Inclusive technological innovation and quality employment in the mining sector in South Africa

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DECLARATION

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I, Rivoningo Mhlari, declare that this dissertation— **Inclusive technological innovation and quality equal employment in the mining sector in South Africa**— is my own writing, and any references to the sources I have cited or utilised are fully disclosed and acknowledged.

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ABSTRACT

The notion of technological innovation in the mining sector has become a leading topic in discussions relating to the future of efficient and increased production. However, technological innovations such as robotics could lead to the drastic loss of jobs, posing a threat to equal employment for men and women involved in the mining sectors both locally and globally. This study focuses on inclusive innovation and how this model can reduce the inequality gap in the industry while also creating fair employment opportunities. The study explores ways the mining sector can be more inclusive and accessible to excluded communities while achieving desired production outcomes as well as South Africa's sustainable development. Utilising a mixed methods approach and a single mining case study, the study examined the skills profile of South African mining workers for equal employment and sustainable development, the nature of technological advancement for equal employment and sustainable development in the South African mining sector, the challenges or barriers to inclusive innovation for equal employment and sustainable growth in the mining industry of South Africa. The study found that the majority of mine workers are digitally literate. However, low-skilled level rather than high-skilled level employees are impacted by technological innovation displacement. Education, experience, and knowledge assist employees in acquiring digital skills to influence the dynamics of employees' role change due to technological innovation. The mine is adopting new technologies which both have potential or lack potential for inclusive employment and sustainable development. Low-skilled employees require continuous training to align skills with new technological innovations. Employees must be enthusiastic about learning fresh skills and be prepared to let go of any redundant skills. The success of inclusive innovation lies in stakeholder inclusion, training and development, labour union and government support. To improve equal employment and sustainable development, it is recommended that employers expose existing employees to social innovation, retraining, maintenance of employee trust in job preservation and creation.The mines need to maintain responsible mining and information technology development programs. Trade unions can now engage employers to conduct individual and collective bargaining. The government can ensure a change in school curriculum and empower students with digital skills that align with new technologies.

Key words: technological innovation, mines, inclusive innovation, equal employment, sustainable development

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ACRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
ANC	African National Congress
CBO	Community Based Organisation
D & I	Diversity and Inclusion
DMRE	Department of Mineral Resources and Energy
GDP	Gross Domestic Production
GPS	Global Positioning System
IoT	Internet of Things
IT	Information Technology
OECD	Organisation for Economic Cooperation and Development
PGM	Platinum Group Metals
PMG	Parliamentary Monitoring Group
NDP	National Development Plan
NGO	Non-Governmental Organisations
NPC	National Planning Commission
SA	South Africa
SD	Standard Deviation
SDG	Sustainable Development Goals
SETA	Sector Education and Training Authority

SIS	Sectoral Innovation System
SLP	Social Labour Plan
SMMEs	Small, Medium and Micro Enterprises
SPSS	Statistical Package for the Social Sciences
UN	United Nations
UNDP	United Nations Development Programme
VR	Virtual Reality
WEF	World Economic Forum

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

A significant portion of South Africa's Gross Domestic Product (GDP) originates from the mining industry. Having rich minerals, South Africa ranks first in the world for platinum production, third for coal, sixth for gold, and seventh for diamonds (Department of Mineral Resources and Energy (DMRE), 2021). In South Africa, there are a total of 526 mining companies as of November 2019 (DMRE, 2021). In the first quarter of 2021, a growth of 18.1% was seen in mining, contributing 1.2% to the annualised and seasonally adjusted 4.6% of the GDP (DMRE, 2021). Increased production of gold, iron ore, and platinum group metals (PGMs) was the cause of this growth. South Africa's National Development Plan (NDP) depends on technological innovation, especially in the mining sector, to stay competitive in the international market (National Planning Commission (NPC), 2012). According to the National Development Plan, South African businesses and sectors may benefit from robust African growth by making investments in retail, construction, mining, banking and telecommunications (NPC, 2012). Furthermore, racial and gender disparities continue to pose severe challenges to the quality of employment and access to equal and fair opportunities, further posing a threat to equality of opportunity for women and men.

The mining industry is fast becoming relevant in the world of markets and a lucrative source of revenue for nations with raw materials, such as South Africa, having a significant influence on economic growth. Critical commodities like precious metals, iron ore, bauxite and copper are now mostly produced and available in developing nations (Walser, 2002). One indicator of mining's influence is its ability to create jobs and generate revenue. South Africa is amongst the main global supplier of iron ore, coal, diamonds, platinum, gold, and manganese. About 60% of South Africa's exports are made up of the mining industry, which has a sector worth of about R 450 billion (Minerals Council South Africa, 2023).

The notion of technological innovation in the mining sector has become a leading topic in discussions relating to the future of efficient and increased production in the industry. However, technological innovations such as robotics could lead to the drastic loss of jobs or, at best, shift the mine site to remote locations or abroad, posing a threat to equal employment for men and women involved in the mining sectors both locally and globally. For example, in England alone, since 2000, 1.7 million employment were eliminated due to automation, and an additional 1.5 million positions are at risk of becoming mechanised (Darina, 2019). It is essential to develop and use inclusive technological innovations to improve work and working conditions in mines that cater for different skill types while also taking into consideration the gender and racial disposition of the mining industry and where improvements can be made.

Furthermore, The 2020 World Summit on Sustainable Development's action plan included the notion of "sustainable mining", thanks to the Global Mining Initiative, which also aimed for internal reform, an assessment of the industry's multiple groups, and a thorough investigation of the social problems it faces (Orozco, 2021). However, there is continued inequality and groups that are excluded or disadvantaged due to technological and mining innovation. Hence, this study focuses on inclusive innovation and how this model can reduce the inequality gap in the sector while also creating fair employment opportunities. The study explores ways the mining sector can be more inclusive and accessible to excluded communities while achieving desired production outcomes and sustainable development in South Africa.

Even though inclusive innovation has been the subject of literature, information is still lacking regarding inclusive innovation's applicability to the mining sector. It is thus crucial to define the terminology utilised in this study as inclusive innovation can mean various things, depending on the industry and market (Heeks et al., 2013). Development is consciously envisioned through inclusive innovation as actively involving individuals who belong to the marginalised in the course of advancement. Therefore, inclusive innovation relates with the subject of the involvement of currently marginalised people inside some area of innovation, notwithstanding its different foundational vision of development (Foster & Heeks, 2013). The study, therefore, seeks to explore inclusive technological innovations that are sustainable and that will lead to economic growth that also takes into consideration the gender and racial differences that may be prevalent in the mining industry, thus affecting the realisation of quality equal employment.

1.2 Problem Statement

According to the National Development Plan (NDP), the mining industry still needs to meet global standards regarding imports of raw materials, which is attributable to poor infrastructure and policies that do not correspond with the investment patterns in the country (NPC, 2012). Accordingly, "laws requiring companies to take into account community social responsibility, small company growth, skills development, the environment, black economic empowerment, employment equity, local content, and a number of location-specific imperatives", is necessary for the mining sector to prosper and operate efficiently (NPC, 2012, p. 45). Though the NDP is a critical policy paper that shapes the trajectory of the economy in South Africa, it fails to offer a thorough plan for making the mining sector inclusive of previously disadvantaged groups in South Africa's context of the past. Furthermore, technological progress has affected the employment market by favouring people with higher skill levels over those who are primarily low skilled and in danger of being swapped out with algorithms and machines where men are also given preference over women in this regard. Thus, this is what researchers such Katz and Autor (1999), refer to it as technological change that is skill-biased. Many academics believe that less skilled people are the ones most at risk from automated processes, as they could be substituted by intelligent machines (Arntz et al., 2016; Badiuzzaman & Rafiquzzaman, 2020; McGuinness et al., 2019). While automation may displace some lower-skilled employees, Fillipi et al. (2023) contend that technology can also increase demand for new job opportunities that call for various skill sets, lowering the overall risk for those with less training. According to Schwabe and Castellacci (2020), the consequences of automation may differ depending on the industry, and less trained workers may be able to find new employment opportunities in fields supported by technological advancements. To transform possible job losses into chances for skill improvement, less skilled people can be retrained (Howcroft & Taylor, 2022).

Furthermore, The United Nations' Sustainable Development Goals (SDGs) make minimal mention of how the mining industry can be transformed to alleviate issues such as inequality and unemployment. South Africa’s mining industry is a crucial market involving raw materials used for trade with other countries; therefore, diversity in this sector enables black-owned enterprises and Small, Medium and Micro Enterprises (SMMEs) with innovative technologies access to the market. For example, beyond just concentrating on improving energy utilisation in the mining industry, mining companies may capitalise on their demand for energy to expand power to areas that have become undersupplied through collaborations that permit collaborative usage of energy infrastructure, assisting in SDG 7's accomplishment, "Sustainability and Energy Access.” (United Nations Development Programme (UNDP), 2021).

1.3 Research Objectives

The investigation's first objective is to examine the skills profile of South African mining workers for equal employment and sustainable development, with technological advancements that are being developed in the mining innovation systems to achieve inclusivity and sustainable development that would benefit underprivileged communities. Secondly, the study seeks to examine the nature of technological advancement for equal employment and sustainable development in South Africa's mining sector. In low-income nations, mining firms can provide jobs, economic growth, and profits through their direct operations. Additionally, by forming alliances with the government and civic society, they may guarantee that the advantages of mining last longer than the mine's lifespan, resulting in a favourable effect on the environment, nearby communities, and human and social capital (UNDP, 2021). Thirdly, this study examines the challenges or barriers to inclusive innovation for equal employment and sustainable development in the South African mining sector. The research, lastly, seeks to identify ways in which inclusive innovation for equal jobs and sustainable development can be improved in South Africa's mining industry.

1.4 Research Questions

The following important questions are the focus of this investigation:

- What is the current skill profile of human resources in the mining sector in South African mines?
- Which novel technologies are currently being created or introduced within the system of mining innovation with the potential for inclusive employment in South African mines?
- What are the challenges and barriers to inclusive innovation for equal employment and sustainable development?
- What are the pathways through which willing players might better promote improved employment opportunities through inclusive technological innovation in the sector?

These are the four main questions of the study, though not limited to this. This is because technological innovation is seen as a threat to the traditional mining sector, where mining is a labour-intensive industry, and bringing technologies into the sector will create instability in the labour market, where people may be retrenched and lose jobs. The labour force will undergo a disruptive transformation due to technological advancements, which will gradually remove humans from whole industries and cause a large number of individuals, even white-collar workers, to lose their jobs and never go back to permanent employment (Brynjolfsson & McAfee, 2016; Ford, 2016).

1.5 Assumptions

The study's first assumption is that inclusive technology innovation in the mining sector requires technology that complements labour and does not disrupt it. It assumes that there is innovative technology that can be used which is inclusive and can affect nearby areas on both an economic and social scale, the environment and the labour market. The second assumption is that skills profiles within the mining sector make the realisation of inclusive innovation challenging and hinder the quality of equal employment from a racial and gender perspective. This is because the innovations made have been linked to inequality and are not particularly relevant to or connected to the economically disadvantaged community (Heeks et al., 2013), and previously disadvantaged people, which is most of the South African population. The third assumption is that there are possible pathways that role players can utilise better to achieve quality and equal employment in the industry. Lastly, the analysis assumes that inclusive innovation is a platform for developing grassroots and underdeveloped countries and previously disadvantaged people, such as women, in a male-dominated industry.

1.6 Significance of Study

The UN's SDGs constitute a mix of universal objectives adopted in 2015 within the subject, "Transforming our World: The 2030 Agenda for Sustainable Development." The SDGs seek to identify and tackle concerns pertaining to justice, inequality, impoverishment and deterioration of the natural environment (UNDP, 2021). The SDGs are essentially an international appeal to sustain harmony and balance among all aspects of society, the environment, and the economy in order to promote sustainable development via environmentally conscious consumption and production. Reaching the 2030 Agenda's SDGs requires a creative, ecologically conscious, and socially inclusive approach to innovation (Moallemi et al., 2020). The result is that the SDGs inform the policy formation in South Africa to align with globalisation and standardisation studies. Hence, this research is significant as it develops the collective comprehension that can be used by policymakers and businesses that operate within South Africa's mining industry. The research also seeks to problematise and critique the National Development Plan and how it responds to technological innovation, especially at the grassroots level, where most people are affected. The research also aims to analyse the skills profile of the mining sector and how technological innovations provide training and development that results in quality employment and lessens the inequality gap.

1.7 Delimitations of Study

Firstly, the study is explicitly concentrated on what inclusivity in the mining industry would entail and how technological advancements could impact the sector and economy in South Africa. Secondly, the study investigates the possibility of the application of technology to support labour in the South African mining sector. Lastly, the study explores the possibilities of the role of new inclusive technologies in upskilling low-skilled labour in the South African mining sector. Therefore, the research centres on inclusive innovation as a broad term but specifically references the mining industry. The study also looks at technologies applied for general use and the ones that are relevant for mining. The study is thus limited in investigating and analysing in that it focuses exclusively on the mining industry as a section of the economy and does not look at other mining-related industries.

The study does not specify which technologies will be utilised for innovation, thus broadening the scope of which technologies can be used as the methodology and data collection takes place. There is also little research in that it is a mixed-methodology study with mining professionals and workers in the mining sector and not the DMRE employees. This limitation is because the sampling gives the researcher enough time to gather as much information and data as possible.

1.8 Definition of Key Terms

Definitions of the terms and concepts utilised are provided in this section throughout the study. These definitions are not limited to this study, and the research only extrapolated the relevant definitions for the study.

Innovation – Innovation is establishing new ideas and new viable business offerings. Innovation is not only limited to ideas but also methods, which is the definition which will be helpful in the study.

Technology – Technology is the database of knowledge used to make instruments, analyse movements, and extract materials.

Inclusive innovation – scholars identify inclusive innovations as:

Development is commonly seen and sometimes indirectly as generalised economic expansion in conventional perspectives on innovation. As opposed to this, inclusive innovation expressly views development as involving marginalised people's active participation inside the development procedure. Accordingly, inclusive innovation, which has a different underlying theory of development, refers to including presently marginalised people in various elements of innovation (Foster & Heeks, 2013).

1.9 Outline and Structure of the Research Report

The outline for the chapters in the dissertation is as follows:

Chapter 1: Introduction

The aim of the research is described in this chapter. It lays up the framework for the study's emphasis, the issue it aims to address, and the suggestions it makes for policy.

Chapter 2: Literature Review

The review of the literature looks into the theoretical basis most appropriate for this research while evaluating, analysing, and discussing the diverse literature available on the subject. The literature study examines and evaluates sectoral mining systems that are in line with community participation as well as inclusive technology utilised in the mining industry.

Chapter 3: Research Methodology

The plan and method used in the research, participant selection, research techniques, gathering and analysing data, study limits, ethics considerations, and the study's validity and reliability are all included in this segment.

Chapter 4: Presentation of Results

The fourth section provides the research outcomes. This chapter includes graphs, tables and charts displaying the findings and results from the collected data.

Chapter 5: Analysis of Results and Discussion

This section addresses the questions for research in light of the findings and outcomes, analyses them, and discusses them.

This chapter also engages the study's assumptions about the findings and results and ascertains by way of discussion whether there is a correlation between the assumptions and the findings and results.

Chapter 6: Conclusions and Recommendations

This section wraps up the investigation and offers pertinent suggestions in light of the data and outcomes.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter assesses, analyses and explores various past studies findings on the subject of inclusive innovation and technological innovation in the mining sector while also exploring the theoretical framework that is best suitable for this kind of study. The literature review discusses and analyses various theories of innovation and more exclusively inclusive technologies in the mining industry, as well as sectoral mining systems consistent with the engagement of communities. The literature review also discusses the conceptual relationship and distinction between technological change and inclusive innovation, adoption theories of mechanisms for innovation to explain technological change and technical innovation, and technological change and its employment relationship. This leads to the conceptual framework that combines sustainable innovation, technological change and inclusive innovation.

The theoretical framework used is inclusive innovation, in which the hypothesis is that excluded groups of people should be included in economic development processes. In the first place, Heeks et al. (2013, p. 334) state that the beginnings and the premise of inclusive innovation is that inclusive innovation is "inclusive in the manner in which it is accomplished and inclusive of the issues and solutions it addresses." However, Mortazavi et al. (2021) do not state their assumptions clearly and rely on a literature review methodology to map out inclusive innovation using a bibliometric analysis of various articles on inclusive innovation. Patnaik and Bhowmick (2020) also, contend that the central proposition is to utilise creative approaches aimed at boosting rural productivity, changing traditional leadership roles into effective and beneficial kinds, and enabling communities to improve their well-being. This shows that scholars have been less explicit about identifying individual actors or stakeholders; nonetheless, the assumptions are that inclusive innovation is a platform for developing grassroots and underdeveloped countries and people.

The reality is that most South Africans need availability of employment possibilities, and the mines within South Africa rely heavily on human labour, mainly dominated by males (Heeks et al., 2013). Moreover, workers have a choice to organise themselves through labour organisations, thus also posing a threat to the stability and implementation of inclusive innovation. Workers also have the option to be part of the solution to inclusive innovation by suggesting ways in which mining innovation can best be implemented without having to replace human labour but rather complement it. This means that some technological innovations can affect the labour market, while in some cases, the labour market may benefit from inclusive technological innovation. The study explores how inclusive innovation can contribute to sustainable development and equal employment to protect jobs and upskill workers rather than threaten the labour market. There is substantial scepticism around inclusive technological innovation, and this study also seeks to highlight its benefits, particularly in developing countries where the majority are underprivileged.

2.2 Inclusive Innovation

A growing decoupling of social and economic progress from economic growth has marked the last twenty years (Mortazavi et al., 2021). The proportion of people living in complete impoverishment has increased significantly in regions like Africa, but it has remained persistently high outside of China (Foster & Heeks, 2015). How innovation develops extensive and high in capital expenditure, and environmentally damaging, has influenced these outcomes, even if this uncoupling has many causes. A shift towards a more "inclusive innovation" approach is imperative to overcome exclusion and inequality (Chataway et al., 2013). According to Chataway et al. (2013), the process through which communities that are marginalised individuals with disabilities, women, the disadvantaged, and those from ethnic minorities, develop innovative products and services is known as inclusive innovation. Interest in the topic is growing as countries turn to innovations to promote more fair and inclusive development (Foster & Heeks, 2015).

Since economic growth is primarily fuelled by invention, innovation is centred on the extensive technological transformation of entire countries (Dosi et al., 1988). But instead of assisting the periphery, this kind of innovation has benefited the centre of the economy and increased marginalisation and inequality. While invention addressing broader societal issues has been overlooked, this innovation has aided large, formal corporations rather than unofficial small businesses; and it has produced items and services for customers with money rather than impoverished ones; and has promoted industrial economic development. (OECD, 2013). Foster and Heeks (2015, p.4) opine that, "it is important to clearly define the role of policy because inclusive innovation is likely to be strongly linked to activities and initiatives driven by the private sector." The systems' approach to comprehending innovation offers an avenue to conceptualise it and representing an active mix of participants from the non-market and market, innovation, and links inside an established framework. The purpose of state policymaking under a systems perspective is to enhance, create, and sustain market mechanisms seen in innovation systems (Foster & Heeks, 2015).

The triple difficulties of inequality, poverty, and unemployment impede South Africa's efforts towards inclusive innovation. Structural disparities left over from apartheid prevent the development of a new social compact, notwithstanding the current African National Congress administration's efforts to encourage inclusive innovation (Phiri et al., 2015). According to Phiri et al. (2015) more focus is now being paid to social policy in the area of technological advancement and innovation where reproduction, redistribution, and social production are highlighted as crucial topics. But given the South African setting, productivity is essential especially in the historically exclusive mining industry (Phiri et al., 2015). George et al. (2012, p.661) focus on the concepts related to innovation for growth that is all-encompassing by defining inclusive innovation as "the addition to being a feature of the techniques that enable creative initiatives of this kind to take place, and inclusive growth is seen as the intended result of programmes that aim to empower people in marginalised segments of society." Cozzens and Sutz (2012, p.12) directly address inclusive innovation, and describes it as "inclusive in how it is accomplished and inclusive of the issues and solutions it addresses." Inclusive innovation has no inherent geography or place of origin and may therefore seem to be a subject that is pertinent to everyone on the entire globe. However, in practice, a large portion of academic writing, practice and policy of inclusive innovation emphasises emerging nations. Thus, it is fair to see the field of inclusive innovation research as the meeting point between developmental research and innovation research (Cozzens & Sutz, 2012).

The professional practices of the framework are that studies around inclusive innovation have often focused on developing countries. Some scholars such as (Heeks et al., 2013, pp.13-14) propose to “create a stakeholder map of inclusive innovation, which combines critical stakeholders from both development and innovation practice and selects those at the base of the pyramid as its core excluded group. This will be of value as one perspective on research priorities and in identifying targets for any demand-led survey of inclusive innovation research priorities. Given that this is a structural representation of inclusive innovation, it must be supplemented by a process representation.”

This reflects an incremental change because the focus remains on developing countries, as innovation is mainly needed in those areas. Other scholars such as (Teece, 2010, p.172) state that “global economic shifts have had an impact on the conventional supplier-customer balance. The advent of advanced computing and communication technologies and the development of reasonably open international trade agreements have increased consumer choice, allowed for the expression of a wide range of customer wants, and increased transparency in the supply chain. Companies must focus more on their customers' needs, especially in light of how technology has developed to enable the more affordable availability of information and solutions for clients. As a result, companies in many industries need to reassess the value propositions they offer clients; the supply-side, industrial period rationale is no longer sustainable.” Businesses must understand how the global economy has evolved and altered the conventional supplier-customer dynamic. This is because technology has advanced to enable the lower-cost provision of information and customer solutions, businesses must, therefore, be more customer-centric.

There are various explanatory variables that the scholars in inclusive innovation (Patnaik & Bhowmick, 2020; Mortazavi et al., 2021) identify it, including people in rural areas and developing countries. The primary variable in the theoretical framework is sustainability and growth; in all the articles, the common theme of inclusive innovation is to sustain businesses, communities and people in developing countries. The primary variable that needs to be included or emphasised is sustainable education for excluded people and communities. Thus, this study focuses on inclusive innovation with a focus on business. However, inclusive innovation is also critical in the education space where research around innovation takes place. Inclusive innovation in the education space allows for information and knowledge to be taught to excluded people as opposed to it being something that is done for them; in other words, it provides for institutions to teach people how to be innovative while also including them in the innovation procedure (Mortazavi et al., 2021).

Innovation is the focal dependent variable in that there is a requirement for excluded people, developing countries and communities that actively need to be included in the overall social and economic development (Patnaik & Bhowmick, 2020). Concepts are defined in such a way that one understands what the theoretical framework seeks to achieve, which is to make accessible to people what ordinarily they would not have access to. The concepts make it easier to identify the needs of the people and for entrepreneurs to be intentional in their innovation by producing items and services that are beneficial for the progression of people. The causal process proposed is that there should be a needs analysis done to identify areas where innovation is needed; then, once the need has been identified, the next step would be to determine whom the excluded people, communities and countries need to be included in innovation. Most scholars follow the same causal process, though their methods are different. However, scholars need to be more explicit in stating the causal process. For example, Heeks et al. (2013) concentrate on the sources of inclusive innovation, while Mortazavi et al. (2021) focus on how inclusive innovation has evolved by looking at various publications on the topic. Lastly, Patnaik & Bhowmick (2020) examine the application of inclusive innovation by studying multiple organisations.

2.3 Inclusive Innovation and Community Engagement

While technology is referred to as "the application of scientific knowledge for practical purposes" (Oxford English Dictionary, 2018, p. 13), innovation is typically defined by scholars as any novel approach, procedure, concept, or product designed to enhance any or all aspects of the continued viability of mining operations (Brem & Wolfram, 2014). Doblin provides the following definition of innovation to increase its significance for business: Innovation is a procedure of developing a fresh, profitable products or services (Deloitte, 2016, p.11). Scholars have recognised a number of inventions whose goal is to benefit less rich cultures in response to these global concerns and in an effort to provide sustainable solutions for alleviating poverty (Brem & Wolfram, 2014).

A definition and theory of innovation that are appropriate for the goals of the study are outlined after a review of several definitions and theories of innovation is conducted. "In developing countries, social innovations are defined as innovations that are frugal, pro-poor, inclusive, reverse, to name a few" (Hasan et al., 2019, p. 3). Inclusive innovation is "a form of innovation that was crafted to develop mechanisms for companies and other actors, so that they not only offer affordability to the needs of lower-income people but also build their capabilities, improve their empowerment and welfare" (Peerally et al., 2019, p.2). Therefore, in this study, relevant in the definitions of inclusive innovation is that it incorporates the inclusivity of excluded and marginalised communities in the world, especially in low-income markets in Africa. Inclusive innovation in this study is regarded as any social innovation intended to provide underprivileged people with prospects for a living and disadvantaged citizens kept out of the marketplace, such as the mining industry market (Foster & Heeks, 2013).

The other concept that has become rather popular amongst experts in spite of the general misinterpretation regarding its fundamental ideas is disruptive innovation (Christensen et al., 2018). Disruptive innovative is a term often used by famous writers to describe any novel innovation or start-up that seeks to upend a sector and change its rivalries' dynamics (Christensen et al., 2015). Consequently, formerly successful incumbents who have encountered problems or are closing their doors are sometimes characterised as being severely disturbed (Christensen et al., 2015). It is thus different from inclusive innovation in that it focuses on business patterns and management strategies instead of creating technologies that promote sustainable development for poor communities.

Sectoral innovation, another type capable of being investigated, comprises businesses that actively participate in a sector's inventive activities. More accurately, a system (group) of businesses creating and manufacturing products for an industry and creating and applying technologies for a sector is known as a Sectoral Innovation System (SIS). According to Edquist (2015, p.131), a Sectoral Innovation System (SIS) can be defined as “that system (group) of firms active in developing and making a sector's products and in generating and utilizing a sector's technologies; such a system of firms is related in two different ways: through processes of interaction and cooperation in artefact-technology development and through processes of competition and selection in innovative and market activities”. These businesses are connected using two distinct processes: selection and competition in the market and innovative activities and interaction and cooperation in developing artefacts and technologies (Christensen et. al., 2018).

Certain industries may have a few huge, nationally and internationally competitive giants, while others have a significant number of regionally dispersed, relatively young little businesses. Certain industries are defined by a number of businesses spread over particular regions that collaborate in the innovation process; in these cases, rivalry happens across regions both within and between nations as opposed to between businesses. Furthermore, in many industries, a small number of very large corporations compete globally while actively engaging in local partnerships with smaller, specialty providers. Sectoral innovation may be defined in all of these industries, along with what it is not and, more significantly, how it can be used in different industry contexts. As both the National Innovation Systems and Sectorial Innovation systems perspectives point out, other agents and organisations play fundamental roles in influencing innovative activities and establishing competition rules (Lee & Malerba, 2017). However, it is important to acknowledge that businesses with varying capacities and creative output are involved in competition and selection processes (Lee & Malerba, 2017).

Lorenz (2013) opines that scholars in innovation research has concentrated on mainly on the significant role of formal research and development, and the knowledge and abilities of scientists, engineers, and management, not considering employees' role in innovation processes. Influential and prolific innovation is becoming increasingly crucial to a company's success in the current world. Several businesses realise that lacking inclusivity and diversity within their workforce stifles creativity. Businesses are also learning that adopting a more inclusive organisational culture enhances their capacity to promptly utilise every employee's varied viewpoints and experiences to generate novel products and experiences for users. An authentic innovation culture can emerge swiftly from a high-trust setting with great diversity. Employees who perceive that their organisation values the contributions of varied ideas from everyone and does not assign blame for unsuccessful ideas are said to work in an innovative culture. Instead, suggestions are welcomed and allowed to be tested by staff members in a setting that values experimentation and flexible learning. Allowing workers to try new things without worrying about failing increases worker engagement and boosts organisational effectiveness (Lorenz, 2013).

Inclusive innovation enables the tackling of disadvantaged and marginalised communities such as people living with disabilities, indigenous communities, low-level employees doing menial work and women (Patnaik & Bhowmick, 2020). These marginalised populations often face social dignity and a lack of reliable means of living to access services, goods, and livelihood opportunities (Ahuja et al., 2023). Thus, within the South Africa's mineral extraction industry, facing the challenge of many older workers and the need to replace them with younger workers, past studies show that older employees might not be willing to uptake new technologies for fear of trust and privacy concerns over applications data collection (Fox & Connolly, 2018). This type of digital exclusion may also be encountered by young and disabled employees arising from the unequal distribution of resources (Tarafdar et al., 2023). The study has explored various forms of innovation and theories of innovation, and it relates to multiple technologies, systems and institutions, but none speak to the inclusion of underprivileged communities. Inclusive innovation as a theoretical foundation is suitable for this investigation as it relates to the engagement of socially sustainable innovation, including the communities within which the innovation occurs. The study has thus chosen inclusive innovation as a theoretical foundation to analyse structures and technologies in the mining industry and how they utilise community-engaged methods of sustainable development to achieve the SDGs.

Ndlovu et al. (2022) concluded that in terms of technological expertise, South Africa's active population had an average advancement score of 29.9% in 2019 as well as 2020 as compared to NDP2030 targets. This reflects a substantial gap in technological expertise within the active workforce in South Africa, which could hinder economic growth, innovation, and competitiveness in an increasingly digital global economy. However, researchers such as Badiuzzaman and Rafiquzzaman (2020) argue that inexperienced employees are the ones mostly in danger from automation, as they might be substituted by sophisticated robots. Similarly, Manyika et al. (2018) predicted that automating might eliminate 400–800 million employment opportunities by the year 2030.

2.4 The Connection between Inclusive Innovation and Technological Change

Literature in the previous section shows that inclusive innovation aims to leverage technology to improve one's standard of living for marginalised and disadvantaged communities. Researchers such as Heeks et al. (2014) argue that inclusive innovation reduces inequalities, whereas conventional or mainstream innovations frequently makes inequality worse. This means technological changes lead to inclusive innovation that has been compared, modelled and interrogated to further associated ideas, like the pyramid's base, responsible, and all-encompassing progression (Chataway et al., 2013).

In the mining sector, technological changes are necessary to extract specific types of minerals, and inclusive innovation ensures that societal values are promoted within such change processes using Industry 4.0 technology (Nwaila et al., 2022). In an investigation by Nascimento et al. (2018), it was shown that the production of copper could be improved to meet rising demand using Industry 4.0 technology permitting waste-free handling and complex extraction to benefit both the mine and the society. Similarly, Zhironkin and Szurgacz (2020) contend on the emergence of smart mines, which adopt new technologies to move towards geo-technology and employ robotics' complexes without humans in both surface and underground mining, artificial intelligence (AI), communication over the internet between machines, and digital telemetry to analyse mining technology and design data.

By creating completely unmanned locations and providing virtual digital training for mining staff, these smart mines guarantee inclusive innovation using artificial intelligence within the analysis of designing data and mine technology, subsurface and surface-based mining robotic systems, telemetry in digital form, and connections to the internet between machines (Zhironkin & Szurgacz, 2020). However, with continued technological improvements, smart mines aspire to improve the efficiency of blasting and drilling, organising for shipping, packing and excavating, and management for operations procedures. In the future, they may even be able to omit people from mineral extraction processes entirely (Klingler- Vidra et al., 2022).

According to Malomane et al. (2021), technological changes take care of inclusivity by addressing the challenges of avoiding economic losses and social consequences caused by industrial accidents and improving labour safety. Despite high-risk factors in mining activities through unpredictable challenges to the earth's crust, human accidents are a root cause (Bonsu, 2017). Thus, researchers such as Onifade et al. (2023) found that technological development that ensures employee safety is related to mining operations, geo-technology and mining engineering innovations. For example, technological development in cloud analysis and smart sensors created labour safety innovations by predicting the likelihood of threats.

Systems of innovation theory help explain how technological transformation is a personal and a group effort that leads to innovation and technology spread (Hekkert et al., 2007). This means individual mine dynamics are certain features of technology and methods of uptake whereby the technology change variables can be identified inside each specific company and the system of innovation that meets the needs of society and other stakeholders. It is significant to remember that these innovation systems consist of all the organisations and financial frameworks that affect the progression and pace of advancements in technology and in society (Hekkert et al., 2007). However, Manzini (2012) argues that the rapid advancement of technology is a prolonged procedure, which is the reason that makes it so hard to have an impact. The systems of innovation approach has also been criticised for being too static owing to its intense concentration on the parts or constituents of the structures, like institutions and organisations (Hekkert et al., 2007).

This focus still needs to contribute to understanding what is happening inside the systems. More specifically, there has been a need for a clearer understanding of the processes inside the innovation systems that influence innovation processes and other firm stakeholders. Therefore, the eventual trajectory and pace of advancement in technology are predominantly influenced by the rivalry amongst the many systems of innovation in use today, both established and developing ones (Lipsey, 2001). Consequently, developing insight into the relationships between established technology and the established innovation system concerning newly developed technologies and the growing innovation system is necessary to comprehend technical change (Hekkert et al., 2007).

2.5 Technological Innovation in the Mining Industry

According to Lööw (2021), technological innovations in the mining sector are being introduced to reduce accidents, harmful exposures and harmful workloads. In this way, new technological innovations create new job responsibilities, such as safe control rooms that provide new space for workers' creativity and expertise. Researchers such as Kalbende and Annavarapu (2022) allude to technological innovations in mining, such as computer-assisted design, robots, drones, and advanced communication systems. These technological innovations bring low-cost and powerful electronic devices with the potential to improve production tasks and productivity. However, low-skill jobs, are being threatened by new technologies connected to inequalities and requires greater consideration or importance in the community (Heeks et al., 2014; Parschau & Hauge, 2022).

(Lööw, 2021; Sánchez & Hartlieb, 2020) also contends that integrating new technologies into operations is strategically necessary for many mining businesses to increase operational performance and safety. As such, Mahdi and Nassar (2020, p.92) opine that “knowledge, as the result of the development of employees, has become a strategic resource and source of competitive advantage of mining companies and their differentiation in today's economy.” Similarly, Lokwani et al. (2020) argue that technological advances positively impact productivity. This positive impact on productivity is when automated systems operate constantly and at a consistent level of quality (Kolade & Owoseni, 2022). As a result, businesses that use labourers to do monotonous jobs prefer automating over using labour by humans (Zervoudi, 2020). In addition, automating lowers expenses and makes the workplace more enjoyable by giving miners greater safety at work (Karolia-Hussain & Fourie, 2021). Additionally, technological innovations in mining offer varying possibilities for new job responsibilities and improved safety through new mining techniques that use automation, image techniques, and camera and sensor usage (Zhironkin & Szurgacz, 2020).

Overall, mine operators may respond appropriately to the decline in prices for commodities with innovation, which would better equip them to withstand the lengthy slump that is anticipated to ensue from the super cycle (Hermanus, 2017). However, researchers such as Eliashvilli (2021) found that new technologies harm labour. This differs from the findings that new technologies in the mine benefit the employee. According to Van Zyl (2020), automation increases the need for specific skills and decreases the need for others. Ciarli et al. (2021) argue that the redundancy of old skills is growing whilst relevant and new skills are increasing with more uptake of technological innovations. According to Buchanan et al. (2020), new careers, professions, jobs, trades and skills must be designed from scratch. However, employee skill development must be ongoing because of the evolution of the fourth and fifth industrial revolutions (Zervoudi, 2020). Yet, according to Degallier et al. (2022), workers are unlikely to be ultimately substituted yet automation will also add to it. In other words, mechanisation supports human strength to help employees realise their full capabilities and relieve them of tedious, repetitive tasks (Zirar et al., 2023). In this way, quality and inclusive employment is maintained. However, in South African mining, inclusive employment is achievable by training low-skilled workers, where 30% of employees are unskilled, 46% are semi-skilled, and 24% are skilled (Reddy et al., 2016). In accordance with Magwentshu et al. (2019), in South

Africa (SA), there are no clear policies to guarantee the generation of jobs in the modern era of technology. In accordance with Collins et al. (2019), levels of inclusive innovation in an organisation complement and promote equity through emerging technological innovations. Despite this, inclusive innovation is more than just a linear process; it is a consultative process that ensures that technological innovations benefit disadvantaged people and communities, thus contributing to sustainable development (Peerally et al., 2019).

2.6 Mining Innovation and Cases of Inclusive Technologies

The goal of inclusive innovation is to comprehend how new technology may help the underprivileged and marginalised (Hermanus, 2017). In this section, an analysis of mining innovation and the role that inclusive technologies have in the industry is uncovered. In order to comprehend the significance that emerging technologies perform in inclusive innovation, cases of inclusive technologies are also researched.

Incorporating non-technological innovations like organisational strategies, procedures, and practices can greatly improve inclusive innovation, which focuses on using technology to help impoverished and marginalised communities (Odame et al., 2020). Organisations may need to undertake cultural changes that give inclusivity top priority in their operations in order to successfully deploy inclusive technologies. In order to create a more equitable workplace, this means cultivating a corporate culture that values diversity and actively incorporates under-represented groups in decision-making processes. Building alliances between mining firms, local communities, the government, and non-governmental organisations is one example of a non-technological innovation. The effectiveness and adoption of inclusive technologies can be increased by involving these stakeholders in the co-creation of solutions that are better suited to the unique requirements of marginalised groups (Ghauri et al., 2022).

The importance of inclusive technologies in the South Africa’s nanotechnologies’ industries is examined by Harsh et al. (2017). The research by Harsh et al. (2017) centres on the potential contribution of cutting-edge technologies, which entail significant uncertainty and need substantial development costs, to inclusive innovation, with a special emphasis on poor nations. The article uses each of the models to analyse a case study regarding South Africa's nanotechnologies and contrasts with inclusive technology with relevant work on equality and new developments in technology (Cozzens, 2010). They employ Cozzens' approaches to enhancing fairness through new technologies and Heek levels of inclusive innovation. Figure 2.1 demonstrates the conceptual framework Harsh et al. (2017) utilised in interrogating the role of inclusive technologies.

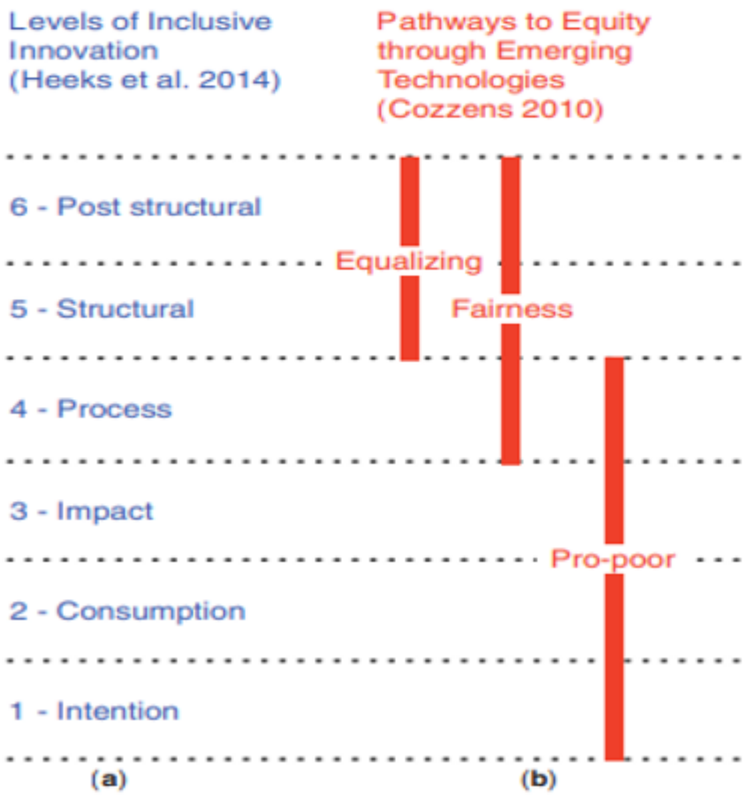

Figure 2.1: Framework for Inclusive Innovation

Source: Harsh et al. (2017, p.99)

Figure 2.1 shows the extent of innovative practices that are inclusive as devised by Heeks et al. (2014) which should complement and promote equity through emerging technologies. A comparison of the three routes to greater fairness through new technology and the degrees of inclusive innovations (Cozzens, 2010; Heeks et al., 2014) is also shown in the diagram. This means that at a conceptual level, innovative technologies should intentionally benefit disadvantaged people and communities. As innovative technologies continue to emerge, processes and structures must create equal opportunity for the fair improvement of underprivileged people and communities. This framework utilised by Harsh et al. (2017) suggests that inclusive is the procedure of invention, which is not linear but a consultative technique ensuring innovative technologies benefit disadvantaged people and communities, thus contributing to sustainable development.

Another case of implementing inclusive, innovative technologies in mining is Operation Mining Phakisa, which was an attempt by the South African government to address the crisis in the mining industry. Under the direction and supervision of the Office of the Presidency's Department of Monitoring and Evaluation, the operation involved several parties, including government agencies, labour unions, and non-governmental organisations (NGOs) operating in the sector. "Rebuilding the mining sector through technological excellence, social inclusion, and job creation" was the process' stated goal. All parties involved concurred that the issues facing the mining industry were systemic, deeply ingrained, and prone to self-reinforcement (Hermanus, 2017). The Mineral and Petroleum Resources Development Act 2002 (Act No. 28 of 2002), a regulation designed to address historic socioeconomic disparities and guarantee historically underprivileged people's meaningful participation in the sector, gives the government authority and clout in the post-apartheid era (Vandome & Khama, 2021). The process saw the collaboration and partnership of the public and private sectors in coming up with agreements and plans for implementing a holistic and inclusive approach to mining development in South Africa. Constructing newer mines techniques, tackling the mines industry's shortage of energy, focusing on particular prospects for benefactors, changing the racial composition of the economy, and encouraging involvement of all people in the mineral extraction sector by raising the quantity of just beginning miners, were a few of these agreements (Vandome & Khama, 2021). Large South African corporations, however, were successful in lobbying the government to oppose structural shifts that would upset the current balance of economic power after apartheid (Mondliwa & Roberts, 2021). Plans were also created to deal with the unfavourable effects of mining. Finally, it was recognised that corrections needed to be made to the problematic relationships that existed between labour organisations and the mining sector as well as between the state and the mining sector (Hermanus, 2017, p. 816).

But with real-time or nearly real-time communications, detectors, automated equipment stoppages, and safe zone monitoring with prompt responses in the event of an incident, some trade unions in the mining sector contend that there is a substantial relationship between digital transformation, literacy, and safety (Ramdoo et al., 2021). This was discussed in a joint parliamentary committee meeting between trade union stakeholders and the Mineral Resources and Energy committee in August 2019. Trade unions concurred that technology played a significant role in modernising mines, increasing their production, and improving worker safety, but that any technological advancements had to benefit all mine workers as a whole (Parliamentary Monitoring Group (PMG), 2019). Companies often grapple with strikes where unions lead mine workers to demand increased wages and improved employment conditions (Makama & Kubjana, 2021). Consequently, according to Ngobese et al. (2023), stakeholder inclusion can lead to better results, increased ownership and buy-in. A human-centred approach to innovation adoption is recommended (Rao & Kalyani, 2022).

Although these agreements are not comprehensive in what kind of innovative utilising technologies in the mining sector, they do pave the way for future technological advancements in the industry in a way that is inclusive and participatory of affected people. The fact that in this process, more government departments were involved indicates the government's responsibility to create an inclusive and beneficial industry for disadvantaged groups. Although there is no clear consensus on technological change's impact on future jobs, more is needed. The kinds of employment that are being created and those that are being eliminated are not the same, even while there is uncertainty over the exact course and rate of change (Beliz et al., 2019).

Mining companies have been entrenched in market power that needs balancing with government interventions to guarantee the profitability and productivity of mining whilst distributing the advantages to every member of humanity (Frederiksen, 2018). Moreover, retraining existing employees is essential if the unemployment level is to be decreased (Grunau & Lang, 2020). According to

O'Donovan (2018), mine leadership are critical in achieving diversity and inclusive employment. The mining sector progressively resorts to Diversity and Inclusion (D & I) campaigns to tackle obstacles such as an ageing labour force, amplified public scrutiny, and the mounting need for inventive technical resolutions to mining predicaments (Kincaid & Smith, 2021). Studies have indicated that inclusive leaders indicated higher performance metrics, includes increased revenue and happier workers, irrespective of how diverse their teams are in comparison (Korkmaz et al., 2022).

Li (2022) argues that tertiary institutions, as skills providers, must align with relevant curricula that keep pace with the growing demand for future-ready graduates who can be up-skilled and re-skilled to manage new mining technological innovations. This funding for cultural change alongside capacity enhancement towards digital literacy for all mine workers is an important move. For instance, workers might be prepared for a changing environment and made more capable of mastering new things whilst remaining relevant by receiving enhanced skills in analytics and cutting-edge technologies (Li, 2022).

2.7 Effect of Technological Change on Employment

The Fourth Industrial Revolution is impacting all facets of the economy, manifested in technologies like big data, cloud computing, 3D printing, artificial intelligence (AI) and the Internet of Things (IoT) (Pages & Ripani, 2017). Technology has impacted employment and employment opportunities, particularly in developing countries that are still experiencing and going through their industrial revolutions (Beliz et al., 2019). Despite the potential benefits, real issues exist on how these changes may affect employment and societal cohesiveness. Concerns on the future of the labour market, namely whether robots would eventually replace humans in the workforce, are growing as the world enters this revolution marked by more rapid and significant technological advancements (Pages & Ripani, 2017). Indeed, the dynamics of work are altered by technological advancement, and the likelihood of jobs being replaced by intelligent robots increases.

According to Beliz et al. (2019), the main concern is not whether employment will disappear (although it already is) rather whether governments and societies will be capable of generating sufficient new jobs, the occupations of the future, to make up for the lost ones. Beliz et al. (2019) opine that a more profound knowledge of the hazards associated with new technologies and a greater comprehension of the changes in motion to turn them into possibilities for the future creation of high-quality jobs. Disruptive shifts in business structures will significantly impact the job landscape in the upcoming years. It is anticipated that a number of the critical forces driving transformation in global sectors today will substantially affect employment, from increased labour productivity to growing skills shortages and from significant creation of jobs to job displacement. Consequently, mines will produce highly skilled employees, who are better remunerated and more computer literate, making them more employable in other sectors outside mining (Dipitso, 2023).

According to a World Economic Forum (WEF) report (2016) popular estimates reveal that disruptive shifts in business structures will significantly impact the job landscape in the upcoming years. It is anticipated that a number of the critical forces driving transformation in global sectors today will substantially affect employment, from increased labour productivity to growing skills shortages and from significant creation of jobs to job displacement. Hane-Weijman (2021) identifies this skills challenge as skills redundancy and skills mismatches. As such, robots are most likely to replace predictable and repetitive jobs, making previous technical skills redundant in the mining sector (Paredes & Fleming-Muñoz, 2021).

The mining industry within South Africa is now faced with the problem of using the right technology to assist the process of producing newer employment while preserving the existence of these already in place in the context of these developments. Massive employment disparity is already a problem in the nation; the unemployment rate for Black South Africans is 31%, whereas it is 5% for white South Africans (Rooks & Oerlemans, 2005).

Furthermore, because they are unable to obtain employment and escape poverty, a significant number of South Africa's youth are growing more and more disgruntled with the political establishment (Dipitso, 2023). It is anticipated that smaller, typically highly skilled jobs, which cannot cope with eliminated jobs from other segments of the labour market, will provide an explanation for a disproportionate proportion of the growth in workforce brought on by technological innovation with considerable upgrading their skills would be required even if they could (WEF, 2016). This means, there needs to be skills interventions for low-skilled labourers in the industry if there is to be a maintenance of current jobs. A notable issue facing business is the gender component of anticipated job shifts, with gender differences appearing more noticeable in both low- and highly-skilled positions (Dipitso, 2023). Governments and businesses must manage it relatively and sustainably to ensure that the technological revolution does not lead to even more inequality. Upgrades to education and professional training programmes for workers should be made, as well as a more significant effort to comprehend what new skills will be required and how current employment will evolve. However, other non-routine cognitive skills are equally important to successfully uptake new jobs initiated by new technologies (Sungsup, 2019). According to Saari et al. (2021), role players should anticipate the talents issues that the fourth revolution will demand and design their training expressly to address skill development. Yet, according to Mouton et al. (2012), the constrained and inefficient educational system is typical of developing nations, which cannot produce more technologically skilled graduates.

According to Verhoef et al. (2020), technological advancements occurring now and in the immediate future are having an effect on many production operations and creating massive prospects for growth and improved well-being. However, Griep et al. (2021) contend that technological changes pose obstacles and threats, especially in employment. Lima et al. (2021) contend that technological changes lead to the substitution of machines for humans and foster technological unemployment. Yet, a study by Seegers and Ehmann (2021) found that technological changes increasingly substitute routine tasks. However, the widespread use of automated vehicles, robotics, and machine learning is increasing reports of adverse employment consequences (Yam et al., 2022). Additionally, according to Okechukwu et al. (2023), it is possible to increase efficiency without significantly reducing employment by implementing sophisticated sensors and machine learning.

There is a considerable degree of uncertainty created by this mix of opportunities and difficulties, and this uncertainty is mirrored in the widely differing estimates of the potential magnitude of employment destruction (Weller, 2019). As a result, technology advancement has a significant influence on future employment responsibilities, skill requirements, and job creation as well as destruction. A number of variables are going to be a substantial influence on the welfare of workers and society at large, as well as the accompanying allocation of costs and benefits, even though technological development will not be the only mechanism influencing employment in the future (Weller, 2019).

Though low-level workers are displaced, it is anticipated that technological developments would generate 133 million new jobs (Tiwari, 2023). Acemoglu and Restrepo (2019) argue that technological change is why there is an increasing creation of complex jobs. A study by Acemoglu and Restrepo (2019) in America found that robotics negatively influences labour market job levels. This shows that job destruction is higher than job creation and that any possible compensatory effect has been less substantial. Contrary to this, an investigation by McGuinness et al. (2019) found that technological change favourably impacted financial services job levels when automated machines were introduced. This resulted from expansion and restructuring that took place due to the technological change in the firm. Nonetheless, Kolade and Owoseni (2022) contend that employment trends respond to technological and other economic factors. When the economy is doing well, bringing novel innovations can be associated with better employment levels and less displacement (Lööw, 2021). In addition, there are conflicting researcher views about technological change impacting employment. Cascio and Montealegre (2016) thus argue that the current conflicting views arise from a deficiency in imagination as well as understanding of job types that can be created under technological innovations.

Lööw (2021) contends that technological change is accelerating to levels where many workers are affected as labour-saving innovations become widely diffused. Maintenance of job security becomes critical. On the other hand, researchers such as Mark (2017) argues that technological changes are not revolutionary but are evolutionary in nature to create more jobs than those being eliminated. Examples include significant developments in large equipment and mechanisation, leading to more job skills, employment and productivity. A study by Dauth et al. (2017) found no evidence of job loss after introducing robots in a German manufacturing company. Hence, the claims for adverse technological change and employment consequences remain conflicting.

Mining firms need help attracting younger individuals who are not highly motivated to work in the industry due to the ageing workforce in the sector (Johansson et al., 2018). While uncertainty remains on the influence impact of advances in technology on jobs, proof is increasing that professional, vocational, and educational training are essential tools to capitalise about the possibility benefit of technological shifts and limit their adverse effect (Autor, 2022). Mining should increase its awareness of alluring and repulsive aspects of the job to attract the best employees and make more informed strategic choices. The role of the miner in the technical system evolves as a result of advancements in technology. The qualifications once indicative of a craftsman autonomy, physical dexterity, and material sensitivity, have now clearly given way to increasingly sophisticated credentials according to the synopsis understanding required to operate the complex novel machinery and equipment (Johansson et al., 2018). In the future, mining businesses will need to hire people with varied backgrounds and levels of expertise (Johansson et al., 2018). As such, an investigation by Motsoeneng et al. (2021) concluded that technology-based engineering required technical proficiency, engineering principles, management expertise, and a theoretical understanding of the platinum mines. New technology is anticipated to revolutionise the mining industry, demanding more specialised and concentrated skill sets. Engineers typically deal with tangible objects and are usually drawn to the technological side of organisations (Motsoeneng et al., 2021).

Furthermore, the Coronavirus global health crisis has highlighted the benefits of fair entrance to creative jobs and the necessity of quick, goal-driven innovation during emergencies (Gkeredakis et al., 2021). Thus, there has never been a greater pressing need for innovation that advances society across all demographic groups, sectors of the economy, and geographical areas. The epidemic has also demonstrated that various individuals and organisations can produce innovation. For example, most organisations focus on enabling employees to work from home by providing computer equipment, training, and connectivity (Klingler-Vidra et al., 2022).

2.8 Conceptual Framework

This section discusses the conceptual relationship between changes in technology and inclusive innovation. It also examines how innovation systems are implemented as a theory to explain technological change, technical inventions, and the relationship between technological change and employment. This leads to the conceptual framework that combines technological change and inclusive innovation. According to the analysis of various literature, inclusive innovation is a framework that began as an interdisciplinary study of innovation and development studies, which evolved further through research to include business and economic studies. The framework has had to change and adapt to the constantly evolving nature of social and global economic activity in different regions. The framework has been applied in various studies ranging from identifying the excluded people from innovation and methods of innovation studies to parts of the world with disadvantaged communities. For example, Patnaik and Bhowmick (2020) state that the theoretical framework enriches inclusive innovation and sustainable development discourse. Additionally, the framework finds businesses whose primary goal has been to use innovative methods to build social values instead of making money. These values result from a collaboration between important stakeholders and creative practices.

The notion of inclusive innovation has evolved and has been segmented into five clusters produced from core literature:

- The first cluster focuses on using innovation as a strategy for affordability, specifically in less inventive areas (Mortazavi et al., 2021). Most literature cited prioritise frugal innovation as a conduit to affordability in developing countries. A secondary theoretical framework that supplements inclusive innovation would be breakthrough innovation in developing countries, which promote the 4As (affordability, awareness, accessibility, and availability); inclusive innovations should meet the 4As.

- Innovation as a vital instrument for inclusivity According to quoted research, innovation can help impoverished populations who have been shut out of the market feel included. Businesses in this cluster should concentrate on the 4As to foster market inclusion. (Mortazavi et al., 2021)
- The third cluster, "Building Capabilities and Social Empowerment through Innovation," focused on the ways that innovation can lead to accessibility of inclusion and stimulate empowerment in society via the development of capabilities (Mortazavi et al., 2021). Research by Mortazavi et al., (2021) conducted in India has demonstrated that enhancing livelihood possibilities and localisation by networking with important actors in underprivileged communities can lead to successful innovation dissemination and inclusion.
- The literature on innovation limits and social empowerment focuses on obstacles and how to get beyond them in nations with limited resources. To foster inclusive innovation in poor countries, firms need to understand limitations related to these market solutions to attain innovation with the least resources (Mortazavi et al., 2021).
- The fifth cluster, "Innovation as an inclusive system," focuses on how innovation can benefit societies by that include them in the entire procedure, enabling marginalised populations to gain insight into new ideas, and ultimately helping to create livelihood possibilities for these underprivileged populations (Mortazavi et al., 2021).

Serving marginalised groups still needs to be strengthened as a fundamental corporate strategy, despite the fact that technological advances in communication and information could be considered amongst the most topical accomplishments inclusive invention narratives. The study focuses on the practicality of applying the five innovation clusters inclusively and engagingly in the mining sectors to minimise inequality and maximise access to South African previously disadvantaged groups. The investigation utilises inclusive innovation as a theoretical and conceptual framework for analysing the innovation patterns In South Africa's mineral extraction sector, what the core business strategies and policies are and how these can be adaptable to allow for inclusive innovation in the sector. Developing nations like South Africa must create innovation strategies that take people with low incomes into account. While innovation can emerge from persons in lower income categories, the subject matter of this investigation is on pro-poor creative output that is started by low-income individuals through state-initiated economic and social reforms and inclusive business practices that promote inclusive development. Utilising innovations within marginalised groups can be supported by policy. It can serve as a guide, draw attention to best practices, and increase the effect of innovations as they spread. Policies that encourage demand-side market forces and encourage the broader and more economical application of innovations in low-income communities are crucial in this regard. NGOs, Community Based Organisation (CBOs), and informal sector business development organisations are examples of broader interventions and support that can be utilised to enhance the knowledge and skills needed for using innovations effectively. These policies aid in correcting systemic shortcomings about innovation users' capabilities.

This growing emphasis on inclusive innovation may be broken down into other analytical sub-themes, such as the influence of development trajectories on inventiveness and inclusivity and the dynamics of community-based and Non-profit innovation originating bottom-up. Proponents of community-based innovation and suitable technology can be broadly characterised as reflecting the push for "innovation from below," which is frequently carried out by NGOs or with their active participation (Chataway et al. 2013, p. 5).

The "innovation from below" paradigm and the idea of community-based innovation serve as a useful addition to the current conceptual framework in the context of the study highlighting that the value of grassroots participation in the innovation process, whereby NGOs and local communities actively contribute to the creation and application of technologies that tackle their problems. This paradigm promotes innovations that are not only technically feasible but also socially meaningful and sustainable by placing a strong emphasis on the needs and viewpoints of marginalised groups, such as small-scale miners and local labourers (Chataway et al. 2013).

In order to ensure that inclusive technologies are user-friendly and accommodate the socioeconomic circumstances of the communities they serve, community-based innovation dynamics demonstrate how local knowledge and experiences may guide their design. By encouraging a sense of ownership, this participatory method increases community members' ability to use new technology and help them succeed. The diffusion of appropriate technologies that improve employment quality and inclusivity in the mining industry can also be facilitated by NGOs acting as facilitators in the innovation process. This helps close gaps between technical competence and community demands. The study may more thoroughly examine how inclusive technical advancements benefit marginalised people in the mining industry and further economic goals by incorporating this community-focused viewpoint. This will ultimately lead to a fairer labour market in South Africa (Mortazavi et al., 2021).

2.9 Chapter Summary

To effectively analyse and frame inclusive innovation, it needs to be conceptualised with sectoral and community-based innovation aspects, where many stakeholders and their contributions to innovation are assessed. This study was particularly interested in the mining industry and how innovation might support sustainable development and employment retention in the industry as a whole. This chapter has illustrated a variety of methods and perspectives about innovation and its application to inclusive development, especially in poor nations. It has theoretically categorised inclusive innovation as a framework and tool of analysis and combined it with conceptual terms such as sectorial innovation and community-based innovation to understand the link between innovations and marginalised groups.

This chapter has also analysed case studies on inclusive technologies and their implementation and methodologies. These case studies have allowed the investigation to ascertain how technological innovation has been put into practice and its possible ramifications. Lastly, the study looked at the impact technology has had on employment and what companies and governments should focus on when introducing technologies, particularly in the mining industry. For the implementation of technological innovation to work and be acceptable to the labour market, it is essential to establish the correct motivation for change and how it is done transparently. The research methodology is presented in the upcoming chapter.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The research methodology is provided in this chapter or philosophy adopted to guide the mixed method research. A pragmatic stance is supported and justified as adequate for the mixed method approach. The research methodology, population, sampling strategy, method of collecting and analysing data, study strategy, and research design are all introduced, discussed, and supported as suitable and sufficient for the goals of the research inquiry. The chapter's final section explores reliability and validity in addition to the moral dilemmas that arose when conducting research.

3.2 Research Philosophy

The pragmatism paradigm, which states that actions cannot be dissociated from prior ideas and experiences generated from those experiences, serves as the foundation for this research (Babbie & Mouton, 2011). Pragmatism emphasises the search of common meanings, cooperative activity, and what works to address the study problems (Hall, 2013). Creswell and Plano Cark (2011) discovered pragmatism works well with diverse mixed techniques. This pragmatism philosophy, therefore, supported the research's use of a mix of approaches.

Pragmatists hold that inquiries into ontological principles, reality, and epistemological theories of knowledge ought to be abandoned (Kaushik & Walsh, 2019). Pragmatists view the study problem or question as the "central" emphasis, with "what works" serving as the primary priority (Kivunja & Kuyini, 2017). This study sought a critical understanding of how inclusive technological innovations impact equal and employment that is sustainable in South African mining industry.

In accordance to Maarouf (2019), finding a pragmatic philosophy that supports using quantitative and qualitative method in one study has become more common as the mixed research approach has gained traction. This is because the different viewpoints of the quantitative and qualitative perspectives are merged in pragmatism, which is a logical, integrative paradigm that views them as two complementary, rather than opposing, ideologies. Therefore, care was taken in the design of this study to guarantee the quantitative and qualitative methods are distinct but complementing to enhance the depth and breadth of the findings. The aforementioned strategy believes that while each technique falls under a different paradigm, integrating quantitative and qualitative methodologies yields more diverse study contributions than any other way (Kivunja & Kuyini, 2017). "Quantitative and qualitative research approaches are compatible and complementary" (Antwi & Hamza (2015, p.217).

Numerous scholars have highlighted how crucial it is for pragmatism to address the ontological distinctions underlying both paradigms. Pragmatic research is implied to be "intersubjective" by pragmatism, which is a term that denotes being objective as well as subjective at the same time, acknowledging that there is a single reality and that different people interpret it in different ways (Asper & Corte, 2019). Furthermore, Saunders et al. (2019) avers that pragmatism suggests that at the same time, reality is extraneous and complex, and that an investigator chooses the viewpoint that most closely matches their requirements. Yet, Dawadi et al. (2021) contend that to perform mixed research, one must have a thorough understanding of what constitutes the logical and personal interpretations of reality. However, whilst avoiding prejudice and trying to influence the phenomenon being studied is important, it is with equal regard crucial to comprehend the perspectives of the social players engaged (Aspers & Corte, 2019).

3.3 Research Approach

When employing a mixed method technique, the quantitative technique is approached using a deductive research strategy, while the qualitative technique is approached using an inductive research approach. According to Woiceshyn and Daellenbach (2018, p.4), deductive method "involves transitioning from an overarching viewpoint to a particular one." This research thus started around the theory of inclusive technological innovation and equal and sustainable employment. After creating a survey comprising open- and closed-ended inquiries, the instrument was tested in order to interrogate the data in relation to the analytical framework. However, to comprehend more deeply on how inclusive technical innovation affects equitable and sustainable employment in South African mines, this research study went on to qualitatively analyse the quantitative outcome using open-ended questions and data from secondary sources analysis. As held by Soiferman (2010, p.5), the induction research approach involves moving from a specific point of view to a broader one, like in the case of empirically examining a fascinating phenomenon and developing hypotheses and conceptions in light of the fact that, the two methods came together to give more details about the scientific methods that the deductive approach needs to clarify (Harriman, 2010).

There is no longer a clear-cut division separating quantitative and qualitative methods. Rather, they represent opposing ends of a spectrum along which the research may be deemed more subjective than numerical, or either way. In the middle of this continuum is the combined study strategy (Creswell, 2014). When conducting mixed research, a researcher combines quantitative and qualitative methodologies and designs within a single inquiry or related studies. This can be carried out sequentially, conducting one portion first and the other second or simultaneously conducting both sections simultaneously (Antwi & Hamza, 2015).

For this investigation, the convergent-parallel mixed method technique was selected due to its "complementary strengths" advantage, which refers to utilising one study technique's capabilities to bolster or strengthen the other (Molina-Azorin, 2016). Combined method researchers think that many research difficulties cannot be solved by relying solely on quantitative or qualitative studies. Each approach has advantages and disadvantages; thus, complementary strengths should be avoided to maximise study quality, and overlapping flaws should be capitalised on (Kaushik & Walsh, 2019). Therefore, in this study, the quantitative measurement of inclusive technological innovation and equal and sustainable employment in mining was considered not enough to use a qualitative approach further to examine in-depth how inclusive technological innovation affects equal and sustainable employment in South African mines. Through more thorough responses, it was anticipated that this integration of research approaches would help achieve more depth and breadth of the investigation's inquiry (Creswell & Plano Clark, 2011).

3.4 Research Methodology

For this investigation, a case method of inquiry was selected. A case study comprehensively analyses a particular research topic instead of a comprehensive statistical survey or exhaustive comparative investigation (Leedy & Ormrod, 2013). It is frequently used to condense a broad study area into one or a few simple cases to investigate (Yin, 2017). Case study research designs can be quite valuable when determining if a particular theory or model explains occurrences that occur realistically (Creswell, 2014). Whenever not much is understood about a problem or phenomenon, it is a good design to use case study design. Since little is known about this phenomena in South African mines, this methodology was judged acceptable for the current study to investigate how inclusive technology innovation influences equal employment and sustainable employment in the mining sector.

One advantage of a case study is its capacity to offer understanding into a complicated topic by giving an in-depth contextual examination of a few conditions or events and their associations (Yin, 2017). A study of a particular case enables the examination of investigation issues using a variety of sources and diverse approaches (Collis & Hussey, 2014). The case study design can deepen understanding or strengthen existing knowledge from earlier studies. Furthermore, this study design is frequently used by social scientists to investigate current real-life problems and serve as the foundation for applying ideas and concepts and expanding methodology (Saunders et al., 2019).

As in the present inquiry on inclusive technical innovation in South Africa's mining sector, the design can offer extensive explanations for specific and uncommon occurrences. However, a small number of examples do not give enough evidence to prove dependability or extrapolate the results to a larger population of individuals, locations, or objects (Saunders et al., 2019). It might be necessary to include important details, which would make the case difficult to understand and require additional qualitative testing after the relationship has been quantitatively tested.

The case study technique suggests triangulating data by providing the observer with the chance to gather information through a variety of methods, including experiments, interviews, and surveys, each falling under the purview of only one investigation (Saunders et al., 2019). A case study is comprehensive, enabling the investigator to see details that would otherwise be impossible (Collis & Hussey, 2014). Yin (2017) powerfully defends the effectiveness of case studies as a technique. Specifically, Yin (2017) recognises the value of case studies in addressing the "what" topic of the research and examining the "how" and "why". Additionally, the case study is adaptable enough to explore and analyse more complicated situations and experiences that might not have a clear-cut conclusion. For many of the reasons listed above, mixed-method research is becoming more and more common. A case study can offer a rich, multi-layered data collection that is in line with a more mixed methodology (Creswell, 2014). Using a case study as a technique enables investigators to employ an adaptable, thorough, and multi-perspective research strategy, supporting the expanding mixed methodologies trend. However, a case study has drawn criticism for lacking generalizability and being too robust (Yin, 2017). As such, the case of a single coal mine employed in this study is supposed to manifest the phenomenon as applied to the organisation.

3.5 Research Population and Sampling

3.5.1 Research Population

A research population is “a collection of people or subject matter that are well-known and identified as sharing comparable characteristics” (Creswell, 2014, p.127). Individuals in a certain population share a shared characteristic or unifying quality. The case study research approach was utilised by selecting one South African coal mine that has adopted inclusive technological innovation. The study included staff at all levels of operation at the mine to understand how inclusive technology generally affects mining employees. The target population was, thus, all permanent employees of the mine, totalling about 3700 as per human resources records.

3.5.2 Sampling Process

As held by Saunders et al. (2019, p.112), “the method for figuring out the right percentage of the population sample” is called sampling. Sampling improves the economy and accuracy of research. Additionally, Yin (2017) argues that the study result’s generalisability is determined by the sampling technique. Sampling, to state it straightforwardly, is the procedure of selecting a population sample for study (Saunders et al., 2019). There are a pair of primary approaches for sampling: probability and non-probability sampling. For this investigation, probability sampling was utilised as the basis for the sample procedure.

3.5.2.1 Probability Sampling

In the probability sampling process, each sample element has the same likelihood of getting selected (Leedy & Ormrod, 2013). A probability sample is one in which every group participant's selection probability is known to be not equal to zero (Creswell, 2014). With this sampling technique, the possibility that a sample is comparable to the population is allowed. Using random selection to select samples from a population when every segment of the population possesses a defined or observable non-zero inclusive probability is known as probability sampling (Yin, 2017). On the other hand, non-probability sampling entails selecting sample items arbitrarily, in which inclusion probabilities may be zero or unknowable for certain population members (Saunders et al., 2019). Both paradigms, meanwhile, offer advantages and disadvantages. The main attraction of probability sampling is that it is based on design-based inference theory, which allows for quantifiable sampling error and objective population mean estimation. However, because probability surveys sometimes have low response rates, impartial estimation is not always guaranteed in practice. Large sample sizes are necessary for reliable estimation in probability sampling, which presents a difficulty for survey companies with modest to moderate-sized budgets. Probability sampling was used in the current mixed study's questionnaire survey procedure. Cluster, multi-stage systematic, stratified random, simple random, and systematic random are a few probability sampling techniques (Creswell, 2014).

3.5.2.2 Sampling Method

Stratified sampling was adopted for this investigation to select participants. After the population is divided into strata, also referred to as subgroups, stratified sampling is used to take a random sample from each segment (Saunders et al., 2019). The study sampling frame included all low-level employees, middle-level employees, and top-level employees at the mine. These levels depict differences in decision making, tactical and operational experience that each individual brings to this study. The decision to select employee level as the strata was to include all mine employees' viewpoints regardless of their level. Because there is a lot of variance within the population, stratified sampling is applied because the mine employs a large number of people. To ensure equitable representation of every strata as the objective of the adopted approach (Leedy & Ormrod, 2013), employees in every managerial level are equally represented in the sample.

3.5.2.3 Sample Size

Sekaran and Bougie (2013, p.112) claim that a sample is "a subset of a population with features shared by the entire population." First, the sample for the investigation was selected utilising the random stratified sampling approach. Using the Raosoft (2004) Sample Size Calculator, 150 respondents were selected to take part in the survey and provide a sufficient number for quantitative analysis. The coal mine was chosen since the researcher could quickly get approval to conduct the study.

3.6 Data Collection Method

Using a survey approach, 150 respondents were given a survey comprising open-ended as well as closed-ended Likert-scale items. The study uses a two- to five-point Likert scale for the measures and also incorporates open-ended questions as follow-up questions (Joshi et al., 2015). Hard-copy questionnaires were printed and distributed equally (150 questionnaires each) to three levels: high, middle, and low representatives. The respondents were to tick their choices on the Likert scale and to write open questions on the questionnaire. The researcher sent weekly reminders by WhatsApp to the representatives to gather all completed forms to inspire voluntary participation and minimise a low response rate. After three weeks, the survey was completed when the targeted sample figure of 150 was achieved. Every completed questionnaire was assigned a special identifying code. The information obtained was captured in the Statistical Package for the Social Sciences (SPSS) v.25 computer programme using the established respondents' identification code.

Secondary data on inclusive technological innovation and equal and sustainable employment at the coal mine was gathered using the archival method. The secondary data was extracted from internal mine documents, including financial reports, performance management reports, and mine status reports. These reports enabled a more balanced enquiry to support the respondents' responses on inclusive technological innovation effects on employment. For the purposes of refuting existing theory, creating new explanations, and creating modern theory all of which need for comprehensive scientific analysis, archival research is crucial (Yin, 2017). This approach supports case study research to enhance and improve the process of verifying theories and generating new data (Yin, 2017). But according to Creswell (2014), archival materials are historical and should only be used in part. Therefore, this research uses the archival method to generate unobstructed and non-reactive data triangulated with both qualitative as well as quantitative techniques to yield a better result in this research enquiry.

3.7 Data Analysis Method

Data analysis is a method of retrieving and evaluating information in which raw data are scrutinised and organised (Saunders et al., 2019). Understanding what information ought to be retained and which should be excluded requires data organising and screening. The data analysis in this investigation involved two processes, which are detailed in the parts that follow:

Step 1: Quantitative data analysis

Descriptive analysis was performed in Step 1 on all of the individuals who responded to the handed out questionnaires, analysing their demographic data. Cronbach's tests were used to gauge the study instrument's validity and reliability. The research objectives guided the descriptive statistics analysed and presented using percentages, tables and graphs.

Step 2 Qualitative data analysis

To facilitate an increasingly thorough investigation of the effect of inclusive innovative technology on fair employment, the qualitative information obtained based on the broad questioning was evaluated with analysis of content (Bansal & Corley, 2012). Content analysis makes it possible to recognise the parts of the entire data related to certain characteristics of the phenomenon (Clarke & Braun, 2013). This investigation used a qualitative content analysis technique to investigate textual data, such as written documents, which were gathered through a questionnaire survey (Saunders et al., 2019).

The secondary data analysis used assessment and sifting processes to reduce and sequence inclusive technological innovation data from the selected mine reports as guided by the research questions. This process permitted the reassessment of my record to confirm the facts of the subject matter (Yin, 2017). This approach uses a narrative to report the systematic, objective description and analysis of documents. The question-driven method concentrates on the implied or explicit implications of communications using descriptive terminology such as characteristics, visual codes, or themes (Bengtsson, 2015). According to this approach, three interconnected steps are involved in analysis of data: reduction of data, data visualisation, and conclusion verification (Shava et al., 2021). As a result, this process is ongoing and iterative due to the recurring nature of the process, with the researcher continuously analysing the data during and after data collection (Shava et al., 2021).

3.8 Limitations of the Study

Study constraints stem largely from areas the researcher needs more control over. Population, sample size, geographical and cultural variances, design restrictions of the methodologies, and response rate are a few common drawbacks (Roberts & Hyatt, 2019). Response rate is a significant limitation, especially when trying to get interview time slots with the executive management of the mines. Erlandsson (2016) found a number of possible issues with the case study approach, such as observer bias, study effect, bias among respondents, and access to participants.

Language and cultural barriers were anticipated to limit the study, especially with the low-skilled labour. Regarding interaction in the interviews, an interpreter could have been utilised to maximise the conversation. Furthermore, due to time issues, senior executives and middle management of mines were not readily available for the researcher to conduct interviews. Constant follow-ups mitigated this and allowed three weeks of data collection. The idea that examining a phenomenon might change itself has long criticised the case study approach. This means that the gathering and examination of data need to mitigate the risk of the research's effect on the participants by identifying unusual behaviour and determining if it is caused by outside influence. Utilising open-ended survey questions restricted the responses provided, which could be improved with full interviews with individuals for a more extended period.

3.9 Validity and Reliability

3.9.1 Content Validity

In accordance with Babbie and Mouton (2011, p.117), the extent whereby a research tool measures or evaluates research constructs is known as content validity. The researcher wants to know if each of the fields or regions are adequately covered in the inquiry to evaluate the content-related validity of the poll's questionnaire. All features of the attributes are defined by two crucial decisions, namely the degree of quantification for each component or combination of items. To ensure content validity, chosen human capital and statistical professionals scrutinised all of this study's research instruments to determine whether the tools used were appropriate and sufficient for evaluating the ideas being evaluated. As a result, the specialists could ascertain whether the things under evaluation corresponded with the suggested conceptual area (Clarke & Braun, 2013). According to Creswell (2014), validity ensures accuracy in qualitative findings. Yin (2017) also asserts that triangulation, audit trails and external audits are good examples of validity strategies. Therefore, triangulation and audit trails were utilised in this study.

3.9.2 Reliability

Creswell (2014, p.128) contends that, when a test yields constant, non-varying results under stable settings and can be used with confidence by other researchers or scholars, it is considered reliable. Reliability demonstrates how the measurement may be repeated and maintained throughout time. Furthermore, as higher errors are linked to less reliable tests, a reliability test is sometimes thought of as the point at which it has no way of measuring faults (Chiang et al., 2020). According to Peter (2014, p.63), reliability refers to "…the degree by which an instrument for measuring is consistent and dependable.“ Repeatability is the critical component of reliability. Will the results of a study instrument that is used again and again be the same?

Among the most often used methods is Cronbach's Alpha for determining reliability. According to Peter (2014) because instrument content sampling is a major contributor of source errors, the coefficient alpha provides the best reliability estimate. Thus, for this study, the Cronbach's alpha test was employed to evaluate the questionnaire's reliability. An appropriate reliability metric was thought to have a 0.7 for Cronbach's alpha, as advised by Bernstein and Nunnally (1994) (Samuel, 2015). For this study, a Cronbach alpha value of 0.768 was computed and instrument was deemed reliable.

3.10 Ethical Consideration

The study was mindful of the contents of Wits' ethical policy governing research and has considered it. Concern for participants safeguarding, gathering and interpreting data, courtesy for the study sites, research writing, and research dissemination are all examples of ethical considerations (Roberts & Hyatt, 2019). Given that some information may be sensitive to the competitive advantage of the mining firm, the participating mining firm was off-limits to require different levels of clearance. In such an event, permission, evaluation of the use and clearance was requested from relevant authorising principles in the firms.

Ensuring a clear understanding of the interview's expectations lead to collection of data that will aid data validation and credibility (Rossman & Rallis, 2016). When conducting interviews with workers and contractors, the interviewer notified the subjects beforehand about the goal of the study to acquire their informed permission. Before the interviews, the investigator requested permission to record the interviews and discuss them if the need arises. Participants were informed that their comments and specific information provided by them could remain confidential if they choose. The aforementioned is essential and impacts how the data is presented in the report. Participants needed to provide the researcher with informed consent to quote participants' responses or whether they would prefer not to be identified in the report. Consideration was made to provide confidentiality or anonymity (Shamoo & Resnik, 2015).

3.11 Chapter Summary

The research was led by an approach and strategy that was provided in this chapter. Discussions were held regarding the study's population, methodology, approach, philosophy, sample strategies, gathering and analysing data, dependability and accuracy of the information, constraints, and ethical issues. The decision to employ a mixed-method technique was explained and supported. The study employed three phases, a combined qualitative as well as quantitative examination of questionnaire data and secondary data examination using the archival method. This study used data from various sources: questionnaires, mine documents, and other academic secondary data. The research findings are provided in the fourth chapter.

CHAPTER FOUR: PRESENTATION OF FINDINGS

4.1 Introduction

The study's findings, that included gathering data that is both quantitative and qualitative in nature, are presented herein this chapter. A closed poll was administered with pre-designed Likert-scaled closed questions and fill-in questions that are open-ended. The numerical information were computed and examined utilising Microsoft Excel and SPSS v.25 software, and the qualitative responses were subjected to thematic analysis to realise the main themes. The results are presented starting with the response rate, reliability tests and demographics. Next, the data, both qualitative and quantitative is shown by the objectives of the investigation described in the first chapter. Lastly, the emerging themes from the secondary analysis are presented.

4.2 Response Rate

One hundred fifty questionnaires were administered amongst workers of a single coal mine. A total of 123 responses were returned and confirmed to be complete and adequate for further analysis, reaching a response percentage of 82%. This was taken into account as a reasonable response rate. As held by Mellahi and Harris (2016), an excellent response rate ranges from 50% and higher and a good response rates range from 5%-30%. The remaining 27 questionnaires (18%) either declined to participate or returned blank questionnaires that could not be processed or subjected to further analysis. Figure 4.1 shows the response rate of the survey conducted.

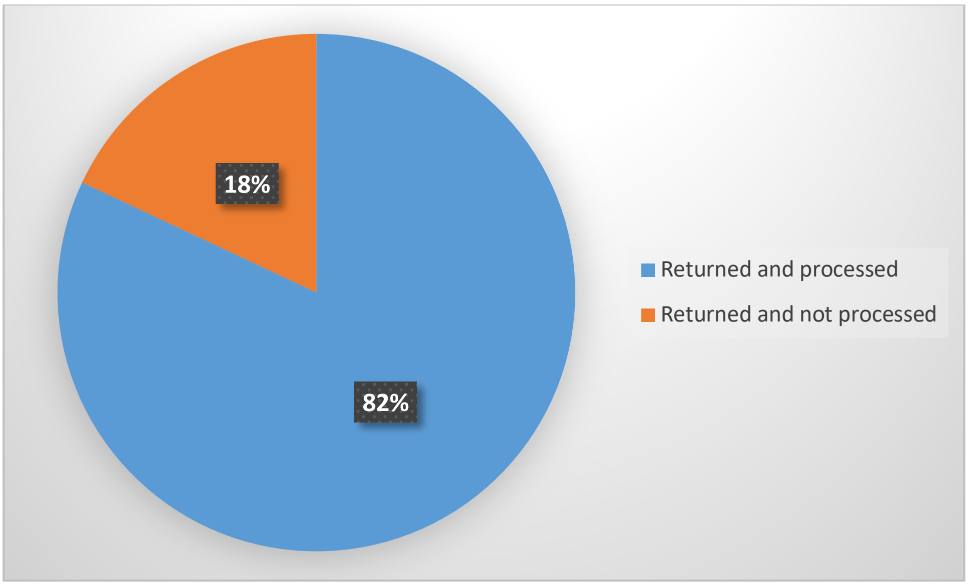

Figure 4.1: Response Rate

4.3 Reliability Tests

The reliability test on the questionnaire's 13 items revealed a Cronbach alpha value of 0.768. Taber (2018) state that good reliability has a Cronbach alpha of at least 0.70. Therefore, the instrument was regarded as a good and reliable measure of this study's quantitative constructs.

4.4. Demographic Analysis

The respondents' demographics are shown in Table 4.1.

Table 4.1: Demographic Analysis

VARIABLE	DESCRIPTION	N	MINING EMPLOYEES' RESPONDENTS (%) N=123
Age	Below 20 years	9	7%
	20-30 years	40	33%
	31-40 years	57	46%
	Above 40 years	17	14%
Gender	Male	93	76%
	Female	27	22%
	Others	3	2%
Race	African	55	45%
	White	23	19%
	Indian	20	16%
	Coloured	18	14%
	Others	7	6%

Table 4.1 reveals that 76% of the respondents were men, 45% were African, and 46% had ages ranging from 31-40 years. The high number of male respondents represents the male domination within the mining industry, and the high number of black respondents shows the dominant African local communities employed by most South African mines. The distribution of the respondents' ages show that most respondents (93%) were from older age groups and had been employed longer to share their experiences and knowledge of inclusive technological innovations in mines. Respondents' various ages, races and genders were necessary for this data collection to understand how diverse individuals view inclusive technological innovation.

4.5 Mine Employees' Skills Profiles

The respondents were asked five questions about their job level, highest qualification, years of mining experience, digital literacy abilities, work experience, and occupational type to understand the skills profile at the mine. Table 4.2 below reflects the analysed responses.

Table 4.2: Skills Profiling

VARIABLE	DESCRIPTION	N=123	RESPONDENTS (%)
Employment level	Senior-level mine employee	30	24%
	Middle-level mine employee	34	28%
	Junior-level mine employee	47	38%
	Others	12	10%
Highest qualification	High school	21	17%
	Diploma	33	27%
	First degree	47	38%
	Masters' degree	12	10%
	Post-graduate	3	2%
	Other	7	6%
Experience in the mining industry	Below five years	24	19%
	5-10 years	45	37%
	11-15 years	43	35%
	Above 15 years	11	9%
Digital literacy training received	Yes	64	52%
	No	59	48%
Occupation type	Administration job	21	17%
	Technical job	25	20%
	Information technology job	25	20%
	Manual job	50	41%
	Others	2	2%

Table 4.2 demonstrates that most respondents (56%) had at least a first degree, indicating that miners are hiring more educated workers who are fluent in innovations and technological advances. Most respondents had more than five years of mining experience (81%), reflecting a very experienced group to articulate the dynamics of inclusive technological innovation and equal

employment. These respondents affirmed (52%) that they had been exposed to digital training at one point in their working life at the mine. However, at least 48% of the respondents needed more digital literacy training, which could mean their inability to use new technological innovations effectively.

Also, against the backdrop of the new technological innovations in mining, at least 41% of the respondents still do manual jobs, which could reflect their lack of digital literacy training because of the nature of their careers. However, most respondents (57%) belonged to administration, technical and information technology (IT) jobs which ordinarily require digital competence for effectiveness. Additionally, junior-level employees made up at least 38% of the respondents, middle-level employees made up 28%, and top-level employees made up 24%.

4.6 Mine Worker's Understanding of Inclusive Technological Innovations

The respondents were asked three questions to test their knowledge and understanding of inclusive technology. The descriptive statistics produced from data collected and shown in the following table.

Table 4.3: Descriptive Statistics

Item	N	Scale item	
		Mean	SD
Innovation is a tool for affordability	123	3.587	0.858
Innovation is an essential tool for the inclusion of the poor and disadvantaged	123	3.786	0.647
Innovation builds capabilities and social empowerment	123	3.623	0.713

The distribution of the frequencies of the survey's items regarding the comprehension of inclusive innovation by mine workers is presented in Table 4.3. The highest mean was recorded on the item, "Innovation is an important tool for inclusion of the poor and disadvantaged" (m=3.786, SD=0.647). This means mine workers understand inclusive technological innovation as essential for including the poor and disadvantaged people. The item with the second highest mean was "Innovation builds capabilities and social empowerment" (m=3.623, SD=0.713), and the minimum average was recorded on the item "Innovation is a tool for affordability" (m=3.587, SD=0.858). This means mine workers least view using innovation as a way to save costs. This shows the three different measurement constructs display a solid strength with a mean value score of greater than three in the outcome (Bhana & Bayat, 2020).

4.7 Nature of Technological Innovation in Mining

The examination of respondents' opinions regarding which mines have adopted technical improvements is displayed in Figure 4.2.

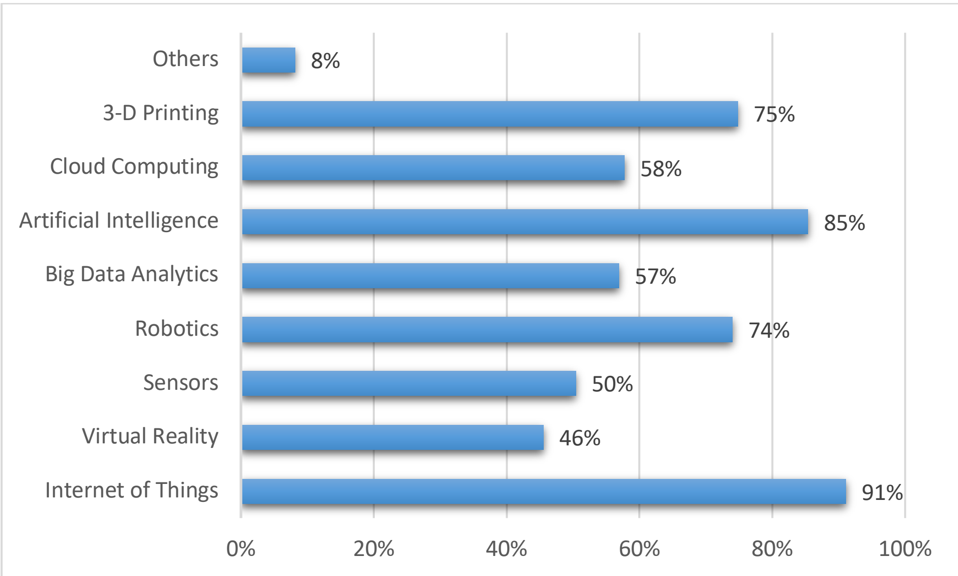

Figure 4.2: Technological Innovations in Mining

The results demonstrate that most of those surveyed indicated said that the Internet of Things (91%), Artificial Intelligence (85%), and 3-D Printing (75%) are the top three technological innovations introduced at the mine. The least common technological innovations were indicated as Virtual Reality (VR) (46%), sensors (50%) and big data analytics (57%). However, some respondents chose the "other" option (8%) and highlighted mechanical dozers, drones, and Global Positioning System (GPS) as additional technological innovations introduced by the mine.

4.8 Benefits of Inclusive Technological Innovation

The respondents were asked to rate three benefits associated with inclusive technological innovation. Figure 4.3 displays the examination of the answers, and Table 4.4 displays the descriptive statistics.

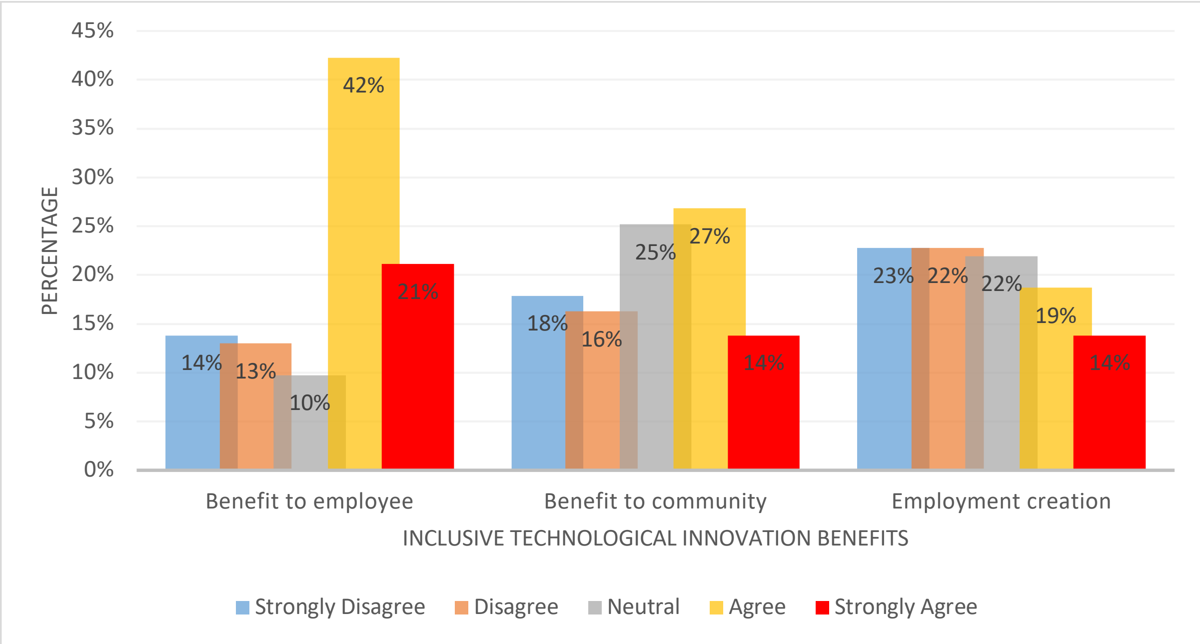

Figure 4.3: Inclusive Innovations Benefits

The results show that most respondents agreed (21%) and strongly agreed (42%) that inclusive technological innovations benefit the individuals at the mine. Additionally, 41% of the respondents agreed, and 34% disagreed that inclusive technologies benefit the community. However, most respondents strongly disagreed (23%) and disagreed (22%) that inclusive innovation is leading to employment creation at the mine.

Table 4.4 presents descriptive statistics regarding the advantages of inclusive technological innovation items.

Table 4.4: Descriptive Statistics for the Benefits Items

Items	N	Scale item	
		Mean	SD
New technological innovation is benefiting me as an employee	123	3.976	0.768
New innovative/new technology in this mine is benefiting the surrounding communities	123	3.555	0.743
New innovative technology in this mine is creating employment opportunities	123	3.006	0.628

The most common benefit of inclusive technological innovation was recorded on the item, "new technological innovation is benefiting me as an employee" (m=3.976, SD=0.768). The least common benefit of inclusive technological innovation was the item, "New innovative technology in this mine is creating employment opportunities" (m=3.006, SD=0.628). For the three measurement constructs, this result demonstrates a robust strength mean value assessment of greater than 3 (Bhana & Bayat, 2020).

4.9 Challenges of Technological Innovations

The question of whether technological innovation causes staff layoffs was posed to the respondents. The result is presented in Figure 4.4.

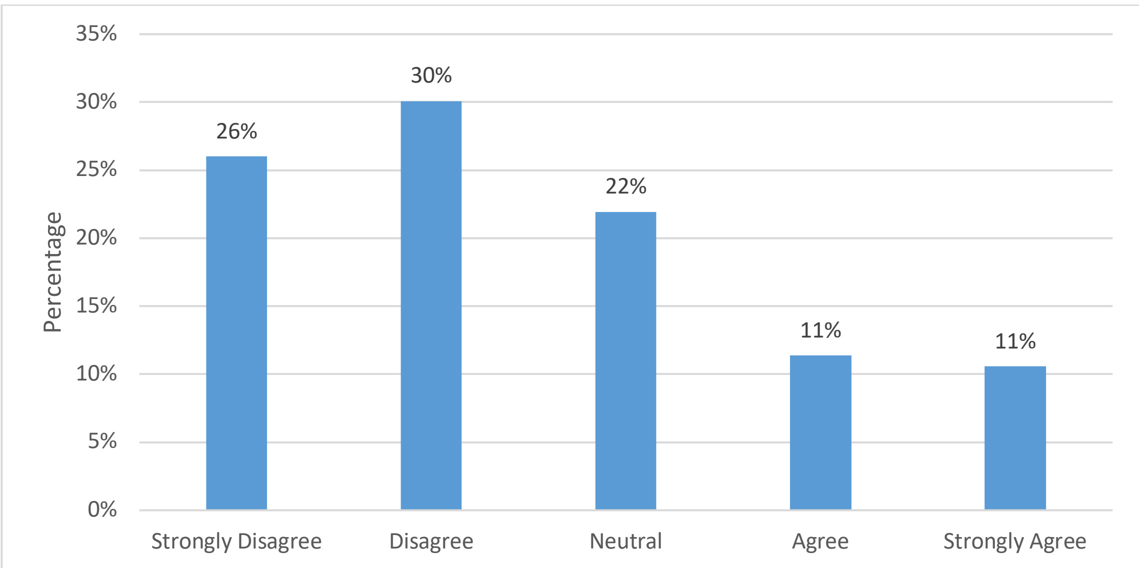

Figure 4.4: Technological Innovation Leads to Employee Retrenchment

According to the graph, most respondents disagreed with the notion (30%) and strongly disagreed (26%). However, 22% remained neutral, whilst the other 22% agreed that employment retrenchment resulted from technological innovation.

4.10 Improvements to Inclusive Innovation for Equal Employment

Two open-ended questionnaires that the researcher created for qualitative inquiries are displayed in Appendix 2. Out of the 123 individuals that took part, only nine responded with ways of improving inclusive technological innovation for equal employment. The two open-ended questions in the qualitative analysis encouraged respondents to share their thoughts and suggestions on how cutting-edge technology enhances labour skills in this mine. At least three participants declined being recorded and preferred note taking during the interview. Those who responded were invited to give their thoughts and suggestions in the second question regarding the best ways that they believed innovative and new technologies could be developed to generate employment rather than take them. The opinions of the nine respondents have been divided into themes; the main themes emerging from the content and secondary analysis are as follows:

Table 4.5: Improvement of Innovative Technologies for Equal Employment

Theme	Percentage	Representative Quote
Training	85%	“Then when we look into existing labour adults, people already working. We need to start preparing them for that time. This will happen in the next ten years". "We need to start preparing the sector for jobs of the future as the fourth industrial Revolution will need workers who can keep up with development through upskilling and training".
Education	72%	“Introduce the concept of technology, IoTs, AI, fourth industrial revolution, specialise in IT, things like electrical engineering and software design, that's when you get exposed”.

		"There needs to be a reskilling through obtaining qualifications that align with technological innovation demands, which means that those with lower qualifications need to develop their educational skills to align to innovation technology demands".
Government support	12%	"Government policies can be changed to provide much-needed support on training interns and new workers in the mine". "Government policies need to be adjusted to regulate the representation of disadvantaged groups, particularly indigent communities around the mine, through government grants for training and skills development."
Labour unions	29%	"As labour, we are open to improving labour skills for workers, particularly those most likely to be affected, such as technical and manual labourers". “Innovative technology has the potential to take jobs, especially from people whose skill set is not aligned to the new technologies. However, on the other side, it's creating jobs for those with the skill set and education aligned to innovation with the mine. It's a catch 22 situation and labour unions are caught in the middle.”.
Management Support	16%	"Management needs to support workers through skills development and having the buy-in from the workers when new technologies are being introduced".
Attraction of more young and skilled workers	46%	“The mine requires younger, skilled workers who can easily adapt to technological changes. This is because mining skills are evolving, which presents a challenge to the inclusivity of employees on the uptake of new technologies. However, the tertiary educated system is not producing enough skills to sustain technological innovations in the mine….”

4.11 Chapter Summary

This section detailed the study's results; out of the 150 questionnaires that were sent, only 123 people responded to the survey. Furthermore, nine participants provided their suggestions and opinions on how there can be improvements in technological innovation for equal employment. The questionnaire was changed to align the analysis with the goals of the investigation. The survey's intended use was to assemble information required in order to fulfil the objectives and research questions mentioned in the initial inquiry. The results are assessed and examined in the following chapter, which details each goal.

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Introduction

This section provides an overview along with an evaluation of the findings from chapter four. To help with addressing the inquiries for the research and enabling conclusions being illustrated, the primary themes and the quantitative findings are examined and connected to relevant literature. In the subsequent parts, discussions are organised according to the research questions.

5.2 RQ1: Current Skills Profile of Human Resources in a South African Mine for Equal Employment and Sustainable Development

The results show that most mining employees have digital literacy (64%). Moreover, the results reflect that at least 56% of mine workers are well-educated and have at least a degree. This result is higher than Ndlovu et al. (2022) assertion regarding digital skills, South Africa's active population had a mean % progression level of 29.9% in 2019 and 2020. However, researchers such as Badiuzzaman and Rafiquzzaman (2020) argue that the low-skilled mine workers who lack digital skills are threatened by the possibility of getting supplanted by ingenious robots. Similarly, Manyika et al. (2018) predicted that between 400 and 800 million employment opportunities may by 2030, be replaced by technology. This frequently occurs due to the emergence of innovative technology and technical processes, when a large number of formerly employed individuals are replaced by extremely productive robots, machines, and other automation processes.

Conversely, however, several organisations standing for employees in the mining industry think a significant association exists concerning digital safety, literacy and transformation with safe zone monitoring, automated machine stops and sensors, and real-time or almost real-time communications with prompt responses in the event of an issue (Ramdoo et al., 2021). Accordingly, mining companies can leverage analytics and data in real time to enhance worker performance and worker safety and health monitoring to enhance end-to-end value-added networks.

In addition, the arguments above mean that automation mostly do not influence equal employment of well-educated, more experienced and highly digitally literate mine employees. New technological innovations quickly displace the low-level, uneducated, less experienced and digitally illiterate employees. The lower-level staff comprises entry-level graduates entering the mining sector and existing employees responsible for manual and technical labour. This means that at the lower level, there is a mix of skilled labour with unskilled labour and educated graduates and non-graduates, which poses a challenge for the transfer of skills between these two groups.

However, though low-level workers are displaced, technological advancements are anticipated to create 133 million additional employment (Tiwari, 2023). As such, Acemoglu and Restrepo (2019) argue that the way that the effects of reinstatement and the displacement effects interact determines how technology affects the workforce. The term "reinstatement effect" refers to a circumstance in which technologies introduce novel responsibilities where employee labour has an inherent advantage over technological capabilities, while the term "displacement effect" implies technologies assuming over work formerly done by human beings (Acemoglu & Restrepo, 2019). Therefore, introducing technology only sometimes leads to the displaced employees. However, the fate of employees and how the work environment is reorganised to preserve equality of opportunity in an era of novel technological advancements depends on the kind and combination of technologies (Tiwari, 2023).

Consequently, this study outcome demonstrates that the participants recognise the significance of innovation in fostering inclusivity (m=3.786, S.D=0.647). Technological innovation ensures that displaced digital illiterate are exposed to new tasks due to new technologies. Since the results show that at least 57% of mining jobs are non-manual jobs in mining core and support activities, introducing new technological innovations displaces many employees. The interview participants expressed similar sentiments that technological innovation has impacted the labour market. Because of recent technological advancements, people with greater skill levels are given preference over low-skilled individuals, who run the possibility of substitution by algorithms and machines. Equality in the employment of low-skilled employees is thus achieved when mines are involved in the continuous reinstatement of displaced employees.

For continuous reinstatement to occur, it becomes essential to educate and provide an inclusive environment where workers understand what technological innovation means and how it may affect their employment. Mahdi and Nassar (2020, p.92) opine that " because of employee development, knowledge has emerged as a strategic asset that gives mining firms an edge over their competitors and helps them stand out in today's economic landscape.” However, technological innovation changes and transforms the dynamics of the workplace in the mining sector; thus, knowledge and learning remain permanent tools for adapting to the changing environment.

5.3 RQ2: New Technologies with Potential for Inclusive Employment and Sustainable Development in a South African Mine

The results show that SA mines have successfully adopted more of IoTs, AI and 3-D printing. The findings also show that technologies such as drones, mechanical dozers and global positioning systems have the potential for inclusive employment. However, the respondents explained how technologies such as virtual reality, sensors and big data analytics still need to be fully implemented and have the potential for inclusive employment in the mining industry. These sentiments are similar to Sánchez and Hartlieb's (2020) assertion that many mining businesses view the strategic importance of implementing new technologies to enhance operational performance and safety. Similarly, Lokwani et al. (2020) argue that technological advances positively impact productivity. When machines operate continuously and at a consistent quality, production increases (Kolade & Owoseni, 2022). Automation is therefore preferred to a worker workforce in businesses where employees are required to carry out routine tasks (Zervoudi, 2020). In addition, automation lowers expenses and makes the workplace more enjoyable by giving mine employees greater safety at work (Karolia-Hussain & Fourie, 2021).

Overall, mining businesses may respond appropriately to low commodity costs with innovation, which would better equip them to withstand the extended slump that is anticipated to ensue from the supercycle (Hermanus, 2017). However, researchers such as (Autor, 2022; Eliashvilli, 2021) found that new technologies harm labour. This differs from the findings that new technologies in the mine benefit the employee. According to Van Zyl (2020), automation will make certain abilities more important and some less important. However, because of how the fourth industrial revolution have changed, workers' abilities must be constantly improved. (Zervoudi, 2020). Yet, according to Degallier et al. (2022), machines will not eventually replace humans; instead, they will enhance them. In other words, automation frees workers from monotonous and repetitive jobs while enhancing human strength to the fullest (Zirar et al., 2023). In this way, quality and inclusive employment is maintained.

Similarly, the results show that most mine workers see technological innovation as crucial for including previously marginalised groups of people that build capabilities and social development. According to Collins et al. (2019), levels of inclusive innovation in an organisation complement and promote equity through emerging technologies. Despite this, rather than being a linear process, inclusive innovation is a consultative process that guarantees emerging technology benefit underserved populations and communities, thus contributing to sustainable development (Peerally et al., 2019).

5.4 RQ3: Challenges and Barriers of Inclusive Innovation for Equal Employment and Sustainable Development in South African Mines

The results show miners do not believe new technologies lead to employee retrenchment. However, literature (Griep et al., 2021; Hlatshwayo, 2017; Lima et al., 2021) demonstrates another perspective, arguing that technological advancements will cause a disruptive reshaping of the job marketplace, eventually driving out a large number of employees, including workers from the white collar and preventing them from ever returning to work full-time (Kolade & Owoseni, 2022). The South Africa's mineral extraction sector is currently confronted with the issue of implementing suitable technology while fostering the creation of novel employment opportunities and preserving the ones that already exist. The development of more sophisticated machinery creates new demands and employment and, on the one hand, reduces the need for some physical employment. Computer-driven machinery and increasingly intelligent computers are characteristics of the most recent phase of technical progress. This has produced discussions on the effects of the computer revolution on low- and middle-skilled workers, coinciding with the growth of economic inequality in formerly egalitarian nations.

Since at least 47% of miners do manual, low-skill jobs, this population needs greater relevance or connection since they are endangered by new technology (Heeks et al., 2014; Parschau & Hauge, 2022). According to Magwentshu et al. (2019), there are no established policies in South Africa (SA) to guarantee the generation of jobs in the age of digitalisation. Thus, in accordance with Buchanan et al. (2020), new careers, professions, jobs, trades and skills must be designed from scratch. Since new skills are required to execute new activities in the fourth industrial revolution, productivity issues resulting from a shortage of skills become more evident. With these skills available, mines can run efficiently. Robots are most likely to replace predictable and repetitive jobs, making previous technical skills redundant in the mining sector (Paredes & Fleming-Muñoz, 2021). Similarly, Hane-Weijman (2021) identifies the skills challenge as skills redundancy and skills mismatches. Developing nations most at risk are those with high rates of low-skill workforce (Hemanus, 2017).

The qualitative analysis revealed that the tertiary education systems in South Africa need to produce more skills to sustain technological innovations in the mine. This is making technological innovations less inclusive towards unskilled workers. Thus, according to Mouton et al. (2012), the constrained and inefficient educational system is typical of developing nations, which cannot produce more technologically skilled graduates. This means a wide gap exists between the mining technologies' needed skill set and qualifications curriculum. Inclusive innovation becomes possible when graduates join mines with the required skills.

Moreover, researchers such as McGuinness et al. (2019) argue that technological changes are generally not skill-neutral. This means innovations will tend to devalue specific skills and favour particular skills. For instance, a study by Seegers and Ehmann (2021) found that technological changes increasingly substitute routine tasks. This means low-skilled employees holding these routine tasks have fewer chances of taking up new roles requiring a more extensive skill set.

The qualitative analysis also showed that mining skills are evolving, and this presents a challenge to the inclusivity of employees on the uptake of new technologies. This is similar to Ciarli et al. (2021) argument that the redundancy of old skills is growing whilst relevant and new skills are increasing with more uptake of technological innovations. Thus, Li (2022) argues that as providers of skills, institutes of higher learning are required to match their relevant curricula to the increasing need for graduates who are prepared for tomorrow's workforce and who can retrain and upskill to handle emerging mining technologies. These technologies are context-specific to the mine as affected by the culture, depth, age and size of the mine. Within South Africa's mining sector, that is faced with issues, for instance mine safety, increasing costs and a cyclical market; new technological innovations are motivated by the need to deal with these challenges.

5.5 RQ4: Ways in Which Inclusive Innovation Can Improve and Promote Equal Employment Opportunities and Sustainable Development in a South African Mine

The results show that adopting new technology improves labour skills in mines. However, such improvement requires commitment and inclusion of mine stakeholders. Thus, according to Ngobese et al. (2023), stakeholder inclusion can lead to better results, increased ownership and buy-in. A human-centred approach to innovation adoption is recommended (Rao & Kalyani, 2022).

The findings show that inclusive employment is improved with better training, education and labour union support. According to Saari et al. (2021), role players should anticipate the talents that the fourth revolution will demand and design their training to particularly address skill development in that context. Li (2022) argues that the most recent technology must be taught, learned, and implemented in order to prepare both the present and future workforces. Moreover, retraining current workers is crucial to lowering the unemployment rate

(Grunau & Lang, 2020). This training must aim to develop a combination of computer skills and convectional task-oriented expertise.

However, literature shows that an older population finds it harder to pick up fresh competencies, and workers in need of increased training and participation in programmes to do so finds it even more difficult (Li, 2022). More semi-skilled or unskilled employees in the mining industry still need to complete their education, and their inadequate levels of technological skills make them susceptible to losing their jobs (Ramdoo et al., 2021). To keep up with technology, however, the majority of highly valuable and skilled workers are retraining and upgrading their skills. Hence, training in innovation is more critical to low-skilled than high-skilled workers. In South African mining, inclusive employment is achievable by training low-skilled workers, where 30% of employees are unskilled, 46% are semi-skilled, and 24% are skilled (Reddy et al., 2016). Therefore, the most important course of action is to engage in capacity training and culture reform so that every one of mine employees are digitally literate. For instance, the workforce could be prepared for an ever-evolving environment and made more capable of learning new things while remaining relevant by receiving upskilling in data analytics and technological advancements (Li, 2022). Introducing innovative technology, such as the IoTs, AI, and 3D printing, exposes workers to more knowledge and provides them with more practical ways to apply their existing knowledge.

The results show a need for reskilling workers by obtaining qualifications that align with technological innovation demands. This means that those with lower qualifications need to develop their educational skills to align with innovative technology demands in the mine. As per Heeks et al. (2014), inclusive innovation is also very critical in the education space where research around innovation itself takes place. Inclusive innovation in the education space allows for information and knowledge to be taught to excluded people as opposed to it being something that is done for them; in other words, it provides for institutions to teach people how to be innovative while also including them in the innovation processes (Heeks et al., 2014).

5.5.1 Labour Union Support

The results reflect that being significant players in the mining sector, labour unions offer a distinct viewpoint on the significance of technological advancement and the coming fourth industrial revolution with respect to low-skilled workers in South Africa. Labour unions are involved in open discussions about improving labour skills and employment of workers, particularly those who are most likely to be affected, such as technical and manual labourers. According to Ndlovu et al. (2022), trade unions, or organised labour groups, are important players in the mining industry having the ability to contribute to policy processes through strong incentives and bargaining power. Companies often grapple with strikes where unions lead mine workers to demand increased wages and improved employment conditions (Makama & Kubjana, 2021). Labour organisations have remained a vital component of South Africa's democracy given that the apartheid was abolished, thanks to the progressive employment regulations that allow for central negotiations (Hlatshwayo, 2017).

Labour organisations are aware that South Africa and other countries are modernising their mines. Labour recognises this in relation to updating older mines and resolving mine employee safety issues. This was discussed in a joint parliamentary committee discussion between trade union stakeholders and the Mineral Resources and Energy committee in August 2019. Labour organisations concurred that advances in technology played a crucial role in modernising mines, increasing their production, and enhancing worker safety, but that any technological advancements had a positive impact on labour as a whole (Parliamentary Monitoring Group (PMG), 2019). The challenge, however, is that labour unions must be fully committed to taking proactive measures to alleviate any potential disruptions to workers and their work environments that may arise from the modernisation of the mining industry. Trade unions are reactive rather than proactive to innovation-driven changes affecting employees (Hlatshwayo, 2017). Trade unions have attendance, engaging only on what the mine has implemented and not being involved in shaping new technologies and ensuring sufficient preparation for workers in these transitions (Ndlovu et al., 2022).

5.5.2 Government Support

The results show a change in policies and more regulation to make allowance for the training of new graduates and indigent communities surrounding the mine. The government can take more action to coordinate mining with the nation's efforts to create jobs and improve skills. According to Ramdoo et al. (2021), the government is a critical actor in influencing policy processes in the mining industry through regulations and legislation. However, prominent South African corporations were effective in lobbying the government during the end of apartheid to prevent fundamental changes that might upset the prevailing equilibrium in financial status (Mondliwa & Roberts, 2021). Therefore, to guarantee that mining is lucrative and gainful whilst partaking the advantages with the remaining members of humanity as a whole, government actions must be used to counterbalance the market dominance that mining firms have established (Frederiksen, 2018). The government has primarily established itself as a keeper, and through its numerous policy tools, it has been focused on optimising mining revenue (Ndlovu et al., 2022). However, the government of South Africa frequently deals with internal issues involving misalignment and inconsistent policies throughout its various branches. The Mineral and Petroleum Resources Development Act (No. 28 of 2002), a statute designed to address the past historical disparities in socioeconomic status and guarantee historically underprivileged people's substantive involvement in the sector, gives the government authority and clout in the aftermath of apartheid (Vandome & Khama, 2021).

5.5.3 Managerial Support

The results show that managerial support is necessary when workers believe management intervention is crucial through providing skills programmes that align with the technologies implemented in the mines. According to O'Donovan (2018), mine leadership are critical in achieving diversity and inclusive employment. The mining sector progressively resorts to activities related to Diversity and Inclusion (D & I) that tackle obstacles such as an ageing labour force, amplified public scrutiny, and the mounting need for inventive technical resolutions to mining predicaments (Kincaid & Smith, 2021). Irrespective of the relative team heterogeneity, studies has shown that inclusive leaders report stronger performance metrics, such as improved staff satisfaction and revenue levels (Korkmaz et al., 2022). Thus, leaders should recognise that the need for inter-generationally equitable leadership is rising due to the mine workforce's increasing ageing.

5.5.4 Attraction of More Young and Skilled Workers

The qualitative analysis shows that the mine requires more young and skilled workers who can quickly adapt to technological changes so that technological use in mining is manageable for employees. The mine has many older employees who must be prepared to reskill and remain employed when faced with technological innovations. This is similar to Li's (2022) arguments that mines most demanded characteristics' are skills, personality and dedication to work. This means mines should provide a conducive environment to attract young employees who are generally believed to have a negative perception of working in mining environments (Johansson et al., 2018).

A study by Lööw (2022) shows that smart mines use technological innovations to build intelligent and safe mining operations to change young people's perceptions of dirty, dangerous, and outdated industries. In this way, mines are using technological change to foster the inclusivity of young people. Additionally, new technological changes permit a mine's extended orebody life cycle, thus saving current jobs and creating new jobs that were not previously there through new technologies (Nwaila et al. 2022). Moreover, these inclusive innovations lower current expenditures on operations, increase asset productivity, boost efficiency in operations, and enhance the health and safety conditions for mining employees (Li, 2022). This makes inclusive innovation a sustainable development in the mine. The technologically advanced mines are more sustainable, efficient, leaner, safer and smarter (Lööw, 2022). These mines produce highly skilled employees, who are better remunerated and more computer literate, making them more employable in other sectors outside mining (Dipitso, 2023).

The qualitative analysis shows that senior employees believe that graduates with at least a high national diploma or degree are required in the 21st-century mining industry. This group of employees comes with basic education and training to develop competencies around current technological innovations. It can be easily reskilled through training to enable them to handle future technological innovations. The participants concurred that this is difficult to accomplish with older skilled employees. According to Okechukwu et al. (2023), using machine learning and clever sensors could increase production without creating a large number of employment opportunities. Thus, certain new technologies may cause the establishment of fresh employment opportunities that demand new skill sets. It becomes essential for workers to be able to shift, improve their skills, cross-skill, and upgrade their skills. Although there is still uncertainty over how technology advancements will affect employment, there is growing evidence that educational, vocational and professional training are crucial resources for maximising the positive effects of these developments while minimising their negative effects (Autor, 2022). This means workers' training is paramount for employees to gain from inclusive innovation. However, other non-routine cognitive skills are equally important to successfully uptake new jobs initiated by new technologies (Sungsup, 2019).

5.6 Chapter Summary

The results were discussed, reflecting that most of mine workers are digitally literate. However, low-level rather than high-level employees are impacted by technological innovation displacement. Education, experience, and knowledge assist employees in acquiring digital skills to influence the dynamics of employees' role change due to technological innovation changes. The mine is adopting new technologies which both have potential or lack potential for inclusive employment and sustainable development. This results in the required training of low-skilled employees to participate in technological innovation. Workers must be open to new skills and ready to relinquish those no longer required. The success of inclusive innovation lies in stakeholder inclusion, training and development, labour union support, government support and leadership support. However, the fourth revolution shifts the workplace from collective to individual, making it challenging for governments and trade unions to represent individual workers. The recommendations and conclusion are presented in the upcoming chapter.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Introduction

The recommendations and findings are included within this last chapter. The outcomes are drawn from the discussions and findings, highlighting the critical new insights and understandings. The research questions guide the discussion to show that research objectives were achieved. Additionally, the chapter includes recommendations, contributions, limitations and areas that require more study.

6.2 Main Findings and Conclusions

The following sections contain the main findings and conclusions for each research question:

6.2.1 Current Skills Profile of Human Resources in a South African Mine for Equal Employment and Sustainable Development

The research's first inquiry was focused on understanding the current skills profile of human resources in a South African mine for equal employment and sustainable development.

The findings show that most mine workers are generally digitally literate and educated with at least a first degree. These findings show a higher level than the South African digital skills score of 29.9% (Ndlovu et al., 2022). It is the minority mining workers who are low-skilled, less educated and more susceptible to technological innovation displacement. The low-skilled mine workers who lack digital skills are threatened by the possibility that humans will be supplanted by machines with intelligence (Badiuzzaman & Rafiquzzaman, 2020). As such, Manyika et al. (2018) project that 400-800 million work opportunities could be replaced by machines, automated systems and robots by 2030. This adoption of new technology by mines is meant to improve performance and workplace environmental health and safety. The lack of digital skills of the low-level mine employees, comprising those at entry-level and manual jobs, means equal employment is more problematic than with highly literate and educated mine employees. However, researchers such as Tiwari (2023) contend that despite displacing low-level employees, it is anticipated that technological advancements would create 133 million new employment. Consequently, digitally skilled employees, though displaced by technological advancement, are quickly reinstated into new roles created by technology. As such, Acemoglu and Restrepo (2019) argue that the way that the effects of reinstatement and the displacement effects interact determines how technology affects the workforce.

Additionally, the introduction of technology only sometimes leads to workers with digital skills being replaced. However, the fate of employees and how the work environment is reorganised to preserve job equality in an age of new technology advancements depends on the kind and combination of technologies (Tiwari, 2023). Technology is thus an essential tool for inclusive employment. Thus, Mahdi and Nassar (2020, p.92) argue that employee knowledge development is critical for successful, inclusive and equal employment when employee education and understanding of technological innovations are prioritised and given more attention.

In summary, the findings show that education, experience, and knowledge assist employees in acquiring digital skills to influence the dynamics of employees' role changes due to technological innovation changes. Low-level employees with low digital skills are more prone to job displacement than high-level employees.

6.2.2 New Technologies with Potential for Inclusive Employment and Sustainable Development in a South African Mine

The second research question was focused on understanding the new technologies with the potential for inclusive employment and sustainable development in a South African mine.

The findings show that the mine has successfully adopted more of the IoTs, AI, and 3-D printing. Technologies such as drones, mechanical dozers and global positioning systems are also being adopted to a certain extent and have an excellent potential for inclusive employment. However, the mine must catch up by adopting novel technology like virtual reality, sensors, and analytics with big data. Researchers such as Sánchez and Hartlieb (2020) argue that integrating new technologies into operations is strategically necessary for many mining businesses to increase operational performance and safety. Automation thus prevails over a human labour force in companies that use workers to complete repetitive activities (Zervoudi, 2020). However, researchers such as Autor (2022) found that new technologies harm labour. The participants of this study argue that new technological innovations benefit employees. According to Van Zyl (2020), automated processes will make certain abilities more important and others less important in general. According to Collins et al. (2019), levels of inclusive innovation in an organisation complement and promote equity through emerging technologies. Despite this, rather than being a linear process, inclusive innovation is a consultative process that guarantees emerging technology benefit underserved populations and communities, thus contributing to sustainable development (Peerally et al., 2019).

In summary, the findings show that the mine is adopting new technologies with potential and lack potential for inclusive employment and sustainable development. This means that more skilled employees require continuous training as more technological innovations are introduced for more inclusive employment.

6.2.3 Challenges and Barriers of Inclusive Innovation for Equal Employment and Sustainable Development in South African Mines

The third inquiry into the study was centred on comprehending the challenges and barriers of inclusive innovation for equal employment and sustainable development in South African mines.

The findings show that the participants do not believe the theoretical view of displacement of employees by technology leads to retrenchment. Researchers such as (Kolade & Owoseni, 2022) contend that technological developments will disrupt the job market by gradually removing employees from entire industries and long-term driving out vast numbers of people, including white-collar workers, who will never again be able to find their way back to work full-time. This theory is only disputed when firms are reinstating employees retrenched because of new technological innovations introduced in the workplace. This means the new technology must have the potential for inclusive employment for all employees, including low-skilled workers. At least 47% of miners do manual low-skill jobs; and their jobs are being threatened by new technologies and requires greater consideration (Heeks et al., 2014; Parschau & Hauge, 2022). Mines offer training and development to ensure adequate skills are available to handle new tasks from technological innovations adopted.

The findings show that the tertiary education systems in South Africa need to produce more skills to sustain technological innovations in the mine. This lack of skills is making technological innovations less inclusive towards unskilled workers. Thus, according to Mouton et al. (2012), the constrained and inefficient educational system is typical of developing nations, which cannot produce more technologically skilled graduates. This means a wide gap exists between the mining technologies' needed skills-set and qualifications curriculum.

In summary, mines have the challenge of adopting a sustainable approach to technological innovation that ensures inclusive employment against the backdrop of low-skilled workers and the need to improve performance through new technologies. Workers need to be ready to let go of any skills which are not anymore required and open to learning new ones.

6.2.4 Ways to which Inclusive Innovation Can Improve and Promote Equal Employment Opportunities and Sustainable Development in a South African Mine

The fourth research question was focused on understanding how inclusive innovation can improve and promote equal employment opportunities and sustainable development in a South African mine.

The findings show that certain technologies exist to improve labour skills in mines. Technologies such as AI, robotics, and sensors have the potential for inclusive employment (Li, 2022). Stakeholder participation is essential to improving equal employment because it produces better outcomes, more ownership, and more buy-in (Ngobese et al., 2023). Better training, education, labour union support, government and management support are essential in improving inclusive employment and sustainable development. Li (2022) argues that to prepare the workforce of today and tomorrow, it is imperative that teaching, education, and training of the newest technology be implemented.

Moreover, if the unemployment rate is to be reduced, present workers must receive retraining (Grunau & Lang, 2020). According to Ndlovu et al. (2022), trade unions, or organised labour groups, are important players in the mining industry having the ability to contribute to policy processes through strong incentives and bargaining power. However, trade unions are reactive rather than proactive to innovation-driven changes affecting employees (Hlatshwayo, 2017).

In addition, according to Ramdoo et al. (2021), the government is a critical actor in influencing policy processes in the mining industry through regulations and legislation. However, large South African corporations were successful in lobbying the government during the end of apartheid to prevent fundamental changes that might upset the present distribution of economic status (Mondliwa & Roberts, 2021). Therefore, mining companies have been entrenched in market power that needs balancing with government interventions to guarantee the profitability and productivity of mining while distributing the advantages to the rest of humanity (Frederiksen, 2018). According to O'Donovan (2018), mine leadership are critical in achieving diversity and inclusive employment. Irrespective of the proportional diversity of their teams, research has shown that inclusive leaders report stronger performance metrics, such as improved revenue levels and staff satisfaction (Korkmaz et al., 2022).

The findings show that the mine needs to attract young and skilled workers. As such, Li (2022) argues that mine's most demanded characteristics are skills. Mines ought to provide a conducive environment to attract young employees who are generally believed to have a negative perception of operating in a mining setting (Johansson et al., 2018). New technological changes are permitting a mine's extended orebody life cycle, thus saving current jobs and creating new jobs that were not previously there through new technologies (Lööw, 2022). Moreover, the technologically advanced mines are more sustainable, more efficient, leaner, safer and smarter to attract more young workers (Nwaila et al., 2022).

In summary, the findings show that equal employment and sustainable development come through the adoption of technologies with a potential for inclusive innovation. The success of inclusive innovation lies in stakeholder inclusion, training and development, the attraction of young and skilled workers, labour union support, and government support. However, because of the shift from collective to individual labour in the workplace brought about by the fourth revolution, it is challenging for governments and labour organisations to advocate for individual workers.

6.3 Contributions from the Study

The sections that follow address the contributions made by this study:

6.3.1 Contribution to the Knowledge Base

Whereas the extent of literature has explored the importance of technological innovation on sustainability in mines, this study explored the extent of technological innovation on equal employment and sustainable development.

The study supports the literature on the notion of adopting technological innovation with the potential for inclusive employment. This means the type and mix of new technological innovation determines how effectively employment inclusion and sustainability are achieved. Technology that only replaces employees with machines and fails to create new roles cannot support equal employment. Instead, it leads to more employee displacement and retrenchment.

The study supports the literature on the adoption of new technological innovations as a strategic necessity that improves operational effectiveness and safety, drawing the lines between technologies that support equal employment and technologies that do not support equal employment. Mines are choosing automation of roles over the human labour force, exerting a negative impact on labour as new skills increase whilst old skills decrease. Mines strikes a balance by adopting inclusive innovations to achieve and complement equity employment inside the company.

The research findings contradict the past study results on the belief that adopting new technological innovation leads to employee retrenchment. The study offers contrasting views to the literature that technology only sometimes leads to disruptive shaping of the mine labour market and eliminating human labour. The study shows that companies can reinstate employees who have been displaced or whose skills have become redundant.

The study also supports literature on trade union support and government support as a means to improve equal employment and sustainable development in mines. However, due to new technologies, labour unions are primarily reactive in influencing labour issues affecting employees. Due to new technological innovations, the government has entrenched too much market power in mining houses and needs to show more intervention in labour issues. Leadership in the organisation is critical in achieving equal employment through conduct and style.

6.3.2 Contributions to Practise

The study shows that most mining workers are becoming digitally literate in Africa as most individuals now own cell phones and can use the internet. Management can utilise this shift to equip employees with digital skills so that there is less retrenchment and displacement of employees when new sustainable technological innovations are introduced. When machines replace more jobs, managers can instate more of these workers into new roles because of their capacity to learn and develop new skills. Employee education, training, and development in organisations are paramount to enhancing employees' understanding of new technological innovations. Managers are thus able to maintain equal employment when a balance is maintained between reinstated employees and displaced employees.

The process of adopting inclusive innovation should be deliberate by mine managers. It is also a consultative process that involves consideration of other stakeholder interests to achieve equality and sustainability. In this way, issues of employee displacement and employee employment are given due consideration so that automation is seen as a great benefit to employees. Employees with redundant skills are reassigned to new roles instead of being retrenched. In addition, some new technological innovations have the potential for inclusive employment and lead to new roles which managers can allocate to displaced employees.

Labour unions are key in collective and individual bargaining for mine employees and can proactively push the agenda for equal employment within the impact of new technological innovations. The government can impact equal jobs and sustainable development through sound legislation and regulations that consider equal employment to avoid retrenchment and loss of jobs by mining employees. In addition, mine leadership should keep active, inclusive employment policies that consider employee interests when faced with technological innovation adoption decisions.

6.4 Recommendations

From the study's conclusions, the following recommendations arise:

6.4.1 Retraining and Development Programs for Existing Employees

Existing employees likely to be displaced by new technological innovations can be retrained and equipped with new skills to handle the new technologies. Both leadership and mining trade unions can collectively negotiate on retraining the current workforce and making them employable after adopting technological innovation. In order to prevent any detrimental effects on worker and mine safety, mine personnel need to be proficient in operating modern equipment. Reskilling and upskilling must be a priority in mining. There is a need for an agile approach to equip employees with future-proof skills and equip them with specific automated tasks.

Trade unions can push the retraining and upskilling agenda due to automation through Social Labour Plans (SLPs) by keeping an eye on the strategy to make sure the commitments to create jobs are fulfilled. Strict sanctions for non-compliance to upskilling and job-saving should be introduced to ensure plans are implemented, and the SLP does not remain cosmetic. These retraining plans must be continuous and ongoing throughout the employment life span of a worker. Since some technologies have the potential for inclusive employment, employees must be trained and proactively developed into new skills through upskilling and reskilling to realise the corresponding employment opportunities.

6.4.2 Government Retraining Finance Support

Retraining requires financial support, which private firms might only sometimes provide. The government may implement a funding plan that compensates staff members for completing upskilling in technological advances or receiving training in accordance with specified training privileges. It is possible to create a public fund through distinct regulations to cover the cost of workers' retraining and education for mining employers who plan to implement automation during the fourth industrial revolution. The mining industry's unique skill requirements are met by the Sector Education and Training Authority (SETA) and pertinent techniques to develop skills. Alternatively, the government ought to assist elderly and vulnerable people who decide not to participate in economic activities and offer incentives to individuals who abandon their employment.

6.4.3 Individual Instead Of Collective Bargaining

When new technical advancements harm employees, the labour negotiations system turns mandatory and there is an obligation to bargain. The emphasis on the person may render the notion of the "collective" in the negotiating process obsolete, leading to a desire to foster private individual bargaining that necessitates new laws. Agreements on collective bargaining should, in general, concentrate on a large number of workers and consider suggestions for future course of action in light of workplace developments. The approach to negotiations should also include individuals affected by technologies with trust, respect and satisfaction of human needs.

6.4.4 Social Dialogue with Workers

There is a need for mine leadership to involve workers in the adoption of new technological innovation. This can be accomplished by empowering employees to take a greater proactive part in the implementation of new technology innovation strategies and options, either individually or by means of employee representation. This will result in more creative and socially resilient adoption outcomes. Social innovation, which refers to implementing and designing new technological innovation adoption solutions intended to enhance the well-being and community well-being and individuals, is paramount. In this way, the company culture is enhanced as employees' interests are taken into consideration to bring understanding and bonding in the workplace.

6.4.5 Change in School Curriculum

To enable students to become skilled in the quickly developing fields of nanomaterials, artificial intelligence, data science, robotics, and genomics, there needs to be a considerable transformation in both the technology and science curricula. Such changes equip school leavers with the Industry 4.0 skills set and literacy to handle these new technologies and computer sciences. Thoroughly contemplation of the state of mankind, how technological advances and changing economic status affect people from all socioeconomic backgrounds, and the threats that come with living in a world that is more interconnected must all be included equally in a successful educational approach to the revolution in Industry 4.0. This is necessary to foster lasting respect for individual rights and freedoms as well as deep cross-cultural awareness.

6.4.6 Employee Trust in Job Preservation

Establishing a positive rapport between the mine and its workforce is vital to guarantee confidence in implementing technical advancements that protect jobs rather than eradicate them.

6.4.7 Creation and Maintenance of Responsible Mining Policies

The mines must uphold responsible mining policies that enable sustainable economic development that can stimulate inclusive innovations. These policies regulate the transformation processes and the innovation that is critical for the sustainability of the mine.

6.5 Limitations

The research was constrained to one coal mine, which affected the generalisability of the outcomes. However, the primary goal of the purpose of the investigation was to examine and generate fresh ideas that could be extensively investigated by other academics, rather than extrapolating the results.

6.6 Areas for Further Studies

Future studies can focus on the following areas:

- An investigation of the association between the mining industry's embracing of new technical innovations, equitable job opportunities, and sustainable development

- An examination of the connection between workforce displacement and the mining industry's implementation of novel technological advancements
- An examination of the connection between employee reinstatement and the mining sector's embracing innovative technological breakthroughs

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APPENDICES

Appendix 1: Consent Letter

CONSENT TO PARTICIPATE IN THIS STUDY

I, _______ (participant name), attest that I have been informed regarding the nature, process, possible advantages, and expected inconveniences of participating in the study by the individual requesting my consent. I've read the data sheet and understand the study's explanation, or I had it communicated to me.

I've had enough time for asking questions, and I'm ready to take part in the research. I am aware that my involvement is completely optional and that there are no consequences if I decide to stop at any moment (if applicable).

I understand that the results of this study may be used in a report of research, journal articles, proceedings from conferences, and/or various other publications, but that, except stated otherwise, information about how I participated will be kept private.

I agree/disagree to answer and respond to the 15 semi-structured questions. (circle the one applicable to you).

I have received a signed copy of the informed consent agreement.

Participant Name & Surname... (please print)

Participant Signature..Date.....................

Researcher’s Name & Surname...(please print)

Researcher’s signature...Date.....................

Appendix 2: Research Instrument

PART 1: DEMOGRAPHIC PROFILE

Question 1

Please complete the block below

Age	Gender	Race
☐ Below 20 years ☐ 20-30 years ☐ 31-40 years ☐ Above 40 years	☐ Male ☐Female ☐ Others	☐ Black ☐ White ☐ Indian ☐ Coloured ☐ Others

SKILLS PROFILE OF MINING HUMAN RESOURCES

Question 2

What is your employment level in the organisation?

☐ Senior-level mine employee

☐ Middle-level mine employee

☐ Junior-level mine employee

☐ Others

Question 3

What is your highest qualification?

☐ High School

☐ Diploma

☐ First Degree

☐ Masters’ Degree

☐ Postgraduate

☐ Others

Question 4

How many years of mining industry experience do you have?

☐ Below 5 years

☐ 5-10 years

☐ 11-15 years

☐ Above 15 years

Question 5

Have you undergone any digital literacy skills training while working in the mining industry?

☐ Yes

☐ No

Question 6

What is your current occupation type at the mine?

☐ Administration, finance and accounting job

☐ Technical (Civil, mechanical and electrical) job

☐ IT and computers job

☐ Manual job

☐ Others

PART 2: NEW TECHNOLOGIES WITH POTENTIAL FOR INCLUSIVE EMPLOYMENT IN THE MINE

Innovative technology in the context of this study is a newly developed or enhanced method or product with technological features that differ greatly from beforehand.

Question 6

What is your understanding of innovative technology in the mining industry?

1. Innovation is a tool for affordability

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

2. Innovation as an important tool for inclusion of the poor and disadvantaged

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

3. Innovation builds capabilities and social empowerment

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

PART 3: NATURE OF TECHNOLOGICAL ADVANCEMENT IN THE MINING SECTOR

Question 7

What innovative technology have you used/implemented in the mining industry?

☐ Internet of things

☐ Virtual Reality

☐ Sensors

☐ Robotics

☐ Big data

☐ Artificial Technology

☐ Cloud computing

☐ 3-D printing

☐ Others………

PART 4: BENEFIT OF INCLUSIVE TECHNOLOGICAL INNOVATION

Question 8

New new/innovative technology is benefiting me as a mine employee.

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

If yes, please elaborate

Question 9

New innovative/new technology in this mine is benefiting the surrounding communities?

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

If yes, please elaborate.

____

____

____

Question 10

New innovative technology in this mine is creating employment opportunities

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

____

Question 12

What kind of employment opportunities are being created through innovative technology?

____

PART 5: CHALLENGES OF INCLUSIVE INNOVATION

Question 13

Technological innovations has lead to employee retrenchment at the mine

☐Strongly disagree ☐Disagree ☐Neutral ☐Agree ☐Strongly Agree

____

PART 6: WAYS OF IMPROVING INCLUSIVE TECHNOLOGICAL INNOVATION FOR EQUAL EMPLOYMENT

Question 14

How is innovative technology improving on labour skills in this mine?

____

____

____

Question 15

How best do you think new/innovative technology can be improved to create jobs than take jobs?

____

____

____