

School of Mining Engineering



UNIVERSITY OF THE
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JOHANNESBURG

**ANALYSING THE PROGRESS OF SKILLS DEVELOPMENT
NECESSARY FOR MINERAL BENEFICIATION IN THE GOLD MINING
INDUSTRY: A CASE STUDY OF HARMONY GOLD'S MOAB
KHOTSONG MINE**

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I declare that this research report is my own unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other university

Johannesburg, 2024

DECLARATION

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ABSTRACT

The mining industry of South Africa is a cornerstone of the country's economy, having contributed over 8% to the national gross domestic product in 2022. The mining industry has been responsible for major economic growth and job creation due to its mineral resource abundance. However, the socio-economic impact of this industry on communities has fallen short of expectations.

The objective of the South African beneficiation strategy is to transform the country's mineral wealth into competitive economic advantage through the promotion of economic diversification, industrialization, and job creation. The aim of this research is to determine progress made by the mining sector in skills training and development necessary for local mineral beneficiation, particularly in the gold mining industry. This is training provided through the achievement of formal qualifications such as a National Certificate in Jewellery Manufacturing, a Diploma in Jewellery design and Manufacture, as well as through the accumulation of skills such as jewellery processing, wax carving for jewellery, die stamping for jewellery, industrial design for jewellery, and jewellery evaluation. The research also includes a critical review of the company's training initiatives within the context of the beneficiation skills pipeline, the National Skills Development Strategy, and the sector skills plan, which are all key elements of the National Growth Plan and the relevant Sector and Training Authorities.

Harmony Gold company has shown commitment to socio-economic objectives through the implementation of numerous beneficiation projects, such as the Musuku Beneficiation Systems, the Harmony Jewellery School, the Oro-Maska Project, and the SARM project. While these initiatives did not have long-term success, they indicate the company's willingness to play a role in promoting skills transfer and in mineral beneficiation. The short-term success of these initiatives also highlights the complexities involved, underlining the need for proper planning, proper resource allocation, as well as the need for constant and consistent stakeholder engagement.

A significant finding of this research is the identification of a skills gap, especially in areas crucial for mineral beneficiation. Despite existing efforts and policy frameworks like the Skills Development Act 97 of 1998, there remains a need for more targeted training and skills development programs. The existing skills gap must be addressed to maximize the mining sector's contribution to national development objectives.

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LIST OF ABBREVIATIONS

ABET	Adult Basic Education and Training
AET	Adult Education and Training
AfCFTA	African Continental Free Trade Area
AGOA	African Growth and Opportunity Act
AU	African Union
BAE	British Aerospace
BRICS	Brazil, Russia, India, China, and South Africa
DESTEA	Free State Department of Small Business Development, Tourism and
DME	Department of Minerals and Energy
DMR	Department of Minerals Resources
DST	Department of Science & Technology
DTI	Department of Trade and Industry
EFTA	European Free Trade Association
FDC	Free State Development Corporation
FDI	Foreign Direct Investment
FET	Further Education and Training
G20	Group of 20
GDP	Gross Domestic Product
HREs	Heavy Rare Earths
IDC	Industrial Development Corporation
IEA	International energy Agency
IGF	Intergovernmental Forum
ILO	International Labour Organization
IMF	International Monetary Fund
IRR	Institute of Race and Relations
LMI	Labour Market Information
LOM	Life of Mine
MCSA	Minerals Council South Africa

MiHR	Mining Industry Human Resource Council
MPRDA	Minerals and Petroleum Resources Development Act
MQA	Mining Qualifications Authority
NAM S&T	Centre for Science and Technology of the Non-Aligned and Other
NDP	National Development Plan
NDP	National Development Plan
NGP	New Growth Path
NPC	National Planning Commission
NSA	National Skills Authority
NSTF	National Science and Technology Forum
ODI	Overseas Direct Investment
OECD	Organization for Economic Co-operation and Development
PGMs	Platinum Group Metals
PTA	Preferential Trade Agreement
PwC	PricewaterhouseCoopers
RECs	Regional Economic Communities
REEs	Rare Earth Elements
SACU	Southern African Customs Union
SADC	Southern African Development Community
SAIC	South African Investment Conference
SAQA	South African Qualification Authority
SARM	South African Royal Manufactures
SETA	Sector Education and Training Authority
SMEs	Small and Medium Enterprises
StatsSA	Statistics South Africa
TFP	Total Factor Productivity
TVET	Technical and Vocational Education and Training
USA	United States of America
USGS	United State Geological Survey
WTO	World Trade Organization
STEM	science, technology, engineering, and mathematics

NSDP	National Skills Development Plan
SDA	Skills Development Act
CET	Community Education and Training Colleges
SLP	Social and Labour Plan
HRD	Human Resource Development
FLC	Foundational Learning Component
MTs	Management trainees
LMPRB	Plan Rock Breaker learnerships in mining
CHRD	Community Human Resource Development Programmes
HDSA	Historically Disadvantaged South Africans
NGO	non-governmental organisation
QCTO	Quality Council for Trades and Occupations
NQF	National Qualifications Framework
LED	Local Economic Development

LIST OF SYMBOLS

\$	USA Dollar
%	Percent
Km	kilometre
m	metre
R	South African Rand

CHAPTER 1. INTRODUCTION AND BACKGROUND

1.1. Introduction

“The mining industry supports training and skills development in the communities in which it operates, which is important to ensure socio-economic development beyond that of mining” _ Minerals council South Africa, 2017.

Globally, mining is economically significant, with South Africa being recognized as one of the top 50 mining nations among over 100 countries reliant on this industry (Khubana, 2022). In the 1980s, the mining sector was a crucial pillar of South Africa's economy and contributed over 22% annually to the nation's gross domestic product (Statistics SA, 2022). South Africa's mining industry had a significant impact on both the country's national economy and the broader African continent due to its abundant mineral reserves (Malherbe, 2000). Over the course of history, the mining industry has played a significant role in improving South Africa's economic growth and employment, capitalizing on its abundant mineral resources, including Platinum Group Metals (PGMs), gold, iron ore, and manganese (Department of Minerals and Energy, 2008).

However, the economy has failed to generate the necessary and adequate employment opportunities for a significant number of citizens over the past thirty years. Employment in the mining industry reached over 760,000 in 1987 but decreased to as low as 400,000 in 2001 (Khubana, 2022). There was a slight increase in employment in 2008 to approximately 530,000 (South African Institute of Race Relations, 2019) and further decrease to 475,560 in 2022 (Minerals Council of South Africa, 2023). Declining commodity prices, fluctuating demand for exports, escalating operational expenses, uncertainty in policy, labour skills shortage as well as strikes, aging mines, and infrastructure challenges are major factors leading to a reduction in the nation's economic growth and development, employment, as well as the competitiveness of the country's mining sector (Lane et al., 2015).

African nations endowed with abundant mineral resources, such as South Africa are embracing beneficiation with the aim of ensuring that revenues from the country's

mining industry are distributed domestically. This approach is intended to bolster other sectors, thereby creating job opportunities for citizens and their communities (Hlongwane, 2014). Beneficiation also promotes the purchase and utilization of domestic products and services, as well as training and job creation in the host country (Luhende, 2020). However, most African countries that are rich in mineral resources face challenges in processing raw materials and thus persist in exporting them and reduced values, resulting in minimal benefits. As a result, these countries end up importing finished products at significantly higher costs (Busia, 2017).

According to Motsoeneng (2013), the mining industry's ongoing growth encounters obstacles primary owing to a shortage or lack of skilled workforce in the mining sector. This is further argued by Khubana (2022) and Moodley (2017), who highlighted that South Africa is still today striving and working towards transforming its economy and ensuring equitable and sustainable distribution of wealth among its citizens through initiatives such as the Mineral Beneficiation Strategy.

Considering these scholarly reviews and the identified deficiencies within the mining sector, especially regarding skill shortages, this study intends to explore the advancements made by the mining companies in enhancing skills development and training, which are crucial for beneficiation.

1.2. Background

Mineral beneficiation, also known as value-added processing, includes the conversion of unrefined or raw materials into refined products with higher value using domestic resources such as labour and capital, for export markets (Busia, 2017). Beneficiation is typically categorized into three types: upstream, sidestream, and downstream (Leeuw, 2012). However, it is commonly understood as the downstream processing of a mineral product, starting from a raw mineral (such as gold) and ending with a final product such as jewellery.

In February 2011, the government of South Africa expressed its dedication and commitment to prioritizing the finalization and implementation of a mineral beneficiation strategy (Chamber of Mines, 2012), which centered in investment into the mining industry's value chain with the intent to encourage job creation, stimulate

economic expansion, and enhance the country's tax revenues. South African's beneficiation strategy aims to convert the nation's comparative advantage, derived from its abundant mineral resources, into a competitive advantage on a national level (DMR, 2011). This strategy is intended to drive development through enhancing linkages within the mineral value chain, fostering economic diversification, creating jobs, and advancing industrialization (DMR, 2011).

The beneficiation strategy, which was approved by cabinet in 2011, focused on ten specific commodities and five value chains. These are commodities such as manganese, chromium, iron ore, platinum, nickel, vanadium, titanium, and gold, with uranium and coal being classified together. The commodities give rise to five value chains, namely:

- Energy;
- Steel and stainless steel;
- Pigment production;
- Auto catalyst;
- Diesel and particulate filters, and
- Manufacturing of jewellery from precious minerals such as gold and diamond.

This study will concentrate on the value chain for jewellery, stemming from gold mining. These value chains highlight South Africa's inherent potential in fully leveraging beneficiation across all mineral commodities (DMR, 2011), particularly in terms of enhancing employment opportunities and economic diversification.

1.2.1. The Importance of mineral beneficiation from an economic perspective

The rationale behind the emphasis on beneficiation is based on the potential benefits as outlined by Dube (2016), these are:

- i. Logistical value chain benefits: exporting economies often miss out on the full advantages of the value chain related to mining, while importing economies benefit by adding value and exporting final products at higher prices. Implementing beneficiation ensures that value chain gains are retained within the economy, promoting the growth of downstream

industries and allowing for the realization of profits that would otherwise have been accrued abroad.

- ii. Economies of scale and expert development: the establishment of beneficiation hubs leads to the creation of local markets for domestic products, which in turn promotes and stimulates economic by fostering the growth of new and old industries beyond the mining industry. The economic growth and development lead to demand for highly skilled expertise and capital-intensive mining activities, contributing to overall growth and development of specialized skills.
- iii. Economic hubs and development corridors: beneficiation requires substantial investment in infrastructure, particularly in terms of transport networks, water, and energy. While the infrastructure is initially built to support activities associated with beneficiation, it subsequently contributes to improving economic hubs as well as development corridors that already exist and are independent of the beneficiation facilities themselves.

1.2.2. The Importance of mineral beneficiation from a legislative perspective

- The National Development Plan (NDP)

The NDP emphasizes the strategic significance of mineral beneficiation to the development of the national economy. This plan was drafted by the National Planning Commission (NPC) of South Africa, established in May of 2010. The NDP's goal was to eliminate poverty and inequality by the year 2030, hence the name NDP2030. The NPC's mission was to assess the country's failures and accomplishments since 1994, with the aim of addressing the nation's economic difficulties (NSTF, 2018).

In June 2011, a diagnostic report published by the NPC attributed the slow pace of economic progress mainly to ineffective policy implementation and lack of comprehensive partnerships. The report highlighted nine key challenges, which are detailed in Table 1.

Table 1. Key challenges to Economic Growth. Source: Modified after NSTF. 2018.

NPC Diagnostic Report challenges	Summary of NDP 2011 actions
Too few people work	An economy that will create more jobs
The quality of school education for black people is poor	Improving the quality of education, training and innovation
Infrastructure is poorly located, inadequate and under maintained.	Improve the quality of infrastructure and maintenance
Spatial divides hobble inclusive development	Reversing the spatial effects of apartheid
The economy is unsustainably resource intensive	Transition to a low-carbon economy
The public health system cannot meet demand or sustain quality	Quality healthcare for all
Public services are uneven and often of poor quality	Reforming the public service
Corruption levels are high	Fighting corruption
South Africa Remains a divided society	Transforming society and uniting the country
Crime rate steadily climbing	Building safer communities

As per the NDP2030, the following critical components for success were defined:

- Expansion, investment, and job creation;
- Elevated education standards accompanied by a healthy population;
- Government efficiency and capability;
- Cooperation, collaboration, and engagement between private and public sectors.

The NDP's explicit directive was to devise methods for South Africa to urgently mitigate severe unemployment rate among the youth as well as job creation and opportunities for the younger generation. In 2012, the NDP was adopted by the cabinet as the country's long-term vision and plan. While achieving the NDP's goals requires progress on many fronts, three priorities are highlighted (NDP, 2012):

- Promoting employment via accelerated economic growth;
- Enhancing the quality and state of education, skills training and development, innovation; and
- Improving the country's ability to play a transformative and developmental role.

The NPC also emphasized that high employment can be achieved through improved policy coordination and execution, thus, fostering public sector, businesses, and labour partnerships to guide and promote labour-intensive sector investments. This improvement will lead to an increase in competitiveness and export earnings through improved infrastructure and public services, reducing business costs, enhancing skills

and innovation, offering targeted state support to certain sectors, and improving labour markets' functioning in order to enhance skills acquisition, pair job seekers with job openings, and decrease strikes and conflicts (NDP, 2012).

To meet the plan's objective, the NPC proposed the following initiatives:

- Increased exports which are focused on sectors with existing endowments and comparative advantages. These are sectors such as construction, mid-skill manufacturing, mining, agriculture and agro-processing, tourism, business services, and higher education;
- Development of efficient and reliable infrastructure that promote economic activities that lead to the creation of employment;
- Reduction in cost of living for middle and low income households, addressing inequality and poverty through the increase of income by growth in productivity and a reduction in living costs;
- Reduce regulatory compliance costs, especially in small to medium-sized businesses;
- Improve skills through better or superior education and training;
- Strengthen the financial sector and services, with the aim of improving access for small and medium-sized business, as well as to reduce financial services costs; and
- Enhance commercial service with foreign nations to support the expansion of the country's global market share.

The above mentioned objectives align with goals outlined in the New Growth Path.

- The New Growth Path (NGP)

There is a consensus within the government of South Africa that the achievement of decent employment, a reduction of inequality, and poverty elimination can only occur through the establishment and implementation of the NGP. This path should be based on the revamping and improvement of the South Africa economy to improve its performance with respect to labour absorption, growth composition, as well as the growth rate (NGP, 2011).

Introduced in 2010, the NGP policy's objective was to create bold, innovative, and effective strategies for the creation of millions of new jobs required by South African citizens. Additionally, the NGP must also outline the vision for how the country can achieve a more developed, democratic, cohesive, as well as equitable economy and society within the framework of sustained economic growth. The policy was to also identify and outline critical markers for job creation and economic expansion, identifying areas in the production structure where feasible changes can lead to an improved, inclusive, and greener economy over the medium to long term, through the integration of both macroeconomic and microeconomic interventions (DMR, 2011).

According to the NGP(2010), South Africa experienced a period of relatively robust economic growth for the majority of the 2000s. Despite economic volatility in the 1990s, overall economic growth between 1994 and 2008 was approximately 4%, roughly at the same level as other developing and developed countries. However, between the 1970s and the early 1990s, the economic growth of South Africa was low, averaging slightly above 1% per annum, lagging behind its peers. Despite the economic improvement of the 1990s and 2000s, the economy remained among the world's most unequal. During the mid 2000s, 40% of the country's income was contributed by the wealthiest 10% of the population.

South Africa's deep-seated issues on inequalities were accompanied by extremely high levels of unemployment. During the late 2000s, less than half of the South Africans between the ages of 18 to 60 had income earning employment. This was further exacerbated by the lingering effects of apartheid. By mid-2000s, a third of the population resides in townships and former Bantustans. Employment among adults in these areas was less than one in three. Moreover, more than half of the households in these former Bantustans depended mainly on social grants, compared to less than 25% in other parts of the country.

The situation was particularly worse for youth, mainly due to an inadequate number of job opportunities to accommodate the substantial influx of new labour market entrants. During the first quarter of 2010, unemployment rate among the youth individuals between 26 to 30 years of age was at 40%, compared to 16% for individuals aged between 30-65. Furthermore, among those employed, many individuals held low paying, insecure, and dead-end jobs. According to StatsSA (2008), in the third quarter of 2008, half of all employed individuals earned less than R2500 a month, and over a

third earned below R1000 a month. The informal sector, agriculture, and domestic work contributed a third of all employment. Additionally, one in five employed African women was a domestic worker. The wage share in the national income dropped from 50% in 1994 to just over 45% in 2009, while the profit share increased from 40% to 45%.

The NGP starts with the identification of employment opportunities, encompassing both sector-specific and interdisciplinary activities. This is followed by the scrutinization of policies and institutional developments required to take advantage of these opportunities (NGP, 2010).

The NGP identifies the mining sector and manufacturing as a key focus and advocates for the expansion of mineral extraction, improvement of infrastructure, and development of skills. It specifically highlights the importance of supporting mineral beneficiation or value-added processing, which involves the transformation of raw materials into a more refined product, up to the final manufacturing of consumer and capital goods. This initiation holds significant potential for generating widespread employment opportunities. The NGP also highlights the importance of enhancing the local processing of South Africa's abundant natural resources (DMR, 2011), with a particular focus on the mining value chain. This focus facilitated the formulation of the Mineral Beneficiation Strategy.

1.2.3. The importance of upskilling mine workers and surrounding communities to redress past inequalities

The onset of democracy in South Africa in 1994 marked a historical turning point, transitioning from the deeply ingrained racial segregation and discrimination of apartheid to a democratic regime. However, the legacy of apartheid remains deeply embedded in the fabric of the nation, particularly through the persistent issue of skills shortage, a direct consequence of the past regime's policies (Kgoale, & Odeku, 2019).

During the apartheid period, the educational and skills training landscape was profoundly unequal. The education system was racially divided, offering vastly unequal opportunities and resources to distinct racial groups. This deficiency in skills presents a substantial barrier to South Africa's economic progression and global competitiveness.

Organisational success largely depends on hiring employees with the right skills to effectively carry out tasks crucial to achieving the company's strategic goals (Robbins & Decenzo, 2001). Although much progress has been made politically, economically, socially, and legislatively since democracy was established, the challenges of critical skills shortage persist in the mining industry. According to the MQA, beneficiation is crucial for creating economic linkages between the mining and manufacturing sectors, ensuring downstream beneficiation, maximizing upstream linkages, and potentially generating employment. Nevertheless, such an initiative demands the development of relevant skills.

In South Africa, the mining industry is targeted for economic growth through value addition or beneficiation, as outlined in the new beneficiation strategic plan. This shift will enable the country to transition from selling commodities in their raw form to trading value-added products (Dworszanowski, 2013). The implementation of the beneficiation strategy is anticipated to create and sustain more jobs in the mining industry, implying that beneficiation will necessitate new skills and qualifications.

Policymakers contend that if developing countries process their commodities locally, rather than exporting them in raw and unprocessed forms, it could boost key economic indicators such as employment and economic growth (Robinson et al, 1990). To make this a reality, government and mining companies must support research and development initiatives like internships and training for skills enhancement. This approach may be the key to addressing the constraints of a lack of skills needed for accelerating local beneficiation (Kgoale & Odeku, 2019). For the success of beneficiation, it is critical that mining companies invest in equipping their employees with the skills necessary for effective mineral beneficiation (Mitchel, 2013). As it currently stands, a mere 12% of employees in the mining sector possess qualifications higher than a certificate, while 53% hold either a high school certificate or a diploma (Figure 1).

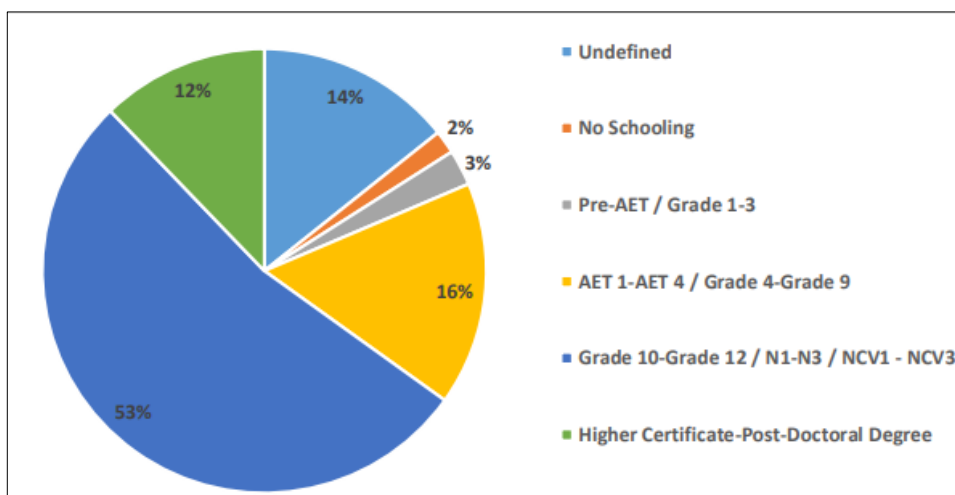


Figure 1. Highest education obtained by MMS employees. Source: Mining Qualification Authority, 2021

According to the NGP (2010), there is a pressing need for an extensive overhaul of the training systems to redress the deficit in artisanal and technical skills associated with mineral beneficiation. Sector Education and Training Authorities (SETAs) and the respective industry sectors are mandated to adhere to quantifiable objectives for completed apprenticeships.

1.2.4. The type of skills and training required for mineral beneficiation with an emphasis on the gold value chain/jewellery manufacture

It is critical for the mining industry to focus on investing in the necessary infrastructure to support local beneficiation efforts prior to considering exports. Through strategic partnerships among the mining sector, government bodies like the Department of Trade and Industry (DTI), academic institutions, the MQA, and the South African Qualifications Authority, South Africa can cultivate distinctive competencies and a workforce equipped with the necessary skills.

The growth and realization of the industry's potential in beneficiating raw materials rely on the cultivation of production skills. These skills serve as the foundation for growth and create a pool of skilled labour necessary for further advancement.

The Mining Qualifications Authority (MQA) is the responsible SETA for the mining and mineral industry and is tasked with the identification and funding of major sector skill needs, drawing from the New Growth Path (NGP, 2010). It holds the principal responsibility of orchestrating skills development processes and programmes specific

to the mining and minerals sector. The primary aim of the MQA is to support stakeholders in the mining sector in continuously cultivating adequate competent personnel in occupations that are fundamental to the sector (MQA Strategic Plan, 2020-2025).

The skills or qualifications required for downstream beneficiation are outlined below:

- **Jewellery Manufacturing**

According to the South African Qualifications Authority (SAQA) in 2012, the purpose of this qualification is to prepare individuals with the necessary knowledge, insight, and skills to produce jewellery by employing the necessary tools within the jewellery production sector. This includes mastering techniques such as melting, wire drawing, wax injection, soldering, setting, and drawing. The qualification is outlined in detail below:

Table 2. Jewellery manufacturing qualification. Source: SAQA (2016).

National Certificate: Jewellery Manufacturing

SAQA QUAL ID		QUALIFICATION TITLE		
65049		National Certificate: Jewellery Manufacturing		
ORIGINATOR				
SGB Mining and Minerals				
PRIMARY OR DELEGATED QUALITY ASSURANCE FUNCTIONARY			NQF SUB-FRAMEWORK	
MQA - Mining Qualifications Authority			OQSF - Occupational Qualifications Sub-framework	
QUALIFICATION TYPE	FIELD		SUBFIELD	
National Certificate	Field 06 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	MINIMUM CREDITS	PRE-2009 NQF LEVEL	NQF LEVEL	QUAL CLASS
Undefined	134	Level 2	NQF Level 02	Regular-Unit Stds Based
REGISTRATION STATUS		SAQA DECISION NUMBER	REGISTRATION START DATE	REGISTRATION END DATE
Passed the End Date - Status was "Reregistered"		SAQA 06120/18	2018-07-01	2023-06-30
LAST DATE FOR ENROLMENT		LAST DATE FOR ACHIEVEMENT		
2024-06-30		2027-06-30		

The qualification focuses on key elements of jewellery manufacturing, covering the employment of various materials, embedding diamonds and gemstones into various pieces, designing jewellery aimed at specific markets, and techniques for polishing and finishing jewellery. Those who complete this program will possess skills in diverse jewellery making techniques, involving the incorporation of synthetic stones and silver, and will come to value the materials employed. This qualification was designed with the intention of enhancing technical knowledge and expanding the workforce or employment, thereby enabling the industry to fulfil jewellery demands and reduce the reliance on imports.

The University of Johannesburg also houses the Department of Jewellery Design and Manufacture, offering two distinct programs:

- **Diploma Jewellery Design and Manufacture**

This diploma curriculum is structured to encompass the disciplines of jewelry design, Computer-Aided Design (CAD) drawing, and advanced manufacturing techniques. It further extends into specialized areas such as Gemmology, Technological advancements, Contextual Studies, and Design Management principles. The prerequisites for enrollment into this program include the possession of a Senior Matriculation Certificate, accompanied by an Average Point Score (APS) of 18, with a requirement for Mathematics or Mathematical Literacy.

The career opportunities that exist include:

- Contemporary jewellery designer/maker
 - Commercial jewellery designer/manufacture
 - Jewellery retail industry
 - Retail/wholesale buying
 - Gemmology/diamond industry
 - Jewellery workshop manager
 - Education/training
 - CAD jewellery designer
-
- **BA Honours Design.**

The Bachelor of Arts (Honours) in Design qualification serves as a postgraduate continuation of the previously discussed diploma in jewelry design and manufacture qualification. Its primary objective is to ready graduates for research-oriented postgraduate studies and to embark on careers in design, where they will be tasked with finding solutions to complex issues within the specialized field of design. This program can be finalized within one year for full-time students or extended to two years for those opting for part-time study. Throughout the course duration, students will engage with the following modules:

Table 3. Modules offered within the course. Source: uj.ac.za.

MODULE CODE	MODULE NAME	MODULE TYPE
CDH8XA4	Communication Design A (1st semester)	Elective
FDH8XA4*	Fashion Design A (1st semester)	Elective
MDH8XA4*	Digital Media Design A (1st semester)	Elective
JPH8XA4*	Jewellery Practice A (1st semester)	Elective
IDH8XA4*	Industrial Design A (1st semester)	Elective
DPH8XB4	Design Project B (2nd semester)	Compulsory
RMH8XA4	Research Methodology: Design A (1st semester)	Compulsory
DTH8XA4	Design Theory A (1st semester)	Compulsory
REH8XB4	Research Essay: Design B (2nd semester)	Compulsory

The MQA (2016) also identifies the following skills as some of the skills crucial for downstream beneficiation:

- Jewellery processing;
- Finishing machine operator;
- Jewellery wax carver;
- Jewellery die stamper;
- Jewellery industrial designer; and
- Jewellery evaluator.

These are all skills essential for the effectiveness of the beneficiation strategy and will also extend interventions beyond the mining sector. Enhanced cooperation with industry councils and jewellery manufacturers needs to be initiated to promote the sustainability and growth of the sector. Presently, small jewellery manufacturing companies encounter difficulties in accessing markets that support their products. The need exists for programs that encourage the provision of demand-side approaches and integrate small companies with supply-side inputs (MQA, 2019).

The MQA also reiterated that the sector should consider how the demand profile of employees will evolve. Although the education and training system might not respond with precise timing, understanding the various sets of skills that will be in demand in the future provides an excellent basis for planning. This is also accompanied by the need to consider interdisciplinary training that would allow students to develop skills and knowledge in a range of subjects but also produce a flexible workforce that can adjust to rapid shifts in changing skills demands within and outside the mining and minerals sector.

The qualifications will also need to be properly examined against these new developments with a longer-term view of the type of workforce in mind. The future of beneficiation hinges on employees with skills in science, technology, engineering, and mathematics (STEM); supporting these skills will become a critical component of a sustainable industrial development.

1.3. Problem statement

The importance of the mining sector within the economies of numerous African nations is undeniable. Beyond its economic contributions, mining plays a vital role in generating employment, bolstering governmental revenues, and stimulating demand for local services and goods within the host countries (Olewu, 2017). However, the prevalence of poverty and underdevelopment across the African continent presents a striking paradox when juxtaposed with the richness of its mineral resources (Kabemba, 2016). The extensive reserves of raw materials within numerous African economies and their subsequent influence on economic growth and development has been under scholarly scrutiny for some time (Hlavova, 2015), and like numerous nations on the African continent, South Africa is grappling with escalating unemployment rates alongside diminishing economic growth (Kgoale, 2019).

In February 2019, the South African government emphasized its viewpoint of the Mining and Minerals Sector (MMS) within South Africa as a key sector in the prospective growth and evolution of the nation's economy, attributing it significant potential for exploration, production, and beneficiation. He emphasized that the MMS presents an exceptional opportunity for a new industrialization movement and overall economic progression. This applies across the value chain: from mining equipment and services, infrastructure development, to extraction, skills development, research and development, all the way to downstream beneficiation.

This sentiment was echoed by the Department of Mineral Resources in 2012, who articulated the government's rejection of nationalism in favor of launching a Mineral Beneficiation Strategy. This strategy involves the transformation of mineral resources or their combinations into higher value products for local fabrication and export (Kgoale, 2019), and thus creating economic growth, jobs, and poverty alleviation.

Several scholars (Kola, 2019 and Kabemba, 2015) have shed light on the challenges facing this initiative. A key issue identified is the apparent lack of progress in the mineral beneficiation initiative (Kola, 2019). Kabemba (2015) identified various reasons for the failure or slow progress of this initiative, including poor leadership, a gap between policy making and implementation, the lack of strong institutional support, and more importantly, a deficiency in necessary skills.

1.4. Research Objectives

The purpose of the research is to investigate the progress in mineral beneficiation by scrutinizing the evolution of skills development within the gold mining industry. The study focuses on the training programme of Harmony Gold's training department, with the following objectives:

- Examine if the training provided aligns with the government's agenda of re-skilling the workforce for mineral beneficiation; and
- Determine whether a collaboration exists between the necessary government stakeholders and the mineral sector to achieve the objectives set forth in the Beneficiation Strategy.

1.5. Research Aim

The primary aim of this research is to examine whether gold mining companies are fostering the necessary skills for accelerating local beneficiation of gold, specifically through the final processes of jewellery manufacture. Such investigation will shed light on whether there is progress being made in the mining industry towards downstream beneficiation. Additionally, it will help identify and address the barriers to mineral beneficiation within South Africa's mining value chain.

1.6. Research question

Does the mining industry possess the necessary skills currently, and are they being adequately enhanced to meet the demands of downstream beneficiation. Is the gold mining industry investing adequately in skills development for downstream beneficiation?

1.7. Hypotheses

To answer the research question, the study puts forth and examines the following hypotheses:

- i. Mining companies in South Africa are either slow to answer or are not addressing at all the mandate to beneficiate mineral commodities.
- ii. A shortage of skills and their inadequate development are the principal reasons for the low levels of beneficiation in South Africa.

1.8. Research Gap

While numerous studies have examined the economic and policy aspects of beneficiation in South Africa's mining industry, fewer have focused specifically on the role of skills development within mining companies to facilitate local beneficiation. Little research has been conducted on how gold mining companies are training their employees for beneficiation, particularly the final stages of jewellery production.

The purpose of this study is to bridge the existing knowledge gap by providing scholarly research on skills development from the perspective of the industry.

1.9. Scope of the Study

This study concentrates on the progression of beneficiation at Harmony Gold's Moab Khotsonong Mine. The site was chosen primarily for its projected 25-year Life of Mine (LOM), providing an ample timeframe to observe the results of local content beneficiation.

1.9.1. Research Location

Moab Khotsonong is a deep-level mine near the towns of Orkney and Klerksdorp, some 180km south-west of Johannesburg. It is situated on the border between the North West and Free State provinces of South Africa (see Figures 2 and 3). The mine lease area is divided into a northern portion, which falls under the City of Matlosana Local Municipality in the North West province, and a southern portion, which is within the Moghaka Local Municipality in the Free State Province. The respective local municipalities operate under the jurisdiction of the Southern Districts Municipality and the Fezile Dabi District Municipality. The mine, which began producing in 2003, was acquired from AngloGold Ashanti Limited by Harmony Gold in March 2018.

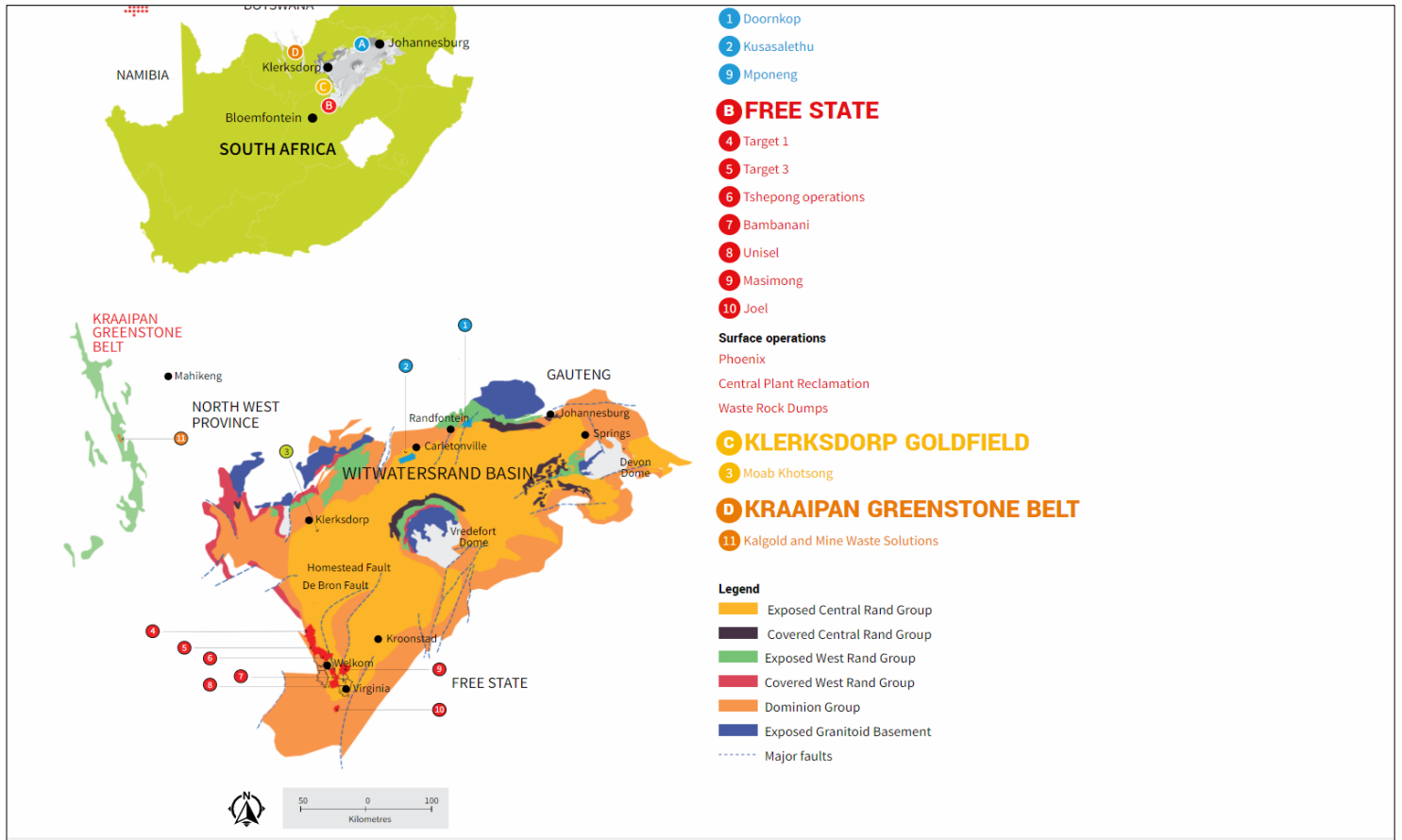


Figure 2. An overview of Harmony Gold operations in South Africa. (Source: AngloGold Ashanti Annual Report, 2018)

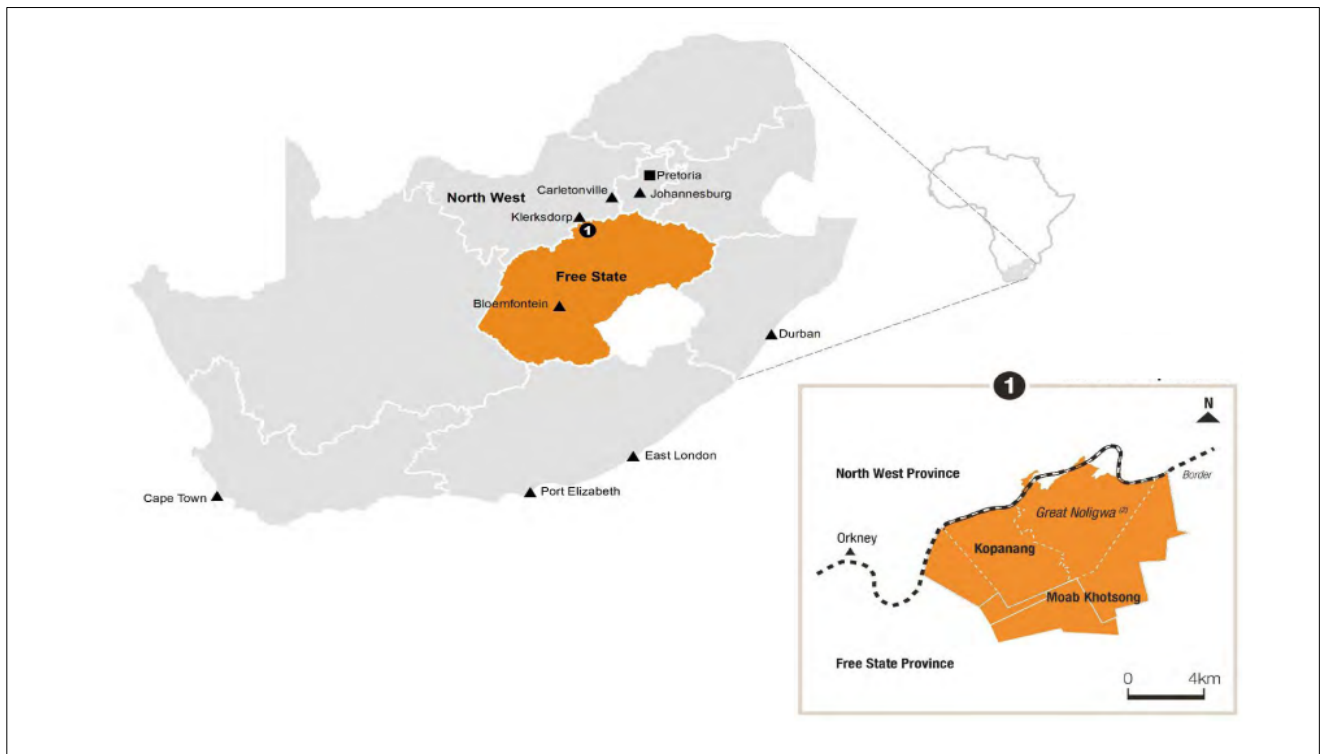


Figure 3. Location of Moab Khotsong Mine. (Source: Anglo Gold Ashanti Annual report 2018)

Moab Khotsoeng Mine utilizes a scattered mining method combined with an integrated backfill support system that incorporates bracket pillars. The geological conditions at the mine are complex, with extensive fault-loss areas between the three mining sections: the top mine (Great Norigwa), middle mine, and lower mine (including the growth project and Zaaiploots project, which is currently in the execution phase).

The primary orebody exploited at the mine is the Vaal Reef. The economic reef horizons are extracted at depths ranging from 1,791 meters to 3,052 meters below the surface. The extracted ore is then processed at the Great Norigwa gold plant, using the reverse gold leach method, which involves gold cyanide and uranium leaching to achieve gold and uranium recoveries (AngloGold Ashanti Annual Report, 2018).

Moab Khotsoeng Mine holds a significant position within Harmony Gold, being the second-largest gold operation and contributing 15% of the total production. It is also the largest contributor to the operating free cash flow. With an estimated Life of Mine (LOM) of 17 years, the mine presents a 17-year opportunity for ongoing operations. The mine plays a crucial role in the local economy by providing employment opportunities for approximately 6,551 individuals (AngloGold Ashanti Annual Report, 2018).

1.10. Layout of the Study

Chapter 1: Introduction - This chapter provides a broad overview of the research topic, addressing the impact of skills shortage in the mining industry and its effect on beneficiation success and the South African economy. The objectives, problem statement, and research questions, along with corresponding propositions, are clearly defined.

Chapter 2: Methodology - This chapter delineates the methodological framework employed for the research project. It elaborates on the approaches taken to manage data and derive insights regarding the training department at Harmony Gold, specifically in the context of the Mineral Beneficiation Strategy.

Chapter 3: Literature Review - This chapter explores the theory of mineral beneficiation, related issues and practices, including an examination of developed countries that have achieved success in beneficiation. The chapter also conducts a comparative analysis between South Africa and the countries reviewed, drawing lessons from their experiences.

Chapter 4: Mining Skills Training and Development Legislation - This section delves into the policies pertaining to skills training and development in South Africa's mineral resources.

Chapter 5: Training and development at harmony Gold - This chapter scrutinizes Moab Khotsoeng training department to determine if it complies with the legislative framework discussed in Chapter 5.

Chapter 6: Beneficiation at Harmony Gold - This chapter provides a detailed overview of the progress made in natural resource beneficiation at Harmony Gold, scrutinizing both past and present projects and their respective statuses.

Chapter 7: Results and Analysis of questionnaires – This chapter presents the outcomes of the conducted surveys.

Chapter 8: Discussions and Research Findings - This chapter explores and discusses the findings of the research.

Chapter 9: Conclusions and Recommendations - This final section summarizes the significant findings from the research and provides recommendations.

2.1. Introduction

This chapter outlines the research methodology employed in this study. To optimize information collection from a limited sample size (Creswell, 2014), the methodology encompasses a combination of literature review and questionnaires containing closed-ended questions to gather relevant data.

Given the limited knowledge of the beneficiation concept among the sampling population at the selected mine, primarily closed-ended questions were used following a presentation and discussion on the definition of mineral beneficiation. Consequently, the research adopted both qualitative and quantitative methods, embodying a mixed-methods approach. This approach entailed analyzing training programs at Moab Khotsong and interpreting questionnaire responses.

Utilizing literature review and questionnaire analysis concurrently enhances the comprehensiveness of the analysis, as these methods mutually enrich the research findings (Ivankova, 2006). This mixed-methods design, known as a convergent parallel design, was described by Creswell in 2014 and by Tom in 2015. It involves collecting and analyzing qualitative and quantitative data separately before comparing the results to determine if the findings corroborate or contradict each other (Figure 4).

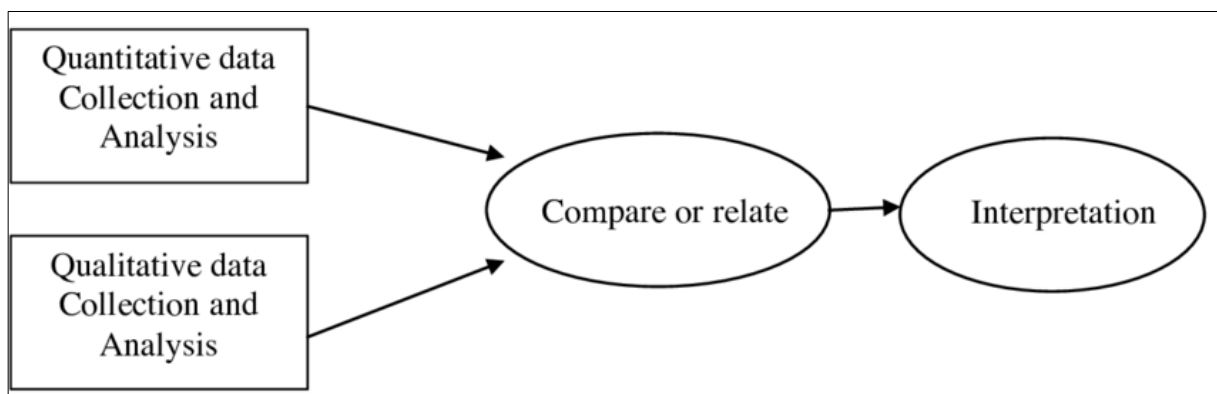


Figure 4. Convergent Parallel Mixed Method Design. Source: Creswell, 2014; Tom, 2015.

2.2. Data Collection and Research Instruments

Data for this study was collected from both secondary and primary sources. Secondary data was obtained through an examination of existing documents, such as training programs and social labour plans at Moab Khotsong. Primary data was collected using questionnaires that featured closed-ended questions, distributed among Moab Khotsong employees (see Appendix A). Closed-ended questions yielded quantitative data, while reviewed documents provided qualitative insights (Zohnrabi, 2023).

2.3. Literature/Theoretical study (Secondary Data)

The literature review will analyse the skills development strategy employed by Moab Khotsong to determine its alignment with the broader beneficiation strategy of the country (Figure 5). The study included a review of internal training programs and policies, examining their connection to beneficiation.

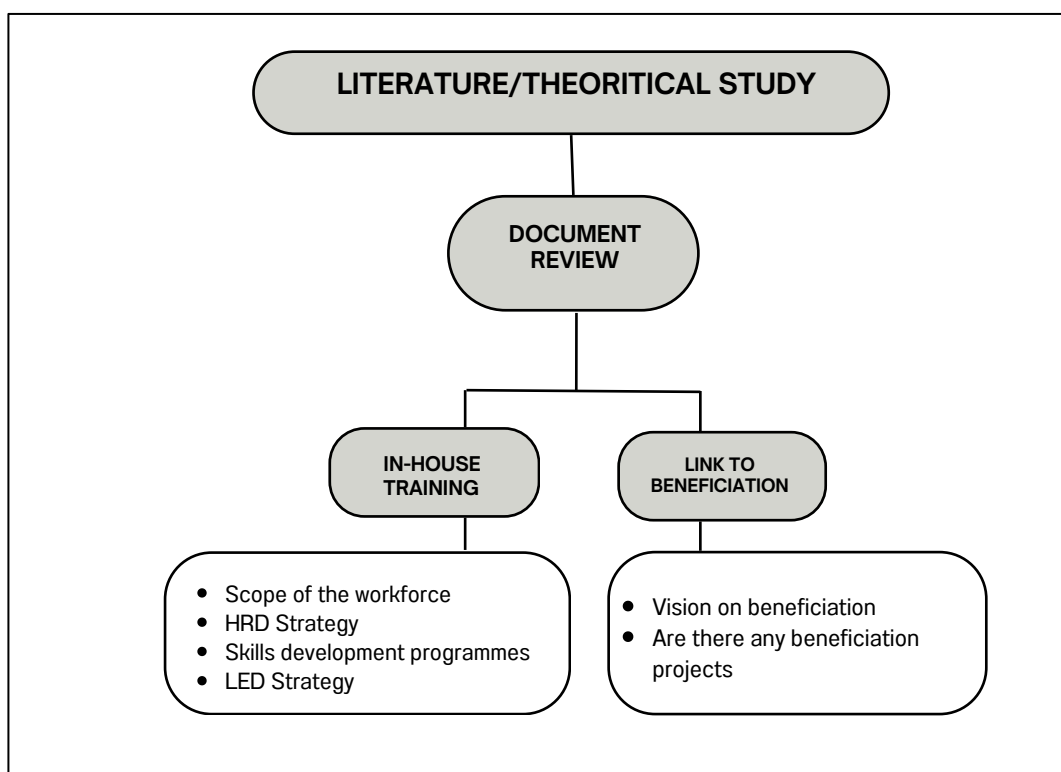


Figure 5. Literature review conducted during the research.

Additionally, the literature review will provide context and examine the approaches taken by developed countries, such as China, Canada, and the USA, in enhancing

their economies through natural resource beneficiation. The report aims to evaluate the capacity of each country in creating development opportunities for their population and businesses. Through an analysis of these countries, valuable insights and lessons can be derived to support South Africa in its pursuit of beneficiation initiatives.

2.4. Qualitative and quantitative Research and Analyses (Primary Data)

The study utilized questionnaires to gather data from opinions of employees within the company (Figure 6). A qualitative-analytical approach was employed, utilizing semi-structured close-ended questionnaires (Cresswell, 2012) that were distributed to selected employees at Harmony Moab Khotsoeng mine. The questionnaires aim to capture data based on participants' experiences and provide an opportunity for respondents to share their knowledge and insights as well as to investigate the perceptions of employees regarding the potential of beneficiation within the company and the local community.

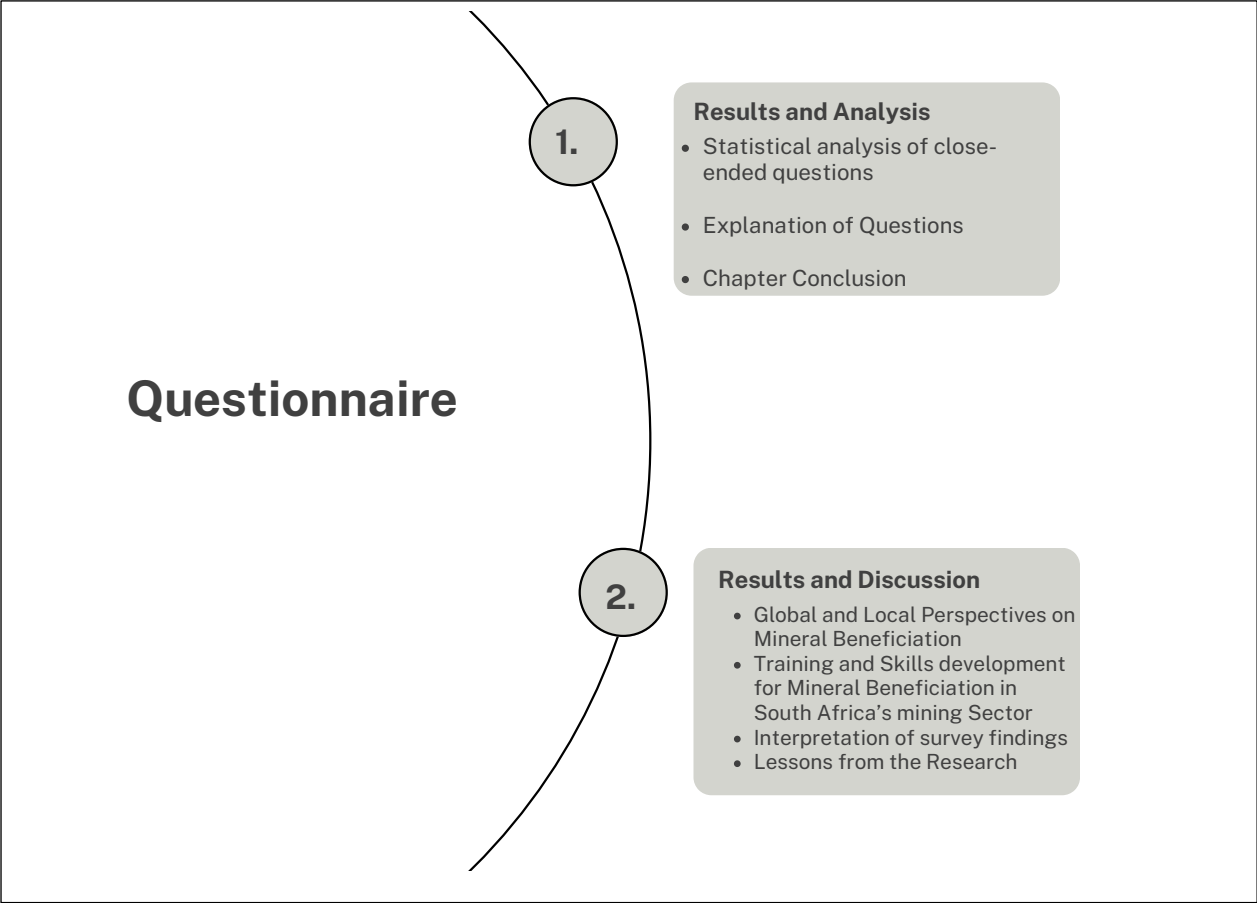


Figure 6. A survey was conducted in the form of a questionnaire to employees who understood beneficiation.

2.4.1. Analysis of the questionnaire results

This section follows the methodology elaborated by Lind et al (2008), and employed by Zonwabele Zweli Tom in his 2015 paper, which involved conducting a frequency analysis of closed-ended questions. The statistical descriptions of frequency tables, mean, skewness, and range were used to analyze the data. The research draws inspiration from the work of Lind et al (2008), who highlighted that frequency distribution involves organizing data into distinct and non-overlapping categories to display the number of observations in each category.

- *Mean*

The mean value represents the average of a given set of numbers. In the context of this study, a mean value of 4 or higher indicates that the majority of responses are positive, while mean values of 3 or lower indicate disagreement among respondents. Mean values between 3 and 4 suggest a lukewarm response, indicating a neutral or undecided stance.

- *Skewness*

Skewness refers to the degree of distortion in data from a perfectly symmetrical distribution (Figure 7). A symmetrical or "bell-shaped" curve represents a normal distribution. If a distribution is skewed to the left, it exhibits negative skewness, with the mean being less than the mode. On the other hand, if a distribution is skewed to the right, it demonstrates positive skewness, with the mean being greater than the mode.

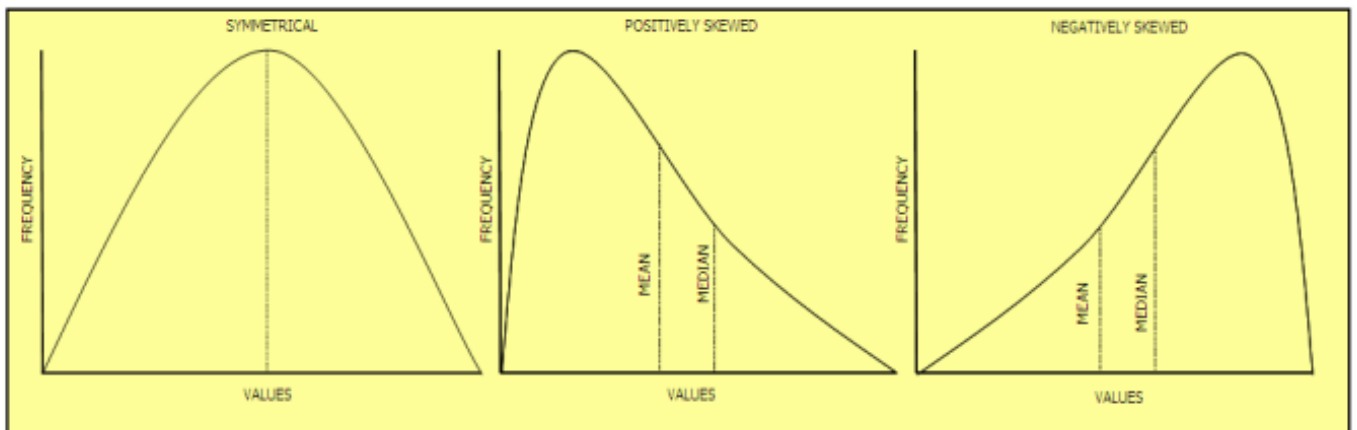


Figure 7. A depiction of various skewness types (Lind, et al., 2008)

- *Range*

The range is a measure that calculates the difference between the largest and smallest numbers in a dataset. In the context of this study, a range of 6 and above indicates that respondents' opinions were either strongly positive or strongly negative, while a range of 5 and below suggests that respondents leaned towards a more neutral position.

- *Mode*

The mode, as depicted in Figure 8, represents the most frequently occurring value in a dataset. When compared to the mean, it provides insight into the type of skewness exhibited by the data set.

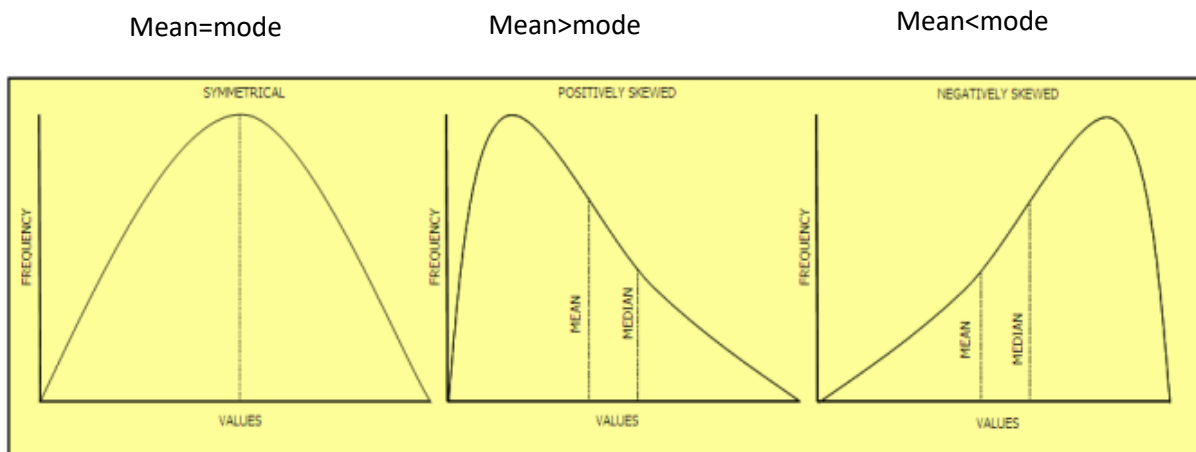


Figure 8. A representation of the relationship between mode and the various skewness types.

2.4.1.1. *Population and Sample Size*

The research will employ a targeted sampling approach, selecting participants from employees at Moab Khotsonong based on specific criteria such as their level of education or qualifications. Employees, by virtue of their training, education, credentials, and experience, are presumed to possess a certain level of knowledge about beneficiation or to have the capacity to understand this concept more thoroughly than the average person. This level of understanding is deemed adequate for the purposes of this research, allowing for a reliance on their opinions (Tom, 2015). This method is

expected to be highly effective in gathering insightful contributions, thereby optimally fulfilling the objectives of the study (Cresswell, 2014).

The following section examines the professional information of the participants, including their departmental representation within Harmony, their years of work experience, and their educational background.

- *The Departments within Harmony represented by the respondents*

Table 4 provides an overview of the distribution of respondents across different departments.

Table 4. Departments represented by respondents

Department	Frequency	Percentage
Geoscience	9	43%
Ventilation	5	24%
Survey	3	14%
Evaluation	1	5%
Grade Control	2	10%
Training	1	5%
Total	21	100%

Out of the 21 participants who participated in the questionnaire, 43% were from the geosciences department, 24% were from the ventilation department, 10% were from the Grade Control department, 14% represented the Survey department, 5% were from the evaluation department, and 5% were from the Training department.

- *Work Experience of the Respondents*

All the respondents in this study are from service departments, indicating that they are not miners or general workers. They have some degree of qualification or sufficient experience, which makes their opinions credible. The distribution of the respondents' number of years of experience is presented in Table 5 and Figure 9.

Table 5. Representation in terms of experience.

Department	Frequency	Experience
Geoscience	9	2 to 10yrs
Ventilation	5	2 to 6 yrs.
Survey	3	>10 yrs.
Evaluation	1	>10 yrs.
Grade Control	2	>5yrs
Training	1	>10yrs
Total	21	

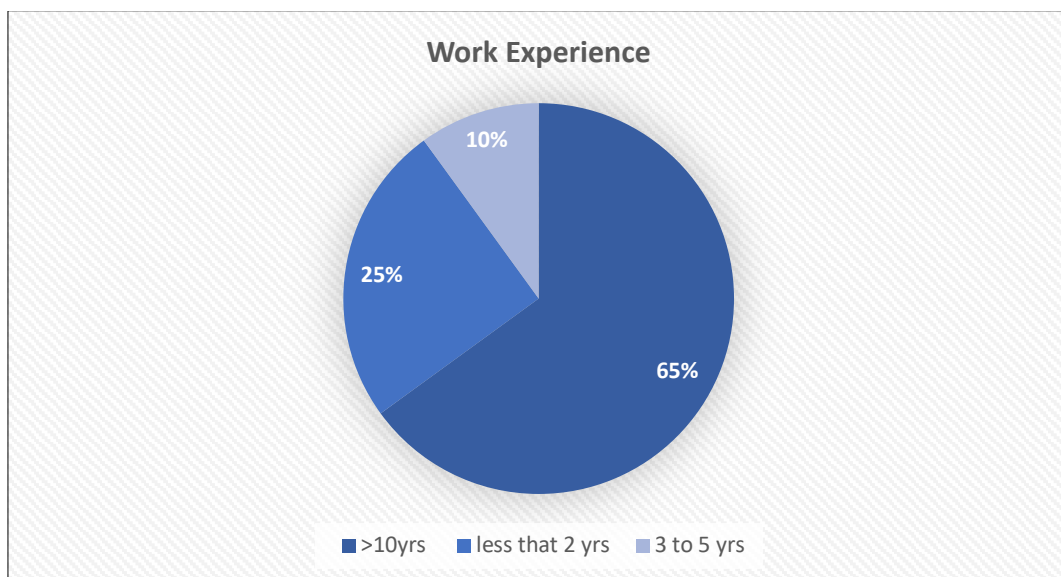


Figure 9. Graphical representation of the respondents in terms of experience.

Out of the respondents, 65% had over 10 years of working experience in their respective fields, 25% had between 3 to 5 years of experience, and 10% had less than 2 years of experience. The 10% who had less than 2 years of experience represented the current MQA interns or students.

- *Education level of the Respondents*

All respondents have attained a higher level of education, indicating that they possess the necessary knowledge and qualifications to provide informed opinions on matters related to the mining industry. This is evident from the data presented in Table 6 and Figure 10. More than half of the respondents possess an FET certificate, while over 30% have obtained a graduate degree. Additionally, 10% of the respondents hold postgraduate qualifications.

Table 6. Summary of the respondents' qualification.

Department	Frequency	QUALIFICATION
Geoscience	9	FET Cert to Postgraduate
Ventilation	5	Graduates
Survey	3	FET Cert and Graduate
Evaluation	1	FET Cert
Grade Control	2	FET Cert
Training	1	FET Cert
Total	21	

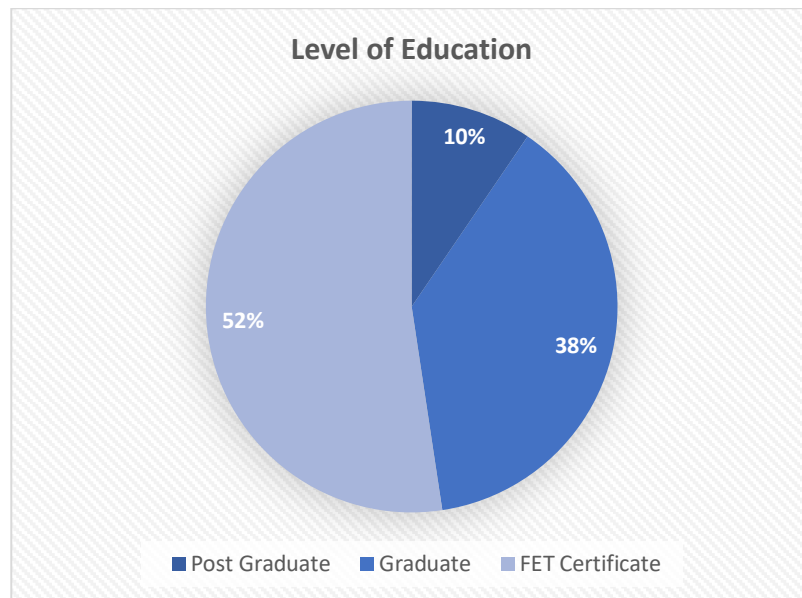


Figure 10. Highest Level of education of Respondents.

2.5. Pre-testing for the Questionnaires

Testing was conducted to verify that the instructions of the questionnaire were clear, straightforward, and that its statements were comprehensible to respondents. It also ensured the language used was clear, and understandable. This questionnaire was tested on four respondents from the geoscience department within the mine. Based on their feedback, necessary modifications were implemented, with particular attention to factors such as language clarity, logical consistency, and the sensitivity of the statements.

2.6. Validation and Reliability

The concepts of reliability and validity represent different characteristics of a measurement tool, though they are closely linked. Surucu (2020) explains that a measuring instrument can be reliable without being valid, but if it is valid, it is likely to be reliable as well. However, reliability on its own does not guarantee validity. This is because a reliable test might not necessarily capture the specific behavior or quality it aims to measure accurately. Therefore, researchers must assess both the validity and reliability of the measurement tools they use to ensure accurate and consistent results.

2.6.1. Validity

Anastasi and Urbina (1997) highlighted that validity concerns whether a measurement instrument accurately measures the behavior or quality it is supposed to measure, essentially evaluating how effectively the instrument performs its intended function. Whiston (2012) echoes this by defining validity as the degree to which data obtained is suitable for the intended use of the measurement tools.

Furthermore, scholars like Blumberg et al. (2005) and Robson (2011) describe validity in terms of the degree to which a tool measures what it claims to measure and the accuracy with which it reflects what it is specifically designed to assess, respectively. Pallant (2011) also adds that validity involves the extent to which the results of the measurement are truthful and reflective of what they signify to represent.

Zohrabi (2013) emphasized the crucial strategy of enhancing the validity of evaluation data and findings by collecting data from various sources. Similarly, this research incorporates this approach by utilizing a mix of qualitative and quantitative data collection methods. Oluwatayo (2012) identified a range of validity types that assess the efficacy of measurement instruments in scholarly research. These types include predictive, concurrent, criterion-related, internal, external, construct, face, systematic, theoretical, jury, consequential, cultural, interpretive, descriptive, evaluative, statistical conclusion, and translation validity.

The measurement tool for this research was adapted from the one Tom utilized in his 2015 study, a study that employed a validated testing method. A factor analysis was applied to explore the relationships between various variables and to identify groups of closely linked variables that signify underlying themes. This approach helped to eliminate redundant and duplicate variables, streamlining the dataset to represent the foundational aspects of the mineral beneficiation program more accurately. Additionally, Tom (2015) employed the Kaiser measure of sampling adequacy to assess the suitability of factor analysis, as it offers insights into the variables' interrelations. The Kaiser measure of sampling adequacy (MSA) calculates values between 0 and 1, with a value of 1 indicating perfect predictability among variables. Hair et al. (1998) provided guidelines for interpreting this measure (Table 7).

Table 7. Guideline for interpreting the factor analysis results. Source: Modified after Tom, 2015.

≥0.80	meritorious
0.70	middling
0.60	Mediocre
0.50	miserable
< 0.50	unacceptable

Consequently, the validity of this paper is thus deduced as it was determined by comparing one question with another that had already been validated previously (Okoro, 2002). This approach adheres to the methodology outlined by Lind et al. in 2008 and utilized by Tom in his 2015 study, as discussed in section 2.4.1.

To ensure the validity, several measures were taken:

- A methodology suitable for the study's specific characteristics was selected;
- The most appropriate sampling method for the research was chosen; and
- Respondents were given the freedom to answer without any pressure towards selecting specific responses.

2.6.2. Reliability

Reliability assesses the consistency, accuracy, repeatability, and trustworthiness of research findings (Chakrabartty, 2013). Researchers may also refer to reliability as dependability, highlighting the extent to which an assessment tool yields stable and consistent outcomes. This concept underscores the stability and consistency of the measurement tool over time. Therefore, reliability is the capacity of measurement instruments to produce similar results across different occasions, where a strong positive correlation among the outcomes signifies reliability (Surucu, 2020).

Merriam (1998) also emphasized that the goal of reliability is not necessarily to produce identical results, but to confirm that, due to the data collection methods used, the findings are consistent and dependable. Following this perspective, Tom (2015) employed the Cronbach's Alpha Coefficient, as introduced in Reynaldo and Santos's 1999 study, to assess the internal consistency among the items of the measurement

tools. This assessment thus determined the reliability of the data retained in the exploratory factor analysis. The logic is that a higher Cronbach's Alpha coefficient indicates a more reliable scale, calculated by evaluating the internal consistency or the mean correlation among items in the test. Given its focus on social perceptions, this research accepts a Cronbach Alpha value of 0.60. Consequently, the Cronbach Alpha coefficient was not recalculated for this study.

2.7. Limitations of the study

The study focused on employees at Moab Khotsonk who have mining industry qualifications and are capable of comprehending and expressing opinions on skills development and beneficiation. It is important to note that the majority of employees at Moab Khotsonk are general workers, which accounts for the relatively low number of respondents in the study.

CHAPTER 3: LITERATURE REVIEW

1.2. Introduction

This chapter delves into the topic of mineral beneficiation, examining its practices worldwide, within South Africa, and finally focusing specifically on Moab Khotsoeng Mine. This section seeks to evaluate South Africa's overall ability and preparedness for downstream beneficiation in comparison to other countries that have benefited from such a process.

It examines various aspects of beneficiation in the country, including its historical context, current status, and potential for economic value enhancement, with a specific focus on gold. Additionally, it explores the interconnectedness between beneficiation and manufacturing, along with other economic activities, while addressing the challenges and opportunities associated with this field.

1.3. Mineral Beneficiation

Different definitions of beneficiation exist, based on where the feasible economic opportunities within the value chain are perceived to be (Dube, 2016). In general, beneficiation can be defined as the downstream transformation of a mineral or combination of minerals into a higher-value product that can be consumed locally or exported (Baxter, 2005; Bassaïc, 2015). It involves converting a primary material, produced through mining and extraction processes, into a more refined product with increased export sales value.

Robinson and Von Below (1990) also emphasized that mineral beneficiation entails any further processing of a mineral beyond the stage where it represents a saleable raw material. For example, metallic minerals occurring naturally as oxides, like manganese or chromium, are typically first sold as ores, while concentrates represent the most basic saleable products of metallic minerals occurring naturally as sulphides, such as copper or zinc. If physical concentration methods are insufficient, the ore must undergo metallurgical and chemical processes to produce a marketable basic product. Further processing, whether through separation processes that refine the product or chemical/metallurgical processes that alter its chemical composition, constitutes beneficiation and adds value. In cases where there is no saleable raw material or basic

product, the metal must be smelted and refined before it can be sold, as in the case of gold and platinum.

To compare the levels of beneficiation for different raw materials, Robinson and von Below (1990) developed a classification system. They divided the beneficiation process into four stages, these are:

- i. Saleable smelted ore refined products;
- ii. Fabrication alloys;
- iii. Semi-manufactured articles; and
- iv. Fabricated articles.

Maximizing mineral beneficiation, according to Munghoshi (2011) and Tom (2015), involves a combination of downstream and side-stream linkages. Side-stream beneficiation/linkages encompass inputs such as capital goods, consumables, services, electricity supply, and infrastructure integrated into the value chain. Downstream beneficiation, as described by the South African Minerals Policy White Paper (1998), includes activities such as crushing, grinding, gravity concentration, floatation concentration, smelting, refining, milling, and fabrication/manufacturing. Beneficiation covers a range of activities, including:

- i. Large-scale, capital-intensive activities such as smelting;
- ii. Sophisticated refining plants; and
- iii. Labour intensive processes, such as craft jewellery, metal fabrication and ceramic pottery.

In order to provide further clarity on beneficiation, Baxter (2005) divided it into four stages. It is noteworthy that these stage definitions align with those provided by Robinson and Von Below (1990). These stages are explained in the following section.

- Stages of beneficiation

As outlined by Baxter (2005) in Table 8 and Mtegha (2009) in Figure 11, beneficiation consists of four categories, namely: primary, secondary, tertiary, and the final stage of downstream beneficiation.

The primary stage, encompass mining, recovery, and smelting processes aimed at transforming raw minerals into concentrates. The secondary stage acts as a bridge

between the mining sector and the industrial sector, primarily focusing on converting mineral concentrates into intermediate products. The tertiary stage involves the manufacturing of high-value products that are ready for consumers. This stage requires expertise in manufacturing (Baxter, 2005).

Table 8. Four Stages of Beneficiation Process. Adapted from Baxter (2005).

Stages of Beneficiation	Example of Metals	Industrial Minerals	Labour Intensity	Capital Intensity	Industry Cluster
Primary	Sealable smelted products (copper cathode)	material (granite blocks)	High	High	Mining
Secondary	Fabricated alloys and metals (copper tubes)	Basic final products (granite slabs)	Low	High	Mining
Tertiary	Semi-manufactured articles (amatures)	Refined products (polished granite tops)	Low	High	Refining/ Manufacturing
Final	Fabricated articles (electric motors)	Fabricated articles (granite worstations)	Medium-High	Medium to High	Manufacturing

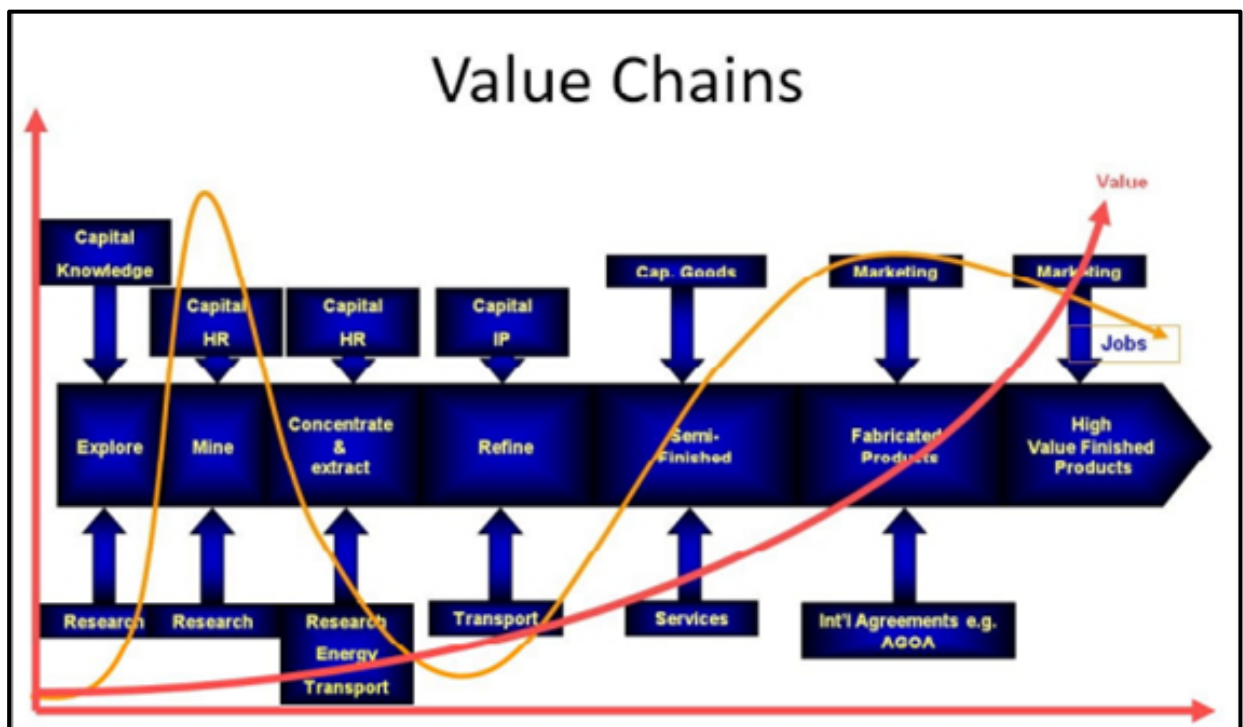


Figure 11. Mineral value Chain, including the Linkages. Source: H. Mtegha, 2009.

Each stage of mineral beneficiation enables the goods to be traded at an increased value than the previous intermediate product or raw material. Adding value at each stage (DMR, 2011). Manufacturing holds greater potential than mining for job creation (Figure 11), especially for individuals with lower skill levels, due to its high labour absorbency (Leeuw, 2012). This research will focus on the last two stages on beneficiation.

1.4. Factors that determine downstream beneficiation investments

The motivation behind a nation's inclination towards downstream industries stems from the belief that transitioning from an extractive or commodity-based economy to a manufacturing-based economy is crucial for enhancing economic development and competitiveness (Deloitte, 2014).

This transition involves harnessing the potential of resource-rich nations to develop manufacturing industries that add higher value products. The aim is to counteract or prevent the negative impacts of the resource curse, which encompasses the failure of many resource-rich countries to fully benefit from their natural resource wealth and effectively address the welfare needs of the citizens (Robinson et al., 2006).

By diversifying the economy into downstream industries, countries can reduce their dependence on the volatile nature of the minerals commodity industry. This diversification strategy offers the potential for economic growth, the generation of tax revenue, employment opportunities, and skills development. However, governments must consider certain prerequisites to attract investment and ensure the viability of downstream industries (Intergovernmental Forum on Mining, Metals, and Sustainable Development, 2018). These prerequisites are outlined below:

- **Guaranteed market demand: domestic or international**

The downstream industrial sector is capital-intensive in nature, necessitating substantial upfront investment. Therefore, a stable and adequate demand is crucial to attract investments. To ensure domestic demand, many countries implement import

tariffs as a means of protecting the local industry from cheaper international suppliers. In certain cases, governments may offer temporary assistance to the sector if the market share of domestic producers is impacted. The role of government in shaping market demand is significant, as factors such as political stability, governance issues, policy implementation, and proper management of funds can influence the market conditions.

- **Location and good infrastructure**

Efficient infrastructure plays a crucial role in enabling smooth business transactions and contributes to both a country's overall efficiency and the well-being of its citizens. There exists a positive relationship between a nation's economic development and the quality of its infrastructure, with the factors influencing each other in a cyclical manner. Economic growth enables increased investment in infrastructure, while well-developed infrastructure is essential for fostering favourable economic conditions. The following are examples of infrastructure;

- Transportation;
- Energy;
- Communication; and
- Water

Adequate transportation infrastructure plays a vital role in supporting both the mining industry and manufacturing sectors. Countries that possess well-developed road networks, railway systems, and port facilities are in a favourable position to benefit from domestic and international trade. Such infrastructure enables efficient movement of goods, facilitating trade activities and enhancing economic opportunities for the mining and manufacturing sectors.

- **Reliable and inexpensive energy access**

Downstream industrial advancements heavily rely on power consumption, making it a significant component of operational costs alongside labour expenses. Energy-intensive processes, particularly in smelters and refineries, necessitate reliable and

cost-effective access to power. As a results, countries that have access to abundant and low cost energy sources, such as hydropower, which provides the most cost-effective form of energy, tend to host smelters and refineries.

- **Labour force competitiveness and specialized expertise**

The competitiveness of the labour force as a valuable resource can be characterized by several factors, including the size of the labour supply, the flexibility of the labour market, and the qualifications of the workforce (Scharle, 2003). Labour force competitiveness is closely tied to labour productivity, which measure the total output, typically measured in terms of GDP, produced per unit of labour, which can be measured by the number of employed individuals, or the number of hours worked within a specific timeframe (International Labour Organization, 2023). Additionally, labour force competitiveness is linked to labour costs, which encompass the expenses incurred by employer.

These costs include remuneration for work performed, compensation for paid but unworked time, bonuses and gratuities, training expenses, provision of personal protective equipment, and subsidies for housing, vehicles, and medical insurance. In essence, the competitiveness of the labour force hinges on the quality and output per worker relative to the wage rate. Competitiveness advantage is determined by a combination of:

- Low wage rates;
- Transferrable skills of the workforce; and
- Educated labour force that adapts to changing circumstances.

- **Business environment, government support and policy cohesion**

Policy and legislation play a crucial role in the mining industry as they significantly impact the investment environment of a host country. They have the potential to either attract or discourage foreign investments. Given the high-risk and long-term nature of

the mining sector, the adaptability, consistency, and stability of a host country's mining policies are essential. The effectiveness of policy and legislation is influenced by factors such as the country's political system, the capability of the ruling party, and the overall political stability.

In the case of downstream manufacturing, it involves substantial capital investments with a lengthy payback period, making it a complex business environment (Intergovernmental Forum on Mining, Minerals, Metals, and Sustainable Development, 2018). This sector requires not only political stability but also government support and commitment in terms of policy coherence and facilitates the investment process.

- **Monetary and macroeconomic stability**

Macroeconomics is a field of economics that examines the overall behavior and performance of an entire economy (Thomas, 2021). Maintaining macroeconomic stability is crucial for achieving sustained and inclusive development. Large fluctuations in economic activity, high levels of inflation, deteriorating fiscal positions, unstable debts levels, and volatile exchange rates can have detrimental effects on a country's economy.

In the context of downstream manufacturing, stability is achieved when key economic factors such as domestic demand and output are in equilibrium (International Monetary Fund, 2001). Macroeconomic stability, coupled with a currency that is not overvalued and where companies operate in the national currency, helps enhance the competitiveness of export-oriented products in the global market.

3.3.1. Global competitiveness

Competitiveness refers to the ability of a country to develop and maintain an environment that promote robust business and success for its citizens (Garelli, 2005). World Economic Forum (2020) defined global competitiveness as the capacity of a country to achieve sustained high rates of growth in gross domestic product per capita.

Hatzichronoglou (1996) of the Organisation for Economic Co-operation and Development (OECD) defines competitiveness as “ the ability of companies, regions, nations, or supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis”. This is reiterated by Balkyte (2010), who defined competitiveness as the ability of a country to produce goods and services, under free and equal market conditions, that pass the test of the international market and at the same time ensure long-term growth of living standards.

Governments play a crucial role in enhancing competitiveness by establishing an enabling and attractive environment for investors, promoting trade, and improving systems and procedures, as outlined by the World Economic Forum (2013). Several factors contribute to global competitiveness:

- i. Physical infrastructure: infrastructure including roads, water systems, mass transportation, airports, and utilities, has a significant impact on productivity growth and economic development. Adequate and efficient infrastructure services contribute to higher productivity levels, according to the Palei (2015). Additionally, there exists a two-way relationship between economic growth and infrastructure, as economic growth drives changes in infrastructure.
- ii. High Total Factor Productivity (TFP): Productivity growth, which measures the efficiency of transforming inputs into outputs, is closely linked to economic growth. According to Solow (1956), there is a direct correlation between productivity growth and economic growth. Convergence of productivities between developed and undeveloped countries is also observed.
- iii. Intensifying R&D Activities: Scientific reaserch and technological advancements are vital for innovation, productivity, and overall economic growth, as highlighted by Broughel (2019).
- iv. Improving the Capacities of SMEs: Small and Medium Enterprises play a significant role in most economies, particularly in developing countries. SMEs contribute to job creation and economic development on a global scale, as emphasized by Enaifoghe (2023).

The Global Competitiveness Report, issued by the World Economic Forum, ranks countries based on the Global Competitiveness Index (Schwab, 2017). This index integrates microeconomic and macroeconomic aspects of competitiveness, assessing countries' ability to provide development opportunities for their citizens and businesses. The report is based on extensive research conducted on over 140 countries and emphasizes that productivity drivers may vary between countries. It identified 12 pillars of competitiveness (Figure 12), the impact of which varies depending on a country's level of economic development.

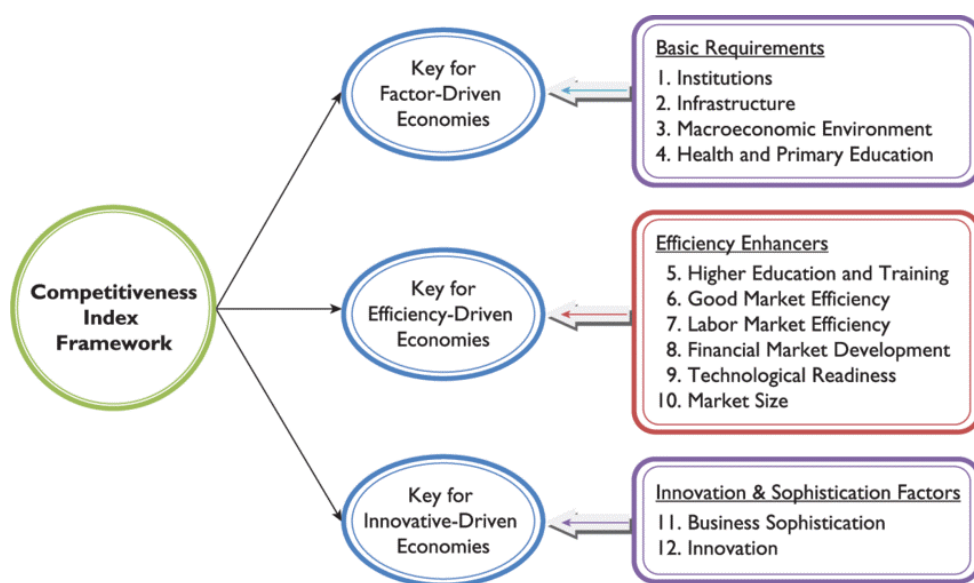


Figure 12. Factors that govern the competitiveness of a country. Source: Adapted from World Economic Forum, 2013.

the culmination of the 12 pillars (Figure 12) of competitiveness leads to the classification of economies into three distinct types. The categorization of economies into these three types highlights the progression and different drivers of competitiveness as countries evolve and advance in their economic development:

- i. **Factor-driven economies:** these economies compete primarily based on their endowments, such as skilled labour and natural resources. Their competitiveness is centered on low prices and commodities, with low wages reflecting low productivity levels. The competitiveness of factor-driven

economies relies on public and private institution that function well, on appropriate infrastructure, a stable macroeconomic environment, and access to quality health and primary education.

- ii. Efficiency-driven economies: as countries progress in their development, wages begin to rise, and competitiveness shifts towards efficiency-driven factors. At this stage, countries must focus on developing more efficient and adequate production processes as well as on improving product quality. Competitiveness in efficiency-driven economies is increasingly driven by higher education and training, efficient goods and labour markets, well-developed financial markets, the ability to leverage existing technologies, and both domestic and international market size.
- iii. Innovation-driven economies: in order to sustain high salaries and high standard of living, countries must focus on further innovation. These economies compete by producing new and unique goods, utilizing sophisticated production processes, and driving innovation. Innovation-driven economies place a strong emphasis on research and development, technological advancements, entrepreneurship, and the ability to create and adopt cutting-edge technologies.

1.5. Case studies on mineral beneficiation practices and competitiveness around the globe

Developed countries have experienced significant benefits from the mineral extraction industry and subsequent manufacturing. Nations such as Canada, Australia, the United States, and China have all built strong mineral industry and used them as a foundation for comprehensive industrial development. These countries have achieved remarkable economic success on global scale.

In many developing countries with abundant natural resources, there is a strong belief that processing raw materials domestically, rather than exporting them in their raw form, is essential for achieving industrial development. These countries aspire to emulate the success of resource-rich developed nations. In pursuit of this objective,

some governments , like South Africa have implemented measures to promote downstream beneficiation, either through regulations or incentives.

This section examines the factors that contributed to the success of downstream beneficiation and investments in countries where such processes already established. The case studies selected for analysis are China, Canada, and the United States of America. These countries are evaluated based on identical factors, which are subsequently applied to examine the South Africa context to assess its advancement towards downstream beneficiation. These factors are discussed in section 2.4. they are:

- Market Demand;
- Infrastructure;
- Energy Access;
- Business environment, government support, and policy cohesion;
- Labour force competitiveness and specialized expertise; and
- Monetary and macroeconomic stability.

3.4.1. Case Study 1: China

3.4.1.1. An overview of mining in China

Mining plays a crucial role in the economic and social development of China, serving as a fundamental industry. The country heavily relies on mineral products and their processed forms, with approximately 90% of primary energy, 80% of industrial raw materials, and 70% of agricultural production materials originating from the mining sector (Guo et al., 2021). China's mining sector is considered one of the largest in the world, demonstrating rapid growth with a compound annual growth rate (CAGR) of 12.41%. it is projected that the market share of the mining sector will reach \$242,785 billion by 2025 (Zhang, 2022).

The significance of China's mining sector extends beyond its domestic needs as it also contributes to global employment and development (Srai, 2008). Many key industries, such as automobiles and construction, heavily rely on materials extracted from the mining sector (Yang, 2022). Thus, China's industry serves as a powerhouse,

supporting various sectors and driving economic growth both domestically and internationally (Zhang, 2022).

China has a diverse range of mineral resources, with a total of 173 different types of minerals discovered within its borders (Figure 13). These minerals include various energy materials, such as oil, natural gas, coal, and uranium. Additionally, there are 59 different metals, including iron, manganese, copper, aluminum, lead, and zinc. Non-metallic minerals account for 95 types, including graphite, phosphorus, and sulphur, while 6 liquid minerals are also present, such as groundwater and mineral water (Wu and Li, 2021). Among these minerals, over 158 have been identified as proven reserves (Anthony, 2022).

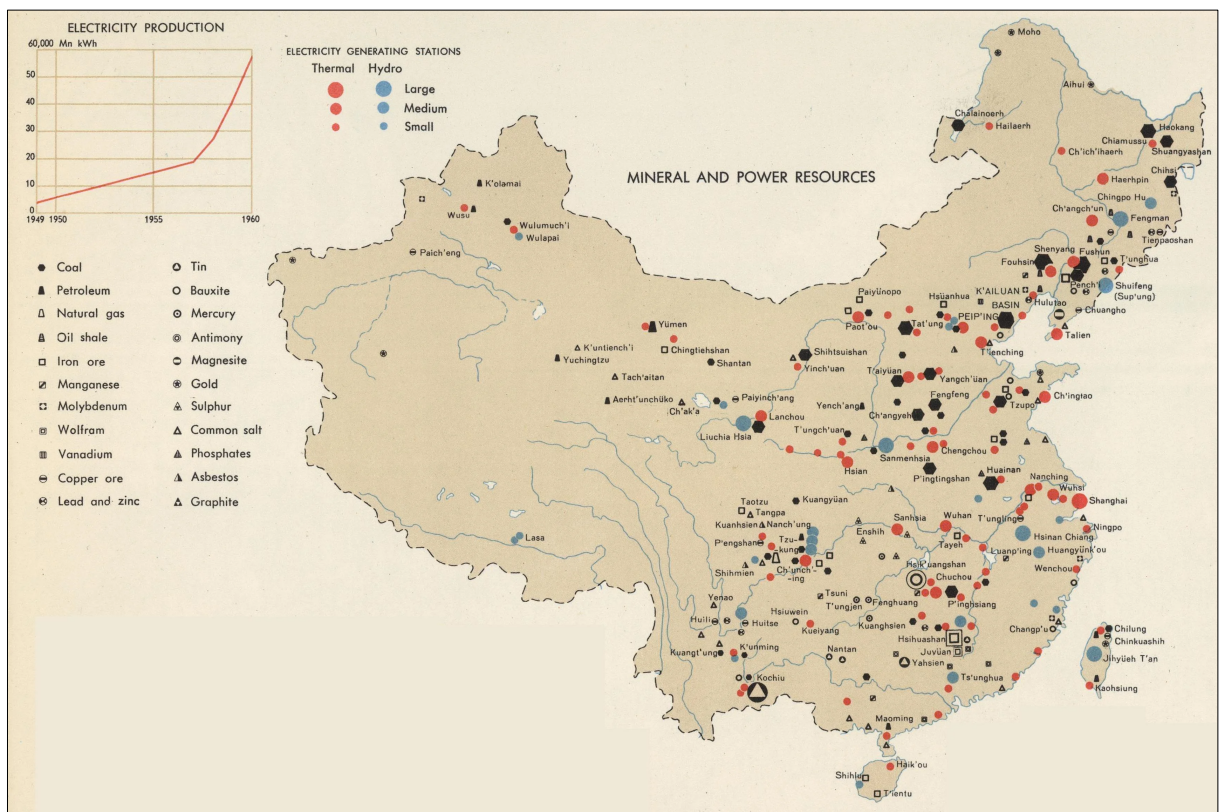


Figure 13. Mineral and Power Resources of China. Source: Wu, 2021

China possesses abundant reserves of Rare Earth Elements (REEs), which have become increasingly important for various sectors including traditional industries, new sectors, and national defense science and technology (Zhang, 2022). REEs find applications not only in fields like glass and metallurgy but also in emerging areas such as permanent magnet materials and hydrogen storage materials. Recognizing their

significance, countries like the United States, the European Union, and Japan have included REEs in their list of critical minerals (Zhang, 2022).

In 2016, China's National Mineral Resources Planning (2016-2020) was issued, designating REEs and 23 other minerals as critical mineral resources (Ministry of Land and Resources, 2016). China holds a prominent position (Figure 14) in terms of both reserves and production of Heavy Rare Earths (HREs), with the largest proven resources globally (Mancheri, 2019). As of 2020, China's REEs reserves amounted to 44 million tons, accounting for approximately 37% of the world's total reserves (Zhang, 2022).

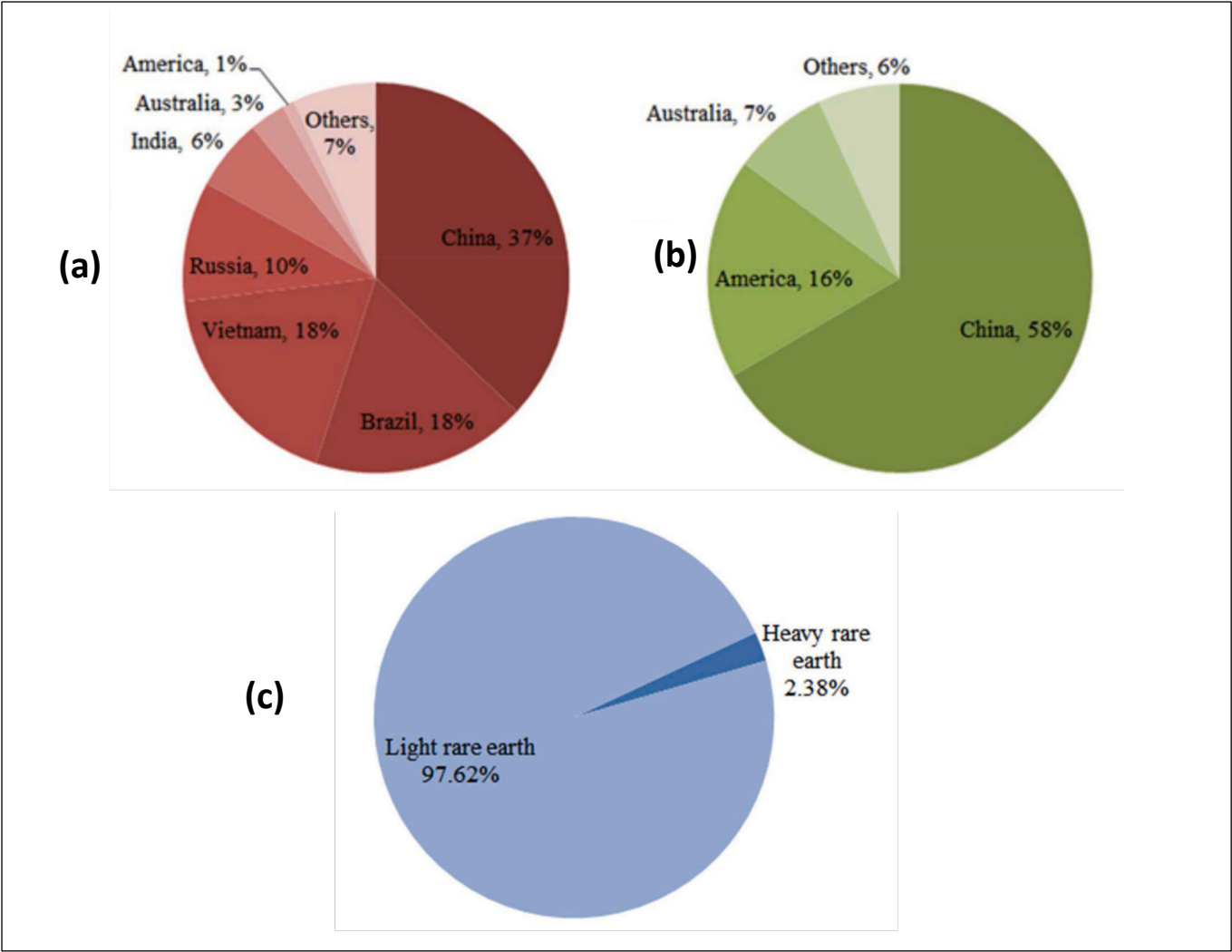


Figure 14. Distribution of (a) global rare earth reserves (b) production and (c) China's rare earth reserves in 2020. Data Sources: USGS, Sinolink Securities Research Institute, Xingye Securities Research Institute (Modified by, Zhang, 2022).

The value of China's natural resources is estimated to be approximately \$23 trillion. This vast wealth of mineral resources plays a significant role in China's economy and industrial development.

- Market demand

The mining industry plays a crucial role in China's national economy as it serves as a major source of raw materials for the country's manufacturing sector (Shen, 2015; Zhang, 2022). The Chinese government places significant importance on sustainable development and the responsible utilization of mineral resources, making it a key part of their national strategy with a focus on resource protection (Center for International Knowledge on Development, 2021).

In response to global environmental and development concerns, the Chinese government formulated the "China Agenda 21-White Paper on China's Population, Environment and Development in the 21st Century" following the United Nations Environmental and Development conference in 1992. Subsequently, in April 2001, they approved and implemented the "National program on Mineral Resources" followed by the implementation in the Early 21st Century in January 2003 (China's Geological Survey, 2013).

The objective of these programs was to primarily rely on the exploitation of domestic mineral resources to meet the needs of modernization. The government actively encouraged the exploration and extraction of mineral resources in line with market demand, aiming to enhance the country's self-sufficiency in resources supply (Centre for International Knowledge on Development, 2021). Recognizing the importance of accessing foreign markets and utilizing foreign capital and technology, the Chinese government implemented policies to promote the import of these resources to help domestic mining enterprises and mineral products enter the international market.

Over the past two decades, China's economic growth has largely been driven by investments and exports of minerals commodities, resulting in significant increases in both production and demand for these resources (Xun, 2022). As a result, China has become the world's leading producer and consumer of numerous mineral commodities (Figure 15).



Figure 15. Top 10 mining countries in the world. Source: Modified from Statista, 2022.

China holds the dual distinction of being the world's largest producer and consumer of commodities such as aluminum, iron ore, and copper (Figure 16). In the past decade, China's significant demand and consumptions of commodities accounted for more than 50% of global consumption across major commodity markets, as reported by Ro (2015).

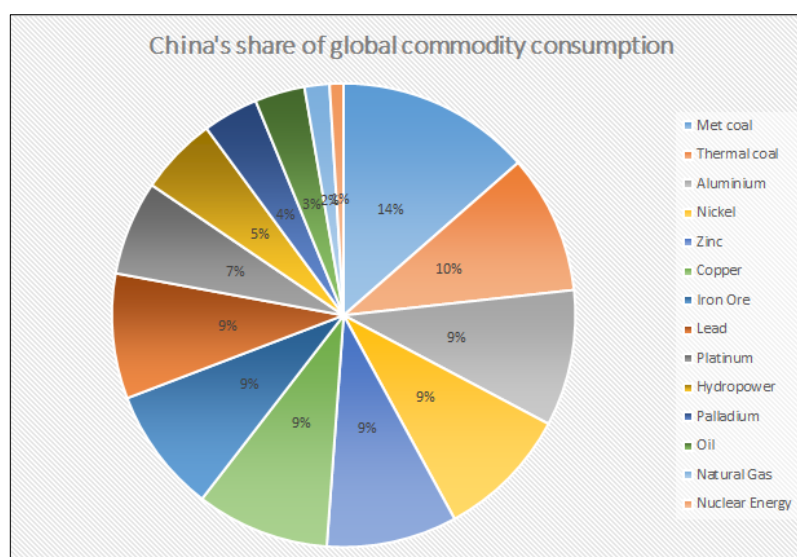


Figure 16. Share of global commodity consumption. Source: Modified from Ro, 2015.

As of 2021, China attracted a significant amount of foreign direct investment (FDI), amounting to \$ 181 billion, making it the second-largest recipient of FDI globally (Figure

17). In 2019, approximately 1.6% of the FDI was directed towards the mining sector, while 25.6% was directed towards the manufacturing sector. Conversely, China also ranked second in overseas direct investment (ODI) from 2019 to 2021 (Figure 18), which represents investments made by Chinese companies in other countries.

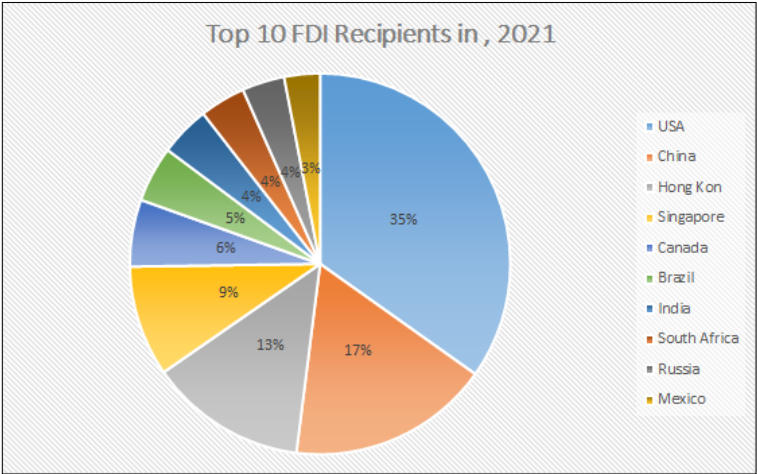


Figure 17. Recipients of FDI Globally. Source: Modified from the United Nations Conference on Trade and Development, 2022.

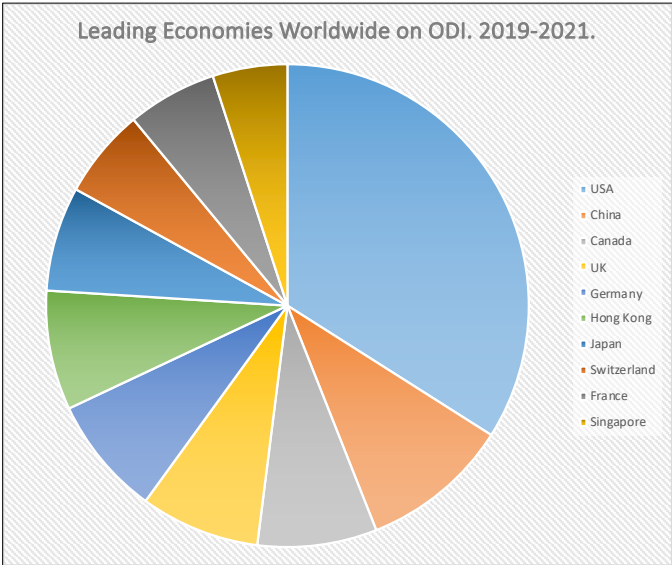


Figure 18. Countries leading in ODI from 2019-2021. Source: Modified from Statista, 2022.

China’s economic performance following the COVID-19 pandemic has played a significant role in enhancing its global competitiveness, as stated by the institute of Management Development (2021). According to IMD’s rankings, China is placed 7th in terms of competitiveness worldwide (Figure 19). The industrial sector, comprising

manufacturing and mining, made a substantial contribution of 40% in 2019, surpassing the percentage seen in other major global economies (Xun, 2022).

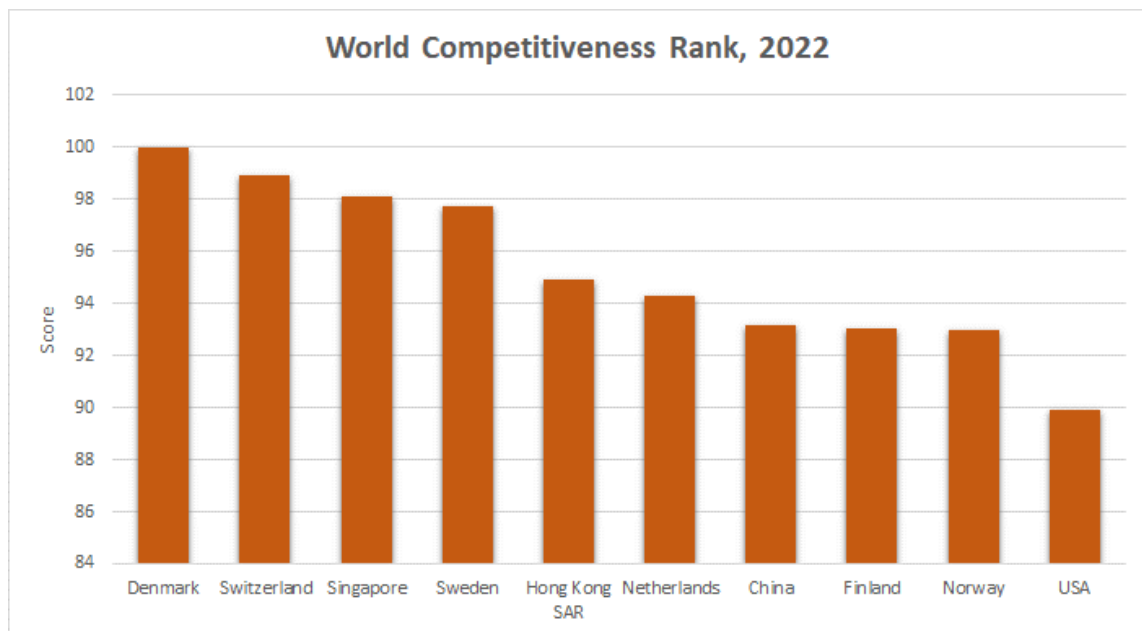


Figure 19. World competitiveness ranking 2022. Modified from the Institute of Management Development, 2023.

- Infrastructure

Over the past two decades, the Chinese government has made substantial investments in infrastructure development. These investments, particularly in the transportation sector, have played a crucial role in providing market access, promoting domestic market integration, reducing production and transportation costs, and enabling China to compete effectively in both domestic and international markets (Chaun, 2008). As part of these efforts, China has established over 60 border gates and introduced more than 140 routes for passenger and freight transportation with neighboring countries, thus facilitating international road transport (Yan, 2004).

- Energy access

Access to energy is a fundamental requirement for economic growth, education, transportation, environmental sustainability, and overall public health, although energy alone cannot eradicate poverty (Lenz, 2017). Since the development of its “open door” policy in 1978, China has undergone rapid economic development, leading to a significant increase in energy demand (Lam, 2005). To meet this growing demand, the Chinese government implemented structural changes, market incentives, and decentralization policies that have greatly expanded the country’s energy sector.

In 1997, the Chinese government initiated a reorganisation of the electric power sector, followed by a similar restructuring of the oil and gas sector in 1998. The primary focus of these reforms was to develop energy sources, particularly hydropower, oil, and gas, in western China and establish efficient transportation networks to deliver these energy resources to coastal regions (Lam, 2005). Presently, China holds the position of the largest coal producer and the second-largest producer of electricity in the world. It also ranks as the second largest energy consumer globally, trailing only the United States. Over the past two decades, China has successfully met its domestic energy demand (Figure 20).

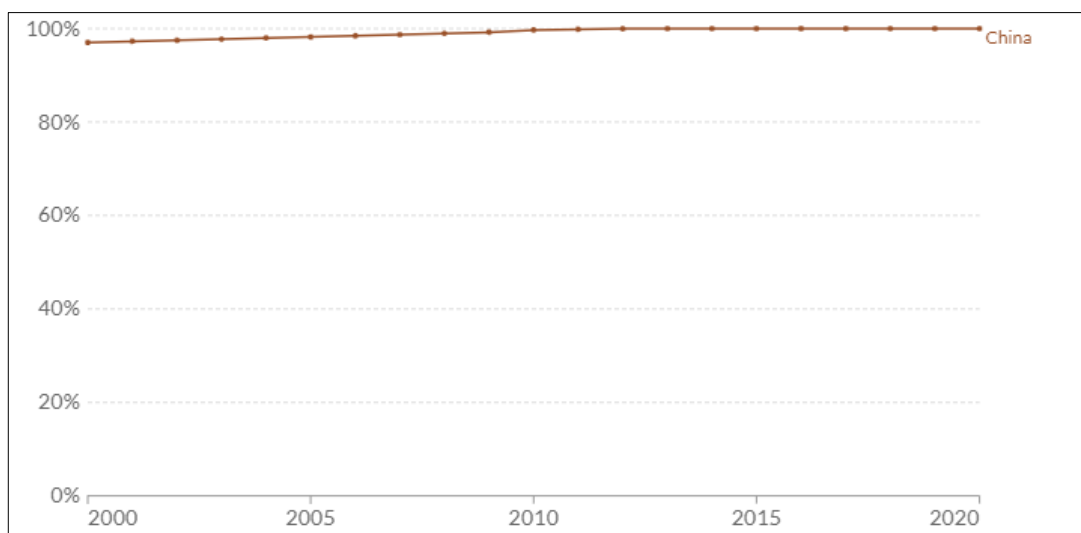


Figure 20. Electricity access in China since 2000. Source: The World Bank, 2021.

China’s energy sector has a crucial role in the country’s economy, it provides employment opportunities and drive industrial output. A shortage of energy supply

would have severe implications for the economy, hindering the growth of various industries and reducing overall competitiveness. To mitigate this risk, the Chinese government took measures to address the issue, including the construction of the Three Gorges Hydroelectric Power Station in 2012. This landmark project facilitated the development of three robust trans-regional interconnected power networks: the North China Interconnected Power Network, Middle China Interconnected Power Network, and Southern China Interconnected Power network. By connecting these networks, a nationwide power network was established, optimizing generating capacity and improving the reliability of energy supply to industries. This enhanced energy infrastructure has contributed to sustained economic growth in China.

- Business environment, government support and policy cohesion

The business environment in China is characterized by strong domestic demand, which has contributed to its favourable conditions. China's accession to the World Trade Organization in 2001 marked a significant milestone in reshaping the global economic landscape of the 21st century (The State Council Information of the People's Republic of China, 2018). The move towards liberalization allowed for increased foreign investment (Han, 2023).

Since the economic liberalization policies initiated in 1978, particularly through the "open door" policy and its reaffirmation in 1992, China has experienced substantial growth in foreign direct investment. The Chinese government and legislature have implemented positive revisions to industrial and financial policies, creating favourable conditions that have attracted foreign investment (Wang, 2012). This investment is driven by the country's immense market potential and the expectation that China will continue to gain market share and trade globally (Chen, 2022).

- Labour force competitiveness and specialized expertise

China's ability to cultivate , attract, and retain human capital is a key factor in shaping its labour force competitiveness. The country's vast population provides a fundamental advantage in terms of labour supply. China's rapid economic growth in recent decades can be directly attributed to its effective mobilization of human capital, with an

increasing share of the population attaining higher levels of education and joining the workforce. (Boland, 2022).

The manufacturing industry in China has established global dominance over the past two decades. This can be attributed to factors such as low labour costs, technically skilled workforce, and robust infrastructure. China's labour market is highly attractive due to the presence of a well-educated workforce, making the country a magnet for investment, particularly in the high-technology sector (Brooks, 2003). Furthermore, China's expertise in technology has positioned it as a favourable destination for investments from leading global companies in the technology industry.

- Monetary and macroeconomic stability

China's adoption of the open-door policy facilitated its integration into the global economy and led to a more market-based economy. As a result, it became increasingly important for the Chinese government to establish an independent and effective monetary policy regime (Goodfriend, 2006).

With its manufacturing and export-driven economy, China attracted significant foreign capital for its exports and maintained a trade surplus. This means that Chinese exporters receive foreign currency for their exports but have local expenses and wages to pay in the local currency. The large supply of foreign currency and the demand for the local currency can cause the local currency to appreciate against the foreign currency (Statista, 2022). When this occurs, Chinese exports become more expensive, losing their competitive price advantage in the international market. This situation has the potential to reduce or halt the sales of manufactured goods, leading to widespread unemployment and economic stagnation.

To manage its money supply and mitigate the effects of the trade surplus, the Chinese government exercises control through the central bank, known as the People's Bank of China (Seth, 2022; Chin, 2013). The central bank employs various methods to manage the money supply, as outlined below (Seth, 2022):

- Controlling forex rates

To manage the influx of foreign capital resulting from China's trade surplus, the central bank employs a strategy of absorbing these capital inflows. It does so by purchasing foreign currency from exporters and issuing an equivalent amount of local currency. The central bank has the authority to create and release as much Yuan as needed in exchange for foreign currency. This approach helps maintain stability in foreign currency rates, keeping them fixed or within a narrow range. The objective is to ensure that Chinese exports remain competitively priced, and that China maintains its position as a manufacturing-driven, export-oriented economy.

- Sterilization

Sterilization is a monetary measure undertaken by the central bank to counteract the effects of continuous capital inflows and outflows on the money supply. To control excess liquidity in the market, the central bank sells domestic currency bonds, effectively removing surplus cash from circulation. Conversely, when additional liquidity is required, the central bank purchases domestic currency bonds, injecting cash into the market. This sterilization process helps maintain stability and control the impact of capital flows on the money supply.

- Printing currency

The Chinese government has the ability to print additional domestic currency, when necessary, although this practice carries the risk of inflation. In order to manage inflationary pressures, China implements various measures such as adjusting subsidies and implementing price controls to regulate inflation levels. These actions are taken to ensure stability in the domestic currency and mitigate the potential negative impacts of excessive inflation on the economy.

- In conclusion, China has experienced steady growth in its money supply and GDP in recent years, positioning itself as a financial superpower (IMF, 2023). While some of the measures discussed are applicable globally, others are specific to China's unique financial system. Through its controlled approach, China has been able to achieve significant economic expansion.

3.4.1.2. Mineral beneficiation in China

According to the National Development and Reform (2016), the Chinese government has implemented policies and regulations aimed at promoting the growth and expansion of the beneficiation industry. These measures are intended to enhance the competitiveness of China's domestic mining and mineral processing sectors. The policies include various incentives such as tax benefits, subsidies, and funding for research and development in mineral beneficiation.

China has developed a well-established mineral beneficiation industry, which is evident in its strong manufacturing sector. China accounted for 28.7% of global manufacturing output in 2019, and manufacturing contributed 30% of the country's total economic output which amounted to \$4 trillion (Richter, 2021).

China is recognized as one of the leading countries where mineral beneficiation is practiced extensively, including the final stage of product readiness for consumer use (Montja, 2011). The country holds a dominant position in refining strategic minerals (Figure 21), with significant global markets shares, such as 68% of nickel, 40% of copper, 59% of lithium, 73% of cobalt being refined in China (Castillo, 2022).

In the field of gold production, China has emerged as a global leader, surpassing South Africa in 2007 (Figure 21). As of 2022, China produced an estimated 375 metric tons of gold, representing around 10% of the world market (World Gold Council, 2022). Additionally, China has been the largest consumer and exporter of the gold it produces (Figure 21), through jewellery fabrication for over a decade (World Gold Council, 2022).

Overall, China's focus on mineral beneficiation and its strong presence in the global market underscore its commitment to developing and leveraging its mineral resources for economic growth and industrial development.

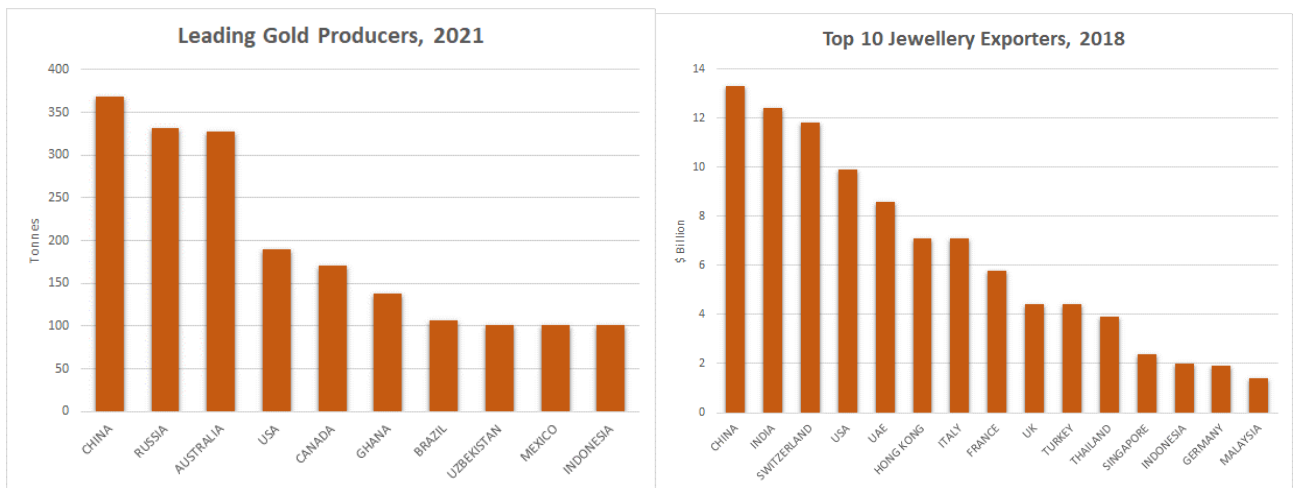


Figure 21. Top gold producing and exporting countries. Source: Modified from World Gold Council, 2022; and jewelry Industry Trends, 2020.

3.4.2. Case study 2: Canada

Mining has long been a significant contributor to Canada's economy, with a rich history dating back centuries. The indigenous communities of British Columbia, for instance, engaged in the extraction of obsidian from volcanic regions to craft tools and participate in trade. The mid-1800s witnessed the discovery of gold in central British Columbia followed by another significant find in the Klondike area of Yukon in the 1890s (Russel, 2010). These discoveries marked important milestones in the development of Canada's mining sector.

3.4.2.1. An overview of mining in Canada

Canada's mineral industry encompasses various activities such as exploration, mining, support services, primary processing, and downstream, manufacturing of related products (Governments of Canada: Minerals and economy, 2022). With its vast resources, Canada boasts some of the largest mining districts and deposits globally, operating nearly 200 mines and extracting approximately 60 different minerals and metals (Figure 22).

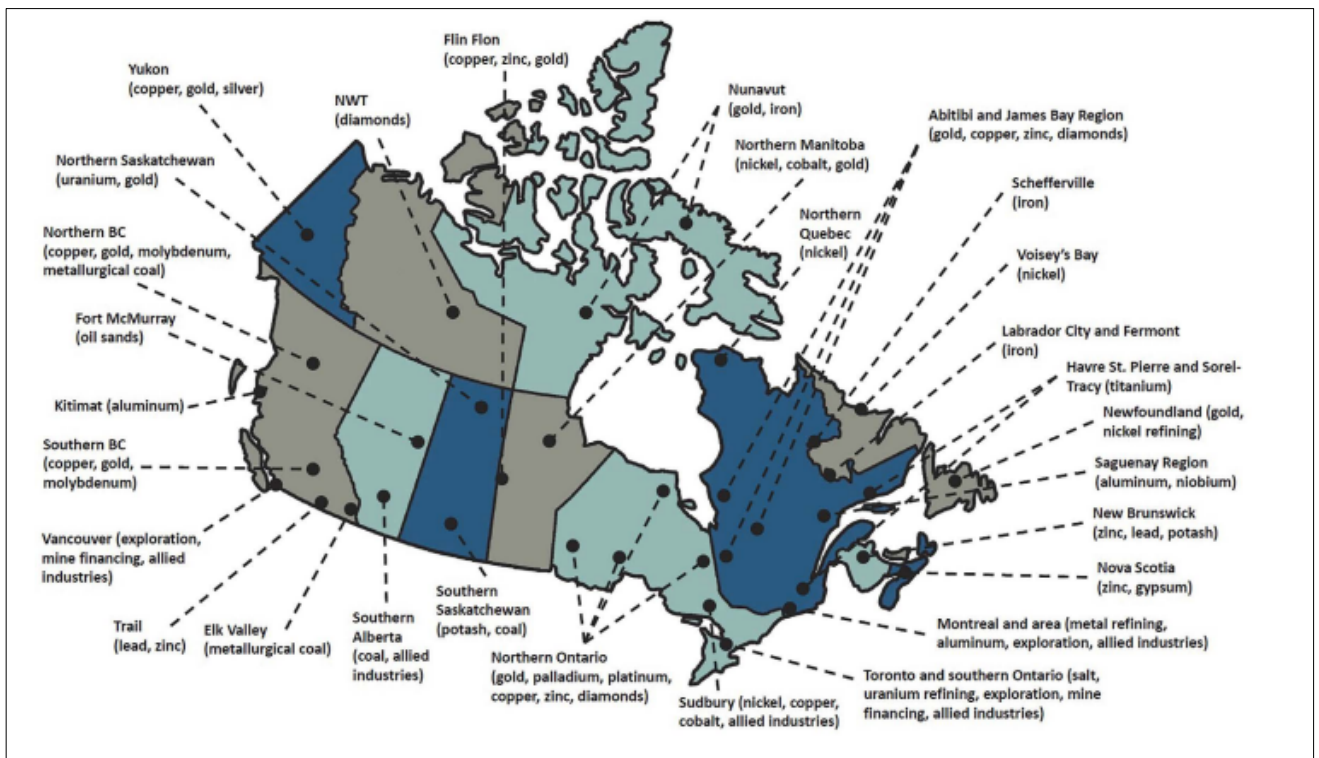


Figure 22. Distribution of mineral resources in Canada. Source: The mining Association of Canada, 2020.

Canada ranks among the top five global producers of various minerals, including diamonds, gemstones, gold, indium, niobium, platinum group metals, titanium concentrate to US\$55.5 billion, with gold being the highest-ranking commodity in terms of production value, reaching \$13.7 billion (Figure 23) as reported by the Government of Canada: Minerals and economy, 2022.

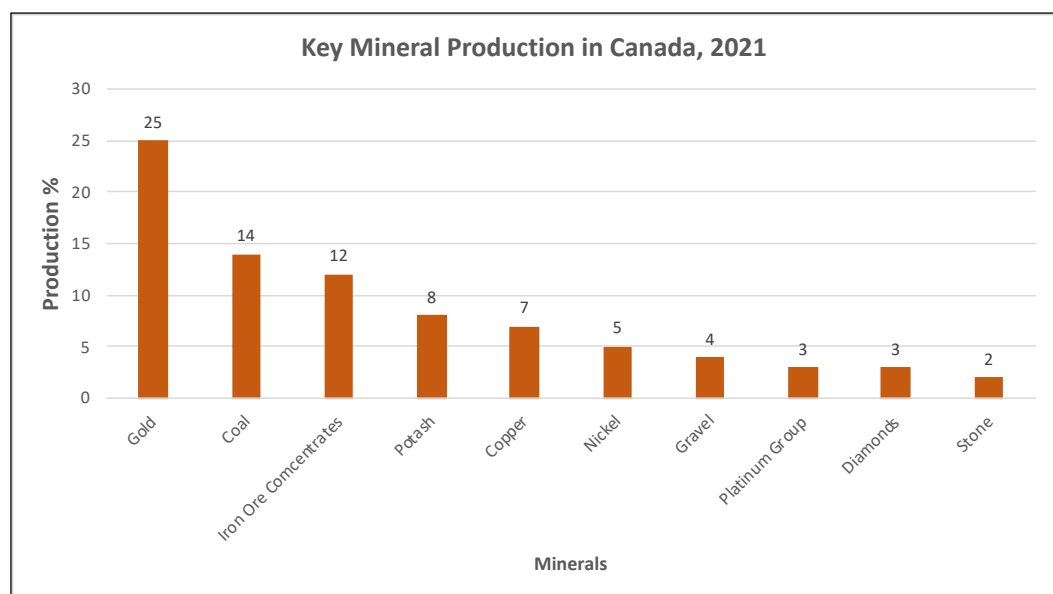


Figure 23. Key Mineral Production in Canada, 2021. Source: Government of Canada: Natural Resources Canada, 2022.

- Market demand

Canadian mining and exploration companies have a strong global presence, particularly in the Americas region. They are actively involved in mining and exploration activities with over 1,412 companies in operation (Government of Canada, Natural Resources Canada, 2023). In 2021, Canadian mining assets abroad contributed \$196 billion to the Canadian economy, with mining within Canada contributing \$89.9 billion (Figure 24).

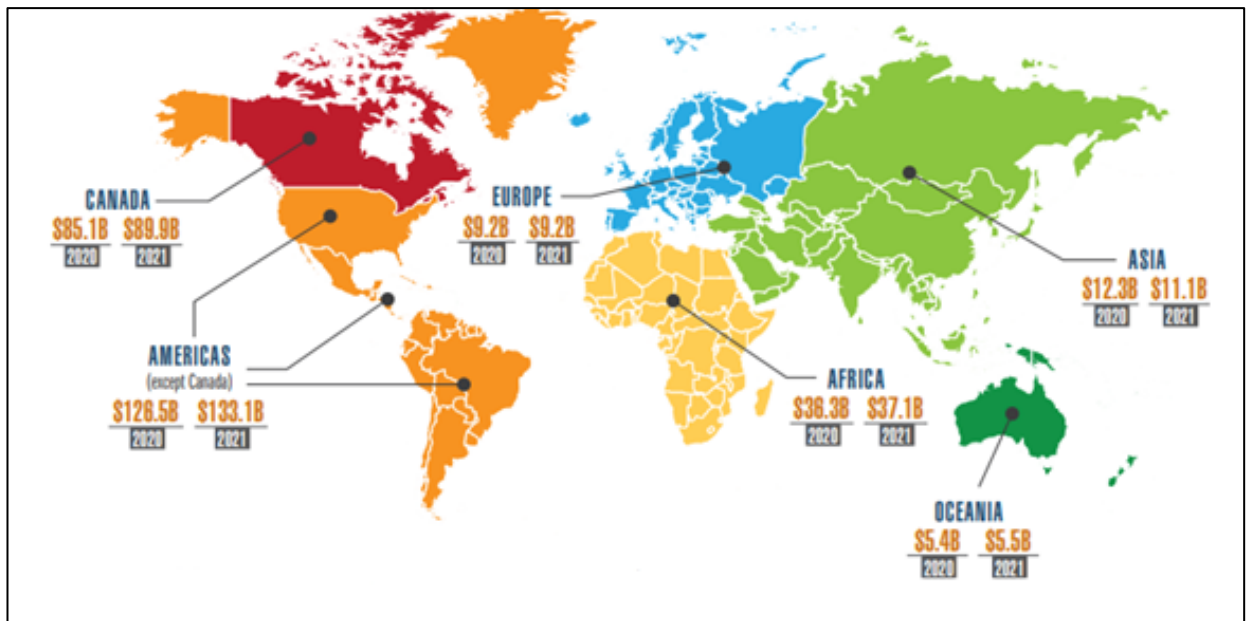


Figure 24. Canadian assets across the globe. Source: Modified after Government of Canada: Natural Resources Canada, 2023.

The mineral sector of Canada made up 6% of the country's GDP in 2021. This contribution was a combination of direct contributions amounting to \$97 billion and indirect effects totaling \$35 billion from the minerals and metals sector, resulting in a total manufacturing contribution of \$132 billion (Government of Canada: Minerals and economy, 2022).

The trade surplus for minerals imports and exports, which includes various mineral products such as ores, concentrates, and fabricated goods, exceeded \$23 billion. Canada's domestic minerals exports, valued at \$126 billion, contributed 22% of the nation's total exports. When examining these mineral exports (Figure 25), 54% were shipped to the United States, 10% to the United Kingdom, and 7% to China (Government of Canada: Minerals and economy, 2022).

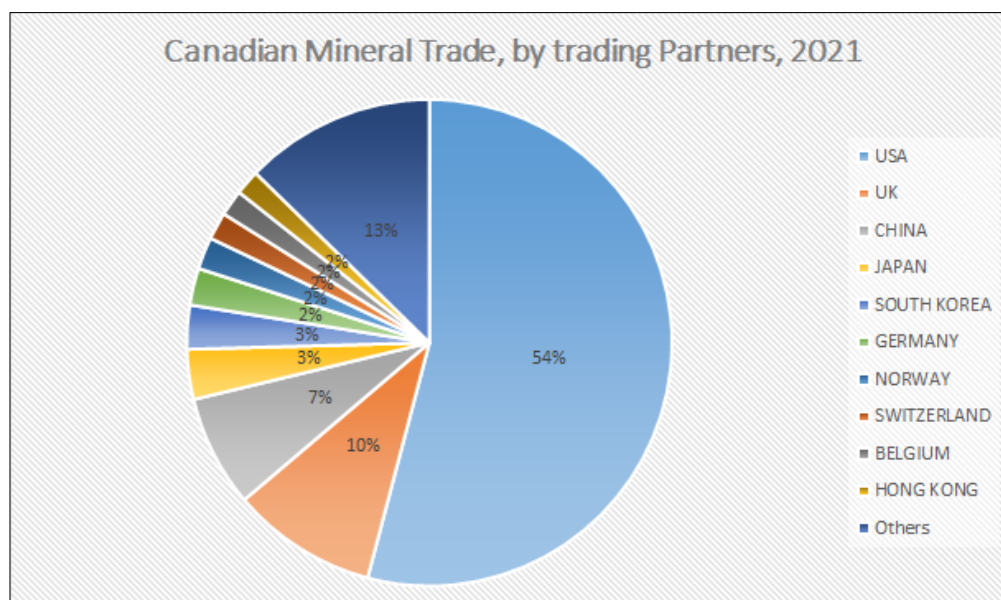


Figure 25. Canadian mineral trade by trading partners, 2021. Source: Modified from Government of Canada: Minerals and Economy, 2022

In 2022, the mineral sector in Canada attracted 5% (\$14 billion) of the nation's total capital investment. This investment was allocated to various areas of capital construction, such as fabricated metal production manufacturing, primary metal manufacturing, mineral processing and machinery and equipment within the mining sector, as illustrated in Figure 26.

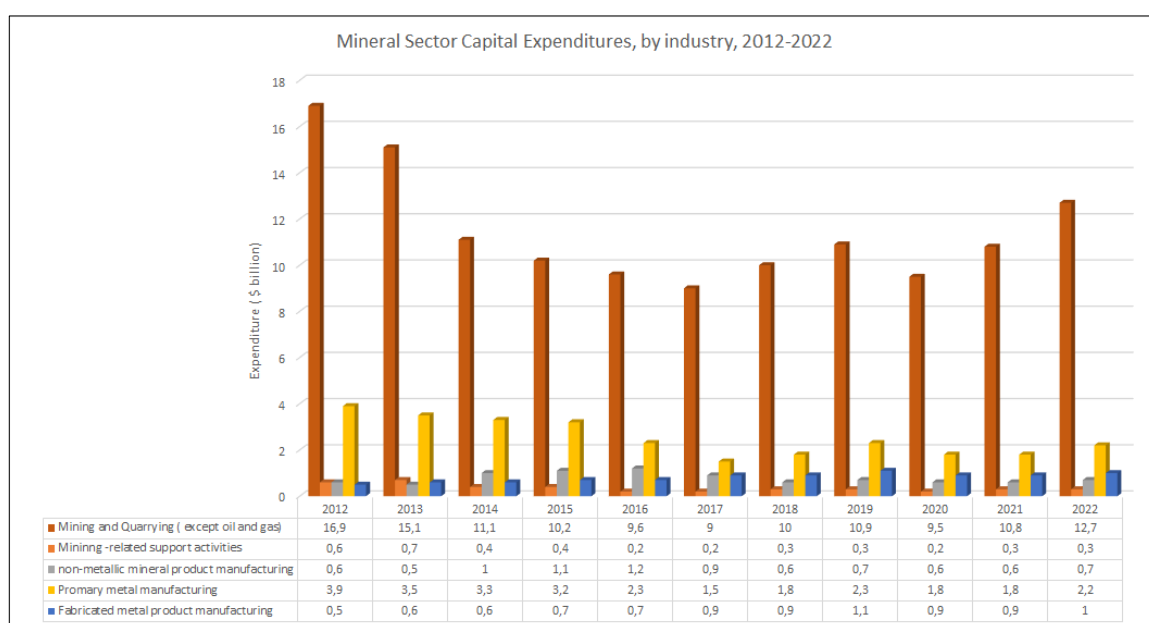


Figure 26. Canada's mineral sector capital expenditures, by industry, 2012-2022. Source: Modified from Government of Canada: Minerals and Economy, 2022.

- Infrastructure

Efficient transportation and modern infrastructure are crucial for the mining industry in Canada for the country to successfully transport its product to market. This includes ports, roads, and railways. As the largest rail shipper in terms of both freight revenue and volume, the mining and manufacturing industry plays a significant role in Canada's transportation sector. Additionally, the industry is a major customer for Canadian ports and contributed significantly to the value of Canadian exports transported by ship to international markets. Furthermore, the mining industry relies on well-maintained roads and highways to facilitate the transportation of goods by trucks.

- Energy access

Canada is endowed with abundant energy resources (International Energy Agency, 20220, including oil, natural gas, hydroelectricity, coal, uranium, and renewable energy sources such as wind, solar , and geothermal power (Figure 27A). While oil and natural gas are significant energy sources in Canada, the country also rely on other sources for electricity generation, including hydroelectric power, nuclear power from uranium, and renewable energy installations. This diversified energy mix ensures that Canada has a reliable and ample supply of energy.

In terms of energy generation adequacy, Canada does not face significant concerns. Final energy consumption in the country is below total energy production, as depicted in Figure 27B. This indicates that Canada has sufficient capacity to meet its domestic energy demand, and there are comfortable capacity margins to ensure reliable electricity supply at all times.

According to the World Bank, Canada has achieved universal access to electricity, with 100% of its population having access to this essential energy source for many years (Figure 28). This reflects the country's commitment to providing electricity to its citizens and highlights the effectiveness of the country's energy infrastructure in delivering reliable power nationwide.

Canada relies significantly on hydroelectricity as a source of electricity, accounting for over 60% of the country's total electricity generation. This makes Canada the second-

largest producer of hydroelectricity globally, trailing only China. Additionally, Canada has been commercially generating electricity from nuclear power plants since the early 1960s. Currently, the country operates five nuclear power plants located in three provinces, with a total of 22 nuclear power reactors. These reactors contribute approximately 15% of Canada's overall electricity production.



Figure 27. (A) Sources of energy as well as (B) usage. Energy consumption is below total production. Source: IEA, 2022.

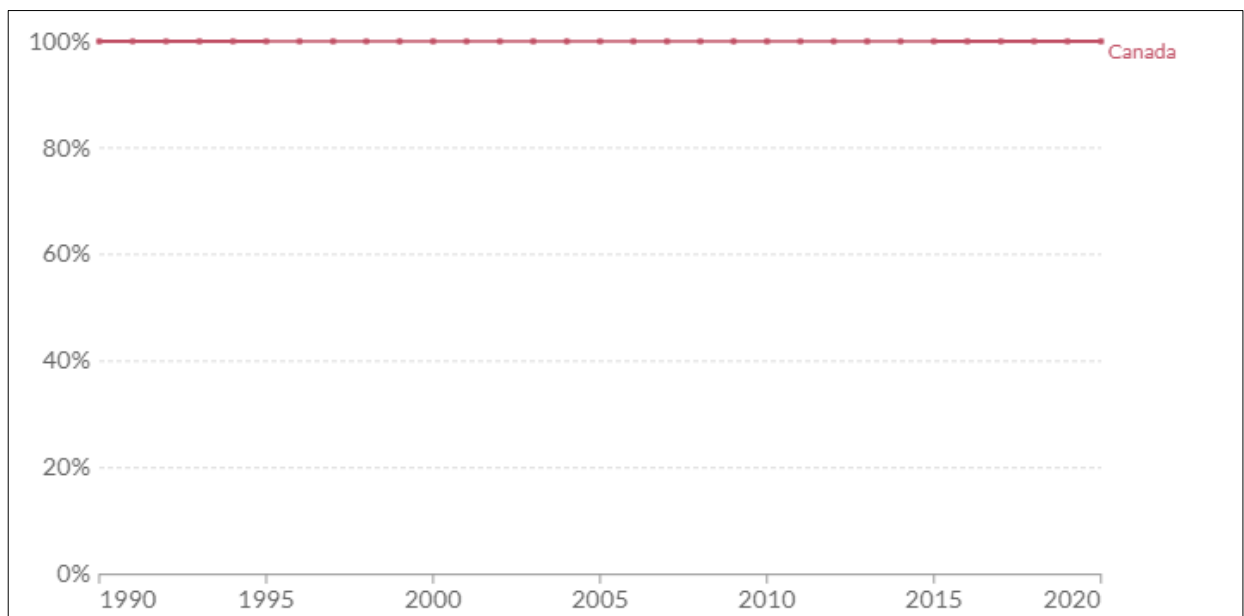


Figure 28. Electricity access in Canada (1990-2020). Source: The World Bank, 2021.

Canada's electricity system is interconnected with the electricity market of the United States, forming an integrated North American market. Electricity is traded between Canada and the United States in both directions, facilitating efficient and reliable supply. The electricity system is supported by a network of 37 transmission lines that span the Canada-U.S. border in a north-south direction. Additionally, there are numerous east-west tie lines that connect provinces within Canada. This extensive transmission infrastructure enhances the overall reliability and resilience of the electricity system, ensuring a stable supply of electricity even in the face of unplanned changes in supply and demand.

- Labour force competitiveness and specialized expertise

The Mining Industry Human Resource Council (MiHR) and the Mining Association of Canada collaborate to address the human resource needs and labour market inefficiencies in the Canadian mining industry (MiHR, 2019). Through their research and programs, they aim to foster an inclusive, sustainable, and skilled workforce.

One of the key contributions of their research is the provision of Labour Market Information (LMI), which helps in understanding labour supply and demand in the mining industry. By utilizing LMI, MiHR aims to be the trusted source of knowledge and analysis for labour market information in Canada's mining sector (MiHR, 2019).

As of 2021, the Canadian minerals sector employed over 402,000 individuals, with over 50% of these employees working in downstream mineral processing industries (Figure 29). The mining sector, which includes coal mines, metallic minerals, non-metallic minerals, and related services, contributed over 100,000 jobs in 2021. The primary manufacturing sector, comprising primary metal manufacturing and non-metal manufacturing, accounted for over 89,000 jobs. Primary metal manufacturing involves the smelting and refining of ferrous and non-ferrous metals, while non-metal manufacturing involves the transformation of minerals into products such as cement, ceramics, glass, and lime.

Downstream manufacturing, which includes secondary metal products derived from scrap and salvage, tertiary mineral products involving additional refining and homogenization, and service and custom work, contributed over 200,000 employment opportunities in 2021 (Government of Canada: Minerals and the Economy, 2021).

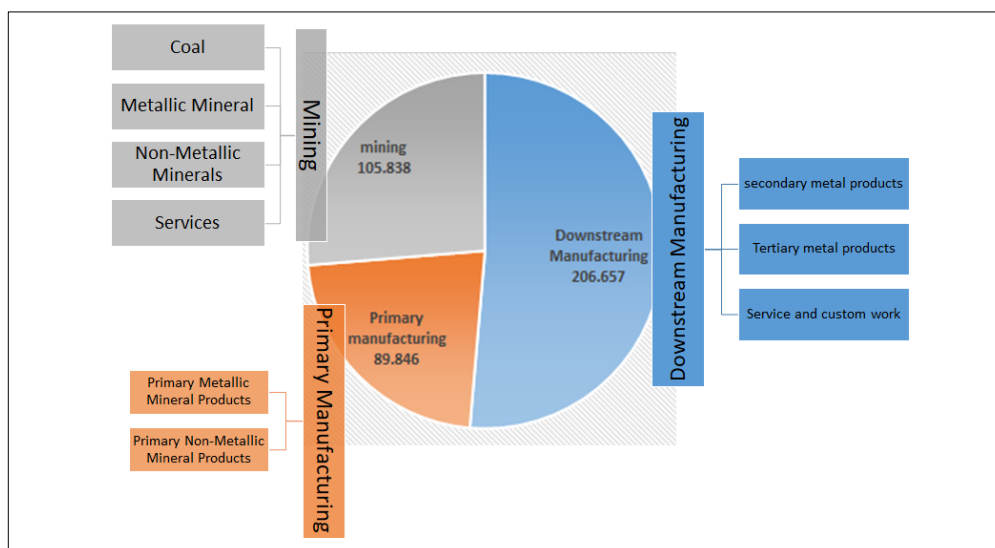


Figure 29. An illustration of the extent of employment in downstream manufacturing as compared to mining/extraction. Source: Modified from Government of Canada: *Minerals and the Economy*, 2021.

- Monetary and macroeconomic stability

The Canadian government employs its monetary policy to maintain the economy operating near its full capacity, aiming for a low and relatively stable inflation rate (Bank of Canada, 2023). This is achieved through the use of the target for the overnight rate, which is the interest rate charged by major banks for short-term loans between themselves.

The Bank of Canada, in collaboration with the government, periodically reviews and updates the country's monetary policy, typically every five years, in order to maintain flexible inflation targeting. Inflation targeting involves setting an inflation target that promotes overall economic performance. Since 1991, Canada has aimed for an inflation target of 2%, which has been consistently maintained (Bank of Canada, 2023). This approach has resulted in an average inflation rate of 2% over the past three decades.

The benefits of inflation targeting in Canada include a more stable economy, enabling businesses to make informed spending and investment decisions. It has also contributed to sustained economic growth, job creation, and improved productivity.

Moreover, it has raised the standard of living for citizens and fostered low and stable borrowing rates for consumers and businesses, promoting favorable conditions for economic activity.

3.4.2.2. Mineral beneficiation in Canada

The mining industry in Canada extends beyond extraction and encompasses manufacturing processes (The Mining Association of Canada [MAC], 2020). Similar to China, Canada also practices mineral beneficiation, which involves refining minerals to the final stage before they are ready for sale to consumers (Organization for Economic Co-operation and Development [OECD], 2017).

Mineral beneficiation plays a vital role in Canada's economy by generating employment opportunities, increasing exports, and stimulating overall economic growth (MAC, 2020). The Canadian mining industry benefits from a supportive government policy environment that includes funding and research programs aimed at promoting mineral beneficiation (Government of Canada, 2020).

The Canadian government has made efforts to support mineral beneficiation and encourage value-added processing of minerals. This includes providing funding for research and development, as well as implementing policies to promote the use of Canadian minerals in the country's manufacturing sector (Government of Canada, 2020). The mineral sector has made significant contributions to metal fabrication and manufacturing since 2012, as depicted in Figure 29.

Canada is also home to several research institutions and universities that actively engage in research and development of new technologies and processes for mineral beneficiation. These institutions include Natural Resources Canada, the National Research Council of Canada, and the Canada Mining Innovation Council (Government of Canada, 2023).

3.4.3. Case study 3: United States of America (USA)

3.4.3.1. An overview of mining in USA

The mining industry in the United States serves as the backbone for manufacturing activities across the country, supplying raw materials to factories for the production of goods. Currently, there are approximately 13,000 active mines in the USA (American Mine Services [AMS], 2019), contributing to the production of various commodities (USGS, 2022), including:

- Metals (iron, copper, steel. Uranium);
- Precious metals (Gold, silver, platinum);
- Minerals (sulfur, crushed stope, cement, gravels, industrial sand); and
- Fuel minerals (Coal).

As of 2020, there were 278 active metal mines in the USA (Garside, 2023). Additionally, over half of the active mines in the country focus on producing industrial sand and gravel, which are crucial for supporting the extensive construction projects undertaken in the USA (Figure 30).

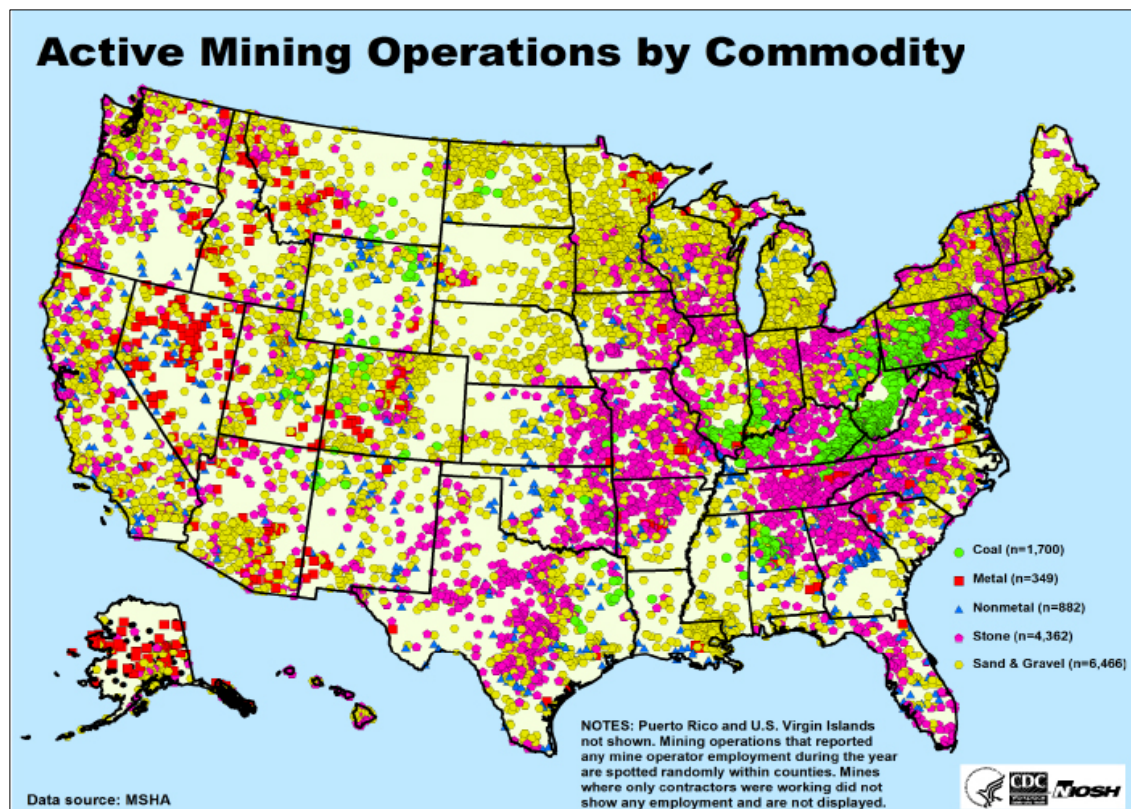


Figure 30. Mining operations in U.S.A. Source MSHA

The United States also ranks as the second most largest producer of critical minerals and rare-earth mineral concentrates, trailing only behind China. (United States Geological Survey [USGS], 2021).

According the USGS (2022), the United States is significantly dependent on external suppliers for both unprocessed and processed minerals (Figure 31), with over half of the domestic consumption satisfied through imports. Specifically, imports were the main source for 46 non-fuel mineral commodities. Moreover, for 17 specific minerals, the U.S. was entirely reliant on external sources. These imported minerals are indispensable components in technologies for renewable energy production and storage, as well as for infrastructural advancements (USGS, 2021).

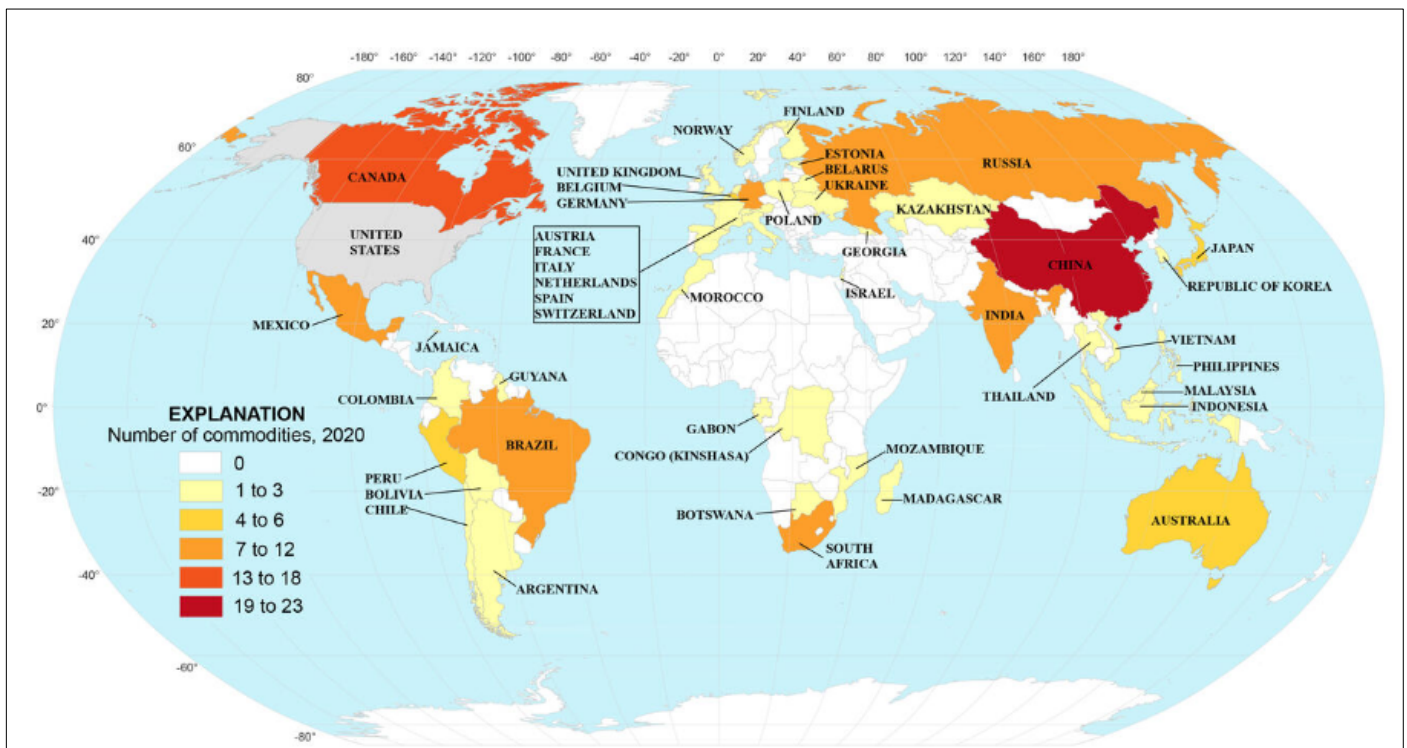


Figure 31. Major import Sources on nonfuel mineral commodities. Source, USGS, 2021.

The mining industry in the United States plays a significant role in the country's GDP. The value of mineral exports, including gold, reached approximately \$4 billion in 2020.

Additionally, domestically recycled products such as iron and steel scrap had a value of US\$28 billion (USGS, 2022). The use of domestic raw materials and recycled materials in the production of mineral materials amounted to \$710 billion. These mineral materials, along with imports of processed minerals, were consumed by downstream industries, contributing to an estimated value of over \$3 trillion in 2020.

Foreign direct investment (FDI) in the USA has more than doubled over the past two decades, as depicted in Figure 32. In 2021, FDI amounted to over \$4 trillion, indicating the country's attractiveness to international investors.

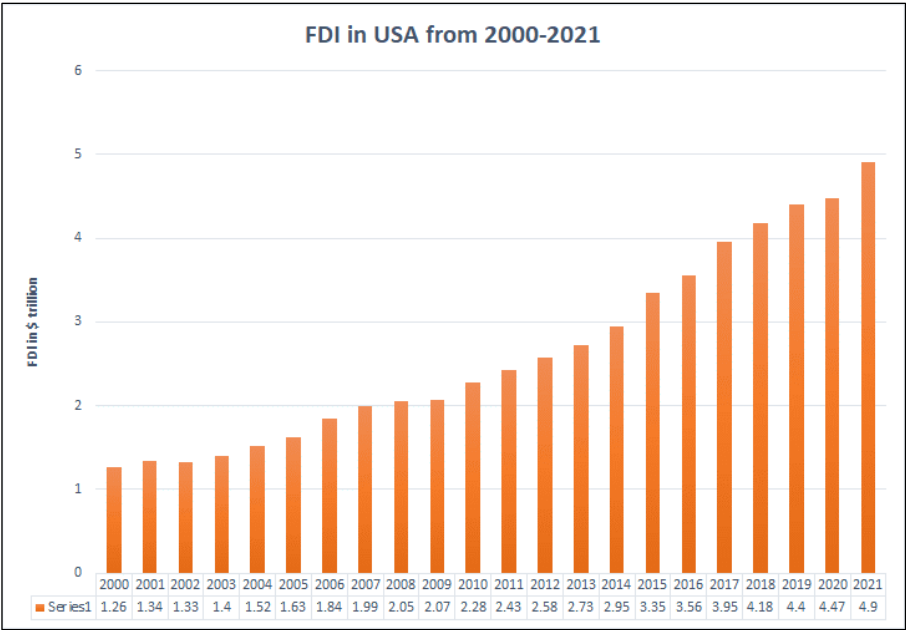


Figure 32. United States FDI from 2000-2021. Source: USGS, 2022.

In 2021, the United States emerged as the top recipient of foreign direct investment (FDI) and overseas direct investment (ODI) globally, as depicted in Figure 33. FDI in the United States was primarily concentrated in the manufacturing sector, which accounted for 42.4% of the total FDI inflows (Bureau of Economic Analysis, 2023).

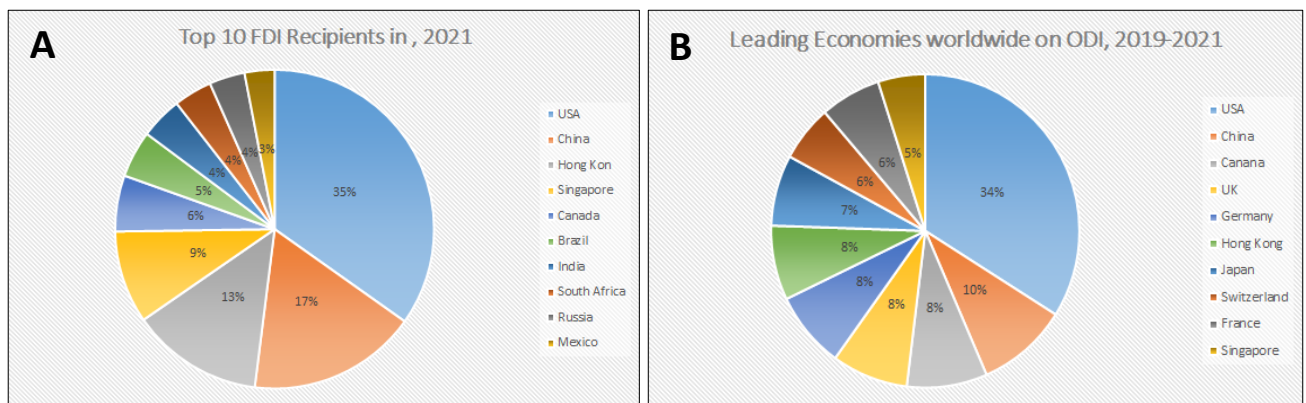


Figure 33. A. United states of America top FDI Recipients, 2021. B. Leading economies on ODI, 2019-2021. Source: Modified from the United Nations Conference on Trade and Development, 2022; and Statista, 2022.

- Infrastructure

The United States relies on an extensive network of infrastructure that encompasses various elements such as roads, bridges, freight rail, ports, electrical grids, and internet provision. This infrastructure plays a crucial role in connecting supply chains, facilitating the efficient movement of goods and services across borders, and providing households in metropolitan areas with access to better opportunities in terms of employment, healthcare, and education (McBride, 2021).

Investments in infrastructure have been instrumental in driving the strong growth of the United States, as highlighted by Heintz (2009). Economic infrastructure, including energy, transportation, and water systems, plays a particularly vital role in sustaining the country's economic performance (Fosu, 2022). A significant portion of the United States of America's infrastructure was developed during the 1930s and 1950s as a response to the challenges posed by the Great Depression and to stimulate the nation's economy after World War II. These infrastructure investments have been crucial in propelling the United States to its position as a global superpower and a leading force in the world economy (Schwartz, 2020).

- Energy access

As stated in section 2.6.2.1.3., the electricity system in the United States is interconnected with the North American market, facilitating the trading of electricity between the USA and Canada in both directions. This integration ensures a reliable

and sufficient supply of electricity to meet the needs of industries and individuals in the United States of America. Access to electricity for powering daily activities is not a concern for the average American, as depicted in Figure 34. The energy supply in the country is adequate to fulfill domestic demand, providing stability and reliability to the electricity system (The World Bank, 2021).

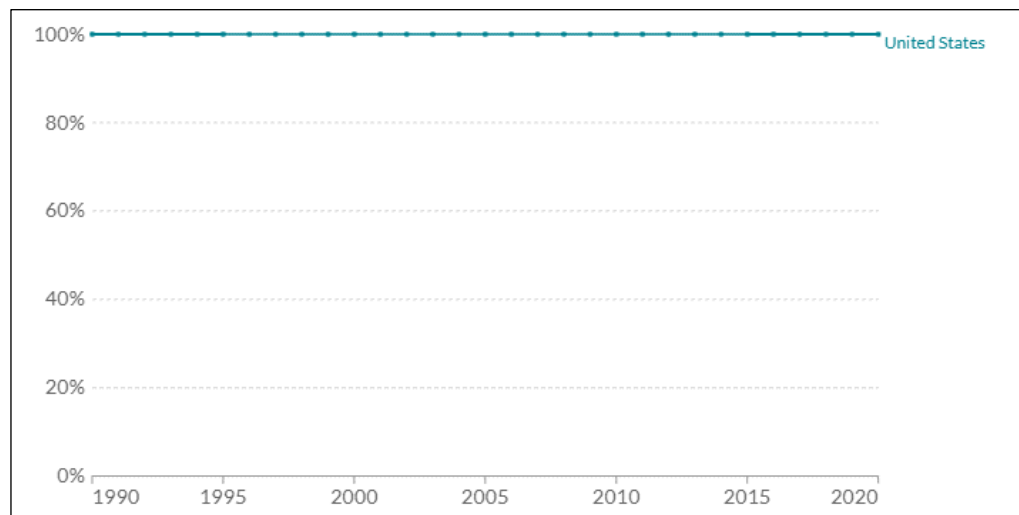


Figure 34. Electricity access in America from 1990-2020. Source: The World Bank, 2021.

- Business environment, government support, and policy cohesion

The United States is an appealing destination for foreign investment due to several factors, as illustrated in Figure 31, these include:

- Large economy with diverse consumer markets;
- Skilled labour force;
- Predictable and stable regulatory system;
- Favorable economic policies; and
- Sufficient infrastructure development.

Since 2006, the United States has maintained its position as the foremost recipient of foreign investment worldwide (Department of Commerce United States of America, 2013). With its pervasive global impact encompassing political, economic, military, and cultural domains, the country is widely recognized as a global superpower.

- USA's mining and manufacturing labour force

The United States of America benefits from advanced economic development, which includes the utilization of cutting-edge technologies such as automation, satellite communications, smart sensors, and robotics in the mining industry. These technological advancements enhance efficiency, reliability, and safety in exploration, mineral processing, and mine operations, while ensuring environmentally sound practices. Despite these advancements, the United States of America's mining sector remains a significant source of domestic employment, providing over 500,000 jobs as of 2020 (Statista, 2022).

The manufacturing sector, which is the fifth-largest employer in the country (Figure 35A), employs over 12 million individuals. Within the manufacturing subsector, the fabrication of metal products is the third-largest employer (Figure 35B), with 14 million employees. The number of individuals employed in downstream mineral fabrication is twice the number employed in mining extraction and quarrying (Figure 35A). Careers in manufacturing and mining offer rewarding opportunities and attract younger generations with their innovation and diversity (U.S. Census Bureau, 2020).



Figure 35. Comparison between employment in the mining/extraction sector and in the United States of America's manufacturing and fabrication sector. Source: Modified from U.S. Census Bureau, 2020.

3.4.3.2. Mineral beneficiation in United States of America

Mineral resources play a vital role in the United States of America's economy, contributing to real GDP across various sectors, including mining, processing, and manufacturing (USGS, 2020). These minerals are crucial for downstream manufacturing activities in the United States. The country boasts a strong and dynamic manufacturing network that is renowned worldwide. From the production of automobiles and jet engines to the manufacturing of servers and computer chips, the U.S. excels in delivering materials and products with remarkable speed and capacity. This has propelled robust economic growth and established the United States of America as a global leader in industrial prowess.

3.4.4. Comparison to South Africa

3.4.4.1. An Overview of the South African Mining Sector

South Africa is globally recognized for its vast reserves of valuable mineral resources (Figure 36). The country's mining industry is predominantly focused on Platinum Group Metals (PGMs), coal, and gold (Figure 37). South Africa holds the position of being the largest producer of PGMs, manganese, and chromium (Turok, 2014). With a wide array of 53 different minerals available, South Africa boasts an extensive mining sector with over 1,700 operational mines (DMR, 2011).

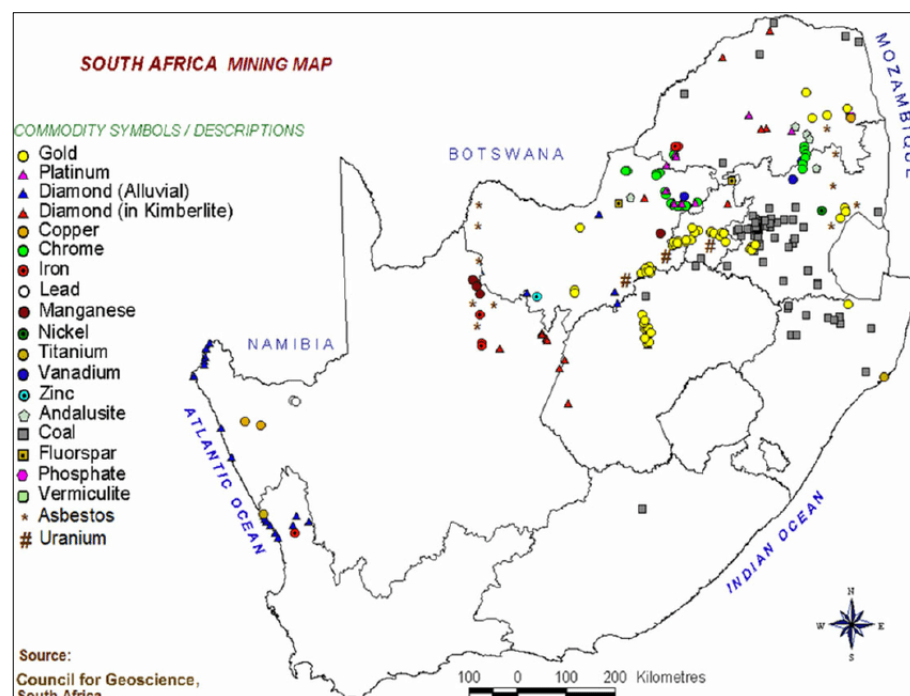


Figure 36. Selected mineral occurrence map of South Africa by Commodity. Source: Utembe, 2015

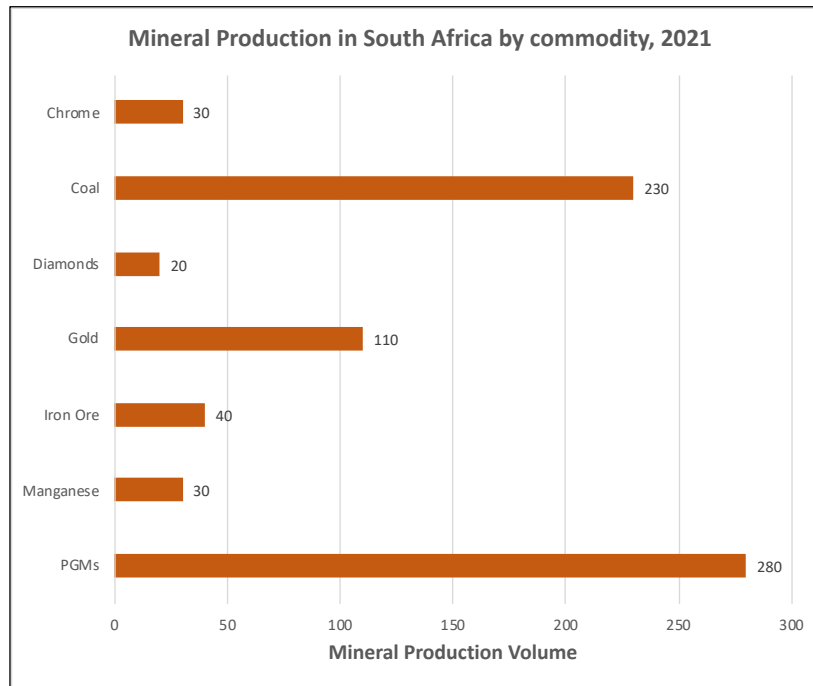


Figure 37. Minerals production in South Africa, 2021. Source: Modified after MCSA, 2022.

In 2021, the mining industry made a significant contribution of approximately R219.5 billion to the overall government revenue by means of direct and indirect tax collections (Statista, 2022). This sector represents 7% of South Africa's portion of the nominal Gross Domestic Product (GDP) and has historically been a major source of employment for a considerable number of South Africans, as depicted in Figure 38. However, it is worth noting that employment figures in the mining industry have experienced a decline in recent years as show by the histogram below (StatsSA, 2022).

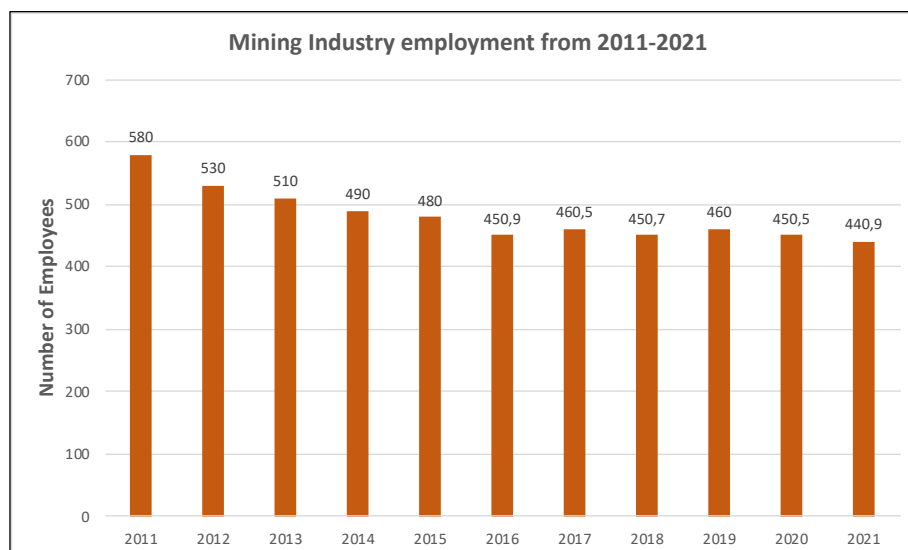


Figure 38. SA mining industry workforce. Source: Modified from StatsSA, 2022

While investment in the mining industry plays a crucial role in sustaining its contribution to the South African economy, its economic impact primarily stems from the revenue generated by the day-to-day operations of various mines in the country (Price Waterhouse Cooper, 2021).

South Africa possesses a well-established mining sector and boasts globally competitive mineral resources and reserves. However, according to scholars like Jordan (2005), there is a consensus that downstream beneficiation is essential for maximizing economic benefits. Currently, many of South Africa's natural resources are exported, and the beneficiation process occurs in manufacturing-focused countries such as China and the United States of America. As a result, these export destinations capture the higher value of the final products, while South Africa is left with lower economic returns associated with the raw materials' lower value. This situation also leads to trade deficits as South Africa imports higher-value downstream products (Jordan, 2005).

There is skepticism among many stakeholders in the South African mining industry regarding the country's ability to effectively implement the proposed beneficiation strategy (Lovells, 2016). They believe that numerous obstacles hinder the progress of beneficiation in the country.

3.4.4.2. History of mineral beneficiation in South Africa

The concept of mineral beneficiation has been present in South Africa for many years. Chirikure (2015) highlights that the process of adding value to materials like iron, copper, gold, and tin dates back to 1000 BC, utilizing primitive technologies including forges and furnaces constructed from animal hides, wood, calabashes, bamboos, and clay for the beneficiation of ore into gold, iron, and copper. Similarly, Mavhunga (2023) notes that metalworkers used tools such as anvils, hammers, files, pliers, and goat skin bellows to craft these metals into finished articles. These articles were often combined with components made from wood, leather, and clay to create tools and objects like holes, axes, spears, arrowheads, and musical instruments, showcasing early integration of various materials for functional and decorative purposes (Figure 39).



Figure 39. Historical practices of iron smelting and value addition in Africa. Source: Mavhunga, 2023. Taken from The Duggan-Cronin Collection, ca. 1940s-1950s.

During the mid-20th century, advancements in technology led to the introduction of gold panning and grinding methods, coinciding with the establishment of mining schools in North America, London, and Columbia. These educational institutions offered courses in mineral benefaction, chemical engineering, geology, and metallurgy, promoting the optimization of beneficiation processes (Montja, 2019).

In the 1990s, the country underwent a significant transformation in its mining sector, shifting from primarily exporting primary commodities to becoming a global exporter of processed minerals. This transition was facilitated by the establishment of large-scale investment projects focused on value addition, such as Columbus Stainless, Hillside Aluminum, Namakwa Sands, and Saldanha Steel. These projects, along with the expansion of Ferro-alloy production, led to the production of intermediate products and accounted for approximately 90% of the total minerals' revenue, while the remaining 10% came from fully beneficiated minerals.

The idea of beneficiation has also gained traction in other African countries, including Botswana and Mozambique, as these nations have recognized the potential of adding value to their mineral resources (Hausmann, 2008). In South Africa, downstream

beneficiation is thought of as a crucial element for the survival and sustainability of the mining industry. The government has shown commitment to promoting high-value downstream beneficiation through legislation and industrialization policies (SAIC, 2023). These initiatives aim to strengthen mineral value chains, increase beneficiation efforts, increase the value of exports, stimulate local consumption, attract investment and create sustainable job opportunities.

The Department of Minerals and Energy has outlined a comprehensive beneficiation strategy that encompasses the entire value chain of mineral processing. This strategy is supported by various policies, including the Minerals and Mining Policy for South Africa, the Minerals and Petroleum Resources Development Act (MPRDA), the Broad-Based Socio-Economic Empowerment Charter, and the Precious Metals Act. Successful implementation of the strategy requires close coordination among government departments, such as the Department of Mineral Resources and Energy, Department of Trade and Industry, Department of Science and Technology, Department of Public Enterprises, Treasury, and collaboration with key mining stakeholders, which include businesses and labour organisations.

3.4.4.3. Current state of downstream mineral beneficiation in South Africa

Despite South Africa's abundant mineral resources and a long history of mining, the country has not fully capitalized on the potential value-added benefits of mineral beneficiation (Khubana, 2022). The levels of beneficiation have been relatively low, with a focus on capital-intensive sectors of the mineral value chain such as smelting and refining. The country has not made significant progress in the production of finished goods for downstream manufacturing and fabrication, resulting in a limited presence in high-value beneficiated mineral output (Deloitte, 2014).

Scholars generally characterize South Africa as having low levels of mineral beneficiation, highlighting the need for dedicated interventions to address the constraints that hinder the realization of a competitive advantage in this sector (Tom, 2015). These constraints pose challenges to the implementation and advancement of beneficiation programs in South Africa.

Key constraints faced by South Africa in achieving successful downstream beneficiation include (Mintek, 2014):

- **Limited access to raw material for local beneficiation**

The mining industry in South Africa is well-developed, with major conglomerates involved in primary production and emerging miners playing a significant role in exploration activities. The country offers diverse mineral resources, including metals, energy resources, ferrous and non-ferrous metals, and industrial minerals, which present attractive investment opportunities.

However, limited access to these resources is a consequence of current structural arrangement of the mining industry, which is primarily focused on exporting raw materials. Many existing mining houses have long-term contracts with international clients, restricting local access to these resources for value-added beneficiation activities (Mitchell, 2016).

Furthermore, pricing methodologies used by some producers of raw and intermediate materials also hinder beneficiation efforts. The international pricing for these materials, which does not consider distance to production, complicates the availability of input minerals for local value input. This situation is particularly relevant in industries such as the diamond and precious metal industries, where laws were put in place to ensure that minerals are available for local beneficiation.

- **Infrastructure**

Infrastructure in South Africa is mostly owned, operated, and maintained by the government through state-owned enterprises. Key infrastructure components such as energy, roads, railways, and water play a crucial role in sustaining current beneficiation initiatives and are vital for future growth prospects in mineral value addition. However, the underdevelopment of infrastructure in the country is further exacerbated by the high volume and capital-intensive nature of the mining industry.

Energy access is a particularly significant issue in South Africa. While the mining and manufacturing sectors have historically benefited from stable and low-cost coal-based electricity supply, the challenges faced by Eskom, including a lack of investment in

sustainable power generation infrastructure, have severely impacted energy-intensive sectors. Load shedding, coupled with electricity tariff increases, has resulted in decreased output volumes and reduced-price competitiveness for the mining and manufacturing sectors.

Power supply in South Africa is characterized by unreliability and inefficiency, leading to disruption costs for operating firms. Factors such as corruption (State Capture), rising fuel costs, inadequate public investment, political interference, and poor infrastructure contribute to the insufficient supply of electricity. Power outages have significant economic consequences, including industrial-related economic losses and disruptions to commodity trading and industrial production.

Figure 40 demonstrates that South Africa's energy supply lags behind, achieving only 84% energy access, in contrast to 100% access seen in countries such as China, Canada, and the United States of America. This has a profound impact on investment attractiveness and overall competitiveness of the country.

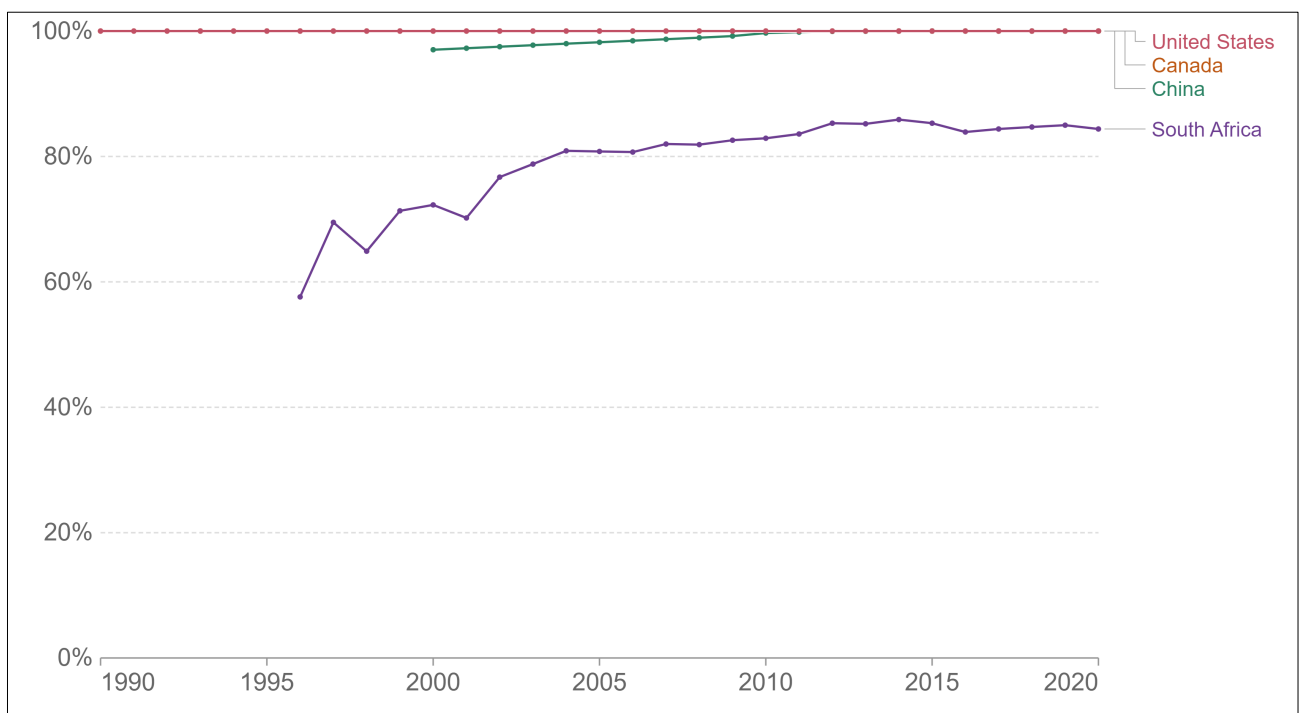


Figure 40. Energy access in South Africa as compared to developed nations. Source: The World Bank, 2021.

The mining and manufacturing sectors in the country have experienced adverse effects due to inadequate investment in freight rails, roads, and port terminals, resulting in decreased transportation efficiencies for raw materials, finished products, and semi-finished products (Tom, 2015).

Transnet, a state-owned enterprise, is responsible for the country's freight rails and port terminals. South Africa boasts the most advanced railway system on the African continent, encompassing a network of over 30,000 km of tracks that connect major cities and ports (Tom, 2015). However, the South African rail network has been in a state of decline, as evidenced by the decrease in freight transported by trains over the past five years. This decline can be credited to various factors, including train delays, cancellations, safety concerns, insufficient long-term maintenance, and vandalism.

Consequently, many mining and manufacturing companies have shifted their transportation needs from rail to road-based transport. However, this transition has additional implications for the economy. Road-based transport is known to have up to four times the economic costs of rail service, primarily due to higher operating costs, increased road congestion, and greater environmental impacts. The decline in railway journeys has also contributed to the financial instability of the state-owned enterprise, reducing the likelihood of future investments in infrastructure (Tom, 2015).

- **Access to domestic and international markets**

South Africa has made remarkable strides in its economic and social development since the end of Apartheid. It now boasts the most advanced, diversified, and productive economy in Africa, creating an environment that fosters business growth and investment (Kgoale, 2019).

This is in part due to the following factors:

- **Regional agreements**

South Africa actively participates in regional economic infrastructure development, as evidenced by its membership in key organisations. The country is a proud member of the Southern African Development Community (SADC), which focuses on fostering sustainable and equitable economic growth, socio-economic growth, and socio-

economic development. The main objective of SADC is to eradicate poverty and improve the standard and quality of life for the people of Southern Africa (SADC, 2022).

South Africa is also a member of the Southern African Customs Union (SACU), which connects member states such as Botswana, Namibia, Lesotho, and Swaziland through a unified tariff system without any customs duties imposed among them. This agreement facilitates smoother trade relations within the region. Furthermore, South Africa holds membership in prominent global institutions including the World Trade Organization (WTO), which plays an important role in facilitating international trade and supporting producers, exporters, and importers in conducting business. South Africa is also an active member of BRICS and the G20, further strengthening its presence in global economic discussions and initiatives.

South Africa benefits from the African Continental Free Trade Area (AfCFTA), which according to the AfCFTA (2023) stands as the globe's most expansive free trade area, unifying the 55 African Union (AU) nations and eight (8) Regional Economic Communities (RECs). AfCFTA's primary aim is to forge a unified continental market that encompasses nearly 1,3 billion individuals and a total GDP of around US\$ 3,4 trillion.

- **Trade agreements**

A noteworthy agreement from which South Africa benefits is the African Growth and Opportunity Act (AGOA). This pact, signed between the United States and Sub-Saharan Africa, allows South Africa, as a member, to access the U.S. market duty-free, thus amplifying its trade potential.

The country's largest bilateral trade partners are the United States, Europe, and China, signifying the value of these economic alliances. South Africa also maintains agreements with the European Union (EU) and the European Free Trade Association (EFTA), which includes Switzerland, Norway, Lichtenstein, and Iceland.

A Preferential Trade Agreement (PTA) with The Southern Common Market, commonly known as MERCOSUR and consisting of Brazil, Argentina, Paraguay, and Uruguay, has been operational since 2016. Although the market opening's extent is somewhat

restricted, the PTA sets up a legal and institutional framework to manage South Africa's trade affairs with these influential Southern nations, creating additional possibilities to augment the country's export growth (Department of Trade, Industry, and Competition (2023))

As highlighted by National Treasury (2023), South Africa still faces challenges that can impact both domestic and foreign business relationships. These include:

- **Management efficiency:** this is a concern, with issues such as corruption, mismanagement in the government, violent crime, insufficient infrastructure, and poor government service delivery raising questions about the country's political, economic, and regulatory capabilities;
- **Disruption to electricity supply:** this significantly affects the output and productivity of existing firms, particularly in the mining and manufacturing sectors. Power shortages curtail production and impact exports;
- **Protracted strikes:** they further contribute to reduced production and output, leading to supply disruptions for certain products. These labour disputes have an adverse effect on the stability and competitiveness of South Africa industries;
- **Exchange rate:** high inflation poses challenges for South African firms, affecting their competitiveness in international markets. Disciplined government spending is crucial to reduce vulnerability to capital outflows and create an environment that supports investment and maintains a competitive real exchange rate.

Addressing these challenges is essential for South Africa to foster a conducive business environment and ensure sustainable economic growth.

- **Regularity and legislative uncertainty**

The South African mining and minerals policy framework, which governs exploration, mining, beneficiation, and related downstream industries, is rooted in the Constitution of the Republic of South Africa (OECD, 2017). Key legislation, such as the Minerals

and Petroleum Resources Development Act (MPRDA), plays a vital role in regulating the sector.

The country's policies prioritize support for investment in exploration activities, expansion of production capacity, competitiveness enhancements in mining value chains, and mineral beneficiation (SAIC, 2022). South Africa has implemented industrial policies and support mechanisms to mitigate risks associated with private equity capital financing for exploration and new resource development in the mining sector. Policy amendments, such as reducing time frames for obtaining prospecting, environmental, and water use licenses, aim to stimulate new mining investments (SAIC, 2022).

When considering investment opportunities, investors typically assess three factors: the regulatory framework governing mining activities, a stable legal environment, and economic stability, which includes currency stability (Morrel, 2008). While South Africa has a well-established regulatory system and a stable legal environment, economic stability has become a challenge. The country's economy is currently grappling with unexpected flooding disasters, volatile exchange rates and interest rates, high unemployment rates, inflation, and poor energy supply. These factors erode investor confidence and perception.

- **Labour unrest**

The mining sector in South Africa has experienced a significant number of strikes in recent years, primarily driven by disputes over wages and employment conditions. These strikes have had a detrimental impact on businesses, employees, their families, and ultimately, the economy. The duration of these strikes is particularly concerning for a developing country like South Africa.

In 2022, the mining industry faced approximately 88 workdays lost due to strikes in just the first half of the year. One notable strike occurred at Sibanye Stillwater's three gold mines, where 31,000 workers engaged in a three-month-long strike due to dissatisfaction with wages (Masweneng, 2023). This strike had a significant impact on the mine's gold output, which decreased by 63% (Naidoo, 2022).

An example of the economic impact of strikes in the mining industry can also be seen in the platinum sector. The labour stoppage in 2012 resulted in approximately R18 billion in lost revenue and a production loss of 900,000 ounces (Tenza, 2020). The frequency of strikes in South Africa is evident in the data provided by the Department of Labour, which in 2023 recorded 114 strikes and 88 strikes in 2014 (Figure 41). One of the largest strikes involved 70,000 mine workers from Lonmin, Marikana, and Impala who went on strike for better wages, lasting for five months. This extended strike pushed the economy to the brink of recession, and it was followed by a four week strike in the metals and engineering sector.

These strikes demonstrate the ongoing challenges faced by the mining sector in South Africa, highlighting the need for effective resolution mechanisms and improved labour relations to minimize disruptions and foster stability (Seedat, 2013).

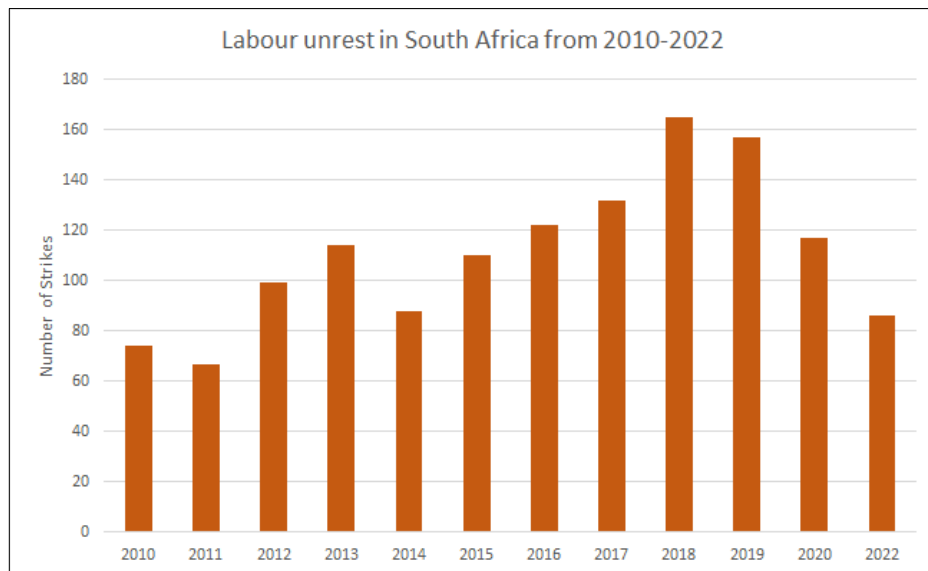


Figure 41. Labour unrest in South Africa (2010-2022). Source: Labour Department (2019) and Masweneng (2023)

Strikes in the mining industry are primarily driven by several factors such as low wages, demands for permanent employment, better working conditions (particularly health and safety concerns), and the lack of personal protective equipment. These issues contribute to labour unrest and have significant implications for various stakeholders.

According to Tenza (2020), the consequences of labour unrest in the mining industry extend beyond the immediate impact on workers and employers. The citizens of South

Africa are affected as well, as strikes often lead to increased unemployment rates and a decline in the overall standard of living. Moreover, the perception of the country as having a poor and unreliable business environment can deter potential investors, resulting in reduced investment opportunities. This, in turn, hampers economic growth and development.

Addressing the root causes of labour disputes in the mining industry, such as fair wages, improved working conditions, and job security, is crucial not only for the well-being of workers but also for the stability and prosperity of the industry and the wider economy. Effective mechanisms for negotiation and conflict resolution are necessary to promote a harmonious labour environment and maintain a positive investor perception of South Africa's business climate.

- **Lack of skills**

The absence of sufficient skills poses a significant challenge to the successful transition towards downstream mineral beneficiation (Lundal, 2008). The presence of innovative and well-educated employees is crucial for maintaining a strong economy. The skill level of employees will ultimately determine the ability of the mining industry and the country as a whole to effectively implement high-level downstream mineral beneficiation initiatives.

The preparedness of South Africa to transition into downstream mineral beneficiation relies on the availability of suitable human capital and a supportive policy framework. These aspects are further explored and analyzed in Chapter 4,5, and 6.

3.5. Chapter Conclusion

The case studies on China, Canada, and the USA demonstrate the importance of several key factors for successful downstream beneficiation of resources. These factors include:

- A favorable political and legal environment;
- An attractive economic environment;

- Access to reliable technology;
- Stability in the socio-cultural environment; and
- A competitive domestic business environment.

While mineral resources offer significant income and wealth potential, their abundance does not guarantee sustained economic growth and development. Without diversification, an economy overly reliant on mineral wealth may face challenges. The countries discussed in the case studies have excelled in diversification, showcasing affluent industrialized economies with comparable living standards and industrial structures. This is evident in their high-value manufacturing and fabrication industries, as well as their levels of foreign direct investment (FDI) and outward direct investment (ODI).

Investors seeking to maximize their success in the global marketplace consider countries that provide a conducive environment for their investments. These investments translate into job creation, tax revenues, and economic development. Assessing a country's competitiveness is crucial in this process. The countries discussed above consistently rank high in terms of global competitiveness, as highlighted in section 2.5, which encompasses factors such as infrastructure, education institutions, macroeconomic stability, research and development, skills development initiatives, product market, market size, business environment, and innovation capability. For instance, according to the World Economic Forum's Global Competitiveness Index of 2019, the USA is ranked 2nd, Canada 14th, and China 38th among 141 economies.

Skills development and initiatives play a vital role in downstream beneficiation and economic diversification. Investment in human resources and skills training is crucial for the success of the downstream sector. This requires collaboration between governments, industries, and educational institutions to ensure an adequate supply of skilled labour for the transition into downstream activities. While the mining and mineral extraction sector may provide limited direct employment, the majority of employment opportunities lie in the manufacturing industry, as evident in the developed countries mentioned above.

This is why many developing countries, like South Africa, have implemented policies to accelerate downstream mineral beneficiation. By focusing on these key factors and promoting skills development, countries can enhance their economic growth and create sustainable industries beyond resource extraction.

- **Minerals Beneficiation in South Africa**

South Africa's mining sector plays a significant role in the country's economy, which is why the country has made efforts to promote downstream mineral beneficiation. However, the levels of beneficiation have remained relatively low, mainly focused on capital-intensive sectors such as smelting and refining.

There are several challenges that hinder the mining industry in South Africa to extend beyond extraction and encompasses manufacturing processes. South Africa faces challenges in infrastructure, particularly in the energy sector, with power shortages and unreliable supply affecting the output and productivity of mining and manufacturing sectors. Inadequate investment in freight rails, roads, and port terminals also hampers transportation efficiencies.

The mining and minerals policy framework in South Africa is based on the Constitution and is supported by relevant legislation. However, concerns about labour unrest due to low wages, demands for permanent employment, better working conditions, and lack of skills continue to affect the industry. These strikes have negative economic consequences, including reduced production, supply disruptions, and investor perception of the country's business environment.

South Africa's membership in regional agreements such as SADC and SACU, as well as trade agreements like AGOA, provides access to key markets and facilitates economic growth. However, challenges related to management efficiency, electricity supply disruptions, protracted strikes, and exchange rate volatility impact domestic and foreign business relationships. To overcome these challenges, South Africa needs to address constraints in accessing raw materials for local beneficiation, invest in infrastructure development, ensure a stable and competitive business environment, and promote skills development. By addressing these issues, South Africa can unlock

the full potential of its mining sector and achieve sustainable economic growth and development.

- **Learnings from China, Canada and U.S.A.**

The case studies of China, Canada, and the USA exemplify how factors such as a supportive political and legal setting, a thriving economic environment, reliable technology, socio-cultural stability, and a robust domestic business sector can significantly enhance the successful downstream beneficiation of resources. The highlighted nations have illustrated successful diversification by developing flourishing industries and attracting foreign investments. Furthermore, they have invested in skills development, essential for downstream activities and economic diversification.

South Africa, despite having a rich mining sector, has faced challenges in implementing similar diversification and beneficiation due to factors such as:

- Inadequate infrastructure of energy access and transportation;
- Labour unrest;
- Labour force competitiveness/Skills shortage; and
- Fluctuating exchange rates.

To improve, South Africa must address these constraints, increase infrastructure investment, foster a stable and competitive business climate, and encourage skills development. By doing so, South Africa can fully harness its mining sector's potential for sustainable economic growth and development. It is clear that the aforementioned key factors, when strategically implemented, can positively affect resource-rich nations' economic outcomes and competitiveness in the global marketplace.

As previously highlighted, this study will address one of the identified challenges of labour force competitiveness or skills shortage. The readiness of South Africa to shift towards downstream mineral beneficiation is contingent upon the presence of suitable human capital and a conducive policy environment. These factors will be delved into and examined more thoroughly in Chapter 4 and 5, and 6 where their significance and impacts are explored in detail.

4.1. Introduction

This chapter outlines the qualifications available in the South African Mining Sector. The aim is to evaluate their adequacy for facilitating the transition and readiness for downstream beneficiation.

4.2. Collaborative Qualifications in the Mining Industry: A Comprehensive Overview

The development of advanced skills is a crucial element for the progression and sustainability of the mining sector (Venier, 2014). Over the years, the mining industry in South Africa has consistently supported higher education infrastructure developments, offered bursaries and scholarships, facilitated teaching and administrative expenses, and sponsored a multitude of students at tertiary education institutions throughout the country (Mining Qualifications Authority, 2017).

Qualifications that are offered in the mining sector through the collaboration of tertiary institutions, the MCSA, government, and the private sector include:

- Certificate in Advanced Mine Survey
- Certificate in Advanced Mine Valuation
- Certificate in Advanced Rock Engineering
- Certificate in Basic Mine Sampling
- Certificate in Basic Mine Survey
- Certificate in Elementary Mine Sampling
- Certificate in Elementary Mine Sampling
- Certificate in Elementary Mine Surveying
- Certificate in Mine Environmental Control
- Certificate in Radiation Protection Monitoring Screening
- Certificate in Rock Mechanics
- Certificate in Strata Control

- Intermediate Certificate in Mine Environmental Control
- Certificate in Mine Survey Droughting

Another critical component of skills development in the mining industry and its local communities is the Adult Education and Training (AET) programme, previously referred to as Adult Basic Education and Training (ABET). Artisan development is also crucial to the enhancement of our economy and the generation of employment opportunities for the youth. The mining sector, in which artisan skills are of core value, has acknowledged this significance and has, over time, facilitated the training of numerous artisans to meet the ever-increasing demand (MCSA, 2022). Apprentices enrolled in artisan development are trained in a variety of areas, including:

- Diesel Mechanic
- Electricians
- Fitters
- Fitters and turners
- Millwrights
- Rigger ropeman
- Instrument mechanic
- Boilermakers
- Welders
- Goldsmiths
- Auto electricians
- Maintenance engineers

Support for learners in tertiary institutions is provided across a variety of disciplines, with a particular emphasis on mining engineering, general engineering, management sciences, and social sciences. 90% of this commitment and support is geared towards mining engineering and general engineering, whereas 10% is allocated to the disciplines of management and social sciences (MCSA, 2022).

This commitment is expressed through various initiatives, including learnerships, bursaries, imparting of portable skills in mechanical, electrical, and construction disciplines, internships, and adult education. The industry recognizes the importance of skills development to its long-term viability. It contributes to enhancing safety and productivity, facilitates opportunities for personal growth, aids in attracting and

retaining competent personnel, and serves as a means for workplace transformation. The mining industry also extends its support to training and skills development in communities within its operational vicinity, which is essential for driving socio-economic development beyond the mining sector (MQA, 2017).

The process of training and skills development in the mining sector is directed by several policy frameworks. These are explained in the following sections.

4.3. Policies and strategies for skills development in the mining industry

The mining sector partners with the government via organisations such as the MCSA. This collaboration aims to establish a favorable policy, legislative, and operational environment that promotes a twofold increase in real investment in mining (MCSA, 2022). This effort aligns with the objectives of the National Development Plan (NDP) to enhance South Africa's economic growth and realize the developmental and transformation vision encapsulated in the NDP.

4.3.1. Skills Development Act 97 of 1998

The Skills Development Act 97 of 1998 is the governing statute for skills development in the mining industry. In the context of enhancing the skills of South Africa's workforce, several objectives have been identified (Skills Development Act, 1998):

- (i) The first objective is to elevate the living standards of workers, augment their job prospects and their mobility within the labour market;
- (ii) The second objective is to enhance workplace productivity and competitiveness of employers;
- (iii) The promotion of self-employment forms the third objective; and
- (iv) Lastly, there is a focus on improving the delivery of social services.

Furthermore, the Act emphasizes the need to boost the investment levels in education and training within the labour market and to enhance the returns on such investments. Employers are urged to:

- (i) Transform the workplace into a dynamic learning environment;
- (ii) Offer employees the opportunity to acquire new skills;
- (iii) Create opportunities for new entrants to gain work experience; and
- (iv) Employ individuals who face difficulties in securing employment.

The Act encourages workers to participate in leadership and other training programs, and it aims to improve the employment prospects of individuals who were previously disadvantaged by unfair discrimination. It seeks to redress these disadvantages through training and education.

Moreover, the Act highlights the need to ensure the quality of education and training in and for the workplace. It seeks to assist work-seekers in finding employment, help retrenched workers to re-enter the labour market, and aid employers in finding qualified employees.

This strategy is to be executed by establishing an institutional and financial framework that includes the National Skills Authority (NSA) and Sector Education and Training Authority (SETA). The strategy also encourages public-private partnerships to provide education and training in and for the workplace and promotes cooperation with the South African Qualifications Authority.

4.3.1.1. National Skills Authority (NSA)

The National Skills Authority (NSA) has been established with the mandate to advise the Minister on a range of matters. These include (i) a national skills development policy; (ii) a national skills development strategy; (iii) guidelines for the execution of the national skills development strategy; and (iv) the distribution of subsidies from the National Skills Fund; and (v) any regulations to be made.

Moreover, the NSA is tasked with liaising with SETAs regarding (i) the national skills development policy and (ii) the national skills development strategy. The Authority is also required to provide reports to the Minister in a prescribed format, detailing the progress made in the implementation of the national skills development strategy.

The NSA holds the authority to conduct investigations on any matter that arises from the application of the skills development act. Furthermore, the NSA is granted

additional powers and duties as provided by this Act. Notably, the Authority has been conferred certain prescribed powers of entry, as well as the authority to question and inspect for the purposes of the aforementioned investigations. The Authority is obligated to execute its functions in accordance with the Act and its constitution.

The NSA holds a functional role in the establishment of a SETA, complete with a constitution, for any national economic sector. The objectives of the NSA policy are designed to align training within private corporations with the New Growth Path, as detailed in Chapter 1, and to enhance the role and performance of Technical and Vocational Education and Training (TVET) colleges. In response to the NSA policy, the MQA has developed a strategic plan that places emphasis on fostering internship and placement opportunities for unemployed youth within the workplace (Figure 42).

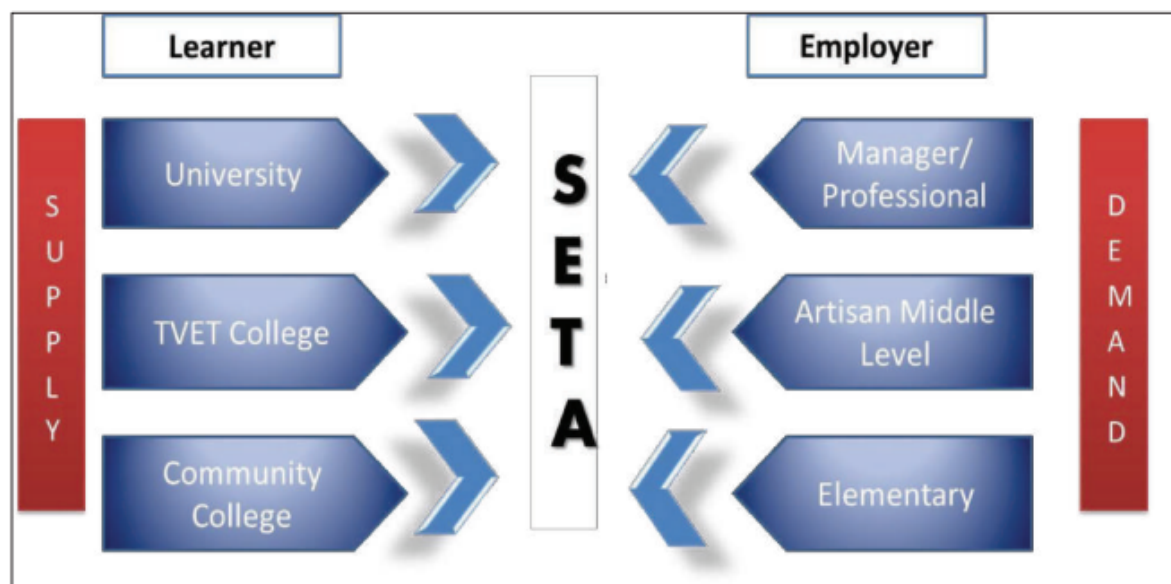


Figure 42. Linkage of Education and the Workplace through SETAs. Source: NSDP 2030 (2019).

- Mine Health and Safety Act of 1996

The Mine Health and Safety Act, 1996 (Act 29 of 1996) Section 41(3) established the MQA on June 1996 to advise the Ministers of Minerals and Energy (now the Minister of Mineral Resources and Energy) on:

- i. The creation of a framework for qualifications and learning achievements in the mining industry to improve health and safety standards through proper training and education;
- ii. Standards and competency setting, assessment, examinations, quality assurance and accreditation in the mining industry; and
- iii. Linking and qualifying framework for the mining industry to the National Qualification Framework referred to in the National Qualifications Framework Act, 67 of 2008.

- Mineral and Petroleum Resources Development Act of 2002

This act stipulates that the Minerals and Mining Development Board must collaborate with the MQA to guarantee the promotion of human resources development within the minerals and mining industry.

- Skills Development Act, Act 97 of 1998

Under the Skills Development Act, a SETA as outlined in Figure 42 is mandated to:

- a) Formulate a sector skills plan within the context of the national skills development strategy;
- b) Implement its sector skills plan by:
 - i. Establishing learnerships;
 - ii. Approving workplace skills plans;
 - iii. Allocating grants in the prescribed manner to employers, education and training providers, and workers; and
 - iv. Overseeing education and training within the sector;

The SETA is also required to promote learnerships by:

- (i) Identifying workplaces for practical work experience;
- (ii) Supporting the development of learning materials;
- (iii) Enhancing the facilitation of learning; and

- (iv) Assisting in the conclusion of learnerships agreements.

Moreover, it must liaise with the National Skills Authority on:

- (i) The national skills development policy;
- (ii) The national skills development strategy; and
- (iii) Its sector skills plan.

As for the mining and mineral sector, the MQA outlines several priority actions:

- Monitoring and supporting interventions that aim at developing the necessary skills for minerals beneficiation;
- Continuing to support interventions to enhance Mine Health and Safety via skills development;
- Continuously monitoring and providing support to interventions that respond to technological changes through skills development;
- Emphasizing the increase of support for core mining-related skills and hard-to-fill occupations in terms of skills development within the mining and minerals sector;
- Developing skills for environmental sustainability; and
- Supporting National Strategies and Plans through skills development.

4.3.1.2. National Skills Development plan (NSDP)

In the context of South Africa's NSDP, the primary objective is to ensure the availability of quality, appropriate, and adequate skills that contribute to the country's economic growth, job creation, and social development (NSDP Plan 2030, 2019). The NSDP is part of the broader government initiative, the NDP.

The NSDP's goals include the identification and increase in the production of high-demand occupations. This is intended to enhance the responsiveness of the post-school education and training system to the economy's needs, as well as the broader developmental objectives of the country.

Moreover, the NSDP supports planning processes within the post-school education and training sector. This pertains especially to enrolment planning, resource allocation prioritization decisions, qualification development, and career information and advice.

Furthermore, the NSDP is committed to establishing connections between education and the workplace. It backs workplace-based learning through various policies and strategies, which include, but are not limited to, the Skills Development Act (SDA), the NDP, the NGP, the SETA Workplace-based Learning Programme Agreements Regulations, the National Skills Accord, the Youth Employment Accord, and the National Youth Policy 2014 – 2019.

The role of the SETAs as intermediary bodies is vital in bridging the gap between the world of work and education. For instance, SETAs like the MQA are tasked with facilitating and brokering the linkages between the labour market, employers, sectors, and the education and training institutional supply. Figure 41 depicted below illustrates the positioning of skills levy institutions as entities aiming to connect demand with supply.

One of the goals of the NSDP is to elevate the skill level within the South African workforce. This is pursued through the NGP, which advocates for enhanced workplace training for existing employees to boost productivity and spur overall economic growth and development. In response to this, the Mandatory Grant, Discretionary Grant, and Administration budgets of the SETAs are set to undergo review, as SETAs are mandated to support employed workers.

Moreover, the NSDP aims to bolster the growth of public college institutions, such as TVET colleges, as key contributors to the skills necessary for socio-economic development. The plan characterizes TVET colleges as the foundation of the post-school education and training system in South Africa and proposes a broadening of these institutions to accommodate the largest enrolment growth in the post-school system.

The NDP also positions TVET colleges as critical elements of the emerging post-school system and as essential for socio-economic development. It suggests that the expansion of robust TVET colleges will extend the provision of mid-level technical and occupational qualifications, which will directly translate into work opportunities for the increasing numbers of young individuals exiting the schooling system.

A significantly expanded TVET institutional environment will also alleviate the higher education institutional environment, which is currently under stress due to high demand driven by student aspirations for post-school education and a lack of alternative and appealing opportunities elsewhere in the post-school education and training system. Again, SETAs are tasked with establishing linkages between these institutions and the workplace.

Another institution recognized by the NSDP is the Community Education and Training Colleges (CET). These colleges are designed to meet the educational and skills needs of a large number of adults and young people in need of education and training opportunities, those unemployed, and those employed in low or semi-skilled occupations.

A significant proportion of South Africans have educational levels below the National Senior Certificate, and opportunities for education and work for these individuals are limited (StatsSA, 2018). Thus, one of the goals of the NSDP is to establish a differentiated institutional framework that caters to the diverse needs of communities, individuals, and society at large.

CET colleges aim to provide programs responsive to community needs, equipping individuals with the capacity to secure employment, start businesses, develop sustainable livelihoods, and progress into other education institutions. These colleges will also aim to facilitate collaboration among community organisations, institutions, local government, individuals, and local businesses to collectively develop their communities by leveraging existing knowledge and skills.

The NSDP also promotes and supports worker-initiated training. Furthermore, the NSDP endorses career development services, as they are essential components of successful skills development initiatives. SETAs are tasked with this responsibility and are expected to foster career guidance initiatives within their sectors and more broadly as a critical element of the NSDP.

The following chapter will highlight the training and skills development initiatives at Moab Khotsoeng. This examination aims to provide a clear depiction of the industry's training programme within the context of the government's policy framework and expectations for skills development.

4.4. Chapter Conclusion

The chapter provides a comprehensive understanding of the various facets of skills development in South Africa's mining industry and the policy frameworks that guide them. It starts by highlighting the various initiatives employed by the companies, such as learnerships, bursaries, internships, and adult education. It emphasizes the industry's recognition of the importance of skills development for its long-term viability, enhancing safety and productivity, fostering personal growth, attracting and retaining competent personnel, and promoting workplace transformation.

The chapter also discusses the development of advanced skills as a crucial element for the progression and sustainability of the mining sector. It describes the sector's support for higher education infrastructure developments, offering of bursaries and scholarships, and sponsorship of students at tertiary education institutions. A list of qualifications offered through collaborations between tertiary institutions and the MCSA is also provided.

The role of AET programs and artisan development in the local communities and the mining industry is also discussed. The various areas of training for apprentices enrolled in artisan development are listed.

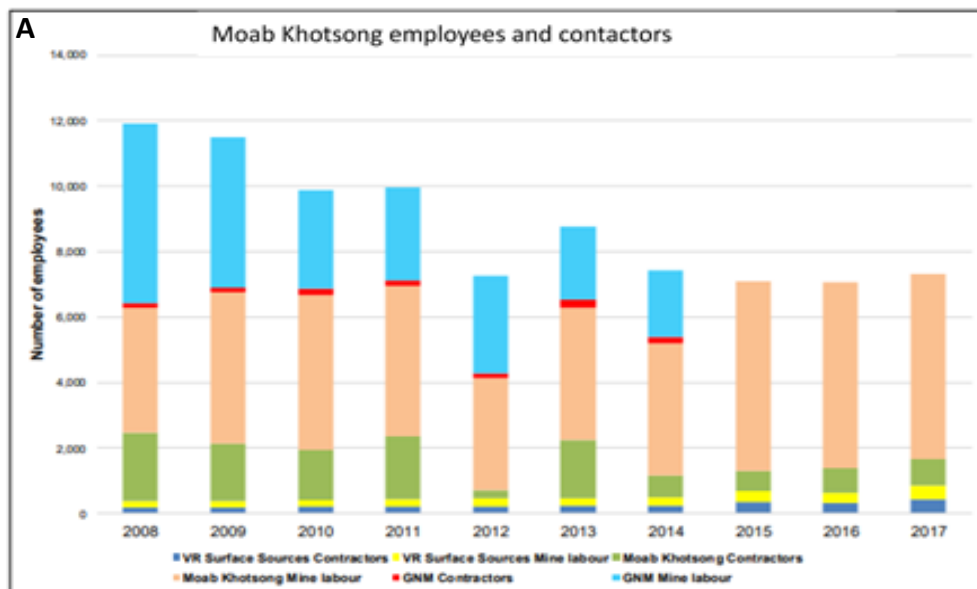
The chapter proceeds to review the policy frameworks that guide training and skills development in the mining sector, including the Skills Development Act 97 of 1998 and the role of organisations such as the NSA and the SETAs. The primary functions of these organisations, their mandates, and their objectives are examined in detail.

In the next chapter, the analysis will focus on examining the degree of compliance exhibited by mining corporations as demonstrated by Harmony Gold's Moab Khotsoeng Mine.

5.1. Training Department Overview at Harmony Moab Khotsong Operations: Insights from the 2018-2022 Harmony Gold Social and Labour Plan (SLP).

5.1.1. Workforce Composition

Moab Khotsong currently has a workforce of 6551 employees, which includes contractors, and 3594 of these employees are engaged in underground work. Significant restructuring and job reductions following the financial crisis of 2008-2009 led to a decrease in employment from 12000 in 2008 to 6551 in 2017 (Figure 43A). The majority of the employees are black individuals hailing from various labour-sending communities (Figure 43B). A detailed breakdown of the employee composition, including contractors in and around Moab Khotsong Mine, is depicted in Figures 43A, B, and C.



B

Area of Employment	Black	Coloured	Indian	White	Male	Female	Grand Total
Moab Khotsong & Great Noliwa Mine	5032	15		338	4795	590	5385
Care and Maintenance GN Mine	15			7	21	1	22
Mispah	56			6	48	14	62
Noliwa Plant	178	5		50	186	47	233
South U Plant	98	5		30	109	24	133
Nufcor	23			4	21	6	27
Great Noliwa PHC	19			1	5	15	20
MOAB Khotsong PHC	15	1			7	9	16
Noliwa Residence	113			7	68	52	120
Properties Central	10			12	13	9	22
Community and Social Development	3				2	1	3
VRM	8			16	13	11	24
ATDS Trainees - Moab and GNM	51	1	2	7	44	17	61
Occupational Health	45	3		8	36	20	56
VR Tailings	35	2	1	14	11	41	52
MET Security	68			23	23	68	91
SAMS / Management	27	1		14	23	19	42
ATDS Engineering Training	15	3		23	10	31	41
ATDS Gateway	40			13	10	43	53
Engineering	78	3		28	16	93	109
High Density Central and Core Maintenance	3			7	2	8	10
High Density Boarding House	19			2	15	6	21
Central WH South U Plant	15			1	3	13	16
Environmental Management	4	1	1	11	5	12	17
Total	5 970	40	4	622	950	5 686	6 636
Percentage of Total Workforce	90%	0.6%	0.06%	9.4%	14.3%	85.7%	100%

C

Area of Employment	RSA	Botswana	Lesotho	Mozambique	Swaziland	Zimbabwe	Total
Moab Khotsong & Great Noliwa Mine	3594	22	899	701	167	2	5385
Care and Maintenance GN Mine	14		2	3	3		22
Mispah	61		1				62
Noliwa Plant	226		4	1	2		233
South U Plant	128	1	2	1	1		133
Nufcor	27						27
Great Noliwa PHC	20						20
MOAB Khotsong PHC	16						16
Noliwa Residence	98	1	18	2	1		120
Properties Central	22						22
Community and Social Development	3						3
VRM	23				1		24
ATDS Trainees - Moab and GNM	58		2	1			61
Occupational Health	55		1				55
VR Tailings	49		1		2		49
MET Security	91						91
SAMS / Management	41		1				41
ATDS Engineering Training	41						41
ATDS Gateway	49		3	1			49
Engineering	105		3	1			105
High Density Central and Core Maintenance	9		1				9
High Density Boarding House	18		3				18
Central WH South U Plant	14	1			1		14
Environmental Management	17						17
Total	4 779	25	941	711	178	2	6 636
Percentage of Total Workforce	72%	0.4%	14.2%	10.7%	2.7%	0.03%	100%

Figure 43. Moab Khotsong employees and contractors (2008-2017). A. Total number of Employees, including contractors at Moab Khotsong operations. B. Profile of employees by race. C. Breakdown of employee's location. Modified after Harmony Moab Khotsong Operations' SLP 2018-2022.

5.1.2. Company skills development objectives

Looking to the future, the company's objectives for skills development include exploring new methods of learning to cultivate diverse skill sets, aligning with the Fourth Industrial Revolution to support the business with effective learning interventions, and promoting a philosophy of lifelong learning. The company is also committed to offering study assistance programs to its employees who wish to further their studies at accredited institutions, especially in areas identified as having critical skills shortages or being key development areas (Harmony Moab Khotsoong Operations' SLP 2018-2022).

5.1.3. Human Resource Development (HRD) Strategy at Harmony Gold

Harmony's HRD strategy is designed to comply with South Africa's legislative and regulatory frameworks that aim to counter the country's overall skills deficit. This strategy outlines a holistic approach for executing people development.

The emphasis of future training, development, and capacity building initiatives is on supporting this strategy by educating employees, directly gauging the impact of training measures on employees' skills and evaluating whether such measures offer a satisfactory return on investment.

A study was carried out at Harmony to comprehend the existing situation and then determine the ideal future state concerning learning and development. This examination focused on the current learning and development opportunities available at Harmony that support the business strategy and strategic focus area, contrasted with what ideally should be in place.

The following areas were recognized as needing immediate attention:

- The full potential of training needs, performance management systems, and talent management systems is not being exploited to drive training and development initiatives;

- While efforts are being made to enhance capability for future requirements, a more comprehensive approach is necessary, especially in relation to granting bursaries, internships, learnerships, and programs aimed at developing on-the-job experience and experiential trainees;
- Training interventions for non-core disciplines are happening without clearly defined career paths;
- Initial and refresher technical training is bundled into modules or skills programs where the main focus is on acquiring technical capability, without considering how specific roles interact within the business; and
- The training provided primarily focuses on basic and minimum requirements.

The company's learning and development model and approach is outlined below (Figure 44):

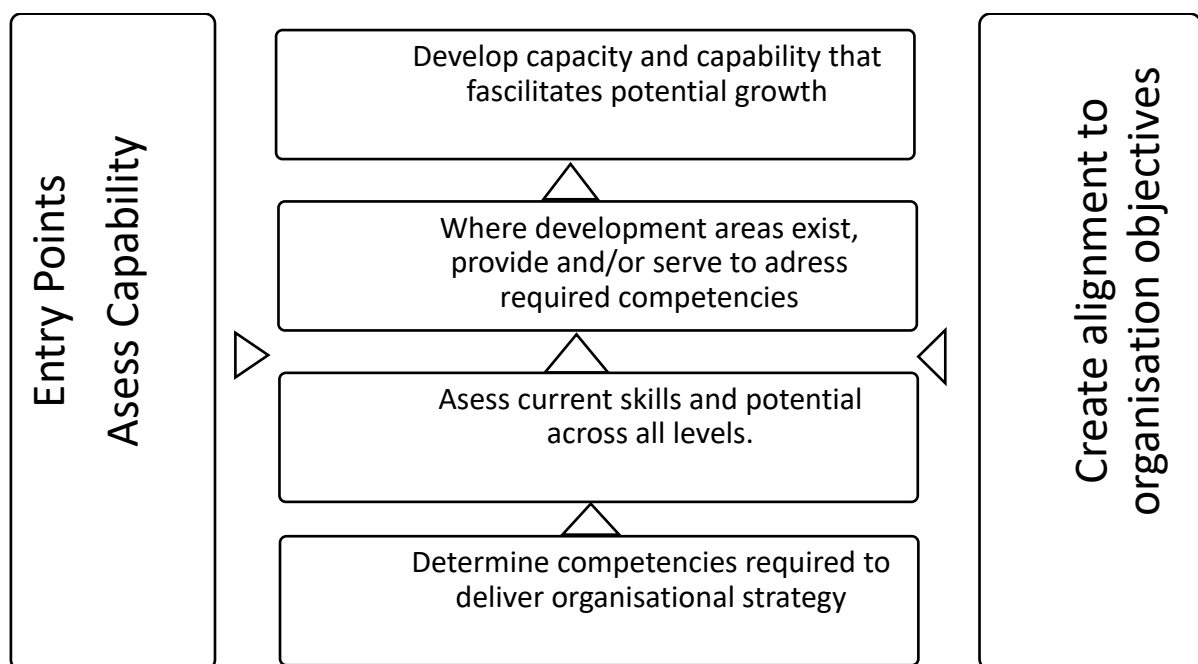


Figure 44. Harmony's learning model. Source: Modified after Harmony Gold, 2022.

The designated model (Figure 43) lays out a number of areas requiring focused effort in order to optimally deliver on the company's goals. Firstly, it advocates for an agreed-upon learning and development plan that is supported by a specific funding model. This plan is intended to amplify both individual and organisational capacities to meet immediate and future operational needs. Secondly, the models propose the integration

of student development programs, such as internships, graduate schemes, bursaries, and learnerships, into an ongoing talent pipeline.

Further strategies involve developing processes for continuously analyzing learning needs and executing a return-on-investment exercise to map out future skills requirements, while also enhancing current skills programs. Consistent and standardized delivery of mandatory and statutory training is also prioritized in these models, as is the need to ensure compliance with applicable legislative requirements and regulations.

To foster personal and professional growth, these strategies aim to link career paths to each employee's individual development plan and to use competency frameworks as a basis for identifying development needs and goals.

5.1.4. Skills development programs at Moab Khotsong

Table 9 outlines Moab Khotsong's five-year strategy aimed at optimal employee development in compliance with the MPRDA and mining charter, specifically The Broad-based Socio-economic Empowerment Charter for the South African Mining and Minerals Industry. It shows Moab Khotsong's commitment to its SLP, which encompasses the company's workforce as well as its host and primary labour sending communities. This presents the 2018-2022 human resource development financial allocations as a proportion of the payroll. In terms of obligations, Moab Khotsong not only fulfils but surpasses the charter's stipulations regarding financial resources dedicated to training.

Table 9. Comparison between Moab Khotsong human resource development commitments and the Mining Charter requirements of the 2018-2022 financial provision target as a percentage of payroll. Source: Harmony Moab Khotsong Operations' SLP 2018-2022.

	Moab Khotsong	Mining Charter
Target for 2018	5%	3%
Target for 2019	5.25%	3.5%
Target for 2020	5.5%	4%
Target for 2021	5.75%	4.5%
Target for 2022	6%	5%

5.1.4.1. Programs offered at Moab Khotsoong and labour sending communities

- Adult Basic Education and Training (ABET)

The goal of ABET is to enhance literacy and numeracy levels, respond to market needs, and equip individuals with knowledge and skills that enrich both the individuals and the company. It promotes personal growth and is open to all employee classifications within the organisation. ABET serves as a general conceptual foundation for lifelong learning and development, encompassing the knowledge, skills, and attitudes necessary for social, economic, and political participation and transformation across a variety of contexts.

The company offers ABET programs such as Pre-ABET, ABET levels 1, 2, 3, & 4, and the Foundational Learning Component (FLC) in the region at different residences and full-time community centers. ABET is provided on a part-time basis, free of charge to the learners who participate during their non-working hours, ensuring It is accessible to all employees.

The plans for the ABET attendees for the years 2021-2022 are outlined in Table 10. In 2022, the plan was to train a total of 62 employees from historically disadvantaged backgrounds, which is a decrease from the 79 employees who were scheduled for training in 2021.

Table 10. ABET attendees for 2020-2022. Source: Harmony Moab Khotsoong Operations' SLP 2018-2022.

ABET Enrolments Planned for 2021												
	MALE					FEMALE					OVERALL TOTAL	TOTAL HDISA
	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL		
Pre ABET	10	0	0	0	10	0	0	0	0	0	10	10
ABET 1	17	0	0	0	17	0	0	0	0	0	17	17
ABET 2	10	0	0	0	10	2	0	0	0	2	12	12
ABET 3	7	0	0	0	7	0	0	0	0	0	7	7
ABET 4 Fund / FLC / GETCA	31	0	0	0	31	2	0	0	0	2	33	33
TOTALS	75	0	0	0	75	4	0	0	0	4	79	79
VR ABET Enrolments Planned for 2022												
	MALE					FEMALE					OVERALL TOTAL	TOTAL HDISA
	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL		
Pre ABET	7	0	0	0	7	0	0	0	0	0	7	7
ABET 1	14	0	0	0	14	0	0	0	0	0	14	14
ABET 2	9	0	0	0	9	0	0	0	0	0	9	9
ABET 3	6	0	0	0	6	0	0	0	0	0	6	6
ABET 4 Fund / FLC / GETCA	26	0	0	0	26	0	0	0	0	0	26	26
TOTALS	62	0	0	0	62	0	0	0	0	0	62	62

- Portable Skills

This program aims to provide transferable skills training to interested employees, particularly those who are incapacitated or laid off. Each employee is entitled to take one course free of charge, equipping them with skills applicable outside the mining sector. According to table 8, in 2022, 82 delegates were planned to be trained in the 8 courses detailed in the table. There has been a gradual decline in the number of trainees since 2018 as illustrated in Table 11.

Table 11. Summary of portable skills Training Planned for 2018-2022. Source: Harmony Moab Khotsoong Operations' SLP 2018-2022.

	Number of:	Number (Delegates)	Duration (Days)	Number of courses and delegates planned for Moab Khotsoong Operations per year									
				2018		2019		2020		2021		2022	
				Courses	Delegates	Courses	Delegates	Courses	Delegates	Courses	Delegates	Courses	Delegates
Basic Welding		10	8	1	10	0	0	1	10	0	0	1	10
Basic Wiring		10	8	1	10	1	10	0	0	1	10	0	0
Basic Brick Laying		10	13	0	0	1	10	0	0	1	10	1	10
Basic Plumbing		10	13	1	10	0	0	1	10	0	0	1	10
Basic Computer		10	7	1	10	0	0	1	10	0	0	0	0
Basic Carpentry		10	13	0	0	0	0	0	0	1	10	1	10
Basic Engine Service		10	8	0	0	0	0	1	10	0	0	1	10
Basic Forklift		6	8	0	0	1	6	0	0	1	6	0	0
Basic Refrigeration		10	13	0	0	1	10	1	10	0	0	0	0
Sewing Course (External provider)		20	18	1	10	1	14	0	0	1	14	0	0
PC Skills (ABET learners)		15	1	6	85	5	70	4	48	4	41	3	32
TOTAL				11	135	10	120	9	98	9	91	8	82

- Trainee Programs

- Management Trainees (MT)

This is a three-year program designed to equip graduates with the skills needed for middle management roles within the company. The program provides opportunities for graduates to gain qualifications and professional accreditations.

Management trainees (MTs) are placed in positions that are critical and in scarce supply (as indicated in Table 12). Progress is competency-based, with the MTs' career development following a specific career path and promotional route. However, this progression can also be influenced by the achievement of relevant certificate of competency where applicable. The pace of progression along this career route largely depends on the individual MT's ability to demonstrate competent performance in their position and their potential for advancement to the next level.

Table 12. List of critical and scarce skills at Moab Khotsong. Source: Harmony Moab Khotsong Operations' SLP 2018-2022.

TOTAL CRITICAL AND SCARCE SKILLS		
DISCIPLINE	POSITION	OCCUPATIONAL LEVEL
Mining	Production/General Managers	Senior Management
Mining	Mining Engineers	Middle Management
Mining	Section Managers	Middle Management
Mining	Mine Overseers	Middle Management
Engineering	Engineering Managers	Senior Management
Engineering	Engineers - Electrical, Mechanical, Rock Engineers,	Middle Management
Engineering	Senior Rock Engineering Officers	Middle Management
Engineering	Artisans - Riggers, Diesel Mechanics, Instrument Technicians, etc.	Junior Management
Engineering	Winding Engine Drivers	Junior Management
MRM	MRM Managers/Geosciences Managers	Senior Management
MRM	Senior Geologists	Middle Management
MRM	Senior Surveyors/Evaluators/Planners	Middle Management
MRM	Mine Planning Technician	Middle Management
MRM	Draughtsperson	Middle Management
Metallurgy	Metallurgical Engineers	Middle Management
Metallurgy	Metallurgical Plant Managers	Middle Management
Metallurgy	Metallurgists	Middle Management

The training managers at Moab Khotsong are responsible for providing each Management Trainee (MT) with a discipline-specific training programme, as well as mentorship and/or coaching from experts in their field. Encouraging the involvement and communication of senior line managers in MT meetings, their inclusion in panels, quarterly interdisciplinary meetings, and monthly discipline meetings are all part of the program. Additionally, MTs receive further technical coaching from subject matter experts.

The MT program focuses on both training and development. The training component provides MTs with the necessary theoretical knowledge and practical experience to deliver quality service in their respective disciplines. On the other hand, the development component equips MTs with the necessary managerial and leadership skills and experience to perform responsibly at the senior management level within Moab Khotsong. The program is divided into four phases:

- Phase A: Onboarding and getting to know the business
- Phase B: Acquiring technical expertise
- Phase C: Developing specialized technical expertise
- Phase D: Taking on acting roles on the job in a substantive position to gain leadership experience.

The plans for the MTs Programmes for the years 2021-2022 are outlined in Table 13.

Table 13. Management trainees planned for 2021-2022. Source: Harmony Moab Khotsong Operations' SLP 2018-2022.

Trainee Programmes: Management Trainees Planned for 2021												
	MALE					FEMALE					OVERALL TOTAL	TOTAL HDISA
	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL		
Mining	1	0	0	0	1	0	0	0	0	0	1	1
Engineering	1	0	0	0	1	0	0	1	0	1	2	2
MRM: Geology	0	1	0	1	2	0	0	0	0	0	2	1
MRM: Survey	0	0	0	1	1	0	0	0	1	1	2	1
Metallurgy	2	0	0	0	2	0	0	0	0	0	2	2
TOTALS	4	1	0	2	7	0	0	1	1	2	9	7
Trainee Programmes: Management Trainees Planned for 2022												
	MALE					FEMALE					OVERALL TOTAL	TOTAL HDISA
	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL		
Mining	1	0	0	0	1	0	0	0	0	0	1	1
Engineering	2	0	0	0	2	0	0	0	0	0	2	2
MRM: Geology	1	0	0	1	2	0	0	0	0	0	2	1
MRM: Survey	0	0	0	0	0	0	0	0	0	0	0	0
Metallurgy	1	0	1	0	2	1	0	0	0	1	3	3
TOTALS	5	0	1	1	7	1	0	0	0	1	8	7

- Learner Officials

The Learner Official Programmes are internal internship programmes that run for a duration of three years. They are designed to equip non-graduates and non-diploma holders with the skills necessary for supervisory roles, such as shift bosses. Upon completion of the programme, learner officials are placed in critical skills positions.

The primary objective of this training is to offer learner officials the theoretical knowledge, hands-on experience, and workplace exposure required to achieve competency at an official level. Moreover, the programme equips learners with the necessary skills to be considered for appointment as officials in entry-level supervisory positions within their respective disciplines. Available learnerships programs for employees include mining learnerships, Plan Rock Breaker learnerships in mining (LMPRB), and engineering learnerships.

The training is organized into three phases: Phase A focuses on entry requirements and service departments, Phase B is discipline-specific, and Phase C is centered on supervisory development. The plans for the Learner Official Programmes for the years 2021-2022 are outlined in Table 14.

Table 14. Leaner Officials planned for 2021-2022. Source: Harmony Moab Khotsong Operations' SLP 2018-2022.

TOTALS	4	0	1	3	8	1	0	0	0	1	9	6
Trainee Programmes: Learner Officials Planned for 2021												
	MALE					FEMALE					OVERALL TOTAL	TOTAL HDSA
	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL		
Engineering	1	0	0	0	1	0	0	1	0	1	2	2
MRM	1	0	0	1	2	0	0	0	0	0	2	1
Occupational Environment	1	0	0	1	2	1	0	0	0	1	3	2
Safety	1	0	0	1	2	0	0	0	0	0	2	1
TOTALS	4	0	0	3	7	1	0	1	0	2	9	6
Trainee Programmes: Learner Officials Planned for 2022												
	MALE					FEMALE					OVERALL TOTAL	TOTAL HDSA
	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL	AFRICAN	COLOURED	INDIAN	WHITE	TOTAL		
Engineering	1	0	0	0	1	0	0	0	0	0	1	1
MRM	0	0	0	1	1	0	0	0	0	0	1	0
Occupational Environment	1	0	1	0	2	1	0	0	0	1	3	3
Safety	1	1	0	0	2	0	0	0	0	0	2	2
TOTALS	3	1	1	1	6	1	0	0	0	1	7	6

- Community Human Resource Development Programmes (CHRD)

The objectives of CHRD programs include enhancing employment opportunities and bolstering the socio-economic welfare of mining communities. These initiatives align with national education strategies and support government initiatives. Moreover, they contribute to the advancement of Historically Disadvantaged South Africans (HDSA), consistent with the objectives of empowerment legislation and the company's commitment to promoting workplace diversity. The CHRD programs encompass:

- Portable skills for the community

As per Table 15, the plan for 2022 involves training 85 participants across the 10 courses specified in the table. This figure has remained steady since 2018.

Table 15. Summary of portable skills training offered at Moab Khotsong for the community. Source: Harmony Moab Khotsong Operations' SLP 2018-2022.

	Number (Delegates)	Duration (Days)	Number of courses and delegates planned for Moab Khotsong per year									
			2018		2019		2020		2021		2022	
			Courses	Delegates	Courses	Delegates	Courses	Delegates	Courses	Delegates	Courses	Delegates
Basic Welding	10	8	1	12	0	0	1	12	0	0	1	12
Basic Wiring	10	8	0	0	1	12	0	0	1	12	1	13
Basic Brick Laying	10	13	0	0	1	13	1	13	1	13	0	0
Basic Plumbing	10	13	1	13	0	0	1	13	1	13	0	0
Basic Computer	10	7	1	13	1	13	1	13	0	0	1	13
Basic Carpentry	10	13	0	0	1	13	0	0	1	13	1	13
Basic Engine Service	10	8	1	13	0	0	1	13	0	0	1	13
Basic Forklift	5	8	1	8	1	8	1	8	1	8	1	8
Basic Refrigeration	10	13	1	13	1	13	1	13	1	13	0	0
Sewing or Cooking or Baking Courses (External)	10	18	1	13	1	13	0	0	1	13	1	13
TOTALS				7		85		7		85		85

The company offers community members who have an accredited degree or diploma the opportunity to gain supervised work experience, which could open doors to future job prospects. During their internship, these individuals receive a stipend as determined by the budget allocation and company approval.

- Bursaries for the community

The aim is to nurture students and create a reservoir of academically proficient individuals to satisfy the future requirements of both Harmony and local municipalities. This involves synergy with existing universities, FET, governmental and non-governmental organisation (NGO) initiatives to enhance and maintain the educational qualifications and standards for the mining industry and South Africa. The company allocates bursaries to the following critical mining disciplines:

- Mining Engineering;
- Engineering;
- Metallurgy; and
- Ore Reserve Management.

5.2. Alignment with Legislation

The MQA is responsible for overseeing the skills development programmes for the mining and minerals sector in South Africa (MQA, 2017). This includes the administration of workplace skills plans, the creation of sector skills plans, and the identification of scarce skills. The MQA operates under the guidelines of the Department of Higher Education and Training, and the NSDS, which in turn is influenced by the NDP to ensure South Africa has sufficient, relevant, and high-quality skills to contribute towards economic growth, job creation, and social development.

Harmony collaborates with the MQA to offer work-integrated learning for students from labour-sending communities, who must meet MQA criteria and fields of study (Harmony Gold Mining Company Limited, 2022). The training programs chosen by each student are managed by training specialists and supervised by operational staff. The MQA, as an approved Assessment Quality Partner by the Quality Council for

Trades and Occupations (QCTO), is accredited for several registered occupational qualifications on the National Qualifications Framework (NQF). These include Mine Ventilation Observer, Emergency Service and Rescue Official, Surveyor, Mining Sampler, Strata Control Practitioner, Mine Ventilation Officer, Rock Drill Operator, Driller, Geological Technician, Hydro Metallurgist, and Material Handler.

Moab Khotsong adheres to the NDP, NGP, and the NDPS, by initiating projects outside of its core business functions to foster the development of communities in and around its mining operations and primary labour-sending areas through the company's Local Economic Development (LED) strategy (Harmony Gold Mining Company Limited, 2022). The aim is to stimulate the social and economic advancement of the disadvantaged and vulnerable populations in these regions. Harmony Gold's local economic development strategy primarily focuses on four areas:

- Social development;
- Poverty reduction;
- Job creation;
- Economic growth triggers; and
- Infrastructure development.

LED projects, agreed upon with local mining and labour-sending communities as per the SLP are consistently reviewed throughout their implementation. This review process ensures that the projects remain dynamic, adjusting to changing needs and supporting long-term sustainability.

These LED projects are guided by the local economic development plans of municipalities at both the district and municipal levels, and they align with provincial and national goals as well as their development strategies. The projects also comply with the LED objectives outlined in the Mineral and MPRDA and its regulations.

Moab Khotsong Mine is situated within the Matlosana local municipality and implements LED projects in both Matlosana (North-West) and the OR Tambo District (Eastern Cape) Municipality. Several projects have been in progress since 2018 in the townships under these municipalities (as shown in Table 16).

Table 16. Ongoing projects in townships around Moab and in Labour sending communities from 2018-2022. Source: Harmony Moab Khotsong Operations' SLP 2018-2022.

Year	2018	2019	2020	2021	2022
Budget	R6.0m	R11.9m	R6.8m	R8.5m	R13.4m
Projects 2018 - 2022	LEDP1: Community Development Contribution towards land acquisition and /or contribution towards bulk infrastructure development in Khuma by June 2017 = R4m	LEDP3: Building and equipping of Physical Science Lab in Dirang ka Natla Secondary School in Khuma = R1,9m	LEDP5: Building of 5 Classrooms, ablution facilities and Computer lab at Sediko Primary School in Jouberton =R3m	LEDP8: Khuma Sports and Recreation Complex. Upgrading of the sports facilities including revamping of ablution facilities and construction of an Athletic Track and Fields in Khuma stadium =R4m	LEDP10: Matlosana Schools Hall to be built at Matlosana Secondary School in Jouberton = R3,4m
	LEDP2: Continuation of the Vaal River Agricultural Project = R2.6m (over 2 years)	LEDP4: Establishment of an Agricultural Project in Tsolo – R10.0m (over 3 years)	LEDP6: Tshebedisano Secondary School in Jouberton - (Social Science Lab)= R1,9m	LEDP9: Building of a Primary Health Centre in Qumbu - R4.5m	LEDP11: Building of 5 Classrooms, ablution facilities and Computer lab Atamelang Primary School in Kanana =R3m
			LEDP7: Building and equipping of Physical Science Lab at Kgogaganyo Secondary School at Rammolotsi = R1.9m		LEDP12: : Refurbishment and equipping of a 2 Physical Science Labs and 2 Social Science Labs at Alabama combined school = R2m
					LEDP13: Replacement of a Mud School by building of 6 Classrooms, admin block, Early Childhood Development Centre and ablution facilities. In accordance with the Provincial Schools Priority List, in the Amatole District - R5m
	Enterprise Development: R15 million over 5 years for the development and operation of the Enterprise Development Centres.				

5.3. Chapter Summary and Conclusion

Harmony Gold's Human Resource Development (HRD) strategy is designed to conform to South Africa's legislation and regulations, which seek to counteract the country's skills deficit. It adopts a comprehensive approach to personnel development, entailing education, the assessment of training impacts on skills, and the evaluation of return on human resource investment.

Harmony's HRD strategy is planned around the exploration of innovative learning methods, aligning with the Fourth Industrial Revolution, promoting lifelong learning, and providing study assistance to employees in critical skill areas. Moab Khotsong Mine exhibits a firm commitment to its Social and Labour Plan (SLP), encompassing not only the company's workforce but also its host and major labour-sending communities. This is reflected in the dedicated financial resources for training, surpassing the requirements stipulated by the mining charter.

Several programs are on offer at Moab Khotsoeng, including the Adult Basic Education and Training (ABET), portable skills training, trainee programs, and community human resource development programs. These initiatives are designed to improve literacy, equip individuals with market-relevant skills, provide transferable skills training, and develop management and supervisory skills, contributing to individual growth and the overall enhancement of the company.

Furthermore, community-based programs aim to enhance the employment prospects and socio-economic welfare of the mining communities, aligning with national education strategies, government initiatives, and contributing to the upliftment of Historically Disadvantaged South Africans (HDSA).

There is an alignment between Moab Khotsoeng's skills development programs and the South African policy framework in a number of aspects. The programs follow the legislative and regulatory frameworks of South Africa, particularly the Skills Development Act 97 of 1998, which was discussed in Chapter 5. This act sets forth objectives to improve the quality of life of workers, their prospects of work and labour mobility, to improve productivity in the workplace and the competitiveness of employers, to promote self-employment, and to improve the delivery of social services.

The training and development programme at Moab Khotsoeng is structured around the above-mentioned goals. For instance, the Adult Basic Education and Training (ABET) program aims to enhance literacy and numeracy levels, equipping individuals with the capacity to secure employment and develop sustainable livelihoods. The portable skills training and trainee programs aim to provide individuals with transferable skills, which could promote self-employment. The Management Trainees (MT) program is designed to equip graduates with the skills needed for middle management roles within the company, potentially improving productivity and competitiveness. The training and development programme at Khotsoeng incorporates courses in the fields of STEM, which include disciplines like mining engineering, metallurgy, geology, and rock engineering. All these programs align with the objectives of the Skills Development Act.

However, while there is general alignment with the policy framework, there seems to be a specific area where Moab Khotsoeng's training program may not fully align.

The MQA and SAQA has outlined certain skills that are necessary for the expedition of Mineral beneficiation as per the beneficiation strategy. These skills are essential for adding value to the raw materials extracted from mines through to the fabrication or manufacturing stage. Moab Khotsong's skills and development programme, does not provide clear evidence that these specific skills for Mineral beneficiation are included in the company's training program. Therefore, while Moab Khotsong's skills development initiative aligns broadly with the South African policy framework, it does not address the skills required or needed for Mineral beneficiation. Harmony's skills development program does not clarify the actions either underway or planned to assimilate mineral beneficiation skills into the company's training program. The training program does not include the skills outlined by SAQA and the MQA in section 1.1.4.

6.1. Vision on Beneficiation

Before we delve into the company's progress in terms of skill development for mineral beneficiation, it is critical to comprehend Harmony's vision and objectives in relation to beneficiation. Harmony works closely with local communities, regulatory bodies, the government, and various stakeholders to foster trust and derive mutual benefits (Harmony Gold Mining Company Limited, 2021).

The company concentrates on initiatives that bring about positive change in neighboring communities and leave enduring legacies. Harmony also supports government-led efforts to establish diversified economies in host communities post-mining mines (Harmony Gold Mining Company Limited, 2022).

Harmony strategically aligns its efforts with national priorities such as job creation and poverty reduction. Key areas of focus include infrastructure development, human settlements, the development of alternative industries, education, and community skills enhancement, as well as procurement (Harmony Gold Mining Company Limited, 2021).

Harmony Gold has made the following commitments concerning skills enhancement, as reported in their 2022 sustainability report:

- Through Harmony's community skills development initiative, the company is committed to equipping beneficiaries with transferable skills that promote sustainable livelihoods beyond mining; and
- Harmony is committed to supporting government-led economic diversification initiatives in host countries through local procurement and enterprise development initiatives.

Following the release of the Department of Mineral Resources (DMR)'s evaluation of the mining industry's compliance with the mining charter by Minister of Mineral Resources Advocate Ngoako Ramatlodi, Harmony Gold issued a statement on March 31, 2015:

“As Harmony continues its journey to cement its future in South Africa, pro-actively participating in transforming the South African mining industry, we remain committed to identifying other opportunities to further facilitate HDSA ownership, transform our workforce, invest in developing South Africa and create opportunities for small business entrepreneurs. Our presence in South Africa is real and lasting and so will our legacy be” (Graham Briggs- Chief Executive Officer)

According to Harmony Gold, the company takes pride in its performance relative to the nine pillars outlined in the mining charter (Harmony, 2022), asserting that it not only adheres to the requirements but goes above and beyond in its commitment. These pillars encompass growth and beneficiation, reporting, ownership, housing and living conditions, procurement and enterprise development, employment equity, human resources development, mine community development, and sustainable development.

6.2. Current and Previous Mineral Beneficiation Projects at Harmony Gold

As per the Beneficiation Strategy for the Minerals Industry of South Africa, the implementation of beneficiation, as shown in Figure 45, calls for the creation of interconnected jewelry hubs throughout the nation. Additionally, it necessitates investment in skills development.

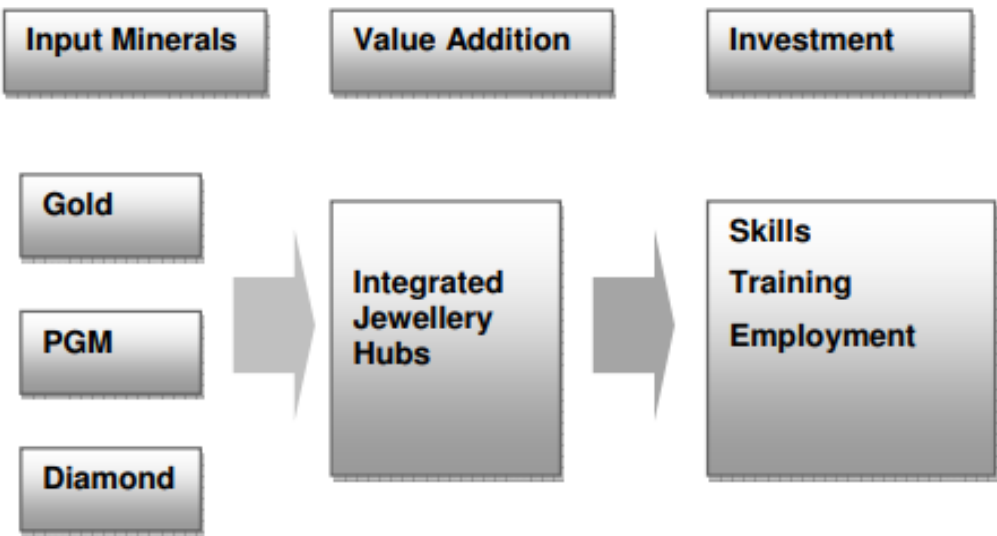


Figure 45. The Beneficiation Strategy for the Precious Minerals Industry of South Africa (2011).
Source: DMR (2011)

The implementation into these hubs, as shown in Figure 45, should involve several steps. These include the formulation of a well-structured training programme tailored to meet specific current needs, the promotion of investments in jewellery, which entails enhancing awareness of existing incentives within the jewellery sector, and the introduction of interventions from the private sector. These interventions are geared towards furthering the objectives of the strategy concerning jewellery manufacturing. These initiatives should be prioritized and provided with the necessary support for advanced development.

Low productivity within the gold industry has led to considerable restructuring and employment cuts in regions heavily reliant on gold mining. Recognizing the necessity to launch projects that generate jobs within the communities reliant on gold mining, both the national government and gold mining firms, such as Harmony Gold, have made concerted efforts. Harmony has been instrumental in initiating and facilitating an array of projects in the Free State province aimed at enhancing the downstream value of Harmony's production (DESTEA, 2018). The projects' dual objectives were to identify alternative employment opportunities in communities historically dependent on gold mining and to increase the value of Harmony Gold's output. The Projects are outlined below:

6.2.1. Musuku Beneficiation Systems

Initiated in 2001, the project was situated in Virginia in the Free State Province and was a subsidiary of the Harmony Gold Mining Company Limited. The project, which featured a gold refinery and processing factory dedicated solely to beneficiation, was celebrated as South Africa's first gold public-private partnership between Mintek - the nation's state-owned mineral and metallurgical services organisation - and Harmony Gold Mining Company (Minerals Engineering International, 2002). According to Wellmann's 2010 research, Harmony Gold wanted to operate Musuku as a utility, while Mintek aimed for it to be a profit center. As a result, Mintek withdrew from the business within the first operational year due to differing approaches by the two entities (Wellmann, 2010).

According to Wellmann (2010), the Musuku Beneficiation Systems initiative received financial support from British Aerospace (BAE) Company, which allocated \$9 million in 2001 for equipment improvements and downstream processing of gold and jewellery manufacturing, as part of its offset commitments. Wellmann also noted that some of the allocated funds remain unaccounted for, and no reports have been released on this matter to date. The project ceased operations in December 2006, with Harmony Gold Mining Company being the sole proprietor at the time of its closure.

Throughout its existence, Musuku successfully developed 15 product lines across four sectors (Wellmann, 2010; DESTEA, 2018):

- Large, small, and granulated gold bullion bars;
- Jewelry alloys (ranging from 9ct to 18ct in yellow, white, and red gold), semi-manufactured and custom-made orders, fine silver granules and crystals, gold, silver, and platinum solder blocks, bangles, wedding and blank coins;
- High purity industrial gold and silver including silver anodes for the electroplating industry and gold fuse wire and connectors; and
- Dental alloys consisting of a wide range of casting and bonding alloys, solders, and wire for restoration purposes.

6.2.2. Harmony Jewellery School

In September 2000, Harmony Gold Mining Company initiated a jewellery school in Virginia. The institution began with 20 students, culminating in the graduation of the first 12 students in December 2003. As part of their beneficiation obligation, BAE Systems contributed funding of US\$400,000 to the jewellery school in 2002/2003 (Wellmann, 2010). Moreover, the school benefitted from additional financing from the Italian government via the United Nations Office for Project Services. By 2004, the Central University of Technology secured authorization from the Department of Education to provide a National Diploma in Jewellery Design at the Harmony Jewellery School's location. Today, the school functions as a satellite campus of the university.

6.2.3. Oro-Maska Project

Established in October 2001, the Oro-Maska jewellery manufacturing facility was situated in Virginia, within the Free State Province. The project attracted funding from a variety of stakeholders. The Industrial Development Corporation (IDC) invested R4.5 million; Harmony Gold Mining Company not only provided the physical infrastructure but was also committed to supplying gold via the Musuku Beneficiation System's refinery. Additionally, the Free State Development Corporation (FDC) made a financial contribution of R15 million. BAE System, fulfilling its offset obligations, invested \$4.5 million into the project. Furthermore, the Bhagwanji Group, based in Dubai, held a majority ownership with a 51% stake in the company as reported in The Harmony Gold Mining Company's 2001 and 2002 annual reports.

Between October 2001 and February 2002, the plant employed 110 Indian goldsmiths and designers, who were brought to Virginia with the aim of transferring their skills to local goldsmiths and factory workers. This was in line with the skills transfer element of the beneficiation obligation. Operations began in February 2002 to test machinery. However, the plant was shut down by May 2002, and the Indian goldsmiths were repatriated. According to Wellmann (2010), the reasons for the factory's closure remain ambiguous. Mr. Makhubalo, the then-Managing Director of the Free State Development Corporation (FDC), described the situation as an "unfortunate coincidence". On the other hand, Mr. Ferdi Dippenaar, who served as the Marketing Director for Harmony Gold Mine at the time, ascribed the shutdown to issues involving a major shareholder.

6.2.4. South African Royal Manufactures (SARM)

The SARM gold beneficiation project, located in Virginia's Free State Province, was established by Harmony Gold Mining Company primarily to produce high-carat gold rope chains designated for the U.S. market. Harmony Gold viewed this project as a dual opportunity: firstly, to meet its corporate social investment commitments and secondly, to contribute to domestic metal beneficiation.

The project's financial structure included capital from the Industrial Development Corporation (IDC) and an additional \$9 million investment from BAE Systems (DTI,

2004). According to Wellmann (2010), BAE Systems' financial contribution was configured as a revolving loan facility, which was available over a five-year term and could be reimbursed through export revenues. Harmony Gold provided the necessary infrastructure and the gold for manufacturing operations, sourced as a loan from Musuku Beneficiation Systems refinery.

Harmony Gold indicated that the project had hired over 700 women for the labour-intensive task of crafting handmade gold rope chains (Harmony, 2003; Wellmann, 2010). In 2004, SARM reported that the company employed 500 individuals and projected an additional 1,000 job opportunities. However, the company unexpectedly ceased operations in December 2004, leaving its employees without work (Wellmann, 2010).

In a legal development in 2005, SARM's CEO and Managing Director were arrested on charges of fraud and theft and appeared in Johannesburg Magistrate Court. Although the trial was initially postponed and subsequently resumed in June 2006, the prosecuting agency indicated their unpreparedness to proceed, resulting in the removal of the case from the court's schedule and permitting the CEO and Managing Director to depart the country (Wellmann, 2010).

6.3. Chapter Conclusion

The vision of Harmony Gold Mine for mineral beneficiation is centered on cultivating mutual trust and shared advantages with local communities, regulatory authorities, governmental bodies, and various stakeholders. It concentrates on initiatives that leave enduring legacies in the communities and support government-led efforts to establish diversified economies in host communities post-mining.

In accordance with the Beneficiation Strategy for the Minerals Industry of South Africa, Harmony Gold has initiated several beneficiation projects to increase the value of its output and provide employment opportunities. These projects include Musuku Beneficiation Systems, a gold refinery and processing factory; Harmony Jewellery School, which provided training for jewelry design; the Oro-Maska project, a jewelry manufacturing plant; and the SARM, a gold beneficiation project.

Musuku Beneficiation Systems, established as a public-private partnership between Mintek and Harmony Gold Mining Company, encountered a challenging obstacle in the form of conflicting organisational objectives. Despite securing \$9 million in investment from British Aerospace (BAE) Company, the project was shut down within the first year, exacerbated by issues of unaccounted funds and lack of transparent reporting.

The Oro-Maska Project stands as a prime example of a swift rise and fall trajectory in mineral beneficiation projects. Despite attracting a wide range of investors, including the Industrial Development Corporation (IDC) and the Free State Development Corporation (FDC), the project's operations were suspended within a year of its establishment, leaving questions regarding its abrupt closure largely unanswered.

South African Royal Manufactures (SARM) stands as a case study in governance failure. While the project initially showed promise by creating hundreds of employment opportunities, its sudden closure, followed by legal ramifications for its management, emphasizes critical issues in governance and oversight.

The next chapter aims to explore the sentiments of the employees towards beneficiation. This investigation, offering an on-the-ground viewpoint on the matter will be conducted through an analysis of collected questionnaire responses.

CHAPTER 7. DATA PRESENTATION AND ANALYSIS

7.1. Introduction

This chapter highlights the viewpoints of employees from various departments at Moab Khotsong, who have earned degrees or diplomas from higher education institutions such as universities or colleges as outline in Table 17.

Table 17. Employees from various fields and departments who completed the survey.

Department	Frequency	Percentage
Geoscience	9	43%
Ventilation	5	24%
Survey	3	14%
Evaluation	1	5%
Grade Control	2	10%
Training	1	5%
Total	21	100%

Department	Frequency	QUALIFICATION
Geoscience	9	FET Cert and Postgraduate
Ventilation	5	Graduates
Survey	3	FET Cert and Graduate
Evaluation	1	FET Cert
Grade Control	2	FET Cert
Training	1	FET Cert
Total	21	

7.2. Results and analysis

7.2.1. Statistical Analysis for Close ended questions

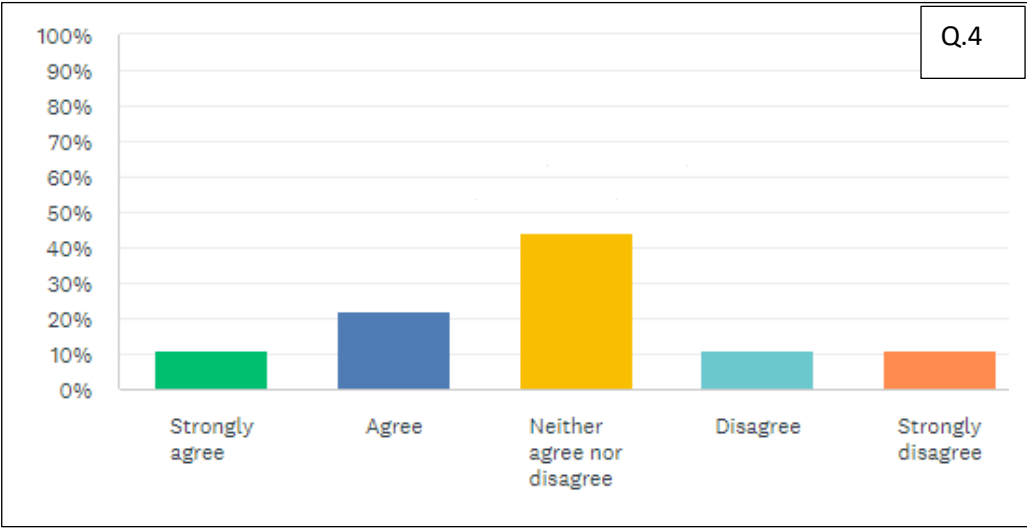
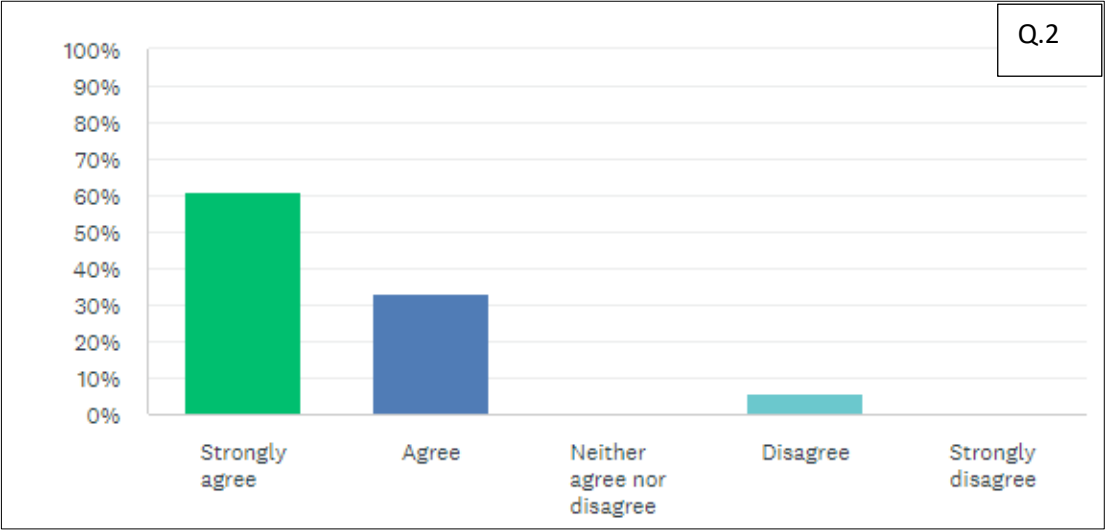
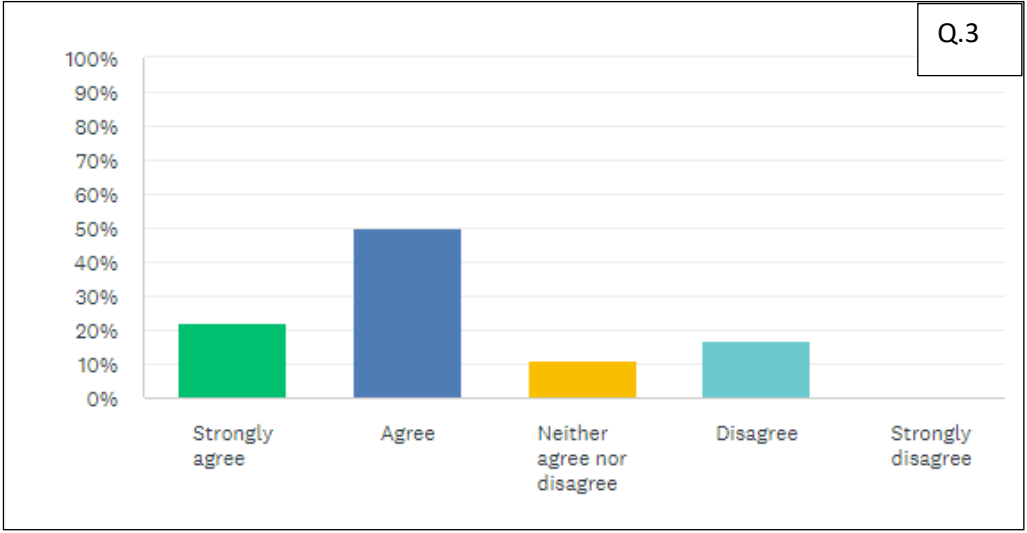
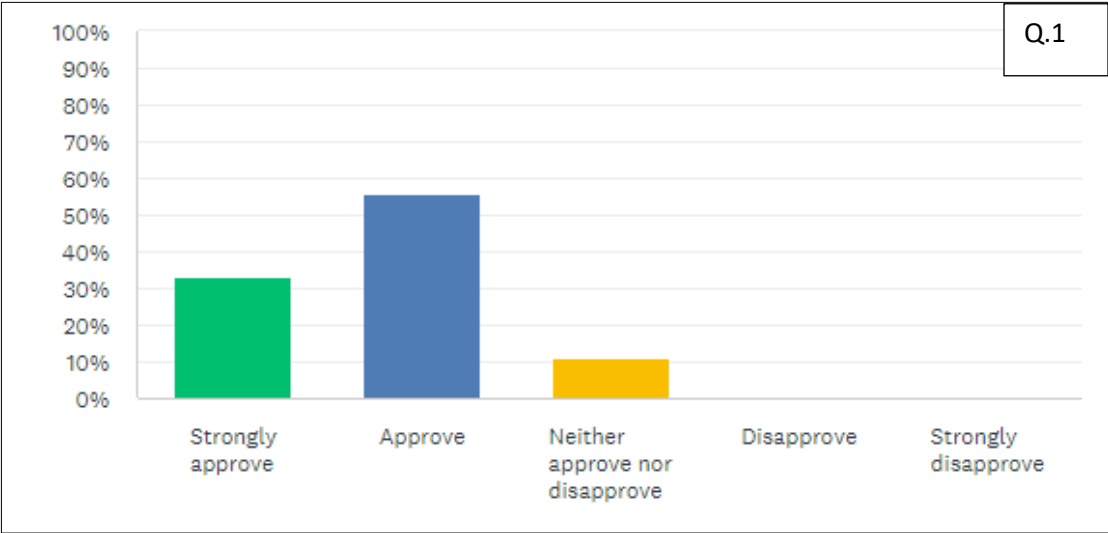
As outlined in Chapter 5, for this particular study, mean values of 4 and above imply a predominantly positive response, while mean values of 3 and below suggest respondents' disagreement. Values between 3 and 4 represent a lukewarm response, meaning neither positive nor negative. A range of 6 and above indicates that respondents exhibited either a positive or negative stance, while a range of 5 and below suggests respondents tended towards a neutral position (Table 18).

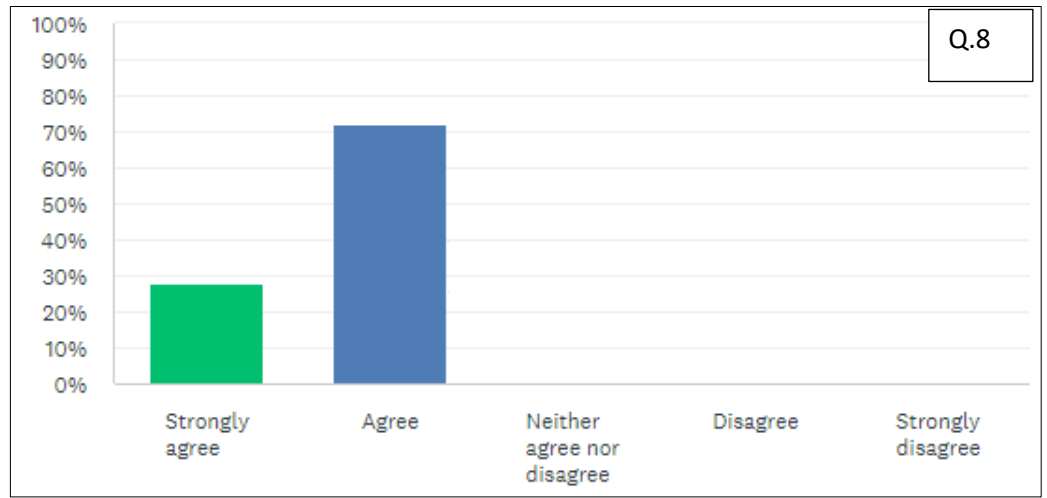
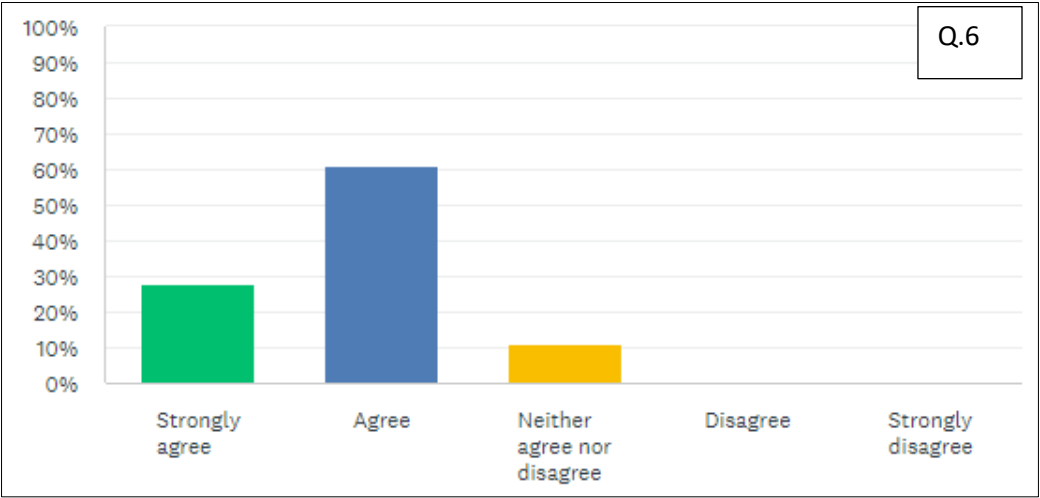
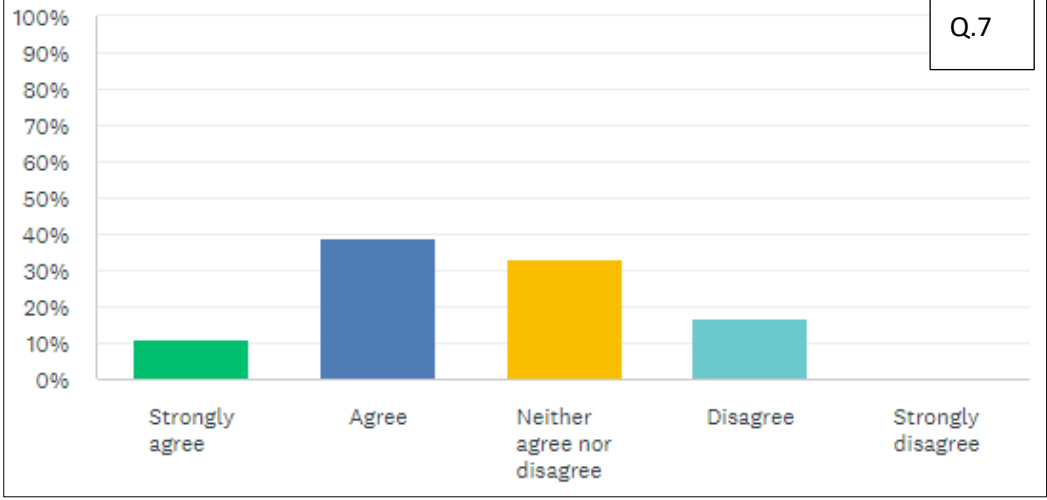
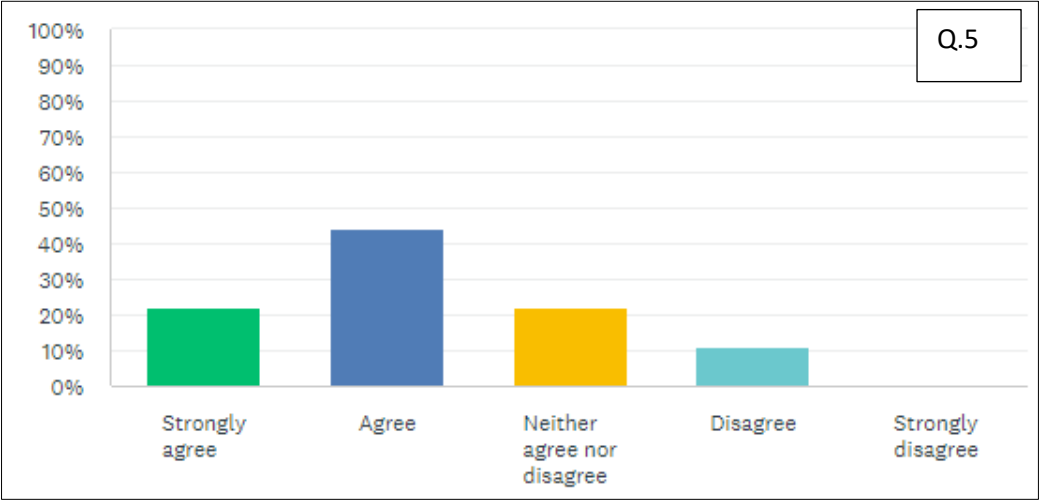
Table 18. Analysis of the questionnaire results depicted in Figure 46.

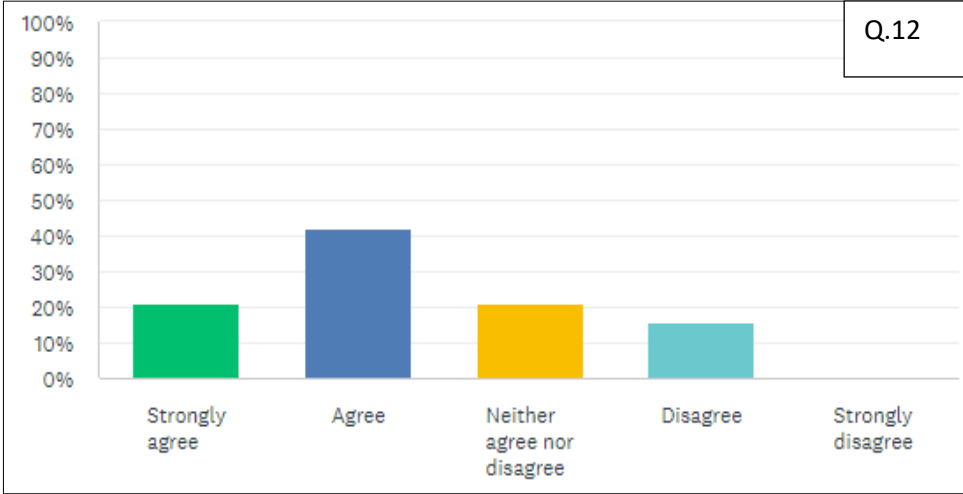
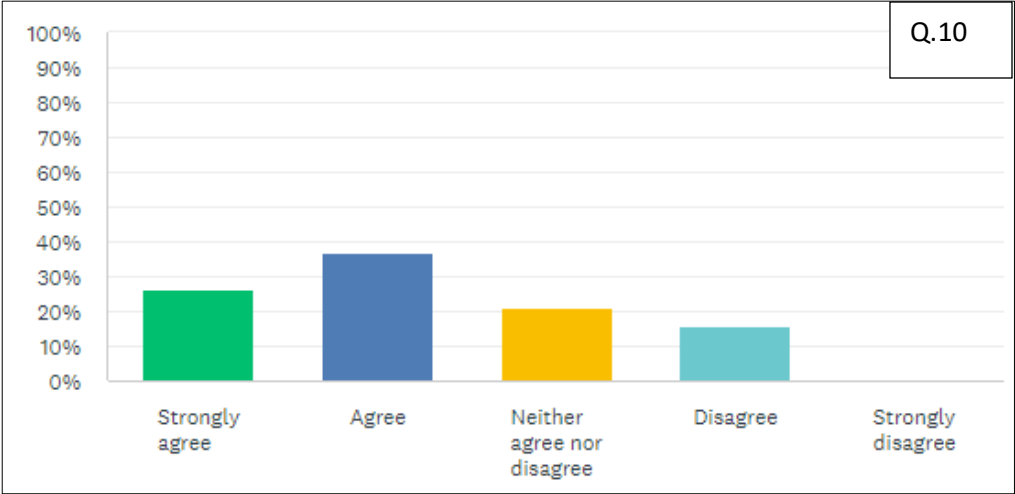
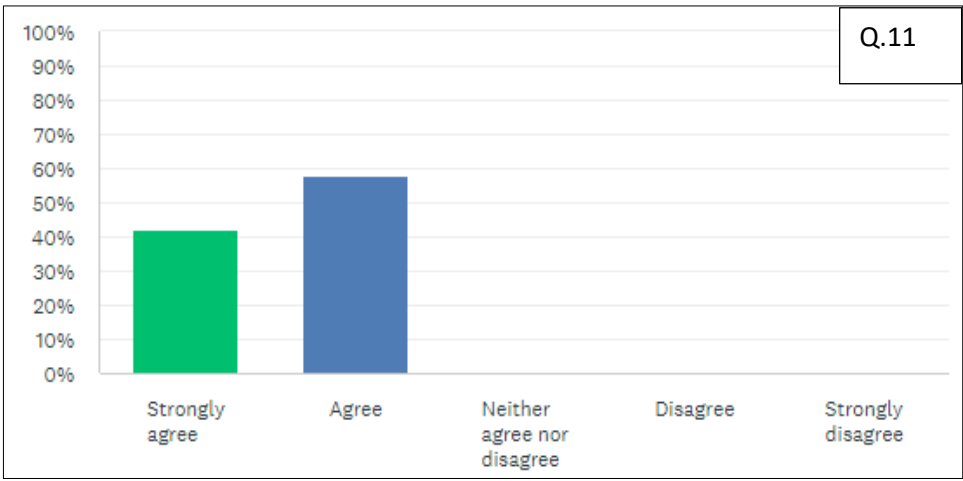
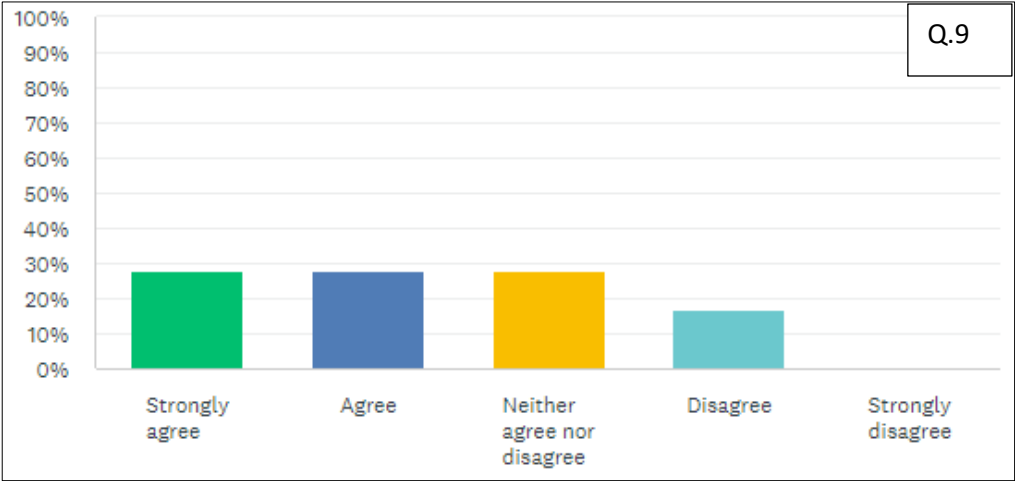
Item	Question	Mean	skewness	Range	mode	Agree and stngly disagree(%)	Disagree and strongly disagree(%)	Neither agree nor disagree(%)
Q1	Please specify which one of the following categories strongly describes your opinion on mineral beneficiation.	6	1.630083182	10	4	88.89	0	11.11
Q2	Gold mining plays a vital role in the future of South Africa's economy	6	1.710625413	6	4	94.44	5.56	0
Q3	South Africa has enough raw materials (gold) for mining to continue to be a priority sector.	4.5	1.679446394	9	4	72.22	16.67	11.11
Q4	Harmony gold supports local Beneficiation	3.6	0	2	3	33.33	22.22	44.44
Q5	Harmony Gold has the capacity to operate Beneficiation processes.	4.5	1.457862967	8	4	66.66	11.11	22.22
Q6	Mineral Beneficiation programs should be among the company's major priorities	6	1.631996721	11	4	88.81	0	11
Q7	The company has plants for further development of skills needed for Beneficiation.	4.5	0.00090009	7	4	50	16.67	33.33
Q8	Mineral Beneficiation will increase employment by a significant amount	9	1.732050808	13	4	100	0	0
Q9	Harmony Gold has the skills and capacity tp acquire and operate beneficiation plants.	4.5	1.15222471	5	4	55.56	16.67	27.78
Q10	Harmony Gold has the skills and capacity to operate a Gold Beneficiation project.	4.75	1.652422081	7	4	63.16	15.79	21.05
Q11	It is economically viable for gold mining companies to develop competencies necessary for beneficiation.	9.5	1.732050808	11	4	100	0	0
Q12	Harmony Gold Mining Company has the necessary technical skills for beneficiation.	4.75	1.652422081	8	4	63.16	15.79	21.05
Q13	Has there been any changes in the company's development programs that encompass beneficiation technical skills?	3.8	1.732050808	4	3	36.85	31.58	31.58
Q14	Following Harmony Gold's objectives, please indicate which one of the following categories best describes Harmony's level of interest in the beneficiation policy.	4.75	1.292905154	8	4	57.89	15.79	26.32

A frequency analysis, reflected in Figure 46 and Table 19-21, was conducted for each question in the questionnaire. This approach follows Lindt et al (2008) 's definition of a frequency distribution as a categorization of data into distinct classes that express the count of observations within each class, thereby efficiently summarizing and representing the data. Detailed information of the statistical analysis, which includes summaries of each question and individual responses are provided in the Appendix B.

Figure 46. Frequency Analysis of questions







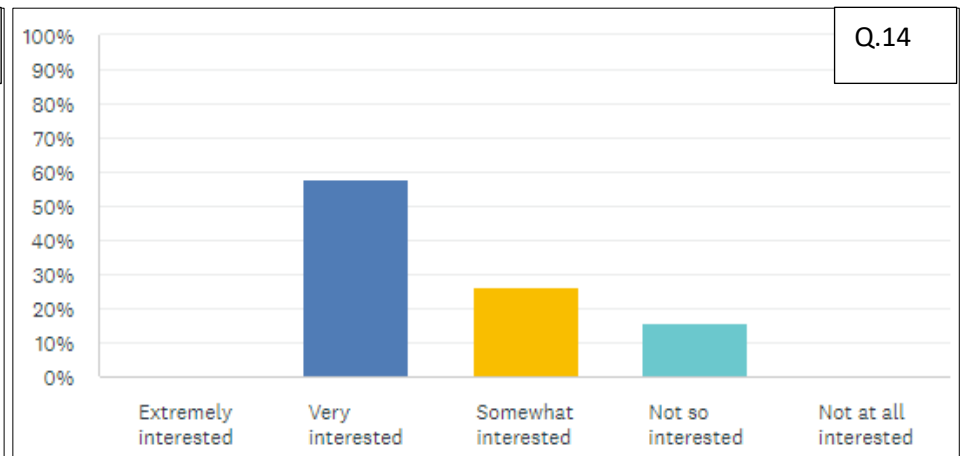
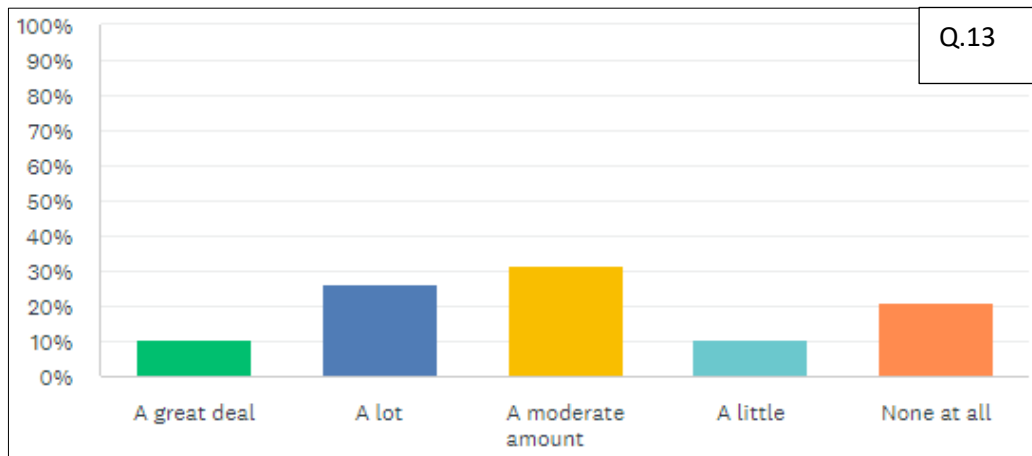


Table 19. Ranking (Question 1-12)

	Stongly agree	Agree	Neither nor	Disagree	Stongly disagree
Ranking	1	2	3	4	5

Table 20. Ranking (Question 13).

	A great deal	a lot	A moderate	A little	None at all
Ranking	1	2	3	4	5

Table 21. Ranking. (Question 14).

	Extremely Interested	Very Interested	Somewhat Interested	Not so Interested	Not at all Interested
Ranking	1	2	3	4	5

7.2.2. Explanation of questions

- *Q1: Please specify which one of the following categories strongly describes your opinion on mineral beneficiation.*

The objective of the question was to gauge the respondents' perspectives on beneficiation. The descriptive analysis reveals a mean value of 6, a mode of 4, a skewness of 1.630, and a range of 10 (Table 18). The skewness is positive as the respondents chose lower values, as evidenced in Table 19. The mean is also greater than the mode of 4, confirming that the distribution is positively skewed.

This suggests that the majority of respondents view the implementation of beneficiation at Harmony Gold Mine positively. The author believes that the successful integration of beneficiation in the mining industry largely depends on the responses from the employees and the wider community.

- *Q2. Gold mining plays a vital role in the future of South Africa's economy*

This question was aimed at understanding the respondents' perspectives on gold mining's role in the future of South Africa's economy. The results produced a mean of 6, a positive skewness of 1.710, a mode of 4, and a range of 6. A substantial majority, 94%, of the participants agreed that gold mining remains crucial for the future of the nation's economy.

- *Q3. South Africa has enough raw materials (gold) for mining to continue to be a priority sector.*

This question was designed to complement Q2, aiming to validate respondents' perspectives on the future of gold mining in South Africa, and assess whether gold mining will keep contributing to the country's economy. The descriptive statistics showed a mean of 4.5, a positive skewness of 1.679, a mode of 4, and a range of 9. The sustainability of the gold mining industry is essential for beneficiation, as it directly affects the longevity of jobs within the sector and its associated industries.

- *Q4. Harmony gold supports local Beneficiation*

This question aimed to understand the perspective of Harmony Gold Mine's employees, particularly the training department, on the company's response to gold beneficiation. The distribution revealed a positive skewness, with 72% of respondents affirming that Harmony supports local beneficiation, while 17% disagreed. The researcher believes that mining companies' support for local beneficiation is vital, as the sustainability of local beneficiation hinges on the mining industry's active participation.

- *Q5. Harmony Gold has the capacity to operate Beneficiation projects.*

The distribution demonstrated a mean of 4.5, skewness of 1.457, a range of 8, and a mode of 4. The positive skewness signifies that respondents opted for lower values outlined in Table 19. Table 18 reveals that 66% of the respondents agreed that Harmony Gold possesses the capabilities to execute beneficiation programs, while only 22% stated that Harmony Gold cannot implement such programs.

Drawing from the research outlined in chapter 4, the researcher is concerned that all projects previously launched by Harmony Gold Mine are now inactive, and currently, the company does not oversee any beneficiation project.

- *Q6. Mineral Beneficiation programs/projects should be among the company's major priorities*

Descriptive analysis produced a mean of 6, a skewness of 1.632, a range of 11, and a mode of 4. The positive skewness demonstrates that respondents leaned towards lower values, suggesting that beneficiation should be a key focus. It is the researchers view that Harmony Gold needs to be more prominent in their backing of local beneficiation.

- *Q7. The company has plans for the development of skills needed for Beneficiation.*

The aim of this question was to discern whether the training department had any plans for the advancement of skills specific to beneficiation. As indicated in chapter 6,

Harmony's development and training program lacks any of the skills needed for gold beneficiation.

This question resulted in a mean of 4.5, a skewness of 0, and a mode of 4. The responses to this question display a normal distribution, meaning that respondents selected a broad range of values. Half of the respondents believe that Harmony has some plans to enhance or develop employees' beneficiation skills, while the other half either disagreed or didn't voice their opinion. The notion held by half of the respondents that Harmony has no plans for training or skill development related to downstream gold beneficiation is worrisome.

Based on the research conducted for this report, no evidence has been found that Harmony currently has a development program for beneficiation skills. The researcher believes that if mining companies wish to align with the beneficiation strategy, there should be some evidence of progress or plans for beneficiation projects.

- *Q8. Mineral Beneficiation will increase employment by a significant amount*

The objective of the question was to evaluate whether the implementation of beneficiation would positively influence employment rates at Harmony Gold and the neighboring communities. The descriptive statistics suggest a mean of 9, a skewness of 1.7320, and a mode of 4, with the mean exceeding the mode, indicating a positively skewed distribution. All respondents concurred that the implementation of beneficiation could substantially boost employment opportunities.

- *Q9. Harmony Gold has the skills and capacity to acquire and operate beneficiation projects.*

The results from this question indicated a mean of 4.5, a skewness of 1.152, and a mode of 4, pointing to a positive skewness given the lower choices made by respondents. Table 15 demonstrates that 56% of respondents agreed that Harmony Gold possesses sufficient skills to undertake beneficiation projects, with 17% disagreeing.

The researcher believes that the majority of employees who participated in the beneficiation projects outline in chapter 7 have been incorporated into various roles within Harmony Gold. These individuals could be leveraged to train newcomers. Being a substantial enterprise, Harmony Gold could also consider bringing in external trainers to equip new recruits.

- *Q11. It is economically viable for gold mining companies to develop competencies necessary for beneficiation.*

All respondents, 100%, affirmed that it is economically worthwhile for mining companies to invest in their employees for the further beneficiation of gold. This viewpoint is further reinforced by the positively skewed distribution and notably high mean. Questions 9 and 11 aimed to gauge the beliefs of different departments, especially the training department, on whether Harmony possesses the requisite skills for gold beneficiation.

- *Q12. Harmony Gold Mining Company has the necessary technical skills for beneficiation.*

The majority of respondents provided positive responses, as illustrated in Question 9.

- *Q13. Has there been any changes in the company's development programs that encompass beneficiation technical skills?*

36% of respondents reported changes in the skills development programs, whereas 64% disagreed or chose not to express an opinion. Question 7 also suggested that half of the participants did not concur that the company has any plans for the development of beneficiation capabilities, a sentiment echoed in this question.

- *Q14. Following Harmony Gold's objectives, please indicate which one of the following categories best describes Harmony's level of interest in the beneficiation policy.*

Only 57% of participants acknowledged that Harmony Gold exhibits some level of interest in the policy of beneficiation.

7.3. Chapter conclusion

The Chapter presents and analyzes data gathered from employees at Moab Khotsoeng who have earned higher education degrees or diplomas. The insights are drawn from employees from various departments and present an inclusive understanding of the attitudes towards beneficiation within the organisation.

The statistical analysis reflects an overall positive perspective on beneficiation among respondents, with the majority considering it beneficial for Harmony Gold Mine. They believe in the crucial role of gold mining for South Africa's future economy and see Harmony Gold as a supporter of local beneficiation. Additionally, they consider beneficiation a priority for the company, and they believe it could substantially boost employment opportunities.

However, there are areas of concern. Notably, half of the respondents don't think Harmony Gold has plans to develop the necessary skills for beneficiation. Furthermore, respondents feel that although Harmony shows interest in the beneficiation policy, there have not been significant changes in the company's development programs that encompass beneficiation technical skills.

Harmony Gold should reinforce its commitment to beneficiation, not only by showing interest in policies but by investing in concrete plans for skill development and operational programs. The active participation of the mining industry is crucial for the sustainability and success of local beneficiation, and Harmony Gold has the potential to lead the way.

8.1. Global and Local Perspectives on Mineral Beneficiation

8.1.1. Overview of Mineral Beneficiation in Developed Nations as Demonstrated by the Case Studies of China, Canada, and the USA

Mineral beneficiation is a practice that has been adopted by several nations globally, its implementation varying between countries due to differences in the type of the resource, abundance of said resources, economic structures, as well as the level of technology. This is illustrated in the literature review chapter (chapter 3), where the case studies of China, Canada, and the United State of America showed the diverse approaches to mineral beneficiation that these developed nations implement.

The approach taken by China signifies the important role that government policies and market demand have in augmenting the beneficiation industry. China has used the country's vast research and technology advancement to enhance mineral beneficiation processes, which is evident in the country's high demand for both domestic and global mineral resources required for the country's extensive manufacturing industry.

Canada emphasizes the importance of education and R&D in improving mineral beneficiation processes. The country established high quality education and mining institutions that focus on chemical engineering, geology, metallurgy, as well as mineral beneficiation courses that contributed to the promotion and optimization of beneficiation processes.

The United States of America is a country with a conducive and well established business environment, reliable infrastructure, and extensive technological advancement which facilitated the growth of the country's considerable manufacturing industry that contributes greatly to the nation's GDP.

8.1.2. Local Perspectives on Mineral Beneficiation

- *Mineral beneficiation in South Africa*

When compared to countries discussed in 8.1.1., South Africa's manufacturing sector has not made significant progress with regards to the production of finished products required for downstream manufacturing and fabrication. This can be attributed to the challenges outlined below:

- **Infrastructure:** energy access is one of the biggest challenges facing South African industries. Energy supply is unreliable and inefficient, which leads to a reduction in production output, a decrease in price competitiveness for the mining and manufacturing industry.
- **Regulatory and legislative uncertainty:** Although South Africa's regulatory system and legal environment is well-established and stable, economic stability is still a challenge. This can be attributed to unexpected natural disasters such as flooding, volatile exchange rates and interest rates, high unemployment rate, and poor energy infrastructure and supply.
- **Domestic and international markets access:** South Africa is still grappling with challenges that affects foreign business relationships. These are challenges such as unexpected strikes/labour unrests, limited access to energy, as well management inefficiencies that are related to corruption.
- **Lack of skills:** For South Africa to transition to downstream mineral beneficiation successfully, skills shortage must be addressed. A successful manufacturing industry requires innovative and well-educated employees, as shown by China, Canada, and USA. The presence of a strong workforce is essential for maintaining economic growth and development, as well as for the implementation of strong mineral beneficiation initiatives.
- **Strikes/labour unrest:** South African companies are faced with challenges associated with wage disputes, demands for permanent employment. These

strikes are frequent and have various implications for stakeholders, on economic stability, as well as the competitiveness of the country's mining and manufacturing industries.

China, Canada, and USA have demonstrated the important role of a supportive political and legislative environment, a strong and reliable workforce, a thriving economic setting, reliable access to infrastructures such as energy and transportation, access to innovative technology, and an overall attractive and robust business environment in building a successful downstream mineral beneficiation industry. For a successful transition to downstream manufacturing industry, South Africa must follow in these developed countries' footsteps and adopt similar strategies to fully take advantage of the potential inherent in the nation's mining sector. That is the potential for sustainable economic growth and development.

- *Mineral beneficiation at Harmony Gold*

Harmony Gold company's mineral beneficiation vision is centered around developing mutual trust and shared advantages with employees and local communities, governmental bodies, and regulatory authorities. The company's vision is to leave behind lasting legacies for employees and communities by establishing diversified economies that will endure post-mining. Harmony gold has policies and strategies that align the company with governmental priorities such as job creation and the elimination of poverty.

The company has initiated several beneficiation initiatives aimed at creating employment opportunities and increasing output value. These are initiatives such as the Musuku Beneficiation Systems, the Harmony Jewellery school, the Oro-Maska project, and the South African Royal Manufactures. These initiatives were established with the objective of gearing towards economic diversification, skills development, and job creation.

However, all these initiatives have since closed down and are no longer in operation. These projects serve as a representation of the economic, social, and administrative challenges that exist in South Africa's mining industry and potential downstream

industry. Although the company had ambitious goals and financial support, the beneficiation projects were not successful due to various obstacles.

The Musuku Beneficiation System project failed due to conflicting strategic approaches and goals between Harmony Gold and Mintek. This occurred despite the project's massive financial contribution from British Aerospace company. The situation was exacerbated by the mismanagement of funds and lack of transparency from the relevant parties.

The Oro-Maska initiative dissolved almost as quickly as it was established, leaving behind unanswered questions. SARM was inflicted by corruption and incompetent behavior such as poor governance, lack of attention to detail, and lack of accountability by upper management.

8.2. Training and Skills Development for Mineral Beneficiation in South Africa's Mining Sector

Harmony Gold's Moab Khotsoeng is characterized by a diverse workforce of which the majority are the black employees from labour-sending communities. The company's HRD strategy addresses issues of skills shortage in alignment with government legislation and regulatory frameworks. The strategy encompasses training and development, education, skills assessment, and issues of employee retainment and return on human resource investment.

The company's HRD strategy offers a range of programs designed for skills development, these are:

- Adult Basic Education and Training;
- Portable skills training;
- Trainee programs; and
- Community Human Resource Development programs.

The company's commitment to cultivating a robust socio-cultural and socio-economic welfare of employees and the surrounding community is shown by the establishment of various community-based programs. The purpose of these programs

is to increase employment opportunities, for the company to align with government initiatives as well as to contribute to HDSA upliftment initiatives.

Harmony Gold works with SETAs such as the MQA, SAQA, and the NSDS to provide work-integrated learning programs for individuals and students from labour-sending communities. However, these programs failed to demonstrate the inclusion of skills outlined by the SAQA and the MQA as necessary for transition to downstream mineral beneficiation. Although the company's skills development strategy aligns with government 's policy context, it does cover skills critical for mineral beneficiation.

8.3. Interpretation of Survey Findings.

The survey results conducted on employees at Moab Khotsong showed a predominantly optimistic and positive perception of mineral beneficiation. Majority of respondents consider beneficiation in a positive light, which has good implications for future mineral beneficiation projects in the company.

The responses also show that majority of employees hold the perception that gold mining plays a significant role in the future of the country's economy, highlighting the crucial role that mineral beneficiation interventions have on the enduring value and legacy of the mining industry and its contribution to economic growth and development. 72% of the respondents agree that Harmony Gold support mineral beneficiation, however, it is worth acknowledging the 17% who disagree, as this might indicate that some employees do not believe in or are not aware of the company's benefaction efforts.

66% of the respondents also agree that Harmony Gold has the ability and capability to carry out beneficiation programmes, indicating the confidence that employees have in the company and its resources. However, the fact that 22% of respondents do not believe that Harmony Gold can implement and maintain such projects points to a potential issue that needs to be addressed. The survey results also show a unanimous agreement between respondents on the potential of beneficiation's positive contribution to socio-economic growth. Indicating the value that employees place on creating job opportunities in the mining industry.

An overwhelming majority of respondents expressed concerns when it comes to changes in the company's training and development programs, with regards to the inclusion of mineral beneficiation skills development. 64% of respondents disagreed that there are changes geared towards beneficiation skills training in the company's training programs, which indicates potential areas of improvement in implementing skills development initiatives for mineral beneficiation.

In conclusion, majority of respondents do not recognize changes when it comes to Harmony Gold's training programmes concerning beneficiation technical skills. Additionally, respondents have low confidence in the company's capacity to implement sustainable beneficiation projects. The survey results, supported by literature review, point at potential gaps in skills training and development for beneficiation within the company.

8.4. Lessons from the research

The following lessons can be deduced from the research:

- Manufacturing Industry Challenges: There are a number of challenges that stand in the way of successful transition to downstream mineral beneficiation in South Africa. These include limited access to raw material required for local beneficiation, unreliable infrastructure, regulatory uncertainties, and skills shortage within the mining and manufacturing industry. These challenges must be addressed for South Africa to fully exploit the potential of beneficiation.
- Company Beneficiation Initiatives and Ground Reality: Harmony Gold's record on beneficiation initiatives, and employees perception, offer valuable insights into the realities of implementing beneficiation at company level. Although the company has established several projects to promote local beneficiation, these projects had little to no success. The challenges encountered by Harmony Gold in sustaining these projects offer valuable lessons. The following are lessons learned from these initiatives:

- ❖ Alignment of Objectives: The Musuku Beneficiation Project is a prime example of what happens to a company or project when stakeholders do not have aligned objectives. Without this alignment, even financial support cannot save a projects.
 - ❖ Transparency and Accountability: Lack of transparency with regards to accountings and financials lead do Musuku beneficiation project's demise. This undermined the project's success and credibility. Transparency and accountability play an important role when it comes to a project's internal management as well as its external stakeholders.
 - ❖ Governance and Ethical Practices: The disgrace and failure of SARM emphasized the critical role that governance and ethical practices play in success or failure of a project. Poor governance and unethical practices such as corruption lead to the abrupt shut-down of the project. This was accompanied by legal consequences which tarnished the reputations of stakeholders involved.
 - ❖ Holistic Planning: Planning that takes into consideration the project's governance, financial sustainability, stakeholder alignment, and risk assessment could be more effective in achieving the success of beneficiation initiatives and goals set out by Harmony Gold.
 - ❖ Company Exit Strategies and Contingency Planning: It is essential for a company to have a well-thought-out exit strategy and contingency plan, as this can mitigate adverse impacts on employees, communities, and relevant stakeholders.
- **Skills Development Gap**: Chapter 4 and 5 highlighted a significant lesson. That is the gap in skills training and development with regards to beneficiation. Additionally, chapter 7 demonstrated that the majority of employees do not recognize significant changes in the company's development programs concerning beneficiation technical skills. This also highlighted the need for targeted and effective skills development programmes.

9.1. Conclusion

This study has shown an in-depth examination of the role that mineral beneficiation has in the South African mineral sector, with a particular emphasis on Harmony Gold's Moab Khotsong Mine. This was done through the exploration and analysis of international case studies, an analysis of beneficiation projects initiated by Harmony Gold, and through employee perspectives. This research unpacked a mining sector that has a complex landscape full of opportunities and challenges.

Harmony Gold as a company is founded on social and economic upliftment in terms of compliance with regulatory frameworks, as well as on going above and beyond when it comes to ensuring sustainable development of the surrounding communities and labour-sending communities. This is also evinced by the company's endeavor for diversified post-mining economies. The company's commitment to ensuring skills development and job creation emphasizes its pledge to a lasting presence in South Africa, which is testament to its integral role in transforming the South African industry.

The beneficiation initiatives undertaken by Harmony Gold over the years also demonstrate this commitment. Each project, from the Musuku Beneficiation Project, the Oro-Maska Project, the South African Royal Manufactures and the Harmony Jewellery School, has been geared towards harnessing and realizing the benefits of mining for broader socio-economic objectives. Although the initiatives did not succeed, their initiation and implementation alone demonstrate Harmony Gold's stance and proactive role in promoting mineral beneficiation and the creation of lasting and transferable skills that can be utilized after mining has concluded.

However, the downfall and lack of success of these initiatives also stands as testament to the complexities of a transition to downstream mineral beneficiation. The lack of success highlights the necessity for proper and thorough planning, appropriate resource allocation, and consistent stakeholder engagement in the execution of such initiatives.

A significant conclusion and finding from this research is the identification of a skills gap, as indicated in chapter 4 and 5, and demonstrated in chapter 7. Despite the efforts by mining companies and policy frameworks such as the Skills Development Act 97 of 1998 to improve employee skills and create a strong workforce, there seems to be a gap, specifically in the skills necessary for mineral beneficiation, as outlined by the MQA and the SAQA. This gap demands a need for targeted training and skills development programmes that focus on mineral beneficiation.

The survey results obtained from employees at Moab Khotsong provide valuable insight from the ground level, showing an overall positive attitude towards mineral beneficiation, while also revealing potential gaps in skills development related to downstream mineral beneficiation.

The South African mining industry as well as government must focus on economy diversification if we are to avoid further effects of the resource curse. There should be cooperation and engagement between government, institution, and industries to accelerate the development and creation of a skilled labour force, as well as the promotion of technological advancement as highlighted in Chapter 3. The case studies in chapter 3 emphasized how developed countries leveraged their unique natural resource endowment and strength to enhance their mineral beneficiation industries.

This research also highlights the tremendous potential of downstream mineral beneficiation in contributing economic growth and development, job opportunities, as well as the beneficiation of raw materials with South Africa. The research also underlined major challenges hindering a transition towards downstream beneficiation, these are challenges such as limited access to raw materials for local beneficiation, poor infrastructure, regulatory uncertainties, and shortage of skills. Addressing and eradicating these challenges will require collaboration from all stakeholders, these include the mining industry, educational institutions, as well as various government bodies. By focusing on these areas, South Africa can improve its capacity for successful mineral beneficiation, thus strengthening not only the mining sector but also contributing to broader economic growth and development objectives.

9.2. Recommendations

9.2.1. Targeted Skills Development and Training

The availability of a skilled workforce plays a crucial role in the success of downstream mineral beneficiation. This will require targeted training and skills development programmes that focus on mineral beneficiation. As demonstrate in the research, there is a potential for skills gap in mineral beneficiation, and addressing this will greatly improve South Africa's chances of a successful mineral beneficiation industry.

9.2.2. Stakeholder engagement and Partnership

Another significant factor that cannot be stressed enough is the collaboration between government, industries, and educational institutions. This collaboration is critical for continuous and sufficient supply of skilled labour, and also facilitate the transition into downstream beneficiation activities.

9.2.3. Adequate Planning and Resource Allocation

Thorough planning, adequate resource allocation, and consistent stakeholder engagement is essential for successful execution of beneficiation projects.

9.2.4. Further Reaserch and Development (R&D)

The challenges faced by Harmony Gold's beneficiation projects and the perceived skills gap highlights the need for further research and development into understanding the reasons behind the potential for success or failure of such projects. Further investigation in to the perceived gaps in skills development as well as an assessment of the overall impact of beneficiation efforts on local communities and their economies is recommended.

9.2.5. Improvement of Infrastructure

Infrastructures such as energy and transportation are a significant challenge for South African businesses, as well as to the potential for downstream mineral beneficiation. Reliability and efficiency of energy supply as well as other infrastructures necessary for beneficiation should be improved

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APPENDIX A: Close-Ended Questionnaire

Section A: Demographic Information

(Please place a cross (X) in the appropriate box)

Department	
Geoscience	1
Ventilation	2
Survey	3
Evaluation	4
Grade Officer	5
Training	6

Number of years experience in the department	
Geoscience	1
Ventilation	2
Survey	3
Evaluation	4
Grade Officer	5
Training	6

Highest Education Level	
Geoscience	1
Ventilation	2
Survey	3
Evaluation	4
Grade Officer	5
Training	6

Section B : Close-Ended Questionnaire

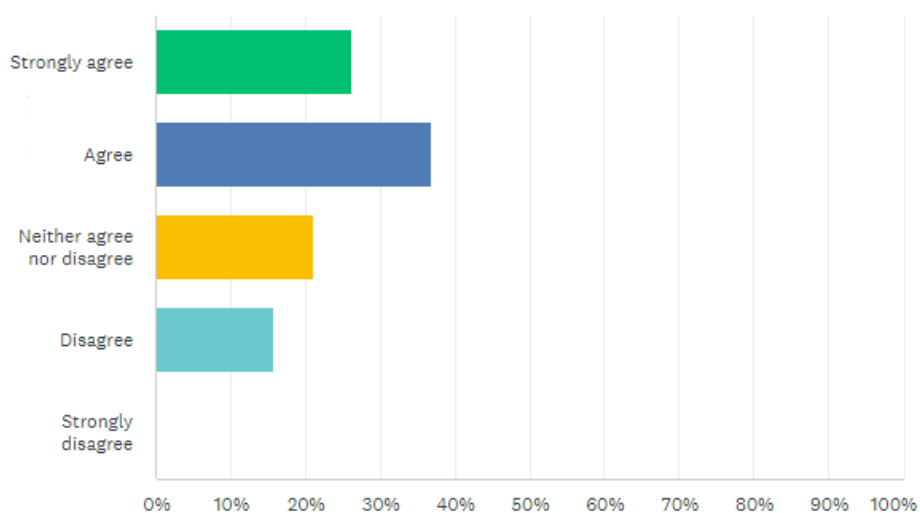
1	2	3	4	5
Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

STATEMENT	SCALE				
Please specify which one of the following categories strongly describes your opinion on mineral beneficiation.	1	2	3	4	5
Gold mining plays a vital role in the future of South Africa's economy	1	2	3	4	5
South Africa has enough raw materials (gold) for mining to continue to be a priority sector.	1	2	3	4	5
Harmony gold supports local Beneficiation	1	2	3	4	5
Harmony Gold has the capacity to operate Beneficiation processes.	1	2	3	4	5
Mineral Beneficiation programs should be among the company's major priorities	1	2	3	4	5
The company has plans for further development of skills needed for Beneficiation.	1	2	3	4	5
Mineral Beneficiation will increase employment by a significant amount	1	2	3	4	5
Harmony Gold has the skills and capacity to acquire and operate beneficiation projects.	1	2	3	4	5
Harmony Gold has the skills and capacity to operate a Gold Beneficiation project.	1	2	3	4	5
It is economically viable for gold mining companies to develop competencies necessary for beneficiation.	1	2	3	4	5
Harmony Gold Mining Company has the necessary technical skills for beneficiation.	1	2	3	4	5
Has there been any changes in the company's development programs that encompass beneficiation technical skills?	1	2	3	4	5
Following Harmony Gold's objectives, please indicate which one of the following categories best describes Harmony's level of interest in the beneficiation policy.	1	2	3	4	5

APPENDIX B : Questionnaire Summaries

Harmony Gold has the skills and capacity to operate a Gold Beneficiation project.

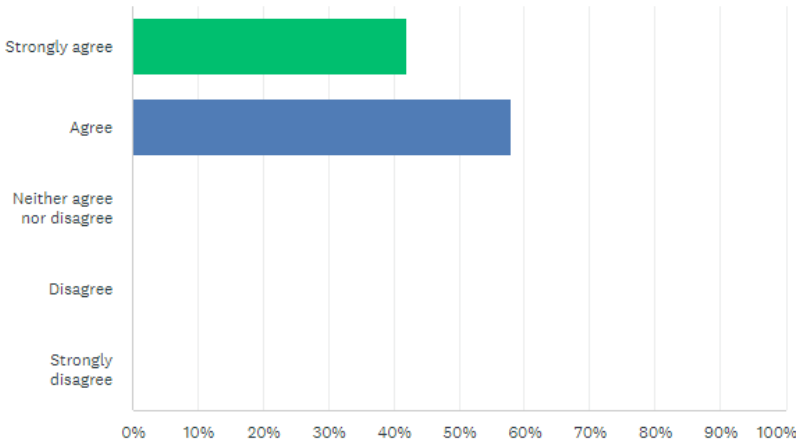
Answered: 19 Skipped: 0



ANSWER CHOICES	RESPONSES	
Strongly agree	26.32%	5
Agree	36.84%	7
Neither agree nor disagree	21.05%	4
Disagree	15.79%	3
Strongly disagree	0.00%	0
TOTAL		19

It is economically viable for gold mining companies to develop competencies necessary for beneficiation.

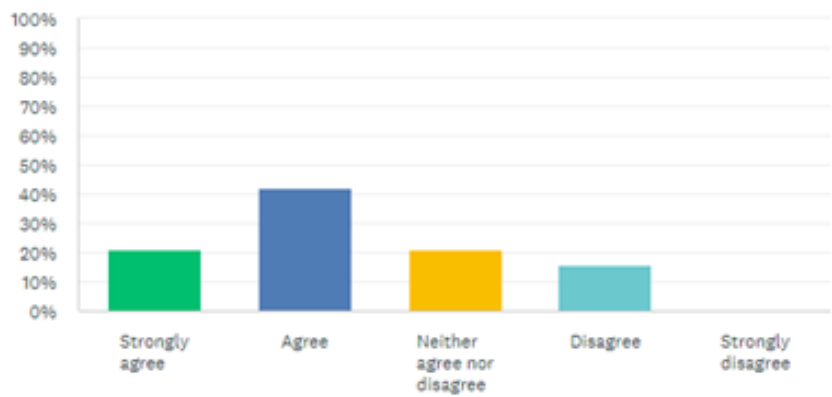
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ANSWER CHOICES	RESPONSES	
Strongly agree	42.11%	8
Agree	57.89%	11
Neither agree nor disagree	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
TOTAL		19

Harmony Gold Mining Company has the necessary technical skills for beneficiation.

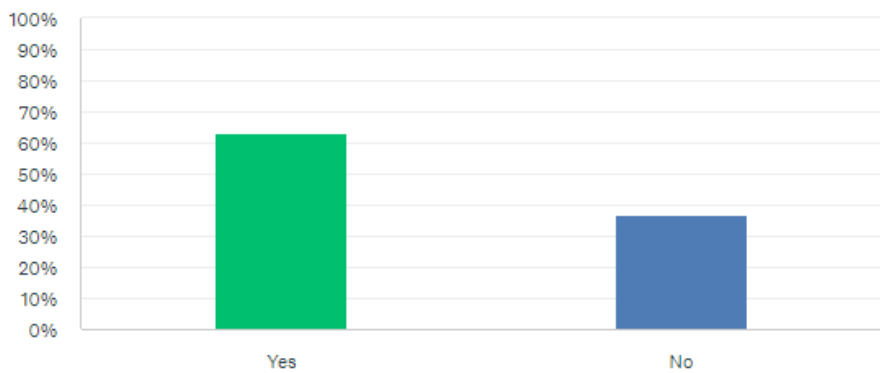
Answered: 19 Skipped: 0



ANSWER CHOICES	RESPONSES	
Strongly agree	21.05%	4
Agree	42.11%	8
Neither agree nor disagree	21.05%	4
Disagree	15.79%	3
Strongly disagree	0.00%	0
TOTAL	19	

Does Harmony Gold currently have beneficiation projects in action?

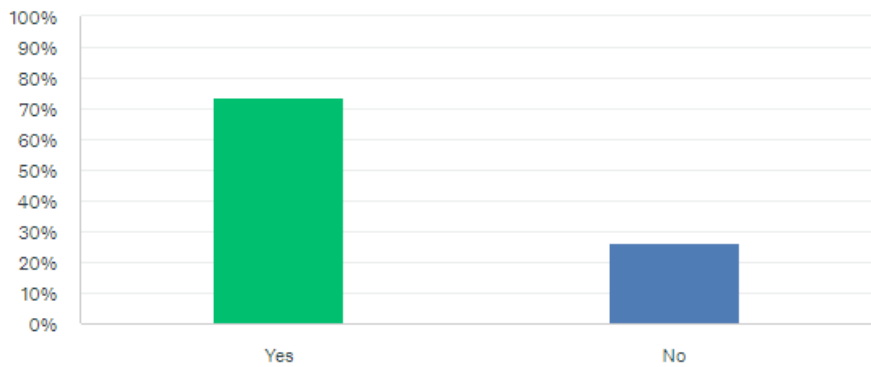
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ANSWER CHOICES	RESPONSES	
Yes	63.16%	12
No	36.84%	7
TOTAL	19	

Does Harmony Gold have further plans for beneficiation of gold?

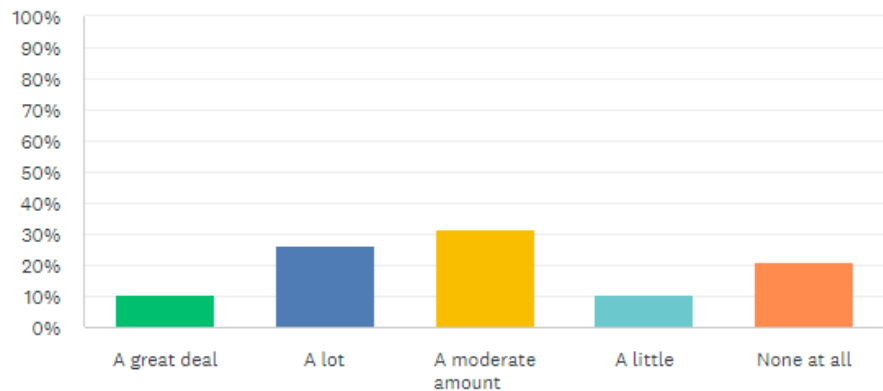
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ANSWER CHOICES	RESPONSES	
▼ Yes	73.68%	14
▼ No	26.32%	5
TOTAL		19

Has there been any changes in the company's development programs that encompass beneficiation technical skills?

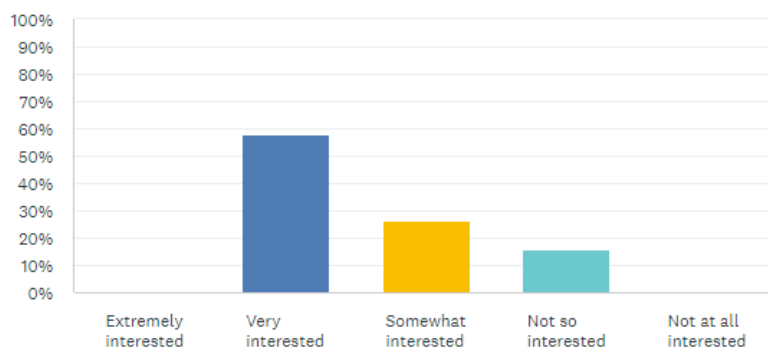
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ANSWER CHOICES	RESPONSES	
▼ A great deal	10.53%	2
▼ A lot	26.32%	5
▼ A moderate amount	31.58%	6
▼ A little	10.53%	2
▼ None at all	21.05%	4
TOTAL		19

Following Harmony Gold's objectives, please indicate which one of the following categories best describes Harmony's level of interest in the beneficiation policy.

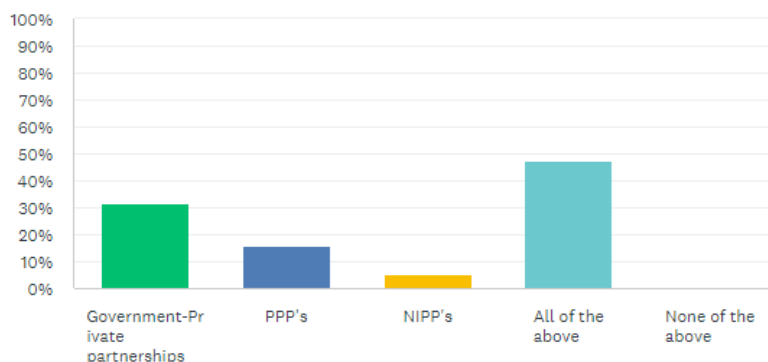
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ANSWER CHOICES	RESPONSES	
Extremely interested	0.00%	0
Very interested	57.89%	11
Somewhat interested	26.32%	5
Not so interested	15.79%	3
Not at all interested	0.00%	0
TOTAL		19

What incentives do you recommend to enable gold beneficiation in gold mining companies?

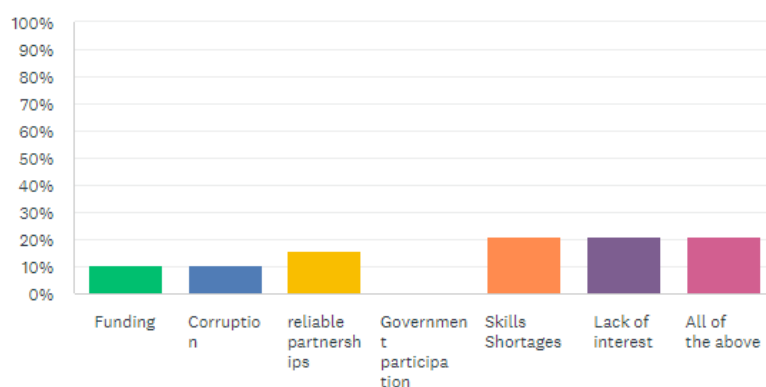
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ANSWER CHOICES	RESPONSES	
Government-Private partnerships	31.58%	6
PPP's	15.79%	3
NIPP's	5.26%	1
All of the above	47.37%	9
None of the above	0.00%	0
TOTAL		19

What challenges does Harmony face in implementing beneficiation projects?

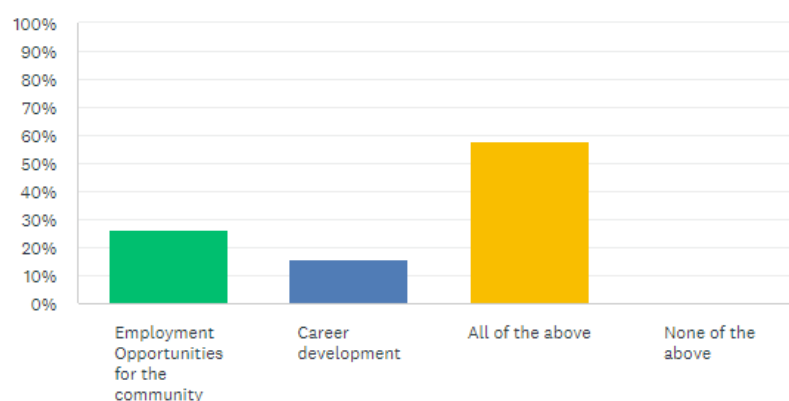
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ANSWER CHOICES	RESPONSES	
▼ Funding	10.53%	2
▼ Corruption	10.53%	2
▼ reliable partnerships	15.79%	3
▼ Government participation	0.00%	0
▼ Skills Shortages	21.05%	4
▼ Lack of interest	21.05%	4
▼ All of the above	21.05%	4
TOTAL		19

What benefits do you anticipate as an employee if beneficiation projects are implemented?

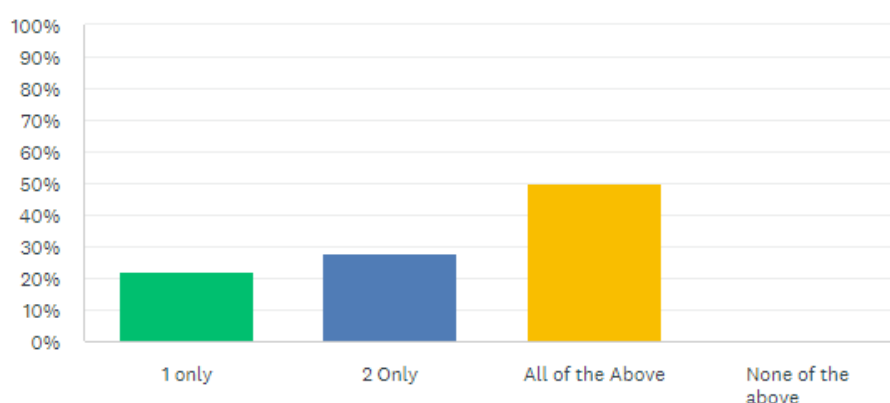
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ANSWER CHOICES	RESPONSES	
▼ Employment Opportunities for the community	26.32%	5
▼ Career development	15.79%	3
▼ All of the above	57.89%	11
▼ None of the above	0.00%	0
TOTAL		19

Beneficiation has been described as:1. A variety of processes whereby extracted ores from mining are reduced to particles that can be separated into mineral and waste where the former is suitable for further processing or direct use.or2. The process or series of processes by which an ore containing a metal or mineral as it is found in nature is converted into a product containing a progressively higher concentration of the metal or mineral concerned. the final result is achieved when the metal or mineral reaches the highly beneficiated or chemically pure form required by the end-user. Beneficiation ends and manufacturing begins when the mineral commodity has been converted into a final usable product.-Which of the above descriptions best matches your understanding of beneficiation?

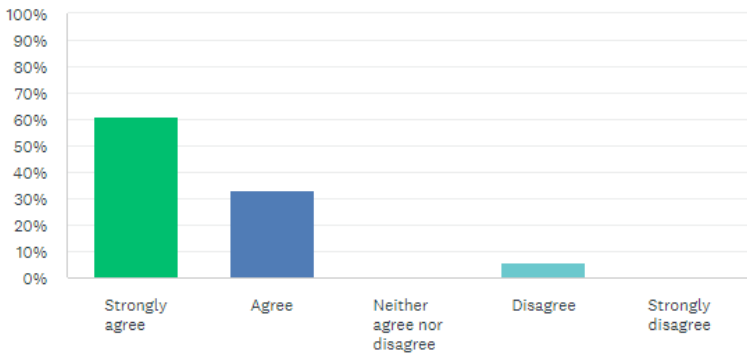
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ANSWER CHOICES	RESPONSES	
▼ 1 only	22.22%	4
▼ 2 Only	27.78%	5
▼ All of the Above	50.00%	9
▼ None of the above	0.00%	0
TOTAL		18

Gold mining plays a vital role in the future of South Africa's economy

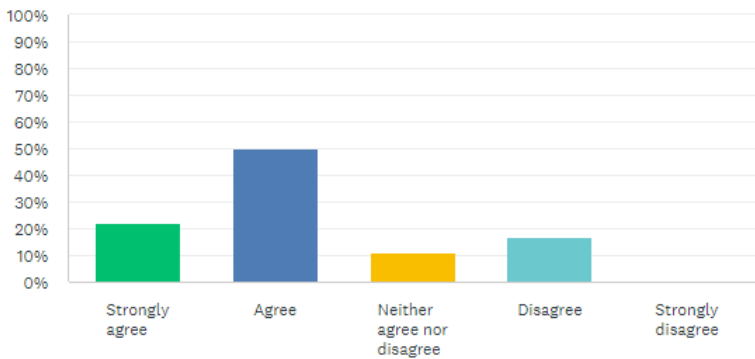
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ANSWER CHOICES	RESPONSES	
Strongly agree	61.11%	11
Agree	33.33%	6
Neither agree nor disagree	0.00%	0
Disagree	5.56%	1
Strongly disagree	0.00%	0
TOTAL	18	

South Africa has enough raw materials (gold) for mining to continue to be a priority sector.

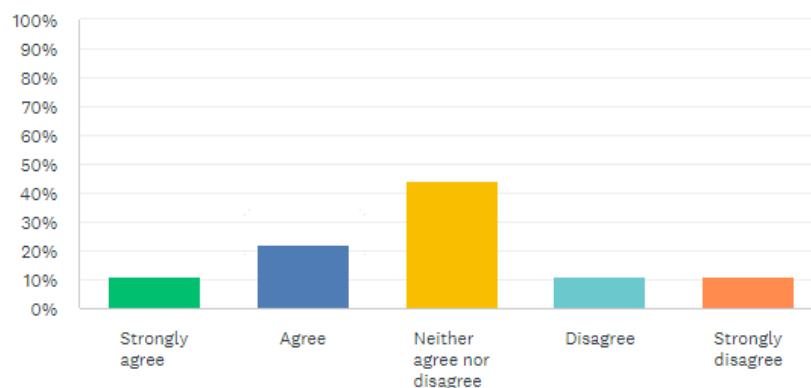
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ANSWER CHOICES	RESPONSES	
Strongly agree	22.22%	4
Agree	50.00%	9
Neither agree nor disagree	11.11%	2
Disagree	16.67%	3
Strongly disagree	0.00%	0
TOTAL	18	

Harmony gold supports local Beneficiation

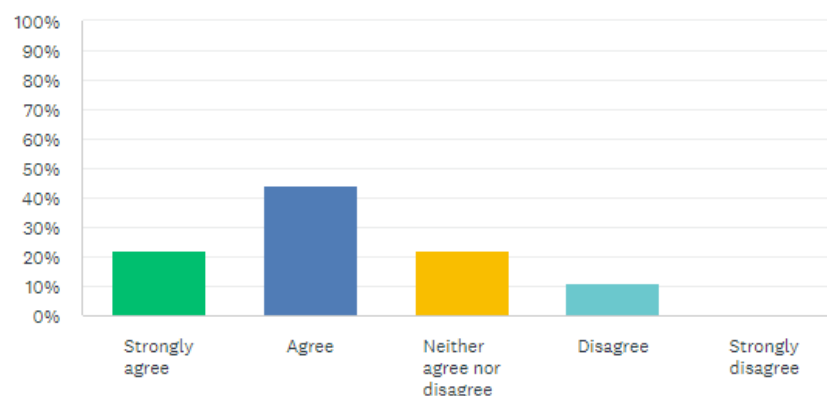
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ANSWER CHOICES	RESPONSES	
Strongly agree	11.11%	2
Agree	22.22%	4
Neither agree nor disagree	44.44%	8
Disagree	11.11%	2
Strongly disagree	11.11%	2
TOTAL		18

Harmony Gold has the capacity to operate Beneficiation processes.

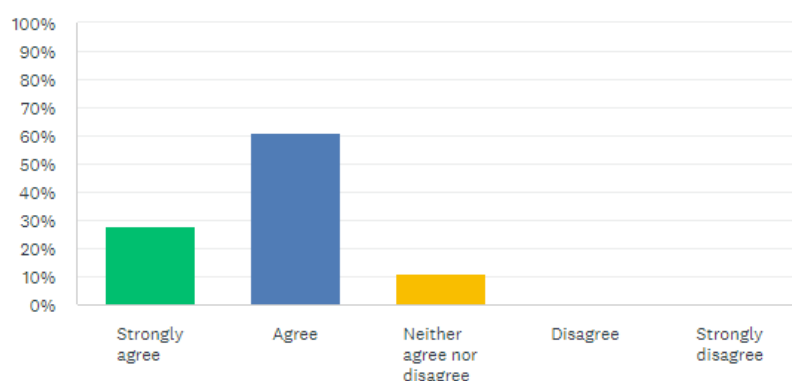
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ANSWER CHOICES	RESPONSES	
Strongly agree	22.22%	4
Agree	44.44%	8
Neither agree nor disagree	22.22%	4
Disagree	11.11%	2
Strongly disagree	0.00%	0
TOTAL		18

Mineral Beneficiation programs should be among the company's major priorities

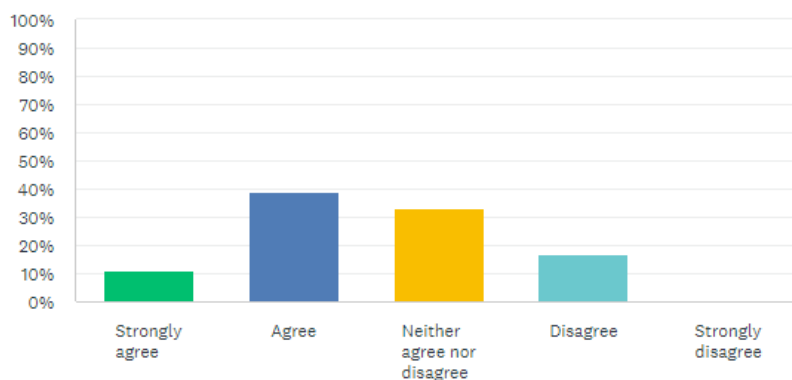
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ANSWER CHOICES	RESPONSES
Strongly agree	27.78% 5
Agree	61.11% 11
Neither agree nor disagree	11.11% 2
Disagree	0.00% 0
Strongly disagree	0.00% 0
TOTAL	18

The company has plants for further development of skills needed for Beneficiation.

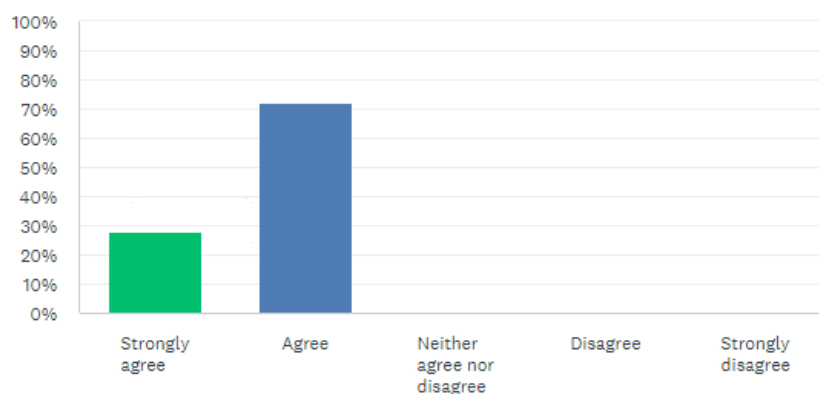
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ANSWER CHOICES	RESPONSES
Strongly agree	11.11% 2
Agree	38.89% 7
Neither agree nor disagree	33.33% 6
Disagree	16.67% 3
Strongly disagree	0.00% 0
TOTAL	18

Mineral Beneficiation will increase employment by a significant amount

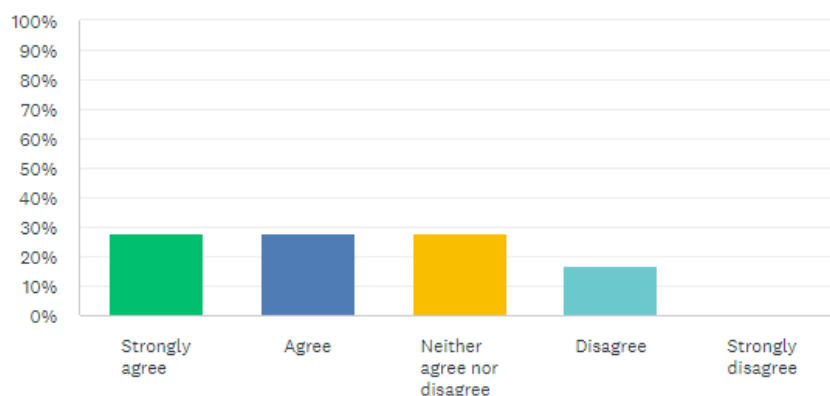
Answered: 18 Skipped: 0



ANSWER CHOICES	RESPONSES
Strongly agree	27.78% 5
Agree	72.22% 13
Neither agree nor disagree	0.00% 0
Disagree	0.00% 0
Strongly disagree	0.00% 0
TOTAL	18

Harmony Gold has the skills and capacity tp acquire and operate beneficiation plants.

Answered: 18 Skipped: 0



ANSWER CHOICES	RESPONSES
Strongly agree	27.78% 5
Agree	27.78% 5
Neither agree nor disagree	27.78% 5
Disagree	16.67% 3
Strongly disagree	0.00% 0
TOTAL	18