citizens of South Africa. The researcher established that there is need to seal the disused mining shafts

permanently below natural ground level and rehabilitate the mining footprint fully, rendering the area safe for public access.

5.3. Impact of abandoned mines on the environment

As cited above, some of the impacts of abandoned mines include land degradation,water pollution,and environmental stresses affecting both human and animal lives.

5.3.1. Threats posed by abandoned mines on the environmetal health and safety of communities

Abandoned mines pose serious threats to the environment and safety of communities. Acid mine drainage and spillages from abandoned mines contaminate water sources endangering human and animal lives. The risk of falling in disused and abandoned mines is also another threat posed to the people living around abandoned mines. Table 5.4 depicts the extreme of these old mines.

Table 5.4: Rate the threats posed by abandoned mines on environmental health and safety.

		Frequency	Percent	Valid Percent
Valid	Extreme risky	75	41.7	54.0
	Very risky	54	30.0	38.8
	Moderately risky	5	2.8	3.6
	Minor	5	2.8	3.6
	Total	139	77.2	100.0
Missing	System	41	22.8	
Total		180	100.0	

Table 5.4: demonstrates the threats posed by abandoned mines on Safety, Health and Environment (SHE), majority of them n=75, 54 %) indicated extreme risky, n=54, (38.8 %) of thinks it was very risky, n=5, (3.6 %) of them said it was moderately risky, and another n=5, (3.6 %) respondents said it was minor. A combined total of extremely risky, very risky and moderately risk (74.5 %) showed that the risks of falling into the abandoned mine shafts and the problems of ground movement were the major physical hazards and environmental stresses of the shafts.

5.3.2. Community support on the rehabilitation of abandoned mines in South Africa

A large number of communities are tired of crimes, environmental hazards, cultural deterioration (high prostitution and theft rates) as a result of these abandoned mines. Based on the responses on Figure 5.14 below, where participants were asked if they think communities honestly support the rehabilitation of abandoned mines in South Africa, from a total of 77.2 % of respondents, the majority n=57, (41 %) were neutral. n=38,(27.3 %) of respondents indicated somewhat support and n=16, (11.5 %) strongly support the statement.

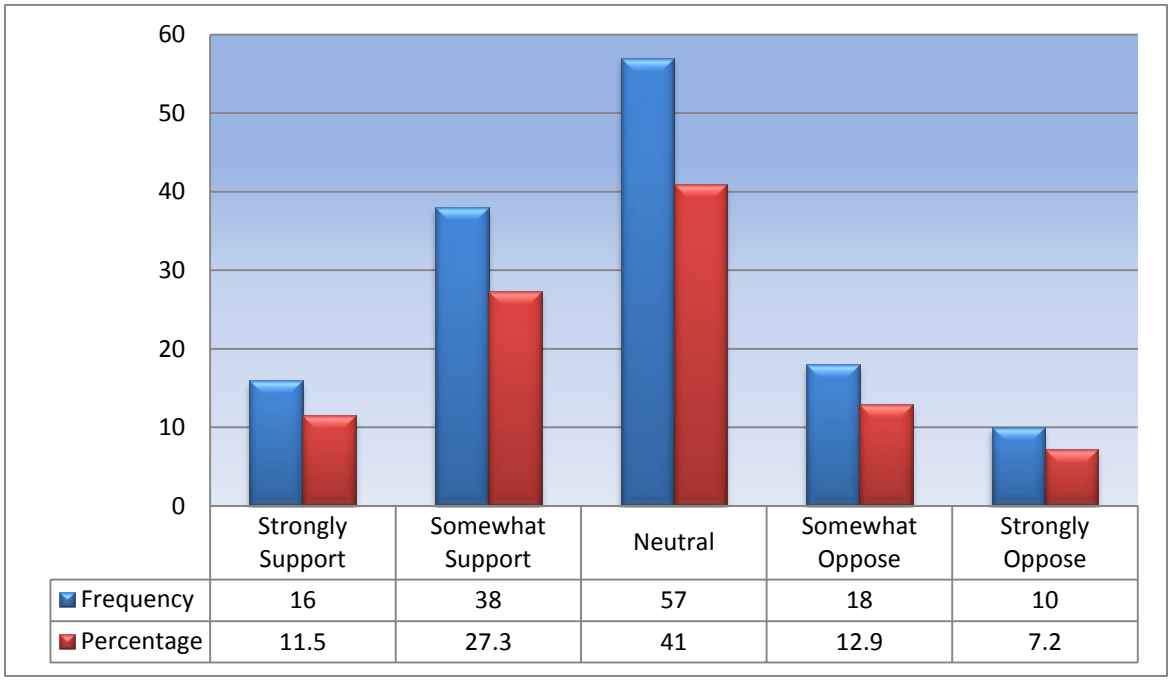
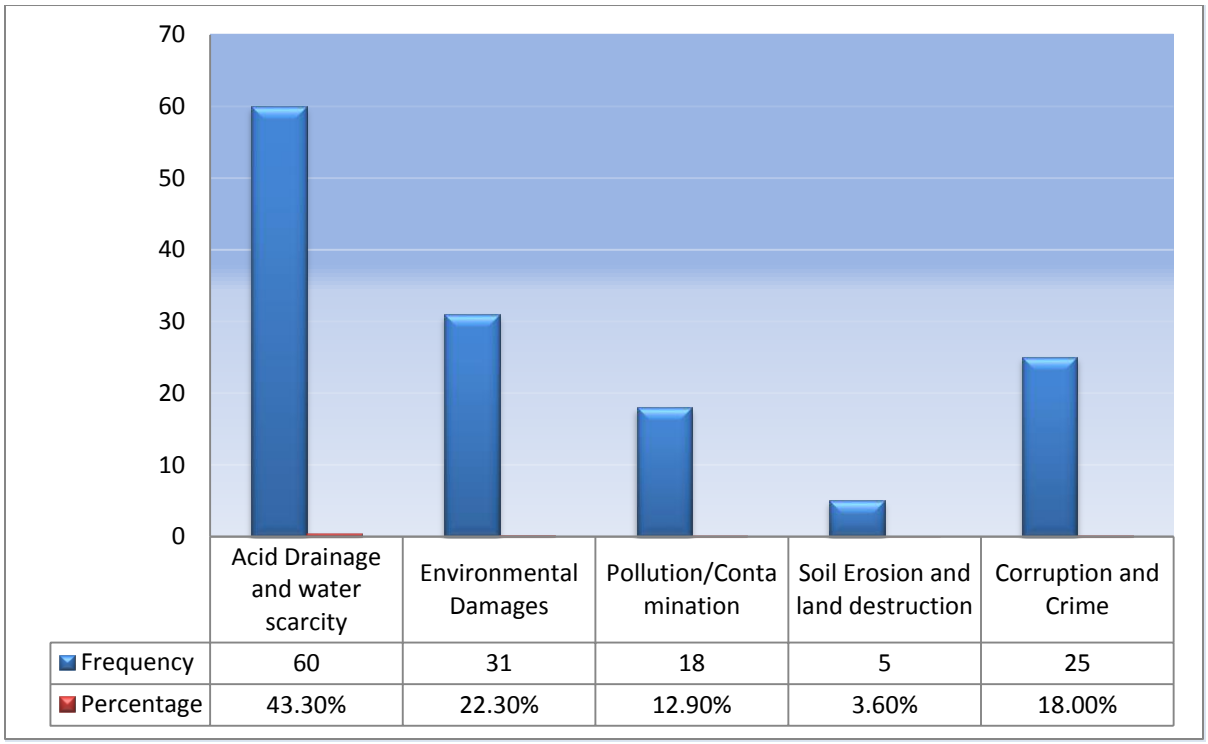


Figure 5.14: Community support on the rehabilitation of abandoned mines in South Africa

The findings of this study indicate that acid mine drainage from abandoned mines was a serious threat that needed immediate attention. They asserted that they were prepared for any support they could render to make sure that abandoned mines are rehabilitated. However, a total of 20.1 % opposed. They thought communities do not support the rehabilitation of abandoned mines in South Africa. Often times, abandoned mines are considered a negative legacy to the mining industry.

5.3.3. Most significant risk associated with abandoned mines in South Africa

Acid mine drainage water from abandoned gold mines flows into streams, dams and sources of groundwater carrying toxic heavy metals and radioactive particles. These are dangerous for people's health as well as plants and animals. As cited by Mhlongo and da Costa, (2016:276) environmental damage such as altered landscape, unused dangerous shafts and abandoned mine waste disposal facilities are death traps to local communities and animals. Based on the statistics on Figure 5.15 below, n=60, (43.2 %) of the respondents indicated that acid drainage and water scarcity was the highest risk associated with abandoned mines in South Africa. n=31, (22.3 %) of the respondents indicated environmental damages, n=18, (12.9 %) of the respondents indicated pollution / contamination while n=5, (3.6 %) indicated that soil erosion and land destruction as a significant risk associated with abandoned mines in South Africa.



	Acid Drainage and water scarcity	Environmental Damages	Pollution/Contamination	Soil Erosion and land destruction	Corruption and Crime
Frequency	60	31	18	5	25
Percentage	43.30%	22.30%	12.90%	3.60%	18.00%

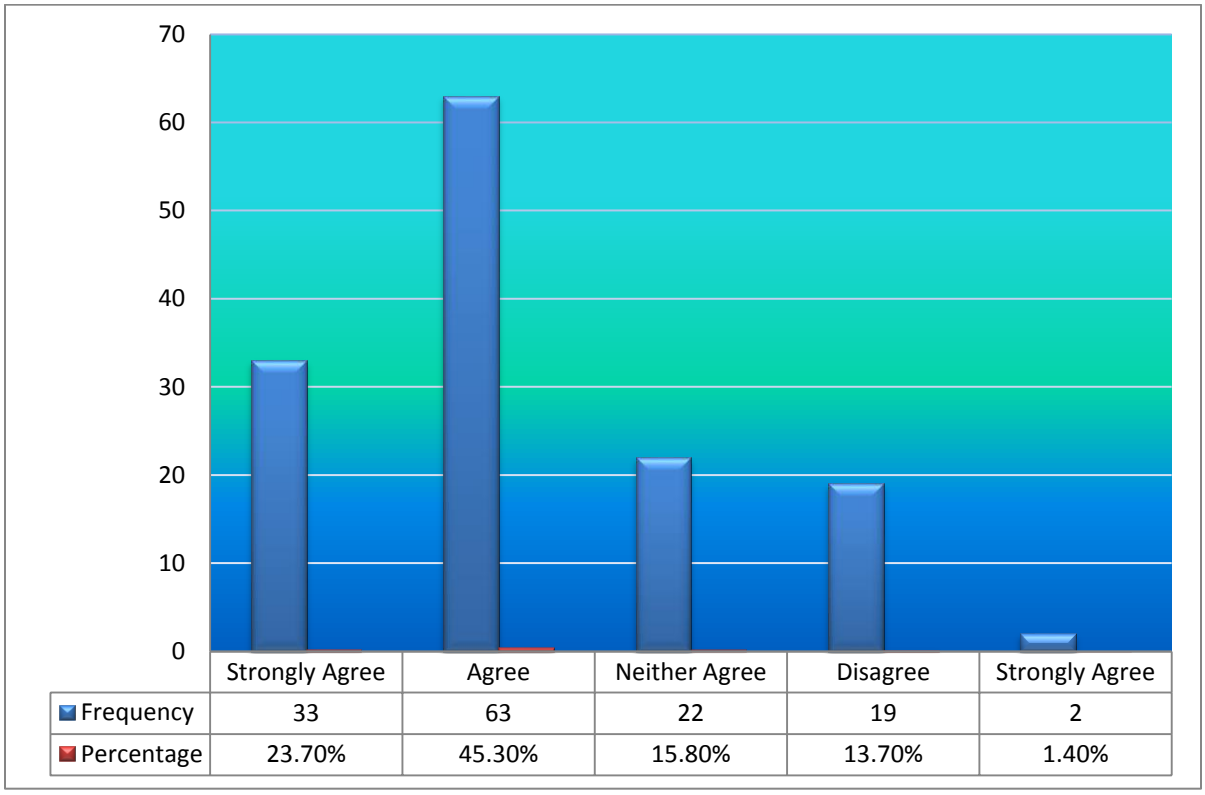
Figure 5.15: Most significant risk associated with abandoned mines in South Africa

The findings suggest that the surge in corruption cases in mining departments poses serious threats to the rehabilitation of abandoned mines in South Africa. Respondents also indicated that abandoned mines in South Africa are sources of toxic chemical and metal pollution. Continued release of mine pollution contaminates land, water and air,

leading to significant costs. Without coordinated effort to curb costs would rise and negatively impact the economies in terms of rehabilitation. The respondents asserted that altered landscape and changes in the ground causes soil erosion. Therefore, it was concluded that the environmental, especially the biomass, pollution, soil erosion, acid drainage and water scarcity should receive remedial interventions.

5.3.4. Government response in the rehabilitation of abandoned mines

The lack of capacity and competence of government to implement legislation poses a great danger in the handling of abandoned mine issues in the North West province. The shortage of relevant mine closure skills and knowledge within the regulator is a major key contributor to unsuccessful closure.



	Strongly Agree	Agree	Neither Agree	Disagree	Strongly Agree
Frequency	33	63	22	19	2
Percentage	23.70%	45.30%	15.80%	13.70%	1.40%

Figure 5. 16: Government response in the rehabilitation of abandoned mines

However, in this study, figure 5.16 illustrates that n=63, (45.3 %) of the respondents agreed and n=33, (23.7 %) strongly agreed that DMRE in collaboration with the government was doing enough to handle the issue of abandoned mines in North West Province, South Africa. n=22, (15.8 %) were neutral as they were not sure whether

DMRE in collaboration with the government was doing enough to handle the issue of abandoned mines in the Northwest Province. N=21, (15.1 %) disagreed that DMRE in collaboration with the government was doing enough to handle the issue of abandoned mines. It was evident from the data released that the government of South Africa was making some strides in addressing the issue of negative legacy of abandoned mines that was a challenge for decades since the beginning of gold and diamond mining around the 1860s as depicted by 45.3 % of the respondents. It was highlighted that the government of SA enacted two frameworks namely NEMA of 1998 and MPRDA of 2002 demonstrating commitment towards closure and rehabilitation of abandoned mines and augmented the researcher's findings. The neutral group stated that problems associated with or resulting from abandoned mines were still dominant hence it was difficult to assert that the government was making any headway in addressing the issue of abandoned mines in North West Province, South Africa. This clearly shows that they did not have enough data in respect to the question. The group that disagreed indicated that the level of environmental hazards in abandoned mines was worrisome.

5.4. Financing the rehabilitation of abandoned mines in South Africa

Mine closure and rehabilitation is an area that is evolving quite rapidly. It is the prerogative of the government to enforce the Finance Act in order for them to easily rehabilitate abandoned mines. Figure 5.17 shows that most of respondents (47 %) said that the effectiveness of the Finance Act in the rehabilitation of abandoned mines in North West Province South Africa was moderate, 44 % of the respondents said it was very effective, 5 % of them said it was extremely effective, and 4 % said it was slightly effective. The findings of the study confirmed that irrespective of supporting the statement, the respondents asserted that South African laws required mining companies to set aside money for the management, remediation and rehabilitation of the environmental impacts of mining operations. The Council for Geoscience (CGS) states that the ongoing environmental impact of the mines was a problem for the state and therefore for the taxpayer.

Sample of the effectiveness of the financing the rehabilitation distribution

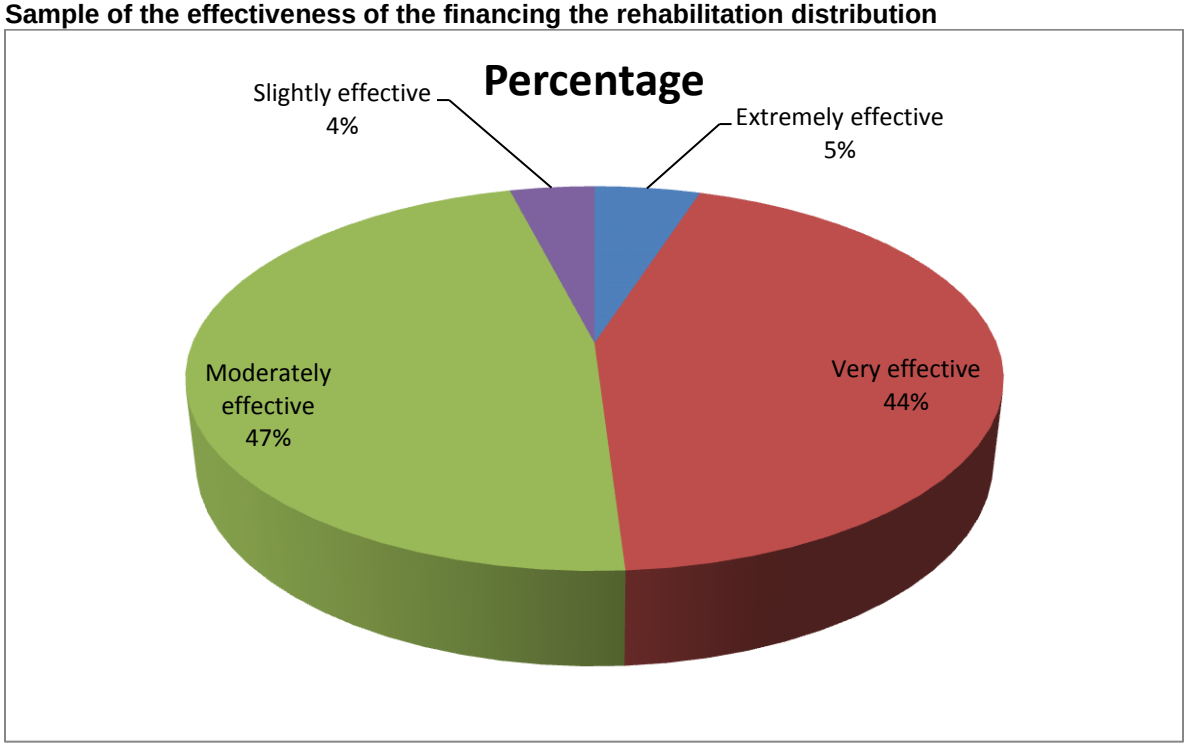


Figure 5.17: Financing the rehabilitation of abandoned mines in South Africa

Fifty (50) mines were rehabilitated during 2015/16 financial years and this highlighted the need to enforce the Finance Act in collection of funds towards rehabilitation of abandoned mines in South Africa. According to Auditor General Report, “rehabilitation of abandoned mines would cost about R48.9 billion, a figure that excluded all costs associated with the treatment of acid mine drainage”. This was a substantial amount that the group asserted that Finance Act became effective in the rehabilitation of abandoned mines in South Africa.

5.4.1. Proposed tax for a rehabilitation fund for abandoned mines in South Africa

It was indicated that abandoned mines pose a huge health risk to a large section of the South African public; hence was a national problem that needed collective effort from all spectrums, government included. Figure 5.18 below shows that 33.8 % agreed, 8.6 % of respondents strongly agreed, and 24.5 % of the respondents neither agreed that the working class be taxed to assist in the Rehabilitation Fund of abandoned mines. 21.6 %

of the respondents strongly disagreed that the working class be taxed to assist in the Rehabilitation Fund of abandoned mines. Some respondents maintained that member companies of the Minerals Council had put in place a total sum of R 48.9 billion for rehabilitation of disturbed environmental sites.

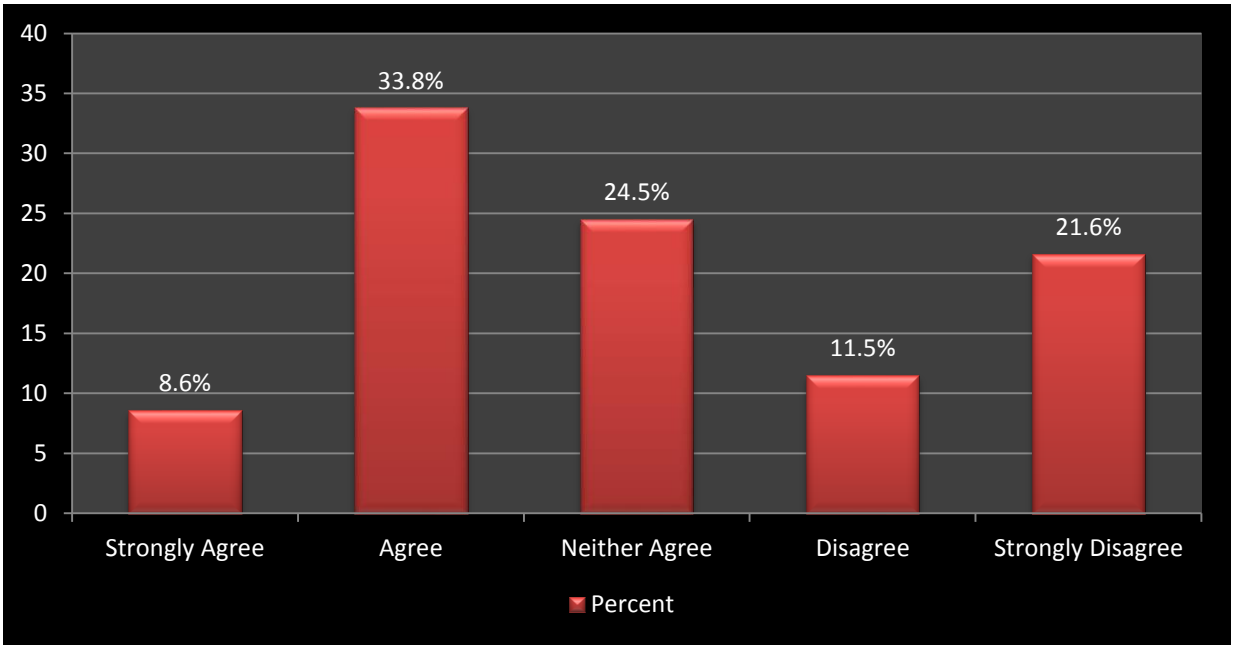


Figure 5.18: Proposing a taxed for a rehabilitation fund for abandoned mines in South Africa

The findings of study show that the majority of respondents support the notion that the working class be taxed to assist in the Rehabilitation Fund of abandoned mines and solve a legacy problem caused post-apartheid era. It was found out that concerned citizens opted to contribute a certain fee for a fixed period towards solving a decades-old problem.

5.5. Exploratory factor analysis

Exploratory factor analysis (EFA) is a classical formal measurement model that is used when both observed and latent variables are measured at the interval level. In EFA, a latent variable is called a factor and the associations between latent and observed variables are called factor loadings. The main objectives of exploratory data analysis are as follows: know underlying structure of the data, to have an insight into a data set, identify important variables, detect outliers and anomalies, and to test underlying

assumptions. In this study, EFA was used to establish the complexity of the patterns by exploring the dataset and testing predictions (Child, 2006:)

5.5.1 Factor Analysis

According to Watkins (2018:220), exploratory factor analysis (EFA) is when an applicable group of variables indicates an inter-dependence to realize the latent factor is collected to observe internal reliability. EFA is often suggested when there is no hypothesis concerning the fundamental factor design of the scale. As a result, when the researcher does not have a hypothesis, EFA should be adopted to observe variables that are not directly noticed but are rather deducted from variables that are noticed.

EFA assumes there is a linear relationship between variables and factors need to have about three (3) variables. However, a factor that has two (2) variables may be considered reliable if the variables have a high correlation among themselves were ($r > 0.70$) but are not correlated with other variables. The researcher is encouraged to use EFA when the sample size is more than 300 respondents and factor analysis has between five (5) and ten (10) observations, because with large sample size error in data lessens.

The older methods using the Kaiser criterion is a preselected option in SPSS, where variables that have Eigen values under 1.0, are not included by a researcher to work with factors that have confidence interval more than 1.0. The Cattell scree test has had a criticism of dropping all elements from the one beginning on the elbow because it is easily controlled by the researcher. The other challenge is the researcher's unwillingness to use resources to maintain 90 % of the variation.

However, a modern model by Monte-Carlo matches the noted eigenvalues with the one acquired from uncorrelated normal variables. In this model, a factor is kept only when eigenvalue is greater than the 95 % of the spread of eigenvalue achieved from unsystematic data. EFA is an interdependence model where there are no dependent

variables, independent variables or causality. It undertakes that data rating can be reduced to a significant magnitude because some characteristics of variables are connected. The advantage of EFA is that both objective and subjective characteristics can be utilized on condition that subjective characteristics can be changed into scores, and it can recognize latent theories that straight analysis may not. However, a limitation of EFA is that the named factors may not correctly indicate the variable that is within a factor, because variables may correlate but reflect no meaning for the factor. The results from EFA may be hard to reproduce and the researcher should survey a large sample in a specific time to reduce the margin of error in the data.

In this study, factor analysis was carried out to: identify the factors from the data that would be used in the development of the framework; reduce the items into constructs that are explained by the factor loadings and their observable variances; and Screen variables for subsequent analysis such as regression or discriminant analysis (Machera: 2020: 136). Hair et al. (2014) suggests that "factor analysis is an interdependence technique with primary purpose to define the underlying structure among variables in a dataset". Factor analysis is used to summarize data and establish relationships where patterns can easily be interpreted and understood (Yong & Pearce, 2013: 79). Field (2009) argues that factor analysis can be used to reduce a data set to a more manageable size while retaining much of the original information.

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used as suitable to test the data. The KMO is a statistical test which measures the suitability of data for factor analysis (Ozfidan & Burlbaw, 2017:6660). The KMO test is a measure of the proportion of variance among items that might be common and a high KMO value is an indication of variables that are highly correlated and can explain a factor or construct. The KMO statistics ranges from 0 to 1 with the value of 0 indicating diffusion in the correlations pattern. Furthermore, KMO is also a measure of sampling adequacy must be equal and greater than 0.7 as any value below 0.7 is an indication of sample inadequacy. The Bartlett's test of Sphericity is used to test the hypothesis on whether the correlation matrix is an identity matrix. Both the KMO and the Bartlett's tests were performed at 5% confidence level.

Table: 5.5 Descriptive statistics for management and rehabilitation of abandoned mines in South Africa

Variables	N	Mean / Standard Deviation
Sector you work in	**139**	**2.01 +/- 1.237**
Duration of work at DMRE and AGSA	**139**	**3.11 +/- 0.857**
Current position in DMRE and AGSA	**139**	**3.26 +/- 1.230**
Public empowerment	**139**	**3.58 +/- 1.063**
Causes of illegal mining	**139**	**3.69 +/- 0.916**
Causes of abandoning mines	**139**	**3.49 +/- 1.395**
Government fiscal muscles	**139**	**2.49 +/- 1.119**
Effectiveness of EMF	**139**	**3.47 +/- 1.346**
Rate of threats by abandoned mines	**139**	**1.57 +/- 0.733**
Communities Support responded	**139**	**2.77 +/- 1.052**
DMRE and GVT enough to handle issues of abandoned mines	**139**	**2.24 +/- 1.011**
Effectiveness of Finance Act	**139**	**2.50 +/- 0.663**
Taxing working class	**139**	**3.02 +/- 1.237**
Elimination/reduction of illegal mining problems	**139**	**2.68 +/- 1.269**
Important risk of abandoned mine	**139**	**2.31 +/- 1.498**

Source: Own Source

The results of some extracted factors and items cross-loading were found not to have a significant contribution to the constructs and were discarded. However, analysis of the significant extracted factors was done based on the research objectives of the study. The mean values and standard deviation of the management and rehabilitation of abandoned mines in South Africa were computed. Trochim (2016) states that if the standard deviation is relatively large, it means the data are quite spread out, away from the mean. If the standard deviation is relatively small, it means the data are concentrated near the mean. The results are presented in Table 5.5.

5.3.2 Sector you work in

A factor analysis was carried out on the sector they work in the DMRE or AGSA. The KMO of the identified factor was **0.710** and associated Bartlett's Test of Sphericity was found in this case as statistically significant at p≤0.00. The factor accounted for 4 % of the total variance. A moderate mean of **2.010** and a low standard deviation of **1.237** were confirmed through the factor 'sector you work in.' The mean reflects a tendency towards a higher public sector as reflected in Table 5.1 above. This concludes that the government of South Africa is the highest employer in the mining industry as depicted by the table above. The findings concur with the findings of Garside, (2021) which concluded that mining is the biggest employer in the country with Sibanye Gold employing 84,760 employees in total.

5.3.3 Length of employment at DMRE and AGSA

Factor analysis was performed to determine the length of employment at DMRE, AGSA and abandoned mines. The duration was ranked as 1-5 years, 5-10 years, 10-20 years, and more than 20 years. The Kaiser-Meyer-Olkin of the identified factor was **0.665** and the associated Bartlett's Test of Sphericity was found in this case as statistically significant at p≤0.00 and this accounted for total percentages of the variance explained at 3.8 %. The moderate mean of **3.110** and a low standard deviation of **0.857** were confirmed through the duration of working in DMRE, AGSA and Abandoned mines. The results reflect that the majority of the respondents have been working for more than 10-20 years as reflected in Table 5.5 above.

5.3.4 Public empowerment

A factor analysis was carried out on own opinion about public empowered with knowledge to make decisions about rehabilitation of abandoned mines. The KMO measure of sampling adequacy factor was **0.638**. The associated Bartlett's Test of Sphericity was found as significantly at p≤ 0.00. This factor accounted for 18% total variance. A moderate mean of **3.580** and a low standard deviation of **1.063** were confirmed through factor 'public empowerment.' The analysis shows that mean scores were between 'neither agree' to 'strongly disagree' ratings on the five-point Likert scale

for this factor. This mean reflects a tendency towards a lower end of the Likert scale above in Table 5.8 and this implies that there is no sense of belonging to the environmental and feel that the problem will go away with time. The majority considers land and water resources as infinite. This indicates that there is a negative co-relationship between stakeholders' involvement in decision-making about the rehabilitation of abandoned mines and management framework.

5.3.5 Causes of illegal Mining

Factor analysis was carried out on what participants think were the causes of illegal mining in South Africa. There is a high unemployment rate in South Africa of 37 % according to the Department of Statistics South Africa 2021 report. The KMO identified factor was **0.678** and the associated Bartlett's Test of Sphericity was found in this case as statistically significant at p≤0.00. The factor extracted accounted for 1.7 % of the total variance. A mean of **3.690** and a low standard deviation of **0.916** were confirmed through factor causes of illegal mining. Due to the high unemployment rate in South Africa, this indicates that unemployed residents and foreigners resorted to illegal mining activities as the only sources of getting quick cash to sustain themselves and families. This implies that the government of South Africa should provide employment by opening up new streams or attract foreign multinational companies to invest in the country thereby providing much needed employed. This could assist in controlling and minimizing attack on abandoned mines as the only source of sustenance. In relation to the results, it may be inferred that illegal mining activities contribute to health risks/chronic diseases, water contamination, pollution, land degradation and safety issues.

5.3.6 Causes of abandoning mines

A factor analysis was carried out on the causes of abandoning mines in South Africa. This variable includes choices such as social factors, economic factors, environmental factors, and political factors. The KMO obtained was **0.592** and the associated Bartlett's Test of Sphericity was found statistically significant at the p≤0.00. This chosen factor accounted for 13 % total variance. A moderate mean of **3.490** and a low standard

deviation of **1.395** were confirmed through factor causes of abandoned mines. All of the above causes were confirmed as contributing to the large number of abandoned mines in South Africa. The results established that government should create opportunities to provide employment to the neighbouring communities.

5.3.7 Government fiscal muscle

Factor analysis was carried out on whether the government has the fiscal muscle to implement NEMA, MPRDA and NWA effectively. The KMO of the identified factor was **0.474**. The associated Bartlett's Test of Sphericity was found as statistically significant at p≤0.00. The factor accounted for 9 % total variance. A moderate mean of **2.490** and a low standard deviation of **1.119** were confirmed through factor government fiscal muscle. The analysis shows that mean scores were between 'agree' and 'strongly agree' ratings on the five-point Likert scale for this factor. On average, the respondents agreed that government has the fiscal muscle to implement National Environmental Management Act, Mineral Petroleum and Resources Development Act and National Water Act effectively. This implies that the government has a great influence in the implementation of the above mentioned acts. The findings of this study revealed that the majority felt that the introduction of the legislative acts came as the best solution of eradicating abandoned mine risks and closure.

5.3.8 Effectiveness of EMFs

A factor analysis was conducted on how effective the environmental management framework outcomes have been analyzed in relation to the broader decision-making context. The majority of the respondents were convinced that it was not effective. The cited reason is the continuous increase of the number of environmental problems that are still affecting abandoned mine areas. The KMO of the identified factor was **0.698** and total variance of 11 %. The associated Bartlett's Test of Sphericity was found in this case as statistically significant at p≤ 0.00. A mean of **3.470** and standard deviation of **1.346** were confirmed through factor effectiveness of environmental management frameworks.

5.3.9 Rate of threats by abandoned mines

A factor analysis was performed on the rate of threats by abandoned mines on safety, health and environment. A scale of extremely risky, very risky, moderate and minor were used to determine the threats. The KMO of the identified factor was **0.752**. The associated Bartlett's Test of Sphericity was found as statistically significant at p≤ 0.00 and a total variance of 7 %. A mean of **1.570** and a low standard deviation of **0.733** were confirmed through factor rate of threats by abandoned mines. The findings demonstrate that a large percentage asserted that it was risky and clearly shows that the risk of falling into the abandoned mine shafts and the problems of ground movement were the major physical hazards and environmental stress of the shafts.

5.3.10 Communities support response

The KMO if the identified factor was **0.808** and the sector accounted total percentages of variance explained at 7 %. The associated Bartlett's Test of Sphericity was found as significant at p≤ 0.00. A mean of **2.770** and a low standard deviation of **1.052** were confirmed. The analysis shows that the mean score was between 'neutral and somewhat support' ratings on the five-point Likert scale for this factor. Based on the results a large number of communities are tired of crimes, environmental hazards, cultural deterioration (high prostitution and thefts rates) as a result of these abandoned mines. This implies that communities regard abandoned mines a serious threat that needs immediate attention hence they are prepared for any support to make sure that abandoned mines are rehabilitated.

5.3.11 DMRE and Government handling of abandoned mine issues

Factor analysis was carried out on whether participants think the DMRE in collaboration with government was doing enough to handle the issue of abandoned mines in North West Province, South Africa. The KMO of the identified factor was **0.579**. The associated Bartlett's Test of Sphericity was found as statistically significant at p≤0.00. The identified variable accounted for 6 % of the total variance. A moderate mean of **2.240** and a low standard deviation of **1.011** were confirmed through factor DMRE and government handling of abandoned mine issues. The analysis shows that mean scores

were between ‘agree’ and ‘strongly agree’ ratings on the five-point Likert scale for this factor. On average, the respondents agreed that the government of South Africa was making some strides in addressing the issue of negative legacy of abandoned mines that had been a bone of contention for decades since the beginning of gold and diamond mining around 1860s. It was indicated that the ministry of mines enacted two serious frameworks namely NEMA of 1998 and MPRDA of 2002 to show that they were serious about abandoned mine issues in South Africa.

5.3.12 Effectiveness of Finance Act

The KMO of the identified factor was **0.476** and the associated Bartlett’s Test of Sphericity was found statistically significant at p≤0.00. The factor extracted accounted for 2 % of the total variance. A moderate mean of **2.500** and a low standard deviation of **0.663** were confirmed through factor effectiveness of Finance Act. The analysis shows mean scores were between ‘moderately effective and extremely effective’ ratings on five-point Likert scale for this factor. Irrespective of supporting the statement, the respondents asserted that South Africa laws required mining companies to set aside money for the management, remediation and rehabilitation of the environmental impacts of mining operation. It has been noted that mine closure and rehabilitation was an area that was still evolving rapidly and need great attention. The research findings concur with the Council for Geoscience (CGS), 2021) which states that the ongoing environmental management impact of the mines was a problem for the state and therefore for the taxpayer. According to Auditor General Report 2018/19, rehabilitation of abandoned mines would cost R60billion a figure that excluded all costs associated with the treatment of acid mine drainage.

5.3.13 Taxation of working class

A factor analysis was carried out on whether the working class ought to be taxed to assist in the Rehabilitation Fund of abandoned mines in South Africa. The KMO of the identified factor taxation of working class was **0.681**. The associated Bartlett’s Test of Sphericity was found in this case as statistically significant at p≤0.00 and a total variance of 3.5 %. A moderate mean of **3.020** and a low standard deviation of **1.327**

were confirmed through factor taxation of working class. The analysis shows that mean scores were between 'agree' and 'strongly agree' ratings on the five-point Likert scale for this factor. On average, the respondents agreed that the working class ought to be taxed to assist in the rehabilitation Fund of abandoned mines. It was found out that abandoned mines pose a huge risk to a large section of the South African public and high risk of falling in abandoned pits, thus treated as a national problem which needed collective effort. Concerned citizens opted to contribute a certain fee for a fixed period towards solving a decade problem. This finding concurs with IMF (2001:6) that standard income tax has substantial benefits in terms of ease of administration.

5.3.14. Significant risk of abandoned mines

A factor analysis was carried out on what participants think is the most risk associated with abandoned mines in South Africa. The KMO of the identified factor was **0.781**. The associated Bartlett's Test of Sphericity was found at p≤0.00 and a total variance accounted for 2.6 %. A moderate mean of **2.310** and a low standard deviation of **1.490** were confirmed through factor important risk of abandoned mine. The finding of this variable outline acid mine drainage water especially from abandoned gold mines flows into the stream, dams and sources of ground water carrying toxic heavy metals and radioactive particles as the most important risk. These are dangerous for people's health as well as animals. Indication from participants cited damages such as altered landscape, unused dangerous shafts and abandoned mine waste disposal facilities as death traps to local communities and animals. Without coordinated effort to curb these problems, costs will rise and negatively impact the economies in terms of rehabilitation. Therefore, the environment, especially the biomass, pollution and soil erosion, acid drainage and water scarcity should receive remedial interventions. The findings concurs with Hermanus et al., (2015:10) who stress that acid mine drainage (AMD) is a major concern in the gold and coal mining sectors in South Africa.

5.3.15 Validation of mixed method

In this study, a mixed method was adopted for robust results. Information was gathered through questionnaires and interviews. This information could assist policymakers in the

management and rehabilitation of abandoned mines. The findings are objective as they relied heavily on statistical tools. A mixed-methods design offers a number of benefits to approaching complex research issues as it integrates philosophical frameworks of both post-positivism and Interpretivism (Fetters, 2016:3) interweaving qualitative and quantitative data in such a way that research issues are meaningfully explained. It also offers a logical ground, methodological flexibility and an in-depth understanding of smaller cases (Maxwell, 2016:12). In other words, the use of mixed-methods enables researchers to answer research questions with sufficient depth and breadth (Enosh, Tzafrir, & Stolovy, 2014:273).

5.3.16 Chapter Summary

This chapter presented descriptive statistics, exploratory factor analysis, factor analysis, among identified variables in relation to management and rehabilitation of abandoned mines in South Africa. This chapter's focus was on empirical analysis and information gathered from the study. The findings were explained, interpreted, analysed and the conclusion was drawn from the study. The findings of this study also reflect mutual relationship between management and rehabilitation of abandoned mines in South Africa. The absence of clearly assigned individuals for the management and rehabilitation of abandoned mines justifies why abandoned mines still exist and leaves negative impact on the surrounding communities and the government. The researcher used the findings of this study to develop a framework for the management and rehabilitation of abandoned mines in South Africa. The next chapter is the proposed modified framework for the management and rehabilitation of abandoned mines that has been yielded from the whole project, which was the main purpose of the research

CHAPTER SIX

A PROPOSED FRAMEWORK FOR THE MANAGEMENT AND REHABILITION OF ABANDONED MINES

6.0. Introduction

The previous two chapters focused on qualitative and quantitative data presentation and analysis. Interviews and questionnaires with mining companies, consultants, and regulators assisted in generating data that spoke to the research questions. The researcher identified some of strengths, weaknesses, opportunities and threats to successful management and rehabilitation of abandoned mines. This chapter focuses on the modified strategic framework for the management and rehabilitation of abandoned mines in South Africa based on the responses from qualitative and quantitative data analysis.

In this study suggestions and contributions from participants form part of the modified framework. It was identified that there is need for greater knowledge sharing of rehabilitation data and practices; improved internal communication and coordination between government and communities. Community based consultation, stakeholder engagements were noted as challenges contributing to the slow rate of rehabilitation of abandoned mines in South Africa. The study identified gaps and shortcomings in practice in the implementation of current legislative frameworks. Strategies and policies for the management and rehabilitation of abandoned mines were highlighted in this study. The absence of clearly assigned responsibilities, criteria and standards of management and rehabilitation of abandoned mines encouraged the researcher to carry this study with the intention of finding lasting solutions to the challenges posed by abandoned mines. Experiences and information from other developed international countries were used to buttress the context of this study.

6.1. A framework for the management and rehabilitation of abandoned mines in South Africa

Figure 6.1: Framework for the management and rehabilitation of abandoned mines
Source: Researcher's findings

The management and rehabilitation of derelict mines is an intricate task requiring seven components for successful implementation. Stakeholders need:

1. Research information (risk assessment and prioritisation)
2. Development of mine closure and rehabilitation process, with predictions based on options
3. Evaluation standards or guidelines
4. Submission and review by competent bodies
5. Rehabilitation of abandoned mine programmes
6. Monitoring and reporting on project success
7. Abandonment and best practices
8. Stakeholders engagement (government, local communities, land owners, local council, trade unions, local companies and interested stakeholders).

The management and rehabilitation of abandoned mines comes at an enormous cost, which with the march of time has increased in geometric proportions based on respective dates of abandonment coupled with the weakest commitment at the highest political level. In that respect, it was indicated from the findings of this study that the government cannot bear the rehabilitation costs single-handed without private or stakeholders input, given the budgetary constraints. Based on the abandoned mines rehabilitation flowchart, the remedial interventions should involve:

Research information, (risk assessment and prioritization)

Each abandoned mine should be approached differently because of the risks and dangers associated with the context of each mine. Gathering information is integral to the management as it assists in addressing the challenges for the complete rehabilitation of the abandoned mine. It is important to evaluate the abandoned mine site and establish the balance between net value and rehabilitation costs. This will depend on views of stakeholders, community, site risks and individual site features. The government should gather as much first-hand information as possible from local communities near abandoned mines to establish how the mine closure would affect

them, challenges and risks posed by the mine. Statistical data on mine rehabilitation process and environmental risk-based approach focused on community safety is a pre-requisite and forms the basis for prioritisation of management and rehabilitation of abandoned mines. It was identified from this study that the risks of falling into the abandoned mine shafts and problems of ground movement were major physical hazards. This is compounded by the risk of environmental stresses coming from the shafts. Acid mine drainage and water scarcity were also identified in Orkney and Stilfontein mines as the most common risk associated with abandoned mines in South Africa. In this view, prioritization of such places by the authorities is needed because many lives are lost. Mhlongo and da Costa (2016:279) argue that unused dangerous shafts and abandoned mines waste disposal facilities are death traps to local communities and animals.

Development of mines closure and rehabilitation process, prediction based on options

A preliminary mine closure plan needs to be developed. This development of a mine closure plan should include identification of management strategies such as scoping, identification of management strategies, monitoring and management, financial provision and costs effectiveness, closure impacts and challenges. All these specified strategies assist in the development of a framework for management and rehabilitation of abandoned mines. Government should ensure that it has the financial resources and wherewithal, to get the process of mine rehabilitation in motion. The effective management and rehabilitation of abandoned mine sites depends on thorough planning, a clear and proven methodology for management. Half-way considerations are best avoided if any positive outcomes are to be envisaged. This is largely due to the premise that poor environmental governance is not unique to South Africa but a phenomenon of universal proportions impacting the entire African mainland. In particular, precise assessment of the impact of old mining activities and the remedial environmental intentions thereof, form a glaring omission.

The assessment of the true extent of the detrimental effects of metal pollutants from old mining sites and their impact on the ecosystem as well as on human and animal health is crucial. To prevent problems emanating from abandoned mines, appropriate legislation development and enforcement has become imperative. As identified by the interviewees, this is because the government lacks the funding to implement existing legislative frameworks due to weakest commitment at the highest political level. The government faces a myriad of budgetary constraints and cannot do it alone without the involvement of other stakeholders' efforts and participation; hence community inputs are needed at all stages of the development.

Submission and review by competent bodies

Information obtained from literature review indicates that the department's enforcement and compliance unit experts from the Council for Geoscience and Mintek receive plans in relation to adequacy and consistency of information provided. Their mining intelligence assessments assist in monitoring the process of the management, closure and rehabilitation of abandoned mines in South Africa.

Rehabilitation of abandoned mine

In normal cases, rehabilitation occurs at the end of the mine closure process. It is prudent for rehabilitation to start during operation of mine, a stage called progressive rehabilitation. This progressive rehabilitation includes rehabilitation of some sections of the mine sites, waste minimization and planting of some vegetation on the dump sites. Qualified reports and updates from competent agencies/bodies should be used to guide in the rehabilitation process.

Adjournment/relinquishment and best practice

The results of full closure / rehabilitation activities by proponent will be used for evaluation and inspection by competent agencies such as the Council for Geoscience and the Department of Mineral Policy and Promotion. A closure certificate will be issued leading to relinquishment.

Stakeholder Engagement and Partnership inputs

Engaging stakeholders' assists in ascertaining the true value of an abandoned mine. If a community could reasonably have an interest in an abandoned mine site, stakeholder engagement should commence during the initial stage of site investigation and assessment and continues throughout to post project handover. This phase is axiomatic as far as cost-burden sharing is concerned for the rehabilitation of such an abandoned mine. Stakeholders and partnerships form the first line of human contact on the deleterious consequences on the environment. Stakeholder's involvement has been cited in the interviews as a challenge relating to abandoned mines. There should be cooperation by stakeholders, and government in creating a lasting solution to manage and rehabilitate abandoned mines in South Africa. This concept of community, government and stakeholder's consultation and dialogue is well rooted in mining legislation in developed countries. This is not always the case, especially in South Africa, where basics such as miners' occupational safety and health receive little to no attention. MCA (2010:10) indicates that an open and transparent approach that involves stakeholders in the management and planning of a rehabilitation project can give stakeholders 'ownership' of the rehabilitation and help improve awareness about issues requiring management. Mirals (2014) confirms that the participation of all stakeholders in mine closure speaks to a broader inadequacy in strategic planning, technical capacity and a cooperative/regional approaches, all underpinned by sustainability principles.

6.2.Chapter summary

The chapter proposes a framework for the management and rehabilitation of abandoned mines in South Africa. The framework provides solutions to the gaps that were identified from the literature review, qualitative and quantitative studies. It was indicated in the abandoned mines rehabilitation flowchart that the remedial interventions should involve research information (risk assessment and prioritisation). Gathering information is integral to the management, assists in addressing the challenges and requisites needed for the complete rehabilitation of the abandoned mine. Secondly, development of a mine closure plan needs the identification of management strategies which include, scoping, identification of management strategies, monitoring and

management, financial provision and costs effectiveness, closure impacts and challenges. These strategies and processes ultimately assist in the development of framework for management and rehabilitation of abandoned mines. Thirdly, monitoring and evaluation plays a crucial role in the management and rehabilitation of disused mines. Failure to monitor, manage and evaluate, will result in risk of reducing the credibility of the science and practice of mine rehabilitation.

It has been identified that collective ideas and efforts always bring results and solutions to issues related to abandoned mines in South Africa. The deleterious effects caused by the negative legacies of abandoned mines pose threats to the social, economic and environmental aspects of the nation. It has been indicated that stakeholders should be involved throughout all the stages of mine rehabilitation because this assists in developing appropriate management options for the site. The delay in rehabilitating abandoned mines which include a lack of clearly assigned responsibilities, limited resources, the absence of criteria, and the priority for rehabilitation of abandoned mines were cited as some of the challenges contributing to the current problems bedeviling the nation. In the end, a closure certificate should be issued after the relinquishment of the project to the satisfaction of the review by the competent bodies.

CHAPTER SEVEN

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

7.0. Introduction

This chapter presents the findings, conclusions and recommendations of the study on developing a framework for the management and rehabilitation of abandoned mines in South Africa. The chapter restates the research problems, objectives, questions of the study, and derives conclusions from the empirical findings. The final part assesses the contributions proffered to the body of knowledge. Finally, it offers recommendations for future work. The framework for the management and rehabilitation of abandoned mines in South Africa has already been presented in the preceding chapter.

7.1 Research objectives

The aim of this study was to develop a framework for the management and rehabilitation of abandoned mines in South Africa. It focused on samples of abandoned mines in the North-West Province of the country and excluded abandoned mines in other parts of South Africa. Based on the aim of the study, the following specific objectives were devised to:

- To explore gaps in the implementation of the existing legislative frameworks for the management of abandoned mines in South Africa.
- To conduct a critical review of literature on theories underpinning the existing management frameworks for the rehabilitation of abandoned mines in South Africa.
- To describe the implementation strategies of the existing management frameworks for the management and rehabilitation of abandoned mines in South Africa.
- To propose an alternative management framework for the rehabilitation of abandoned mines in South Africa.

7.2 Research questions

Based on the statement of the research problem, and the main objective of this study, the main research question was “Are the existing legislations and managements frameworks for mines when they reached their life-span sufficient in addressing challenges related to the rehabilitation of mines in South Africa?”

From the main research question, the following sub-research questions were raised:

- Are there gaps in the implementation of legislations and management frameworks relating to abandoned mines in South Africa?
- What does the review of literature on theories underpinning the current management frameworks for the rehabilitation of abandoned mines in South Africa exhibit on managing abandoned mines?
- What are the implementation strategies in the existing management frameworks for the rehabilitation of abandoned mines in South Africa?
- What suitable management framework could be developed for the rehabilitation of abandoned mines based on findings from this study in South Africa?

The study sought to develop a framework for the management and rehabilitation of abandoned mines in South Africa. The study adopted a case study approach of North-West Province. There were gaps identified in the study such as the ever increasing illegal activities in unsafe abandoned mines shafts; the increasing number of deaths in abandoned mine shafts; the constant iterations of legislations and amendments in the current management framework for the rehabilitation of mines; the ever increasing number of abandoned mines nationwide as well as concerns around the existing frameworks. Other challenges relate to the costs for the management and rehabilitation and this justifies the study in searching for some solutions to the management and rehabilitation challenges of abandoned mines in South Africa. It is upon this background that the researcher develops a framework for the management and rehabilitation of abandoned mines in South Africa to assist the government in minimizing non-management negative effects. The current gap in existing management frameworks for the rehabilitation of mines in South Africa was the basis upon which this study was conducted.

7.3 Conclusion from empirical findings

Based on the findings drawn from thematic analysis, abandoned mines, especially gold mines, turn to be hot spots for illegal and small mining operations that create challenges such as waste disposal, changes in ground compaction, unused pits and steep shaft slopes that have subsequently become death traps to surrounding communities (Mhlongo & Da Costa, 2016:279-294). The findings of the study demonstrate that there is a challenge of pollution in disused mines. It was established that communities were seldom cohesive and were not capacitated to make informed decisions regarding management and rehabilitation of abandoned mines, as well as environmental issues related to water pollution, soil erosion and soil contamination. Miralas et al (2014) confirmed that the participation of all stakeholders in mine closure speaks to a broader inadequacy in strategic planning, technical capacity and a cooperating approach all underpinned by sustainability principles. It was also found that there is the deletion of section 38 to 42 of the MPRDA of 2002, (that is the section that previously dealt with environmental governance under MPRDA). These sections were omitted and have not been covered elsewhere thus leaving a major gap in the legislation. Therefore, if important sections 38 to 42 of the MPRDA of 2002 are omitted, this creates a major gap in the implementation of rehabilitation projects. Based on this backdrop, the study develops a framework for the management and rehabilitation of abandoned mines in South Africa to assist the government to minimise dangers posed by abandoned mines in the North West Province.

Furthermore, with regards cash flow management, the study established that there is need for the government to enhance forensic auditing to make sure that there is financial prudence. Cases of corruption and misuse of Rehabilitation Fund is high in the Ministry and this delays the implementation of set rehabilitation projects. In this vein, it is imperative to address abandoned mine challenges such as changes in legislation and senior management in the ministry. This hampers both the smooth operation and fulfillment of the aims and objectives of management and rehabilitation of abandoned mines.

Thematic results show that there is negative relationship between stakeholder's involvement and management framework for the rehabilitation of abandoned mine. All the interviewees reached consensus on the fact that the public had the essential and critical knowledge to make informed decisions about the rehabilitation of abandoned mines. It was also confirmed that there was no provision and implementation of set out policies and execution of duties by the government in the quest to rehabilitate abandoned mines in the North West Province. In response to assistance received from both government and non-governmental organisations, the thematic analysis verified that there was no tangible proof that the government was addressing hazards associated with the abandoned mines. Existing unused pits remain a real danger to humans and animals. The outcome of the interview also suggested that due to increases in diseases associated with dust emissions from abandoned mines, the amount budgeted falls far too below the target of achieving comprehensive zero harm.

The findings confirmed that the government has made some strides in solving the issue of abandoned mines. In examining the strategies that have been implemented in the rehabilitation of abandoned mines in the North West Province, the researcher found that majority of interviewees indicated that the government has adopted a holistic approach in drafting of a comprehensive legislative framework addressing environmental hazards beginning with risky affected areas. The allocation of R60billion for closure and rehabilitation of abandoned mines could assist in minimizing the challenges faced by communities and businesses surrounding abandoned mines. The government also identified approximately 6 000 abandoned mines in the country and designed a generic concrete plug to seal abandoned open shafts and trenches. However, the government needs support from different stakeholders to combat these problems. In light of the strategies put in place for the rehabilitation of abandoned mines, it was established that the government does have the fiscal muscle to implement adequate policies to minimise problems associated with management and rehabilitation of abandoned mines given the costs associated with Covid-19 and the recent floods in KwaZulu-Natal. In view of this, despite the fiscal deficit the general consensus was that the introduction of the legislative acts was identified as the best organic solution of eradicating abandoned mines risk and closure.

The thematic analysis on the shortcomings in relation to abandoned mines management and rehabilitation in North West Province shows that there is dire need for the formation of community based consultative process comprising community representatives, government and other stakeholders to ensure that all parties work towards in the fulfilment of the initiative. It was found that the little information on monitoring of social and economic condition needs enhancement. The monitoring of the roll out of the rehabilitation process enhances community capability to align with the requirements after mine closure. The emphasis should be on surrounding communities than the environment. Kabir et al (2015:154) equally argue that monitoring of social indicators is more difficult than those relating to the physical environmental.

In response to "what do you think would be the way forward to the challenges concerning the rehabilitation of abandoned mines?" the study verified that it is important to promote innovation and share experiences of success and failure. The government and all other interested stakeholders should put their heads together to find an amicable solution to combat abandoned mine problems and map the way forward in finding a sustainable solution to the problem. Making strategic decisions related to rehabilitation is an important and complex issue and any mistake could be very expensive. Respondents indicated that stakeholders need to make decisions based on unbiased judgment and priority should be given to high risk abandoned mines. The influx of Zama-Zama's in disused mines in search of gold and other precious minerals needs the surefooted involvement of concerned stakeholders to seal and rehabilitate entrances to the mines. Morrison-Saunders and Pope (2013:212), argues that the sites pose social, environmental and financial challenges for the government, and a financial burden on taxpayers.

Furthermore, the researcher found out that the subject of responsibility of abandoned mines management and rehabilitation lies with the government. It was noted that there is need for collaborative effort from all stakeholders to assist the government in the rehabilitation of abandoned mines. According to MPRDA Act 28 of 2002, Section 28, holds that, "every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such

pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorized by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment." The government bears the financial responsibility since it is the institution that should have ensured that there are policies and regulations in the first place to prevent mine abandonment.

In light of the budgeted R60 billion for rehabilitation, communities should also assist financially as the budget is not enough because they are the ones affected by ongoing pollution and health risks posed by these abandoned mines. It was also found out that the full R60 billion is not a recurring annual provision; the quantum relative to mining GDP is evidence of the commitment by mining companies to their environmental obligation. The estimated 6 000 abandoned mines are too many for the South African government alone and it is not realistic whether the government would be able to fund rehabilitation at such magnitude. CER attorney Christine Reddell, (2018) indicated that the information provided about the costs of rehabilitation, and the companies' ability to cover costs is inconsistent, unclear, in some cases unreliable, and not comparable between companies.

The study established that responsible parties on management and rehabilitation of abandoned mines should be transparent in their financial dealings, operations and adhere to principles and regulations as outlined in the MPRDA and NEMA frameworks. Clear roles and responsibilities would assist the government on the direction taken in respect of the management and rehabilitation projects.

It was confirmed that acid mine drainage water, especially from abandoned gold mines, flows into streams, dams and sources of groundwater carry toxic heavy metals and radioactive particles. These are dangerous for people's health as well as plants and animals. As cited by Mhlongo and Da Costa, (2016:276) damages such as altered landscape, unused dangerous shafts and abandoned mine waste disposal facilities are death traps to local communities and animals. The results also indicate that the surge in corruption cases in mining departments poses serious threats to the rehabilitation of abandoned mines in the North West Province. Respondents also indicated that

abandoned mines in South Africa are sources of toxic chemical and metal pollution. Continued release of mine pollution contaminates land, water and air, leading to significant hazards and costs. Without coordinated effort to curb these contaminants, costs would rise and negatively impact the economy in terms of rehabilitation. The findings of this study also demonstrate that Management Frameworks (MFs) have not been effective in relation to the broader decision-making context. In view of this, it can be stated that, insufficient and inadequate capacity within organs of state poses a threat to the successful development and implementation of Management Frameworks. The fragmentations of legislations additionally create management and governance problems, disallowing development to occur in a manner consistent with the principles of sustainability and judicious planning.

The shortage of relevant mine closure skills and knowledge within the regulator was a major key contributor to unsuccessful closure. A recent study of the mineral application process by Corruption Watch (2017) indicates that positions in the regulator have been frozen for many years, leading to a shortage of staff, and resulting in unqualified individuals getting appointed. However, it was evident from the data released by DMRE that the government was making some strides in addressing the issue of negative legacy of abandoned mines that was a challenge for decades. It was highlighted that the Ministry of Mines enacted two frameworks namely NEMA of 1998 and MPRDA of 2002, demonstrating commitment towards closure and rehabilitation of abandoned mines.

7.4 Research Methodology

The research methodology and design of this study was presented in depth in Chapter 3. The study was guided by the pragmatism paradigm. This paradigm was selected because it applies to mixed methods arguing that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in research that calls for a pragmatic philosophical stance (Tashakkori & Teddlie, 2010:271). According to (Creswell & Plano-Clark, 2011), the study links the philosophical research assumptions and research paradigms and considers them as positively correlated; An exploratory

sequential mixed method research (MMR) design was selected to broadly explore and understand human practices, behaviours, and preferences of stakeholders in the mining industry with regards abandoned mines in South Africa. Morgan (2007) and Creswell (2014) show that, “exploration is needed when the measures or instruments are not available, constructs are unknown and when there is no guiding framework or theory as in this study”. The research population, sampling techniques, data collection techniques, data analysis and ethical considerations were discussed in Chapter 3. Braun et al, (2019: 589) argue that, “thematic analysis was used to explore questions about participants' lived experiences, perspectives, behaviours and practices, the factors and social processes that influence and shape particular phenomena, the explicit and implicit norms and 'rules' governing particular practices, as well as the social construction of meanings and the representation of social objects in particular texts and contexts”. Results from qualitative and quantitative were used to develop a framework for the management and rehabilitation of abandoned mines in North West Province, South Africa.

7.5 Contribution of the study

This study contributes to the body of knowledge, practice and policy formulation. The study fills the gap in existing literature by proposing a framework for the management and rehabilitation of abandoned mines in North West Province of South Africa. The study contributes the following:

7.5.1. Risk assessment and prioritization

Each abandoned mine should be approached differently because of the risks and dangers associated to it. Gathering information is integral to the management. This information helps in addressing the challenges and requirements needed for the complete rehabilitation of the abandoned mine. It is important to value the abandoned mine site and the nature of the balance between values will depend on views of stakeholders, community, site risk and individual site features. The government should gather as much first-hand information as possible from local communities near abandoned mines to establish how the mine closed, challenges and risks posed by the

mine. Statistical data on mine rehabilitation process and environmental risk-based approach focused on community safety is a pre-requisite and forms the basis for prioritisation of management and rehabilitation of abandoned mines. It was identified from this study that the risks of falling into abandoned mine shafts and the problems of ground movement are the major physical hazards and environmental stresses of shafts. Acid mine drainage and water scarcity was also identified in Orkney and Stilfontein mines as the most common risk in South Africa. In this view, prioritisation of such places by the authorities is needed because many lives are lost. Mhlongo and da Costa, (2016:279) argues that unused dangerous shafts and abandoned waste disposal facilities are death traps to local communities and animals.

7.5.2. Mine closure and rehabilitation process

A preliminary mine closure plan needs to be developed. This development of a mine closure plan should include identification of management strategies such as scoping, identification of management strategies, monitoring and management, financial provision and cost effectiveness, closure impacts and challenges. All these steps assist in the development of a framework for management and rehabilitation of abandoned mines. Government should ensure that it has the financial resources and wherewithal, to get the process of mine rehabilitation in motion. The effective management and rehabilitation of abandoned mine sites depends on thorough planning, a clear and proven methodology for management. Half-way considerations are best avoided if there are to be any positive outcomes. This is largely due to the premise that poor environmental governance is not unique to South Africa but a phenomenon of universal proportions impacting the entire African mainland. In particular, precise assessment of the impact of old mining activities and the remedial environmental intentions thereof all form a glaring omission.

It is critically essential to assess the true extent of the detrimental effects of metal pollutants from old mining sites and their impact on the ecosystem as well as on human and animal health. To prevent problems emanating from abandoned mines, appropriate legislation development and enforcement has become a prerequisite. As identified by

the interviewees, the government lacks the funding to implement existing legislative frameworks due to weakest commitment at the highest political level. The government faces a myriad of budgetary constraints and cannot go it alone without the involvement of other stakeholders' efforts and participation. Consequently, community inputs are needed at all stages of the development of such a framework.

7.5.3. Submission and review by competent bodies

Information obtained from literature indicates that the department's enforcement and compliance unit experts from the Council for Geoscience and Mintek receive submission plans in relation to adequacy and consistency of information provided. Their intelligent assessments assist in monitoring the process of the management, closure and rehabilitation of abandoned mines in South Africa.

7.5.4. Rehabilitation of abandoned mine

In normal cases, rehabilitation occurs at the end of the mine closure process. It is prudent for rehabilitation to start during the operation of the mine in a process called progressive rehabilitation. This progressive remediation includes rehabilitation of some section of the mines sites, waste minimization and planting of some vegetation on the land. Qualified reports and updates from competent agencies and bodies should be used for guidance in the rehabilitation process.

7.5.5. Adjournment and best practice for mine rehabilitation

The results of full closure and rehabilitation activities by proponent ought to be used for evaluation and inspection by competent agencies such as the Council for Geoscience and the Department of Mineral Policy and Promotion. A closure certificate would then be issued leading to relinquishment.

7.5.6. Stakeholder engagement and partnership inputs

Engaging stakeholders helps in ascertaining the true value of an abandoned mine. If a community could reasonably have an interest in an abandoned mine site, stakeholder engagement should commence during the initial stage of site investigation and assessment and continue through to post project handover. This phase is axiomatic as far as cost-burden sharing is concerned for the rehabilitation of abandoned mine. Stakeholders and partnerships form the first line of human contact on the deleterious consequences on the environment. Stakeholder's involvement has been cited in the interview as a challenge relating to abandoned mines. There should be cooperation by stakeholders, and government in creating a lasting solution to manage and rehabilitate abandoned mines in the North West province, South Africa. This concept of community, government and stakeholder's consultation and dialogue is well rooted in mining legislation in developed countries. This is not always the case, especially in South Africa, where basics such as miners' occupational safety and health receive no attention. MCA (2010:10) indicates that an open and transparent approach that involves stakeholders in the management and planning of a rehabilitation project can give stakeholders 'ownership' of the rehabilitation and help improve awareness about issues requiring management. Mirals (2014) confirms that the participation of all stakeholders in mine closure speaks to a broader inadequacy in strategic planning, technical capacity and a cooperative/regional approach all underpinned by sustainability principles.

7.5.6. Contribution to practice

The findings are important to management and rehabilitation of abandoned mines as they provide a better understanding of how management contributes to rehabilitation. If all mining companies adhered to the legislative frameworks and changes as proposed in the new framework on management and rehabilitation of abandoned mines, the North West Province in South Africa would be a better place to live. The implementation of policies may also be beneficial to the Department of Mineral Resources and Energy (DMRE) in minimizing the risks associated with abandoned mines. The issue of management and rehabilitation of abandoned mines is caused by the lack of clear legal

and financing mechanisms and lack of the willingness on the part of industry, governments and communities to form mutually beneficial partnerships for immediate remediation.

7.5.7. Policy implications

The study assists in the management and rehabilitation of abandoned mines and solves social, economic, environmental pressures and governance issues. An understanding of the newly modified framework assists policy makers in planning for both current and future projects. It is important that the authorities and responsible stakeholders adhere to set down policies in the fight to minimise the dangers caused by abandoned mines. Companies are therefore encouraged to adopt the asymmetry and improve management practices for both practices and policy formulation. Mining companies should promote good governance by enhancing government effectiveness in line with the new proposed framework. Companies must ensure that they incorporate stakeholders in all mining projects. This could minimise the increase of abandoned mines in the North West Province, South Africa. Communication should be enhanced by mining companies, incorporating communities surrounding abandoned mines and taking their views into cognizance. Progress made on any management and rehabilitation projects should be shared in the spirit of dissemination and transparency.

7.8. Recommendations

Based on the findings of the study, the following issues are recommended in order to promote management and rehabilitation of abandoned mines in South Africa:

- There should be an open channel of communication between government and stakeholders. Information about the management and rehabilitation of abandoned mines must be disseminated to the communities and other interested stakeholders since most of them are not aware of the programmes. When government demonstrates eagerness and sensitivity to hear stakeholder's problems, the more willing the stakeholders are likely to proffer solutions to the problems they face.

- It is important to promote innovation and share experiences of success and failure. The government and all other interested stakeholders should come together to find an amicable solution to combat abandoned mine problems and map the way forward for sustainable solutions to this conundrum.
- The rehabilitation of abandoned mines should be prioritised to high risk abandoned mines and stakeholders need to make decisions based on unbiased judgment.
- Community-Based-Consultative process comprising community representatives, government and other stakeholders would ensure that all parties contribute effectively towards the closure and rehabilitation of abandoned mines in North West Province, South Africa.
- The government and responsible parties on the rehabilitation of mines should be transparent in their financial dealings, operations and adherence to principles and regulations as outlined in the MPRDA and NEMA frameworks. The government should report on stages undertaken during rehabilitation so that progress is continuously updated.
- Rehabilitation of abandoned mines is the only solution to address environmental, health, and safety challenges under one auspice.

7.9. Future research

There are several studies conducted in South Africa on abandoned mines, but they have failed to examine the aspect of management of abandoned mines in South Africa. This has caused the problem of abandoned mines as currently experienced today. Regardless of numerous suggestions on rehabilitation by previous researchers, the subject of a proper framework for the management and rehabilitation of abandoned mine in South Africa is still lacking, hence the study. It is recommended that future studies should focus on the broader South African mining space and extend the findings of this study that concentrated on the North West Province only. This could generate some important results with broader applicability to rehabilitation of disused mines

7.10. Limitations of the research

The study is limited to the management and rehabilitation of abandoned mines in South Africa in the form of a case study of North-West province. This is a limiting factor because the study could have covered all the mines in South Africa but for this constraint in time and scope. The researcher's outcomes could contribute immensely to the management and rehabilitation of abandoned mines in South Africa.

7.11. Conclusion

This chapter summarised the key findings of the study in line with research objectives and research questions. A framework for the management and rehabilitation of abandoned mines was developed as a solution to the rehabilitation of abandoned mines in North West Province, South Africa. The framework provides solutions to the gaps that were identified from the literature review, qualitative and quantitative studies. The deleterious effects caused by the negative legacies of abandoned mines pose threats to the social, economic and environmental aspects of the nation. Stakeholders should be involved throughout all the stages of mine rehabilitation because this assists in developing appropriate management options for the site. The proposed framework and existing legislatives could guide mining gurus and policymakers in improving the management and rehabilitation of abandoned mines. This could serve time and money by the authorities and reduce the scale of illegal mining practices.

It is important to promote innovation and share experiences of success and failure. The government and all other interested stakeholders should come together to find an amicable solution to combat abandoned mine problems and map the way forward for sustainable solutions to this conundrum. The government and responsible parties on the rehabilitation of mines should be transparent in their financial dealings, operations and adherence to principles and regulations as outlined in the MPRDA and NEMA frameworks. A study of this nature is important because it assists the government and other interested stakeholders in minimising the dangers and challenges posed by abandoned mines in South Africa.

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Annexure A: Quantitative Consent Letter

Dear participant,

This serve as an invitation to participate in a research study titled **"Developing a framework for the management and rehabilitation of abandoned mines in South Africa".** This study will be conducted by **Mr. Edward Kuipa (36448303)** who is a registered PhD from the Business School at the North-West University, South Africa. The results of the study will be used to understand the management challenges associated with abandoned mines in the North West Province of South Africa.

If you are an employee, community member or stakeholder who was involved with an identified abandoned mine; you are eligible to participate in this study. Participation in this study is voluntary. Information gathered during the research will be used solely for the purpose of this study and all efforts will be made to ensure the confidentiality of participants' personal information.

The information provided by you in this questionnaire will not be used in any manner that would allow identification of your individual responses. The data gathered will be captured in a database, will be statistically analysed and will be used for research purposes. If you decide not to participate, there will not be any negative consequences. Please be aware that if you decide to participate, **you may withdraw from the study at any time and your data will be destroyed. The results of the thesis will be published in the form of a compiled thesis and research-based articles.** If you choose to participate in this survey, it will take **30-40** minutes of your time.

If you choose to participate, please read and follow the instructions provided:

Instructions:

•Please complete only one questionnaire per person.

•It is recommended that you complete the survey in one sitting.

•Please complete this survey within 10 days from the date you received an email from the researcher.

Should you require any further information, want feedback on the study or need to contact the researcher about any aspect of this study, please contact:

1. **Mr. Edward Kuipa at +267 74 783 222, +267 72 262 641 or eddykuips@hotmail.com**

2. Dr. Lekunze, JN at +27 (0) 18 389 2235, +27 83 719 7640 or Joseph.Lekunze@nwu.ac.za.

INFORMED CONSENT

- I understand the purpose and nature of this study and I am participating voluntarily.
- I understand that I can withdraw from the study at any time, without any penalty or consequences.
- I agree that the information that I provided may be used for research purposes.

I agree ☐

I don't agree ☐

Thank you for taking time and for participating in this study. Your time and inputs are most valued.

Annexure B: Quantitative questionnaire

INSTRUCTIONS OF FILLING IN THE BOX:

Double Click on the preferred box then click "checked and ok". If you want to change the answer, double click the same answer; click "Not Checked then Ok"

SECTION A

Demographic characteristics of the respondents (please tick wherever appropriate).

1. Gender

A. ☐ Male

B. ☐ Female

C. ☐ Other

2. Age category of the respondent

A. ☐ 18 – 30 years

B. ☐ 31 – 45 years

C. ☐ 46 – 55 Years

D. ☐ Above 55 Years

3. What is your highest level of education?

A. ☐ Doctorate/Master Degree

B. ☐ First Degree

C. ☐ Diploma Degree

D. ☐ High School Certificate

E. ☐ Primary Certificate

4. Which sector do you work in?

A. ☐ Public

B. ☐ Private

C. ☐ Non- Governmental Organisation

D. ☐ Resident

E. ☐ None

5. How long have you been working in the Department of Mineral Resources or Environmental Affairs, Government, Auditor General of South Africa and abandoned mines?

A. ☐ Less than a 1 year

B. ☐ 1 – 5 years

C. ☐ 5 – 10 years

D. ☐ 10 – 20 years

E. ☐ More than 20 years

6. What is your current position in this Department of Environmental Affairs or Mineral Resources, Auditor General of South Africa, Department of Mineral Resources?

A. ☐ Manager

B. ☐ Technocrat

C. ☐ Supervision

D. ☐ Clerical officer

E. ☐ Others

SECTION B- Opinions on public perceptions on abandoned mines in South Africa

You are required to tick in indicating your appropriate response.

Statements	1.Extremely familiar	2.Very familiar	3. Moderately familiar	4. Slightly familiar	5. Not at all familiar
7. How familiar are you with abandoned mines and their associated environmental concerns?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain what are abandoned mines and environmental concerns? Fill in the box below.

Statements	1.Strongly Agree	2.Agree	3. Neither Agree	4.Disagree	5. Strongly disagree

8. In your own opinion, do you feel the public are empowered with knowledge to make informed decision about rehabilitation of abandoned mines?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain the reason for the choice of your answer in the box below.

Statements	1.Poverty	2.Hunger	3. Unemployment	4.Quick Cash	5. All of the above
9. What do you think are the causes of illegal mining in South Africa?	☐	☐	☐	☐	☐

Please if your response to statement above is 1, 2, 3 or 4, kindly explain in depth your preferred answer as the cause of illegal mining in South Africa in the box below.

Statements	1. Social factors	2. Economic factors	3. Environmental factors	4. Political factors	5. All of the mentio ned
10. What do you think are the causes of abandoned mines in South Africa?	☐	☐	☐	☐	☐

Please if your response to statement above is 1, 2, 3 or 4, kindly explain in depth your preferred answer as the cause abandoned mines in South Africa in the box below.

Statements	1. Strongly Agree	2. Agree	3. Don't Agree	4. Disagree	5. Strongly Disagree
11. The introduction of NEMA, MPRDA, and NWA acts comes as the best solution of eradicating abandoned mine risks and closure. Do you feel the government has the fiscal muscles to implement them effectively?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain how this can implemented effectively.

Statements	1. Very effective	2. Effective	3. Moderately effective	4. Slightly effective	5. Ineffective
12. How effective have the Environmental Management Frameworks outcomes been analysed in relation to the broader decision-making context?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain how the outcomes have been analyzed in relation to the broader decision-making context?

13. How can problems of illegal mining be eliminated/reduced in South Africa?

A. ☐ Government to provide employment for people

B. ☐ Community education on dangers of abandoned mines and any environmental hazards.

C. ☐ Mine companies responsible should rehabilitate abandoned mines.

D. ☐ Government should rehabilitate all abandoned mines as they are health hazards to the environment.

E. ☐ Government should evict residents in abandoned mines proximity.

Please if your response to statement is any of the above A, B, C, D, or E. kindly explain the choice of your answer as the preferred best solution in the box provided below.

SECTION C – Impact of Mining

You are required to put an "X" so as to indicate your appropriate response.

Statements	1.Extreme risky	2.Very risky	3. Moderately familiar	4. Minor	5. Not risky
14. How do you rate the threats by abandoned mines on Safety, health and Environment (SHE)?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain what should be done to minimise the effects of these threats on SHE.

Statements	1.Strongly Support	2.Somewhat Support	3. Neutral	4. Somewhat Oppose	5. Strongly Oppose
15. Do you think the communities honestly support the rehabilitation of abandoned mines in South Africa?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain in depth why communities support rehabilitation of abandoned mines.

16. What do you think is the most significant risk associated with abandoned mines in South Africa (North West Province)? Rank them accordingly.

A. ☐ Pollution/Contamination

B. ☐ Environmental damages

C. ☐ Acid drainage and Water scarcity

D. ☐ Soil Erosion, land destruction

E. ☐ Corruption and Crime

Please if your response to statement is any of the above A, B, C, D, or E. kindly explain the ranking order.

Statements	1.Strongly Agree	2.Agree	3. Neither Agree	4. Disagree	5. Strongly Disagree
17. Do you think the department of Minerals Resources in collaboration with government is doing enough to handle the issue of abandoned mines in North West Province, South Africa?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain why you think so.

18. What successes have been done on the rehabilitation of abandoned mines in South Africa?

Section D – Questionnaire on Financing of abandoned mines

Statements	1.Extremely effective	2.very effective	3. Moderately Effective	4. Slightly effective	5. Not at all effective
19. How effective is the Finance Act in the rehabilitation of abandoned mines in North- West Province, South Africa?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain the effectiveness of the Finance Act.

Statements	1.Strongly Agree	2.Agree	3. Neither Agree	4. Disagree	5. Strongly Disagree
20. Should the working class be taxed to assist in the rehabilitation Fund of abandoned mines in South Africa?	☐	☐	☐	☐	☐

Please if your response to statement above is 1 or 2, kindly explain why there should be such involvement.

21. Who do you think is responsible for the costs of rehabilitation of abandoned mines in South Africa?

A. ☐ Mining Industry

B. ☐ Government

C. ☐ Local Communities

D. ☐ All Stakeholders

E. ☐ None of the above

Please if your response to statement is any of the above A, B, C, D, or E. Kindly specify and give a comprehensive answer for your choice in the box provided below.

22. Do you feel the estimated R40 Billion allocated to rehabilitate all 5906 abandoned mines in SA is sufficient given the socio-economic, environmental and political challenges facing the country in the wake of COVID-19 pandemic, briefly explain.

23. With due to the above mentioned challenges concerning the rehabilitation of abandoned mines, what do you think would be way forward in order to come out with sustainable solution to the problem?

24. If all stakeholders included government were taken on board to roll out initial planning, given the finance act, would their input add value to the implementation of the rehabilitation of abandoned mines as a best practice of finding out an amenable solution?.

25. What recommendations do you have for the rehabilitation of abandoned mines in South Africa?

Annexure C: Qualitative informed consent letter

Dear Participant

I am **Mr. Edward Kuipa (36448303)** a registered PHD student with North-West University.

Purpose of the study

You are invited to take part in a research study titled **"Developing a framework for the management and rehabilitation of abandoned mines in South Africa."** Before you accept we would like to help you understand the research and what participation you will be involved in. Please read through this informed consent and feel free to let us know if you need some clarifications.

Study Procedures

The study procedures are that, you will answer a series of questions in order to evaluate which category you belong to and then you will be asked another series of analytic questions about your opinion on certain matters on management and rehabilitation of abandoned mines. The researcher guarantees confidentiality and information gathered during this research will be used solely for the purpose of this study. Participation is completely voluntary. Data gathered will be captured in a database, will be satisfactorily analyzed and used for research purposes only. You may withdraw from the study at any time and your data will be destroyed. The results will be published.

Duration

This study will take less than 30-40 minutes per individual for answering the qualitative questions.

Contact Information

This research study was approved by North-West University department of Economics and management Sciences with Business Administration. Should you require any further information, want feedback or need to contact the researcher about any aspect of this study, please contact:

1. Edward Kuipa at +267 74 783 222 or 72 262 641 or eddykuips@hotmail.com

2. Dr. Lekunze, JN. at +27 (0) 18 389 2235 or +27 83 719 7640 or joseph.Lekunze@nwu.ac.za

Annexure D: Informed consent form for interview

Full Title of the Project: **"Developing a framework for the management and rehabilitation of abandoned mines in South Africa"**

Name of Researcher: **Mr. Edward Kuipa**

INSTRUCTIONS OF FILLING IN THE BOX:

Double Click on the preferred box then click "checked and ok". If you want to change the answer, double click the same answer; click "Not Checked then Ok"

Please Tick Appropriate Box	**Yes**	**No**
Taking Part		
1. I confirm that I have read and understood the subject information sheet dated: and I have had the opportunity to ask questions which have been answered fully.	☐	☐
2. I understood that my participation is voluntary and I am free to withdraw at any time without any reason and without my legal rights being affected.	☐	☐
3. I agree to take part in the project. Taking part will include being interviewed and recorded (audio or video).	☐	☐

Use of information I provide for project only ☐ ☐

1. I understand that my personal details such as names, phone numbers and addresses will not be revealed to people outside the project. ☐ ☐
2. I understand that my words may be quoted in publications, reports, web sites and other research outputs. ☐ ☐

Please choose one of the following options:

I would like my real name used in the above ☐

I would not like my real name used in the above ☐

Use of information I provide beyond this project

	Yes	**No**
I agree for the data I provide to be archived.	☐	☐
I understood that other authenticated researchers will have access to this data only if they agree to preserve the confidentiality of the information as required in the form	☐	☐

So we can use information provided legally

I agree to assign the copyright I hold in any materials related to this project to Mr. Edward Kuipa ☐ ☐

Edward Kuipa

----------	**----------**	**----------**
Name of Participant	**Signature**	**Date**
----------	**----------**	**----------**
Name of Researcher	**Signature**	**Date**

Guiding questions

Section one: Perception and knowledge of management of abandoned mines.

I. May kindly tell us how long have you been staying around this abandoned mine?
II. What are the challenges relating to abandoned mines and how have they affected your daily lives and business operations?
III. What do you think are the causes of abandoned mines?
IV. How much do you know about abandoned mines?
V. Do you feel the public are empowered with knowledge to make informed decision about rehabilitation of abandoned mines in South Africa?
VI. How much assistance are you receiving from both Government and Non-Governmental Organisation (NGO) in solving these challenges?

Section two: Financing and strategies to be implemented in the rehabilitation of abandoned mines in South Africa

I. What do you think should be done to control the problems that the communities are facing?
II. Tell us about strategies in place that have been implemented in the rehabilitation of abandoned mines in South Africa?

Section three: Government policies in eradicating the dangers and harm caused by negative legacy of abandoned mines

I. Do you feel the government has the fiscal muscles to implement adequate policies to minimise the problems associated with rehabilitate abandoned mines?
II. How much community support exists from the rehabilitation of abandoned mines in South Africa?
III. What are the shortcomings in practice in relation to abandoned mines management and rehabilitation of abandoned mines in South Africa?
IV. Does the mine rehabilitation identify all possible domains?

V. What lessons has the government learnt in the handling of abandoned mines in South Africa?

VI. What policies and strategies have been put in place to make sure that current miners would not fall into the previous miners trap?

Section four: Implementation, check and balances as well as recommendations to curb the challenges posed by abandoned mines in South Africa

I. With respect to the above-mentioned challenges concerning the rehabilitation of abandoned mines, what do you think would be way forward in order to come out with sustainable solutions to the problem?

II. How should responsibility and costs of abandoned mines be shared between the government and other stakeholders?

III. Who do you think is responsible for the high costs of rehabilitation of abandoned mines in South Africa?

IV. Do you feel the estimated R60 billion allocated to rehabilitate all 6000 abandoned mines in South Africa is sufficient given the socio-economic, environmental and political challenges facing the country in the wake of COVID-19 pandemic? Briefly explain your opinion.

V. What successes have been made in the rehabilitation of abandoned mines in South Africa?

VI. If all stakeholders including government were taken on board to roll out initial planning, given the finance act, would their input add value to the implementation of the rehabilitation of abandoned mines as a best practice of finding out an amenable solution?

VII. What recommendations do you have for the rehabilitation of abandoned mines in South Africa?

Thank you for you valuable time in answering the questions

Annexure E: Certificate of editing

NORTH-WEST UNIVERSITY
NOORDWES-UNIVERSITEIT
UNIBESITI YA BOKONE-BOPHIRIMA

Office: 0183892451

FACULTY OF EDUCATION **Cell: 0729116600**

Date: 5th October, 2022

TO WHOM IT MAY CONCERN

CERTIFICATE OF EDITING

I, Muchativugwa Liberty Hove, confirm and certify that I have read and edited the entire thesis, **Developing a framework for the management and rehabilitation of abandoned mines in South Africa,** submitted by **Edward Kuipa, orcid.org / 0000-0003-0230-6743,** in fulfillment of the requirements for the degree **Doctor of Philosophy in Economic and Management Sciences with Business Administration, North-West University.**

Edward Kuipa was supervised by **Professor Joseph N. Lekunze** of the North-West University.

I hold a PhD in English Language and Literature in English and am qualified to edit such a thesis for cohesion and coherence. The views expressed herein, however, remain those of the researcher/s.

Yours sincerely

Professor M.L. Hove (PhD, MA, PGDE, PGCE, BA Honours – English)

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Annexure E: Ethical letter

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Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Economic and Management Sciences Research
Ethics Committee (EMS-REC)

14 April 2021

Dr J Lekunze
Per e-mail
Dear Dr Lekunze

EMS-REC FEEDBACK: 26032021 (Round Robin)
Student: Kuipa, E (36448303)(NWU-00054-21-A4)
Applicant: Dr J Lekunze – PhD In Business Administration

Your ethics application on, ***Developing an environmental management framework for the rehabilitation of abandoned mines in South Africa,*** which served Round Robin, refers.

Outcome:

Approved as a minimal risk study. A number **NWU-00054-21-A4** is given for one year of ethics clearance.

Due to the Covid-19 lock down ethics clearance for applications that involve data collection or any form of contact with participants are subject to the restrictions imposed by the South African government.

Kind regards,

Mark Rathbone

Digitally signed by Mark Rathbone
DN: cn=Mark Rathbone, o=North-West University, ou=Business management, email=mark.rathbone@nwu.ac.za, c=ZA
Date: 2021.04.15 10:07:27 +02'00'

Prof Mark Rathbone
Chairperson: Economic and Management Sciences Research Ethics Committee (EMS-REC)

Annexure F: Turn-it-in report

Kuipa PHD Final Thesis 36448303 Edited for TurnitIn Hove October 2022.pdf

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