



MINING QUALIFICATIONS AUTHORITY

FRAMEWORK FOR FUTURE SKILLS NEEDS IDENTIFICATION FOR THE MMS

Final Report
(Inclusive of All Sub-sectors)

Version: 3.00D

Date: January 2024

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List of Acronyms

4IR	Fourth Industrial Revolution
AI	Artificial Intelligence
ASM	Artisanal and Small-Scale Mining
CEDEFOP	European Centre for the Development of Vocational Training
CLAS	Cement, Limestone, Aggregates and Sand
CMTRP	Canadian Mine Training Recognition Program
CMCP	Canadian Mining Certification Program
CSIR	Council for Scientific and Industrial Research
DMRE	Department of Mineral Resources and Energy
ERRP	Economic Reconstruction and Recovery Plan
ERRS	Economic Reconstruction and Recovery Skills Strategy
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
ILO	International Labour Organisation
LMI	Labour Market Information
LMIC	Labour Market Information Council
LSM	Large-Scale Mining
MEMSA	Mining Equipment Manufacturers of South Africa
MMS	Mining and Mineral Sub-sectors
MQA	Mining Qualifications Authority
NDP	National Development Plan
NMMP	Nelson Mandela Mining Precinct
NOS	National Occupational Standards
NOTS	National Occupational Training Standards

NSDP	National Skills Development Plan
PGM	Platinum Group Metals
SATCAP	Successful Application of Technologies Centred Around People
SSM	Small-Scale Mining
SSP	Sector Skills Plan
STF	Skills Technology Foresight
VR	Virtual Reality

Glossary of Terms

4IR	An era where people are using smart, connected and converged cyber, physical and biological systems and smart business models to define and reshape the social, economic and political spheres.
Artificial Intelligence (AI)	The ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.
Automation	Automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labour
Critical Success Factor	Key features that need to be in place for the Framework to be a success
Data Analytics	The collection, transformation, and organisation of data in order to draw conclusions, make predictions, and drive informed decision making.
Future Drivers	Factors influencing or driving change within the MMS, including any opportunities that may be realised, or challenges that may be experienced that organisations need to respond to.
Innovation	A process by which a domain, a product, or a service is renewed and brought up to date by applying new processes, introducing new techniques, or establishing successful ideas to create new value
Internet of Things (IoT)	Physical objects embedded with sensors and actuators that communicate with computing systems via wired or wireless networks—allowing the physical world to be digitally monitored or even controlled.
Machine Learning	The use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyse and draw inferences from patterns in data.
Modernisation	The process of starting to use the most recent methods, ideas, equipment, etc. so that something becomes or seems more modern

Pilot (Study)	A small study designed to test various aspects of the methods planned for a larger, more rigorous, or confirmatory investigation
Reskilling	The acquisition of new work-related skills by employees in a company that allows them to perform an existing activity in a different way or to take up a completely new activity.
Robotics	Technology dealing with the design, construction, and operation of robots in automation
Technology	The use of scientific knowledge or processes in business, industry, manufacturing, etc.
Upskilling	To provide someone (such as an employee) with more advanced skills through additional education and training.
Virtual reality (VR)	The use of computer modelling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environment.

1 Introduction

This document provides the Future Skills Needs Framework ("the Framework") to be applied within the Mining and Minerals Sub-Sectors ("MMS") ("the Project") developed for the Mining Qualifications Authority ("MQA"). The Framework should assist the MQA in identifying future skills needs as a result of different future drivers impacting the MMS.

In addition to providing an overview of the Framework to be adopted, the critical success factors (i.e. the key features that need to be in place for the Framework to be a success) are outlined. Furthermore, this Report provides background and context to the MMS, including the future drivers that appear to be currently impacting the sector. The table below provides an overview of the detail contained in the Report.

Table 1-1: Document Outline

Section	Contents	Description
1	Introduction	Provides the background to the project, as well as the context within which it is being conducted. Additionally, it describes the scope/ objectives of the project.
2	Overview of the MMS	Provides an overview of the MMS in South Africa, including an overview of the future drivers currently influencing change within the sector.
3	Introduction to Proposed Framework	Provides an overview of the approach adopted in order to develop the Framework presented in this Report, including details surrounding the pilot process undertaken to validate activities proposed as part of the Framework. In addition, the section outlines the relevance of the Framework to the MMS.
4	Future Skills Needs Framework	Provides the Framework proposed that the MQA may look to implement in order to forecast future skills needs of the MMS, including details regarding the nature of the processes and procedures to be followed when implementing the Framework.
5	Summary of Critical Success Factors	Provides a summary of the factors that need to be in place in order to facilitate the successful implementation of the Framework and facilitate a successful outcome following the Framework implementation.
6	International Best Practices	Highlights international best practices with regard to the response to skills changes within the MMS, thus offering valuable insights and benchmarks for

		enhancing the local approach that the MQA may consider.
7	Conclusion	Provides a conclusion to the Report.
8	Annexures	Provides the workshop presentation packs and survey tool for the Framework.

1.1 Project Background

As a result of its skills development mandate, the MQA is expected to respond to the National Development Plan (“NDP”) which aims to eliminate historical and structural poverty and ultimately reduce unemployment by 2030. The NDP seeks to build the capacity of South African citizenry to ensure that South Africa has relevant, high-quality skills for economic growth, employment, and social development. From a skills development perspective, the goals of the broader NDP will primarily be achieved through the National Skills Development Plan (“NSDP”), which outlines outcomes to be met by various agencies, such as Sector Education and Training Authorities (“SETAs”). It is envisioned that these outcomes will be met through the implementation of specific interventions aimed at increasing access to high quality education and training, skills development opportunities and workplace learning and experience, in order to enable effective participation in the economy and society by all South Africans (MQA, 2022).

In addition to the NDP and NSDP, consideration should be given to other national strategies, plans and short-term policies such as the Economic Reconstruction and Recovery Skills Strategy (“ERSS”), a skills strategy linked to the broader South African Economic Reconstruction and Recovery Plan (“ERRP”), which seeks to align skills development with the ever changing needs of industries, ensuring that the workforce is equipped with relevant competencies. The strategy's focus on innovation, technology adoption, and collaboration between public and private sectors underscores a commitment to building a resilient and globally competitive workforce. The ERSS is designed to create a balance between the short- and long-term needs of South Africa, particularly in response to COVID-19. The focus of the ERSS is wide-ranging, and involves optimising the skills development regulatory environment, implementing structural reforms to boost education and skills development and a concerted effort in building the skills base required by the economy, post COVID-19. Within the scope of the ERSS, the list of critical skills, occupations in high demand and priority occupations are seen as critical enablers of the economic recovery and reconstruction effort, as these enablers identify skills needs across the economy and assist to align skills planning with economic planning, which subsequently ensures that skills are not a constraint on economic growth, which is of particular importance in the post COVID-19 economy (MQA, 2022).

In recognition of the need to ensure that the nature of skills programmes align with the needs of the labour market and that individuals within the MMS are equipped with the relevant skills that will allow them to participate in the economy, as per the broader

skills development policies and plans, the MQA needed to conduct research and develop a framework for future skills needs identification for the MMS. It is within this context that the MQA appointed Redflank to research and develop a framework to forecast future skills requirements for the MMS. It was envisioned that this research would be able to provide knowledge that may assist the MQA to develop a fit to purpose strategy and model that addresses skills shortages and gaps in the subsectors across the MMS.

1.2 Significance of the Study

Given the dynamic challenges confronting the MMS in South Africa as a result of various future drivers, such as increased modernisation, economic and environmental factors amongst others, the significance of this study is paramount. The project aims to develop a comprehensive model (the Framework) that may be adopted to forecast future skills needs within the sector, providing invaluable insights that empower sectoral planning bodies, such as the MQA, with the opportunity to proactively anticipate and prepare for evolving skills need and thus, ensure that the workforce is equipped with the necessary skills to navigate the evolving landscape. In addition, the Framework serves as a crucial strategic tool for targeted workforce development, allowing sectoral planners to design training programs aligned with future requirements. By minimising skill gaps and enhancing efficiency, the industry can remain competitive on a global scale.

1.3 Project Scope/Objectives

As per the Terms of Reference (“ToR”), the main focus of this study was to conduct research and develop a framework to identify future skills needs for the MMS. Key objectives of the study, as well as an overview of the sections in this report which respond to these are included in the table below.

Table 1-2: Project Scope

#	Key Area	Relevant Section in Report
1	Understanding what the key drivers influencing future skills needs, including the Fourth Industrial Revolution (“4IR”) related skills requirements, in the MMS are	Section 2.2
2	Identifying international experiences to distil the best practices and the lessons that can be learned and applied to the MMS from the ‘success stories’	Section 6
3	Understanding what the critical success factors (key features) are, that are necessary for the development of a framework for skills anticipation in the MMS	Sections 4 and 5

#	Key Area	Relevant Section in Report
4	Developing a framework that can be applied in the MMS for future skills anticipation and outlining the nature of the procedure and process to be followed in applying it.	Section 4

2 Overview of the MMS

The South African mining sector, classified as the MMS, is rich and diverse and has played a key role in the country's economy for over a century by contributing to the GDP and providing employment for thousands of people. The sector is dominated by large-scale mining ("LSM") organisations, mainly focused on the accessing of large high-grade mineral deposits (Rodríguez-Novoa & Holley, 2023). These include coal, Platinum Group Metals ("PGMs"), gold, diamonds, and other minerals such as iron ore and manganese ore (Minerals Council SA, 2023). These large-scale operations are typically owned and operated by multinational companies, however there are also several locally owned and operated mines. The majority (about 90%) of large mines in South Africa are members of the Minerals Council, which currently consists of 78 members, including Anglo American, Glencore, and AngloGold Ashanti (Minerals Council South Africa, 2023).

The MMS also comprises a number of small-scale mining operations, particularly in gold and diamond mining (Schwartz, Lee, & Darrah, 2021). These small-scale operations are sometimes referred to as artisanal and small-scale mining ("ASM"). ASM entails the use basic mining methods for accessing and extracting mineral ore, and is usually undertaken for subsistence purposes (Debrah, Watson, & Quansah, 2014). In South Africa, ASM and Small-Scale Mining ("SSM") are sometimes used interchangeably to refer to mining activities that employ a limited number of people and involve a small amount of capital investment. The government's 'official' definition of SSM is based on the National Small Business Act of 2003, which states that SSM involves less than 50 employees, generates an annual turnover of less than R10 million, and has fixed and moveable assets valued at less than R15 million (Pontsho & Nellia, 2017). ASM operations are often informal and unregulated and can have significant social and environmental impacts. Such impacts include land degradation, deforestation, landscape impairment, solid waste disposal, water pollution, acid drainage and mercury and cyanide contamination (Mhangara, Tsoeleng, & Mapurisa, 2020).

A range of subsectors make up the MMS including the mining of gold, coal, diamonds, PGM, Cement, Limestone, Aggregates and Sand ("CLAS"), as well as other mineral mining. In addition, the sub-sectors comprise services incidental to mining, diamond processing, as well as jewellery manufacturing (MQA, 2021).

2.1 The Changing MMS Landscape

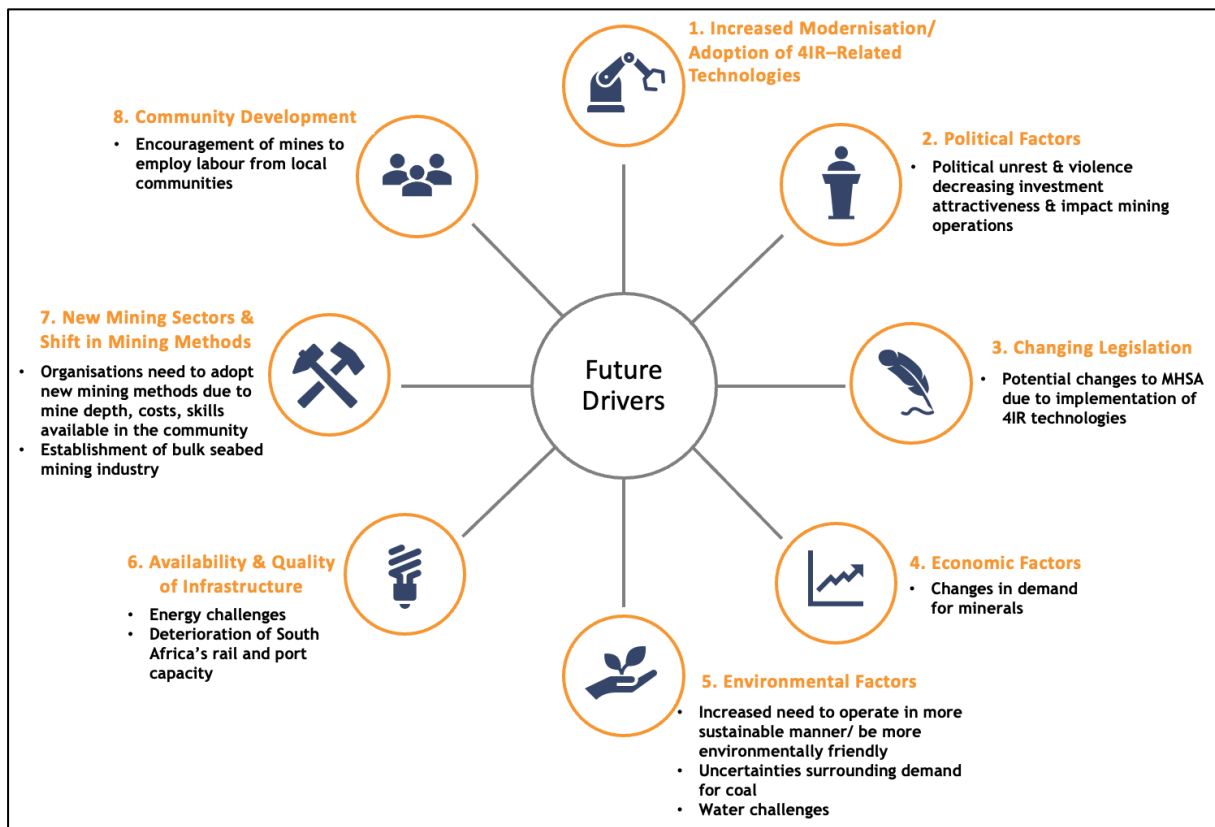
The mining industry is constantly evolving and is influenced by global economic trends, environmental considerations, and community expectations. Embracing innovation, fostering skilled talent, and implementing sustainable practices are increasingly becoming key factors in navigating and thriving amidst these ongoing changes. This has necessitated that the sector remain on par with the changes arising and the skills requirements thereof in order to remain competitive and sustainable (Mining Review Africa, 2022).

Various factors, as outlined in Section 2.2., are currently driving the changes within the MMS, which subsequently have skills and occupational implications for the sector. These multifaceted factors are collectively contributing to dynamic changes in the skills and occupational requirements within the MMS, highlighting the need for a versatile and adaptable workforce. As an example, the increasing use of innovative and cutting-edge technologies to conduct operations within the MMS, in order to improve efficiency, manage risks, improve health and safety, and reduce the cost of maintenance and extraction, is resulting in a requirement for increased access to skills such as data analysis, mechatronics, internet of things (“IoT”), strategic business management, and change management (Mackay, 2023). As a result, there is an increasing necessity to upskill and reskill employees to ensure they remain relevant. Similarly, due to the impact of the future drivers like the 4IR, new occupations or roles such as remote vehicle operators may increase in demand, emphasising the importance of aligning human capital development with innovation strategies (Coates, 2019).

As such, relevant skills development interventions need to be developed, or existing ones updated, in order to ensure skills training is provided on the new and emerging skills, to, in turn, meet the demand for emerging occupations. However, updating and/or developing the new interventions requires that these new skills needed are identified, to ensure focussed effort is placed on developing these. It is, therefore, necessary that a model, such as the Framework, is developed in order to assist the MQA, as the champion of skills development within the MMS, predict future skills needs within the sector.

2.2 Future Drivers

Future drivers refer to factors influencing change within the MMS, including any opportunities that may be realised, or challenges that may be experienced that organisations need to respond to. Various future drivers have been identified that are currently impacting on, or have the potential to, in the future, impact on the MMS in South Africa. These include increased modernisation/adoption of 4IR technologies, political factors, changing legislation, economic factors, environmental factors, the availability and quality of infrastructure, new mining sectors and shift in mining methods, and community development. The figure below provides an overview of these drivers.

Figure 2-1: Future Drivers

2.2.1 Increased Modernisation/Adoption of 4IR-Related Technologies

Modernisation refers to the transition and transformation of the mining sector from labour-intensive operations to more mechanised approaches, thus leading to enhanced employees' skillsets, safer working conditions and increased mine longevity and profitability (Minerals Council, 2022). The increased modernisation and adoption of 4IR-related technologies are catalysing transformative changes within the mining sector. By embracing innovations and technologies such as automation, artificial intelligence ("AI"), and advanced data analytics, mining operations are becoming more efficient, safer, and environmentally sustainable. Furthermore, automated mining practices, such as drilling, and the use of drones are resilient to disruptions due to reduced dependence on labour forces (Walker, Charles, Murphy, & Connolly, 2020). Examples of these include AI-powered drilling systems which improve the accuracy and efficiency of the drilling process by optimising drilling parameters such as speed, direction, and depth, based on real-time data and analysis of the drilling environment. This can help reduce waste and increase recovery rates during the extraction phase of mining value chain (D'Almeida, et al., 2022). Drone technology, on the other hand, expedites mineral exploration surveys, reducing surveying time. Real-time data analytics, predictive maintenance, and the integration of 4IR technologies enhance operational efficiency and safety in mining (MQA, 2023). The MMS also embraces robotics, smart sensors, 3D printing, and machine learning for global competitiveness and environmental, social, and governance concerns. The adoption of these

technologies was accelerated by the COVID-19 pandemic which fostered digitisation and automation in the mining sector (Mungadze, 2021).

The modernisation not only enhances productivity but also addresses environmental concerns by minimising waste and energy consumption. As the mining sector increasingly aligns with the 4IR, it undergoes a paradigm shift, ushering in an era of innovation, efficiency, and responsible resource management. In light of this shift, the MMS will need to ensure that measures are put in place, including reskilling and upskilling initiatives, to equip workers with the necessary skills to either operate these new technologies, or occupy new roles as existing jobs become automated.

2.2.2 Political Factors

Political unrest and violence within South Africa have profound implications on the mining sector, instigating significant changes in operational strategies and risk management. Political instability often results in disruptions to mining activities, impacting production schedules and supply chains. In response, mining companies are compelled to reassess their security measures, needing to implement robust protocols to safeguard personnel, assets, and operations.

Furthermore, political instability and conflict and tension were found to significantly impact foreign direct investment (“FDI”) in the sector, with mining companies generally opting to avoid investing in countries where they perceive the political environment to be unstable or at risk of destabilisation due to the government's actions (Vivoda, 2017). The political unrest and violence observed in July of 2021 in parts of South Africa, which resulted in road blockages, security threats, and operational delays and threatened the productivity and profitability of mines is a prime example of the influence political unrest may have on mining operations. This reinforced existing sector worries around the political risk for the mining sector in South Africa, with the Minerals Council South Africa (“Minerals Council”) warning that this may have long-term impacts on the investment climate and the reputation of the country as a mining destination, due to the potential for occasional pauses in the activities in the mining process (Liedtke, 2021).

2.2.3 Changing Legislation

Changing legislation within the mining sector has a profound impact on skills development. As regulations evolve to address environmental concerns, safety standards, and social responsibilities, the mining sector must adapt its workforce and associated operations accordingly. This necessitates reassessment of training programs to ensure alignment with new legal requirements. The focus on sustainable practices and ethical considerations, driven by changing legislative frameworks, has prompted a shift in skills development towards fostering expertise in areas such as environmental management, community engagement, and compliance with evolving safety protocols. An example of such policy change is the Mine Health and Safety Act 29 of 1996, which is currently undergoing proposed amendments to improve the safety of employees within the sector. Some of the proposed changes being the introduction

of missing person locating systems, where all underground and surface mines with a significant risk of slope failure would be required to provide their workers with a safety locating device that can locate them should they go missing while working or during an emergency (Stoddard, 2023). While this development, along with many others proposed, may ultimately improve miner safety, they also have implications on skills requirements for monitoring and analysing data gathered by the devices, for example, as well as require significant financial investment from the mining organisations. Ultimately, the dynamic nature of mining legislation underscores the need for an agile and responsive approach to skills development within the sector.

2.2.4 Economic Factors

Changes in the demand for minerals were found to be steering transformative shifts within the mining sector. Shifting global economic patterns, advancements in technology, and evolving consumer preferences are altering the demand landscape for various minerals. This was identified through desk-based research, where global demand and prices of minerals were noted as essential factors impacting on the mining sector in South Africa as increased global demand may result in increased investment in the local sector (as a major supplier of minerals and precious metals globally) in order to meet the demand (PWC, 2022). As such, the global economic patterns, advancements in technology, and evolving consumer preferences must be monitored closely to ensure sustainable growth and profitability. Increased global demand for precious metals and diamonds would enable mining operations in the country to continue producing the minerals and jobs within the sector may be sustained (Leikin, 2022). However, the South African MMS is currently experiencing the opposite, with the demand for precious stones, such as diamonds in particular, being in decline, resulting in prices of the minerals plummeting by as much as 15% to 18% over the past year (IBDO, 2023). The mining sector, thus, needs to respond by adjusting production strategies, exploring new mining opportunities, and re-evaluating extraction methods which may necessitate a corresponding evolution in skills development, with a growing emphasis on technological proficiency, sustainability practices, and adaptability to ensure that the workforce remains aligned with the changing requirements of the mineral market.

2.2.5 Environmental Factors

Environmental factors impacting on the MMS include the increased pressure to adopt sustainable and environmentally friendly practices during mineral extraction. Sustainable mining refers to the extraction of minerals using techniques that result in minimal environmental impact, ensuring that mine sites are left in a condition suitable for re-use by both humans and ecosystems (Pan African Resources, 2020). The move towards sustainable mining is reshaping traditional practices toward environmental and social responsibility. Mining organisations are increasingly adopting eco-friendly technologies, implementing stringent environmental management systems, and prioritising community engagement. This shift is driven not only by ethical considerations but also by the recognition that sustainable practices enhance

operational efficiency and foster long-term resilience (Nichols, 2020). In addition, there is increasingly mounting pressure on mining organisations to transform their operations in order to meet sustainability goals and to adopt new digital technologies as noted from desk-based research. This transformation may entail a transition to an integrated, hybrid, electricity mix, with less reliance on fossil fuels such as diesel and coal and more on renewable sources for power generation. This shift is intended to better position mines to achieve the benefits of a flexible system that allows them to reduce carbon dioxide emissions while enhancing energy management and reliability, thus improving the mines' sustainability (Naicker, 2023). Consequently, there is a growing demand for skills development programs that equip the workforce with expertise in sustainable resource extraction, environmental conservation, and social impact assessment.

The emphasis on environmental friendliness is also instigating transformative changes within the mining sector. Increasing awareness of environmental impacts and regulatory pressures is compelling the sector to adopt sustainable and responsible practices. This is because mining activities have been found to pose several environmental degradation risks, including impacting on air quality, water supply and quality, biodiversity loss, land degradation, and greenhouse gas emissions, which in turn, pose health risks to communities, reduce agricultural productivity and increase the costs of environmental compliance and rehabilitation (Leuenberger, et al., 2021). A key contributor to these impacts is the reliance on coal for generating of over 80% of South Africa's electricity, contributing towards carbon emissions. As a result of this, there have been repeated calls for the need to take environmental sustainability in mining into greater consideration, as air quality remains one of the most challenging environmental issues with regard to the health and welfare of the South African population (MQA, 2022). Mining companies are thus, integrating environmentally friendly technologies, such as cleaner energy sources, water recycling, and waste reduction measures, to minimise their ecological footprint. Additionally, there is a growing focus on reclamation and rehabilitation efforts to restore mined areas. This shift towards environmental consciousness is not only a response to societal expectations but also a strategic move to enhance long-term viability and secure social license to operate. As a result, skills development in the mining sector is evolving to include expertise in environmental management, sustainable resource extraction, and the implementation of innovative eco-friendly technologies.

A further transformative shift within the MMS, that may impact coal mining in particular, is a commitment nationally to phase out coal by 2035 and embrace a more sustainable future. Movements such as the Just Energy Transition Partnership are increasingly aiming to accelerate the decarbonisation of South Africa's economy, focusing particularly on the electricity system. This initiative not only seeks to discontinue coal reliance but also endeavours to support the country in transitioning towards low-emission practices, fostering a climate-resilient economy. By prioritising renewable energy sources and sustainable practices, South Africa is poised to contribute

significantly to global efforts in combatting climate change and ensuring a cleaner, greener energy future (Presidential Climate Commission, 2023).

While prioritising renewable energy sources and sustainable practices, South Africa is also exploring the potential to adopt clean coal technologies, allowing for the use of coal in more environmentally acceptable and economically viable ways (Mouton, 2023). This is especially critical given that coal mining makes up almost 20% of the South African mining sector, and the transition away from coal will undoubtedly have an impact on jobs and economic conditions (ESI Africa, 2022). Additionally, the transition from coal in South Africa requires a substantial \$250 billion investment to close existing coal plants. This financial commitment underscores the intricate balance between environmental responsibility and economic feasibility in steering the shift towards sustainable energy solutions (Bloomberg, 2022).

2.2.6 Availability and Quality of Infrastructure

The mining sector relies significantly on the availability of high quality infrastructure, including a reliable transportation network as well as efficient energy resources, in order to efficiently produce and transport minerals to market. The availability and quality of infrastructure are instrumental in propelling transformative changes within the mining sector. Well-developed and efficient infrastructure, including road, rail and sea ports, significantly impact the accessibility and viability of mining projects by allowing the transportation of minerals extracted from the mines to potential markets, both locally and internationally. Improved infrastructure streamlines logistical processes, reduces operational costs, and enhances overall productivity. The demand for upgraded infrastructure is prompting collaboration between mining companies and governments to invest in key areas, ultimately reshaping the sector's operational landscape and driving innovation in mining practices, which in turn has skills implications for the sector (China, 2023).

Currently, the mining sector in South Africa faces significant challenges due to the deterioration of Transnet's rail and port capacity, coupled with issues in the rail network. Underinvestment, inadequate maintenance, rampant crime, and overall inefficiency have collectively led to a compromised transportation infrastructure critical for the mining industry. The consequences of this include delayed shipments, increased operational costs, and heightened vulnerability to criminal activities like theft and vandalism (South African Government, 2023). In addition, the underutilisation of freight rail corridors has led to a 40% decline in the export of minerals through bulk rail transport. This significant reduction in efficiency has resulted in a staggering loss of R50 billion in exports. The decreased capacity and inefficiencies in bulk rail transport not only hinder the smooth flow of minerals from the mining sector but also have severe economic repercussions, emphasising the urgent need for improvements and investments in the rail infrastructure to enhance the export capabilities of the sector (Paton, 2022).

The deterioration of rail infrastructure has further led to a transition from rail to road transportation, which not only introduces higher costs but also elevates safety risks. Transporting exports via road, especially valuable resources from the mining sector, increases exposure to accidents, congestion, and potential criminal activities such as theft. The reliance on road transport, in the absence of efficient rail systems, amplifies logistical complexities, impacting both the safety of the cargo and the economic viability of the mining operations. Improvements in rail infrastructure are required to mitigate these challenges and establish a more secure and cost-effective means of export transportation (Department of Environmental Affairs, n.d.).

The response from the government to the challenges with the rail infrastructure has been the introduction of the National Rail Policy, launched in 2022, which represents a strategic initiative aimed at supporting the modernisation and reform of the rail sector (Parliamentary Monitoring Group, 2022). A key aspect of the policy involves encouraging private participation in the rail sector, fostering collaboration between public and private entities to enhance infrastructure development, improve efficiency, and address the challenges hindering the optimal functioning of the rail network. By promoting private investment and participation, the National Rail Policy seeks to drive innovation, improve operational performance, and contribute to the overall revitalisation of South Africa's rail transport system (Burger, 2022). While the policy holds promise for revitalising the transportation network, its impact is yet to be fully realised. Addressing the challenges related to South Africa's rail infrastructure is crucial for the sustained growth and competitiveness of the mining industry in South Africa (Parliamentary Monitoring Group, 2022).

Furthermore, as noted during desk-based research, mining operators in South Africa are under increasing pressure to transform their operations to solve challenges related to energy security due to unreliable utility generation (Naicker, 2023). This is as a result of the heightened energy risks currently faced by the MMS due to recent electricity shortages and increasing prices, which have rendered it a scarce commodity (MQA, 2022). The sector is negatively impacted by loadshedding which results in production and revenue losses, potential job losses, as well as poses a safety threat to employees within the mines. To address these challenges, stakeholders recommend the formation of self-generation facilities within the mines, to supplement Eskom's constrained energy supply and consider alternative green measures as a source of energy, although it is acknowledged that the transition to alternative energy sources could also impact the coal subsector and the direct and indirect jobs therein (MQA, 2022). Alternative energy sources in these regard include solar, wind and hydrogen, which can help lower the carbon footprint and increase the energy security of mining operations (International Energy Agency, 2022).

2.2.7 New Mining Sectors and Shift in Mining Methods

The emergence of new mining sectors is impacting on the skills-related changes within the mining sector. The new mining sectors emerging within the South Africa MMS includes seabed mining, sometimes referred to as deep-sea mining. This sector entails

the extraction of minerals and precious metals from the seafloor, although the sector is still in the prospecting phase (Hooper, 2020). In addition, the initial consultations conducted as part of this study revealed that new methods of mining are also emerging, not only as a results of the introduction of new sectors, but also as a mode to improving efficiency within existing sectors. One of the new methods, in response to seabed mining, is the use of suction pumps to pull sand up from the seabed to a dredger ship above, where the sand is sorted while still at sea and the valuable minerals or metals are extracted and exported offshore. The residue is then dumped back into the water causing a 'sediment plume' (Hooper, 2020). Moreover, sustainable and environmentally conscious mining methods are also becoming more prevalent, reflecting a commitment to responsible practices. This shift requires a re-evaluation of skills development programs, with an emphasis on training for cutting-edge technologies, environmental stewardship, and adaptable skill sets, as the mining sector undergoes a fundamental transformation to meet the challenges and opportunities presented by these evolving trends.

In addition to the above, organisations within the MMS are increasingly transitioning to mining techniques different to those initially adopted by their organisation. This is as a result of various factors such as the evolving geological landscape, economic considerations, and advancements in mining technologies. For example, the depth of mines is regularly increasing as miners go in search of ores that are found deeper within the earth's surface. This has necessitated a shift to more suitable and cost-effective extraction methods such as those classified as underground, as opposed to surface mining techniques. Furthermore, underground mining techniques have been found to have lesser environmental impacts as opposed to the other techniques due to the lesser surface area covered on the surface of the earth, as well less material extracted from the mine, and are thus, increasing in preference among mining organisations (Underground Miner, 2021).

2.2.8 Community Development

Findings emerging from the workshops conducted as part of this study found that there is increasingly heightened demand from local mining communities for mines to employ labour from these communities, which is instigating transformative changes within the mining sector. The existence of skills gaps as well as limited access to relevant education and training within especially rural communities contribute to the difficulty in finding qualified candidates. Striking a balance between community expectations and operational needs while complying with regulatory requirements, thus, requires strategic collaboration between mining companies, local communities, and various stakeholders. Addressing these challenges necessitates comprehensive initiatives that prioritise skills development, foster positive perceptions, and establish mutually beneficial relationships to promote sustainable recruitment from local communities.

3 Introduction to Proposed Framework

The proposed Framework is envisioned to assist the MQA forecast future skills needs for the MMS, thus allowing the MQA to proactively respond to the needs of the sector and address any potential skills shortages and gaps that may arise. The following sections provide an overview of the process followed to develop the Framework, as well as its relevance to the South African MMS. Section 4 provides a detailed description of the Framework.

3.1 Approach to Developing the Framework

The Framework presented in this Report was informed by both desk-based and field research. In developing the Framework, initial consultations were conducted with stakeholders from research bodies such as the Council for Scientific and Industrial Research (“CSIR”) as well as the Successful Application of Technologies Centred Around People (“SATCAP”) within the Nelson Mandela Mining Precinct (“NMMP”) and the Minerals Council South Africa (“Minerals Council”). The purpose of the initial consultations was to gain an initial understanding of the key future drivers which may impact the MMS, innovations and technologies being implemented by organisations in the sector, and skills and technologies that stakeholders believe would emerge as a result of these future drivers.

Through the desk-based research, the International Labour Organisation’s (“ILO”) Skills Technology Foresight (“STF”) (2016) guide emerged as being crucial in informing skills forecasting within several sectors globally. This guide was developed by global key foresight experts and underwent a testing and validation processes in two distinct countries. As a result, the report was adopted as a baseline for this study and provided a solid foundation for exploring skills forecasting within the mining sector. In addition to the other literature that was studied to inform the development of this Framework, the STF provided key input that guided the formulation of the Framework presented in this Report. Other literature to which reference was made included guidelines from various global labour market and skills development bodies such as:

- The Labour Market Information Council’s (“LMIC”) (2021) primer on forecasting skills demand;
- The European Centre for the Development of Vocational Training’s (“CEDEFOP”) (2021) guide on understanding technological change and skills needs,
- An overview of skills foresight methods (Štefanić & Šimić, 2021).

The consulted literature outlined several approaches to predicting skills needs across differing sectors, given the influence of future drivers such as those outlined in Section 2.2. The information derived from the literature was interpreted and adjusted to inform the Framework which is aligned to the context of the South African MMS and to the MQA to ensure relevance to the parameters of this study.

3.1.1 Framework Pilot Process

Subsequent to the development of a draft Framework, a pilot process was conducted in order to test the feasibility of key aspects and activities of the proposed Framework and identify any key challenges that may arise during the process. As part of the process, 3 sub-sectors were identified to be included in the pilot, namely; Coal and PGM mining, as well as Jewellery Manufacturing sub-sectors. The pilot began with gathering data, through desk-based research, on the current state of the MMS with regard to skills needs, the future drivers impacting the sector as well as the potential technologies being adopted in response to the drivers. Interview questionnaires were then developed and initial interviews conducted with various employers. The purpose of these interviews was to gather further input on key future drivers impacting the MMS, as well as the associated innovations and technologies being implemented by the organisations within the MMS, which are resulting in skills implications for the sector.

In order to validate and expand upon the information gathered through the desk-based research and initial interviews, workshops with key stakeholders were conducted. These workshops took the form of facilitated sessions guided by key discussion points in order to source additional insights into the future drivers within the MMS, the technologies emerging in response to these future drivers, as well as their impact on a selected phase of the value chain. Three varieties of workshops were conducted with various stakeholders in order to focus on and unpack specific themes. The workshops conducted were a Future Drivers Workshop with key industry informants such as SATCAP and the Minerals Council, a Value Chain and Emerging Skills and Occupations Workshop with Employers from the 3 sub-sectors, and an Emerging Skills and Occupations Workshop with Training Providers.

Following this, a survey was drafted using the input received from the workshops and distributed to employers within the 3 identified sub-sectors to validate the input received from all the above-mentioned workshops. The purpose of the survey was to gain an understanding of the top skills needs and occupations that may be required by employers in the sector in the future, as well as to validate the future drivers and technologies that may emerge.

Following the conclusion of the pilot process, preliminary findings were identified and drafted, including the lessons learnt and recommendations to overcome these. These findings were, subsequently, used to refine the Framework.

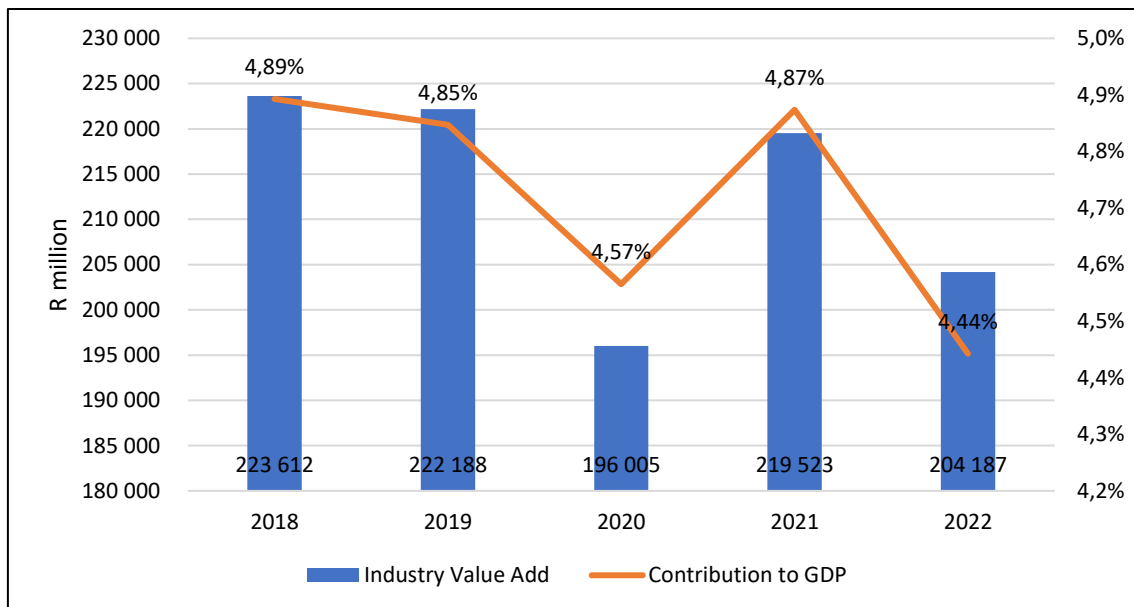
3.2 Relevance of Framework to MMS

ILO (2016) recommends that when deciding which sector to conduct forecasting for, four key requirements should be taken into consideration. Therefore, in order to provide context regarding why it is important to forecast skills in the MMS space, an assessment of the MMS against these requirements was conducted, as outlined further in the paragraphs below.

- **The sector should have a substantial impact on the country's economic growth.**

The mining sector contributes significantly to government revenue, contributing R1.1 trillion in 2021 and R1.18 trillion in 2022 (Minerals Council, 2023). Additionally, contribution to GDP has remained between 4,4% and 4,9% in the 5 years leading to the 2022 financial year, as illustrated in Figure 3-1 below. These fluctuations in GDP contribution, as illustrated in the figure below, indicate that the sector's performance aligns to that of the South African economy as a whole, contracting when the economy contracts and vice versa.

Figure 3-1: Mining Sector Industry Value Add and Contribution to GDP (constant 2015 prices)¹



Source: Stats SA (2023)

The contribution to economy may partly be attributed to the value of exports from the sector, which increased by R21.9 billion in 2022 to R877.6 billion due to the 70% year-on-year increase of commodity prices, despite the volumes of the exports being 20% lower in 2022 than in 2019 (Minerals Council, 2023).

- **Technological change shapes production or service approaches for the sector.**

Technological advancements play a pivotal role in reshaping production and service approaches within the mining sector, as noted through a review of the literature. Some of the technological advancements being adopted include the integration of automation and robotics (an example being autonomous trucks) which has revolutionised operations by enhancing efficiency while minimising the risks associated with hazardous environments (Wadula, 2022). The deployment of sensors and data analytics on the other hand allows for real-time monitoring and predictive maintenance, optimising production processes and reducing downtime (Robben & Wotruba, 2019).

¹ Constant 2015 prices indicates that the monetary values have been adjusted for inflation, providing a standardised measure that facilitates meaningful comparisons across different time periods.

In addition, remote operation technologies enable centralised control over extensive mining sites, contributing to efficient management while digital twin technology facilitates a virtual representation of mining assets, enabling better visualisation and simulation for operational optimisation (NS Energy, 2018).

Other technological advancements within the MMS include drones and unmanned aerial vehicles which enhance surveying and monitoring activities, providing accurate data for informed decision-making in mine planning (Frąckiewicz, 2023). These advancements collectively ensure that the mining sector remains at the forefront of innovation, driving efficiency, sustainability, and adaptability in the face of evolving industry demands.

In addition to the above-mentioned advancements that are already being adopted within the sector, there are other technologies that are planned to be implemented in the future. One example is the use of four-legged dog-like robots, which are equipped with advanced camera payloads, including infrared and thermal imaging cameras. The robots are also equipped with night vision and imagery in challenging conditions, making them suitable for use in surveying studies (Slater, 2022). The robot was first premiered at the 2022 Mining Indaba in Cape Town, South Africa, and is anticipated to be adopted commercially in coming years, although no timeframe has been specified (Solomons, 2022). This illustrates the potential for technological changes to occur in the MMS space which may shape production approaches and require new skills.

- **The sector has the potential to increase country's global competitiveness due to new technologies.**

The mining sector in South Africa has the potential to significantly enhance the country's global competitiveness through the strategic integration of new technologies. As outlined above, the adoption of advanced technologies, such as automation, data analytics, and artificial intelligence, can substantially improve operational efficiency, reducing costs and enhancing productivity. Automated mining processes, driven by cutting-edge machinery and robotics, enable continuous and safer operations, positioning South Africa as a leader in responsible and efficient resource extraction (Wigmore, 2020). By embracing these new technologies, the South African mining sector has the potential not only to increase its own efficiency and sustainability but also to elevate the country's global competitiveness by showcasing innovative and responsible practices in the extraction of valuable natural resources (Mungadze, 2021).

- **The sector occupies a significant share in national employment and/or has the potential to positively impact employment (either directly or indirectly through the supply chain or through induced employment effects), or the sector may experience negative direct employment effects in the short to medium term.**

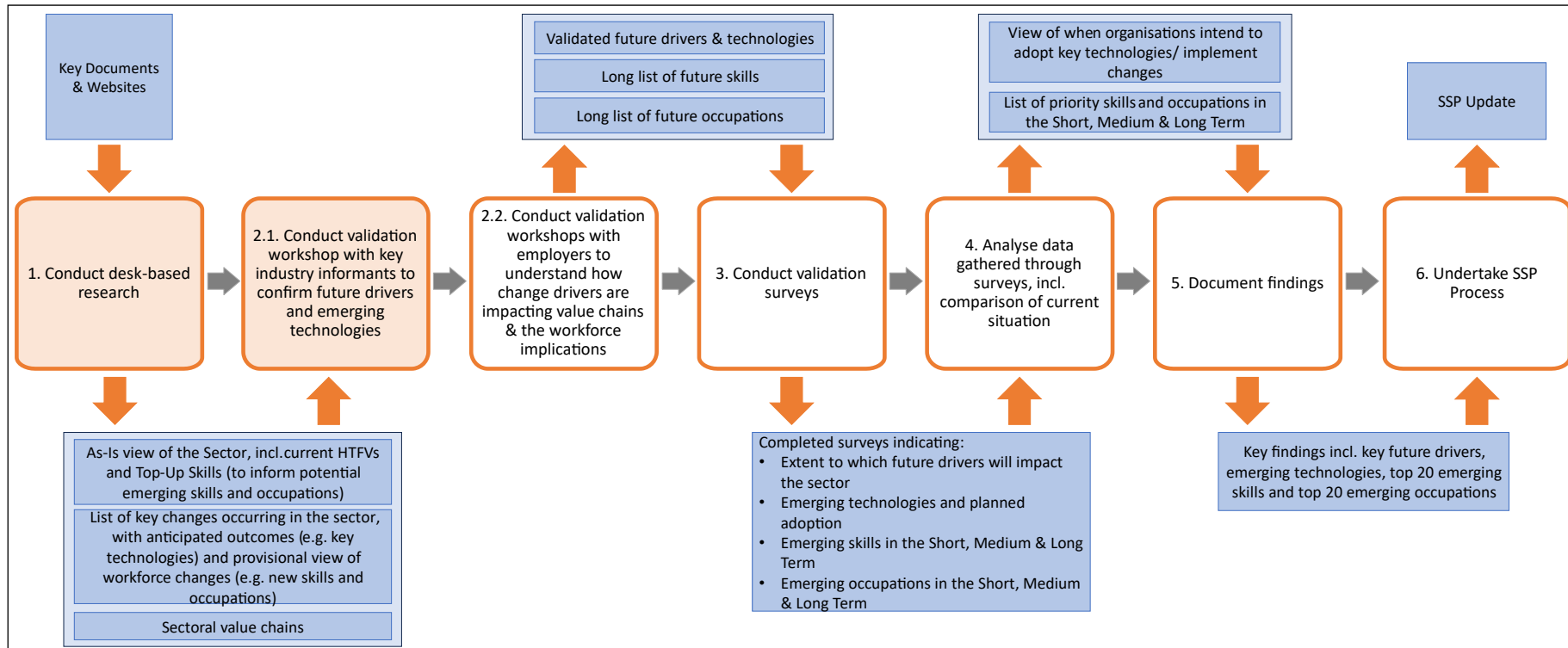
In South Africa, the mining sector has historically played a significant role in national employment, contributing to both direct and indirect job creation. In 2022, the sector

was ranked 7th out of 11 as it pertains to the number of people employed, with 475 561 workers (Cowling, Number of mining employees in South Africa from 2011 to 2022, 2023). This was against a total labour force of 15.6 million in the same year, indicating that the sector constituted 3% of national employment (Cowling, 2023). The potential for the mining sector to positively impact employment remains substantial, given its extensive supply chain and the ripple effect on various support services (Khubanal, RootmanII, & Smith, 2022). Some of the support services include on-site accommodation, cleaning and catering facilities (Mining Technology, 2023). However, the impact can vary based on factors such as the scale of mining operations, technological advancements, and the industry's ability to align with sustainable and inclusive employment practices. While the sector faces challenges and transformations, it continues to be a crucial contributor to employment and economic development in South Africa (Khubanal, RootmanII, & Smith, 2022).

4 Future Skills Needs Framework

This following figure highlights the proposed Framework with the sections that follow outlining the nature of the procedure and processes that should be followed per step when applying the Framework.

Figure 4-1: Draft Framework



As can be seen above, the Framework proposes six steps for the MQA to undertake in order to identify and forecast skills needs in the MMS. The details and processes/procedures to be applied at each of these steps can be found below. These procedures provide detailed instructions for applying the methodologies underlying the Framework and achieving the Framework's objectives.

The step-by-step procedures also include key critical success factors, which outline the key aspects or items that need to be in place to facilitate the successful implementation of the Framework. These key critical success factors have been derived from international and local research best practices. Moreover, the proposed Framework tools which may facilitate the implementation of the Framework are also detailed in the writeups and are further provided in the Annexures.

The step-by-step procedures have been detailed in the form of process descriptions which are detailed narratives explaining how the procedures may be carried out.

A key aspect of the Framework includes determining how regularly to conduct the forecasting process as well as the term for which skills will be forecasted (i.e. short-term, medium-term, long-term).

Best Practice:

According to the ILO (Approaches to anticipating skills for the future of work, 2018), short term and medium-term skills forecasts are usually run or updated on an annual basis. This is supported by a report drafted by CSIR (2016) which found that approximately 20% of skills forecasts can change after a few years given the volatility associated with technologies and innovations.

Further to the above and based on the requirements of the MQA, it was agreed that the Framework would be implemented in the following manner:

- Segments or key steps of the Framework would be implemented on an annual basis;
- A comprehensive forecast (in which all proposed steps are undertaken) would be implemented every two years.

Further to the above, it is recommended that the following key steps(as indicated through the shading in the above diagram) are implemented on an annual basis:

- Step 1: Conduct desk-based research
- Step 2.1 – Conduct validation workshop with key informants

It is envisioned that the proposed sub-steps may be conducted on an annual basis as they may be conducted in conjunction with other activities undertaken to inform the SETA's annual SSP update and will, therefore, not require an additional process to be undertaken by the MQA. By conducting Steps 1 and 2.1. annually, the MQA will be able to observe and confirm if there are any new future drivers occurring in the MMS or if there have been any further changes realised as a result of the previously identified

future drivers. Should any drastic changes be identified that may prompt an immediate response, the MQA may consider conducting the comprehensive forecast.

Further details on Steps 1 and 2.1, as well as the other steps noted in the Framework are provided below.

4.1 Step 1: Conduct Desk-Based Research

The first step in the Framework entails the conducting of desk-based research in order to acquire an understanding of the prevailing and upcoming changes occurring in the sector which may translate into future drivers, including innovations and technologies that organisations are implementing in response to these future drivers that are pertinent to the skills needs in the MMS. In addition, the desk-based research may serve as a cornerstone for comprehending the present state of the MMS in South Africa and internationally. Having an understanding of the current state of the MMS locally and globally will allow the MQA to gain a sense of the extent to which the sector is ready for certain innovations in terms of both organisations and the capabilities of the workforce.

The procedure to be adopted for Step 1 can be found below.

1. Source documents relevant to research

Step 1 begins with the sourcing of documents to provide input on potential emerging occupations, skills needs and innovations, as well as future drivers in the MMS. The table below outlines the documents that the MQA may consider sourcing and reviewing as part of this activity. Furthermore, it provides an indication of their relevance to the Framework process.

Note:

The documents listed in the table below do not represent an exhaustive list of documents that may be used to source information for the process. The MQA is encouraged to include additional relevant documents in the below list that may assist in providing an understanding of changes occurring in the sector, technologies emerging and potential emerging skills and occupations.

Table 4-1: List of Proposed Documents for Review

#	Proposed Documentation	Relevance
1	Latest SSP (previous year or current year) documented by the MQA	Includes list of current skills gaps and hard to fill vacancies as well as identified future drivers.
2	Jobs Forecasting Reports such as the Future of Jobs Report published annually by World Economic Forum	Includes list of skills and occupations emerging in the MMS globally, as well as details around changes that may occur in the MMS globally
3	Related South African Policy Documents (for	May provide details regarding any policy related changes which may impact operations in the

#	Proposed Documentation	Relevance
	instance, the Broad-Based Socio-Economic Empowerment Charter for the Mining and Minerals Industry, the Mining Charter and the National Environmental Management Act, amongst others)	MMS. These should inform the future drivers impacting the MMS
4	Data related to the contribution of the MMS to the South African economy on the StatsSA website	Provides an indication of the contribution that MMS makes to the South African economy
5	Journal for Labour Market Research	Publishes research focused on labour market dynamics, including employment trends and analyses of skills and their relevance to the labour markets, thus contributing to the development of informed skills forecasting strategies, and enhancing the accuracy and relevance of workforce planning in response to evolving labour markets
6	Strategic Plans, Educational Curricula and Programs offered at Training Institutions such as Wits University, University of Pretoria and University of Johannesburg	Current educational curricula and programmes provide information on existing educational curricula, training programs, and courses and can help identify the skills being emphasised by educational institutions and potential gaps in meeting industry needs, while strategic plans provide an understanding of the strategic plans of training institutions, universities, and vocational schools which may assist in gauging their responsiveness to evolving industry needs.
7	Labour Market Reports from reputable bodies such as the International Labour Organisation and the International Monetary Fund	Provides insights into current labour market trends, demands, and challenges thus empowering decision-makers to anticipate skill needs, align education and training programs, and formulate effective strategies for workforce development
8	Mining Industry Reports and Periodicals such as the Global Mining Review,	Offers information on emerging trends, technological advancements, and anticipated changes in skill requirements within a particular

#	Proposed Documentation	Relevance
	Mining Review Africa and the Engineering and Mining Journal	industry, thus providing an indication on which skills and occupations should be prioritised when developing interventions
9	Government Skills Initiatives such as the NDP and National Skills Development Strategy ("NSDS")	Provides information on government-led skills development initiatives or policies aimed at addressing future workforce needs.
10	Documents sourced as part of the Literature Review Report submitted by Redflank	Some of the documents found that are published on a recurring basis and therefore may provide input into the Framework are listed below: • Updated articles published by the Atlas Renewable Energy • Updated articles published by Business Tech • Updated articles published by Career Explorer • Updated Strategic Plans from the DMRE • Updated articles published by Minerals Council South Africa • Updated articles published by Mining Industry Human Resources Council • Updated articles published by Mining Weekly

When conducting desk based research, it is essential that data is gathered from credible sources to ensure that the data gathered is accurate, reliable and limits the probability of disseminating unverified information. Credible sources also allow for strengthening of analysis being made.

Critical Success Factor:

Sources used for the desk-based research should be credible and up to date to ensure that data collected on rapidly evolving fields such as key future drivers and skills needs is up to date. Sourcing data from credible sources also provides a level of comfort regarding the research materials' validity and reliability.

In addition to the above, the MQA should ensure a thorough review of relevant literature is conducted each time the forecasting process is undertaken in order to ensure the latest information available is being accounted for in the Framework.

Critical Success Factor:

The desk-based research should be updated regularly (every time a forecast is being made) so as to incorporate new and relevant insights.

2. Review documents

Following the sourcing of documentation and literature, the documents listed above, and any other relevant documents should be reviewed to understand the current state of the MMS as well as any emerging trends, skills needs, occupations and innovations in the sub-sectors.

3. Compile information to be validated in next phase

The data gathered from the desk-based research through the sourcing and review of the above-mentioned documents should be compiled and documented in order to provide the MQA with a list of key changes occurring in the MMS (i.e. the future drivers), a list of technologies emerging as a result of these future drivers, a view of the sectoral value chains and a current view of the MMS, including current HTFVs and skills gaps.

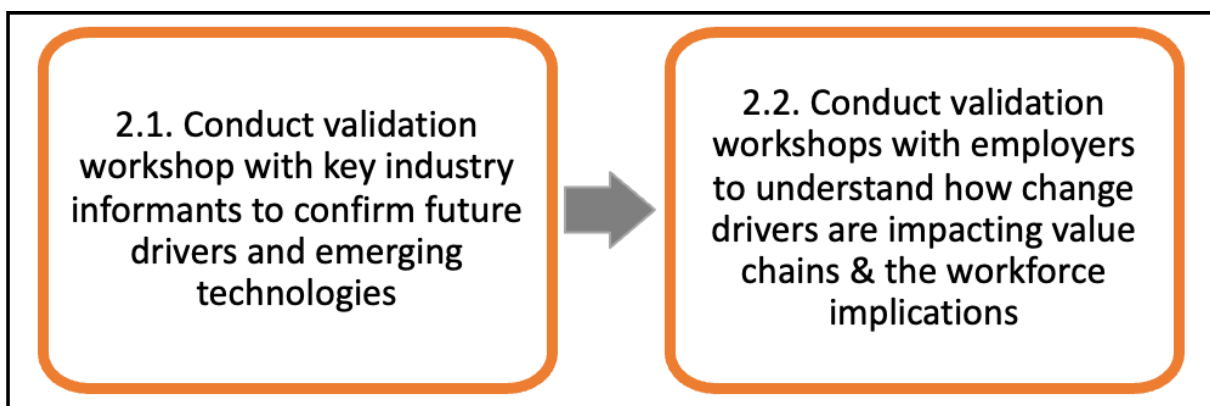
A record of sources consulted during the process should be kept as it will allow the MQA to cross-reference the sources and also refer back to sources for updated data when forecasting in the next period.

Critical Success Factor:

Maintaining a record of all sources consulted during the process allows for traceability for the MQA researchers who will reproduce the desk-based research undertaken. Moreover, having a record of sources allows stakeholders to verify and confirm the validity of the research material.

4.2 Step 2: Conduct Validation Workshops

Following the conducting of desk-based research to understand future drivers and innovations in the sector, Step 2 of the forecasting process relates to the conducting of various workshops with key stakeholders in order to validate and expand upon the information gathered in Step 1. As part of this step, two varieties of workshops should be conducted, as illustrated in the figure below.



The validation workshops should begin with a future drivers workshop conducted with key industry informants. The purpose of this workshop will be to validate the future drivers and technologies identified through the desk-based research conducted in Step 1 and to discuss any additional drivers and technologies which may emerge and impact

the MMS. Key industry informants that the MQA may look to involve as part of this workshop are outlined in the table below.

Following the future drivers workshop, the value chain and emerging skills and occupations workshops should be conducted with Employers in the sector. It is proposed that one workshop is conducted per sub-sector, with 9 workshops being conducted in total. The purpose of these workshops will be to further discuss and validate the future drivers and technologies. Additionally, these workshops should be used to understand areas in the mining and beneficiation value chains which may be impacted by the technologies being introduced, as well as the impact that these changes may have on skills and occupations.

The following paragraphs provide further details regarding the process that the MQA may look to follow when scheduling and conducting the suggested validation workshops. It is noted that as part of the process followed in order to update the SSP, the MQA will be looking to conduct various workshops with key stakeholders (including pre-SSP workshops and post-validation workshop). Should these SSP workshops involve similar stakeholders and should it be practical, the MQA may look to combine the above-mentioned workshops with the workshops to be conducted as part of the SSP process.

1. Confirm Workshop Format and Details and Identify Stakeholders

The first step that should be taken as part of the validation workshops is to confirm the platform through which the workshops will be conducted and confirm the details for the workshops, including recommended dates and times. In terms of the platform for the workshop, the MQA will need to decide whether to conduct workshops virtually or in-person. As part of this decision, there are various considerations that the MQA should take into account, these include:

- The location of the participants to be included in the workshop, should respondents be far-spread a virtual workshop may be preferred;
- The participants access to connectivity and infrastructure that will allow them to join a virtual meeting, should this connectivity be limited a face-to-face workshop may be preferred;
- The willingness of participants to travel to a central location for the workshop;
- The level of engagement required from the participants and the level of interaction intended for the session, should high levels of interaction and engagement be required, a face-to-face session should be considered (Moiso, 2022);
- The content being presented and whether the content/key messages can be conveyed effectively in a virtual setting or if it requires visuals/props more suited to a physical setting (Barnard, 2017).

Further to the above considerations, the below table provides an overview of the key advantages and disadvantages associated with in-person and virtual workshops.

Table 4-2: In-Person vs. Virtual Workshops: Advantages and Disadvantages

Advantages	Disadvantages
In-Person Workshops	
May promote better engagement amongst stakeholders	Less time-efficient due to travel time
Allows for hands-on activities and practical demonstrations	Requires participants to be in a central location or be willing to travel to a central location
Allows for clearer interpretation of body language and non-verbal cues, aiding better understanding and communication	May result in more expenses due to venue costs, travel and costs of refreshments
Virtual Workshops	
Time-efficient as participants don't need to travel to the venue	May exclude people with limited access to/poor connectivity
Easier to include participants from multiple locations	May make communication more difficult, as it may limit the facilitators ability to pick up on non-verbal cues
Limited expenses incurred	Participants might face distractions at home or at their chosen location, impacting their focus and participation during the workshop
May be easier to schedule as less time overall will be required from participants (e.g. due to travel time not being required)	Increased risk of technical issues due to the reliance on internet connectivity or the potential of software glitches
Session can be recorded and distributed to participants who may not be able to attend	

Source: Hypccycl (2022); Nagar (2023); Barao (2023); Luintel (2023); Adams (2021)

Should the MQA decide to conduct the workshop in-person, appropriate venues, such as the MQA regional offices, will need to be arranged. An important consideration when arranging these venues will be to ensure that the venues will be able to accommodate the number of people that are anticipated to attend the workshop.

In addition to confirming the platform through which the workshop will be conducted, other details that will need to be confirmed at this stage include the dates and times for the various workshops. These workshops should be planned far enough in advance, about 3 to 4 weeks prior, to ensure that participants are able to avail themselves

accordingly. In addition, reminder emails should be distributed to invitees 5 to 7 days prior to the workshop (Dickens, 2023).

Critical Success Factor:

When confirming the time for the workshop it is important to ensure that enough time is scheduled for each workshop to allow for in-depth discussions and sufficient input to be gathered. The time to be scheduled for each workshop will be dependent on the content to be covered during the workshop. It is recommended that at least four hours is scheduled for the Future Drivers workshop as well as each Value Chain and Emerging Skills and Occupations workshop with Employers.

Once the details surrounding the workshops have been decided, the stakeholders to be included in the workshops should be identified. The table below provides an indication of the key expertise required for each of the above-mentioned workshops, as well as an overview of the potential stakeholders to be included who may be able to provide this expertise². Beyond confirming the organisations to be included, it is also important to ensure that the relevant representatives from said organisations are included.

Critical Success Factor:

In order to ensure the success of the validation workshops, it is vital to ensure that relevant and engaged stakeholders who are able to provide adequate input on the topics being discussed are included and consulted with.

Table 4-3: Validation Workshops: Stakeholder Inclusion

Workshop	Expertise Required	Proposed Stakeholders
Future Drivers Workshop	- Knowledge of domestic and international trends and changes occurring which may impact the MMS and the potential implications of these on organisations in the sector - Ability to identify trends and understand market implications - Knowledge of technologies being implemented by organisations either domestically or internationally in response to the future drivers	- Minerals Council South Africa - DMRE - CSIR - Nelson Mandela Mining Precinct - Universities conducting research on behalf of mining companies - MEMSA - Council for Geoscience - Affiliation Bodies (e.g. AMIHRP, AMMSA)

² The table presented has been developed using input from the ILO: Skills Technology Foresight Guide (2016)

Workshop	Expertise Required	Proposed Stakeholders
		• Mine Health & Safety Council • Mintek
Value Chain and Emerging Skills and Occupations Workshop	• Knowledge of future drivers in the sector which may impact organisations • Knowledge of technologies currently being implemented in their organisations or technologies that their organisation plans to adopt in response to changes occurring in the sector • Knowledge of existing workforce structure and skills • Knowledge of workforce structure and skills needs as a result of the implementation/adoption of new technologies or adaption of business processes in response to future drivers or ability to derive workforce and skills requirements from technologies applied	• Representatives from large, medium and small mining organisations per sub-sector who are involved in the mining operations and strategic decision-making for the mines, e.g. business owners, research and development managers, operations managers • Human Resource Development Representatives • Organised Labour Representatives

2. Invite Stakeholders to Participate in Workshops

Once the relevant stakeholders have been identified, and the details surrounding the workshop have been confirmed, stakeholders should be invited to participate in the workshops. Stakeholders may either be contacted telephonically or via email.

Due to the nature of the workshop, as indicated in the table above, it will be important to include more targeted individuals from selected key organisations in the Future Drivers workshop. This, in turn, will most likely require a more individualised approach and it is, therefore, recommended that these stakeholders are contacted telephonically. Furthermore, more personalised contact may encourage them to avail themselves to participate in the workshop. Regarding the workshops to be conducted with representatives from Employers in the sector, in order to ensure efficiency, the MQA may consider distributing bulk emails, inviting stakeholders to participate in the Value Chain and Emerging Skills and Occupations Workshops. In an attempt to

facilitate maximum participation in the workshops, the MQA may consider distributing the invite to all Employers in the respective sub-sectors. The text box below provides an illustrative example of the communication that may be distributed to invite stakeholders to the workshop.

Implementation Tool: Workshop Invite

Dear Valued Stakeholder,

The Mining Qualifications Authority is in the process of conducting research to understand the future skills needs of organisations in the Mining and Minerals Sector. The primary objective of this research is to understand key changes that are affecting organisations in the sector, the manner in which organisations are responding to these changes and the future skills and occupations that may emerge as a result of these changes.

As part of this process, we would like to invite you to attend a workshop to gain your perspective on changes occurring in your organisation as well as your future skills needs. This workshop will be held at [insert location] on [Insert date and time].

Your participation in this workshop would be greatly appreciated as it will allow us to gain an understanding of your future skills needs so that we can proactively plan for these needs. Kindly confirm your availability by responding to this email or accepting this invite.

We look forward to engaging with you.

As part of, or following the initial communication, a meeting invite should be distributed to stakeholders confirming key details for the workshop, such as the date, time, and location. Should the intention be to conduct the workshop virtually then the meeting invite should include the meeting link. On the other hand, should the intention be to conduct the workshop face-to-face then the meeting invite may serve as a placeholder to remind stakeholders of the intended workshop as well as the key details.

3. Prepare for Validation Workshops

Following the invitation of key stakeholders to the respective workshops, the MQA should look to prepare to conduct the workshops. Key aspects of this preparation should involve defining clear objectives and outcomes for the workshop, developing a detailed agenda for the workshop that outlines the flow of activities, timing and objectives for each area of discussion (Hoek, 2019). In addition, it is key to prepare the material that may be used to provide context and background on the purpose of the session and the areas to be discussed and that the facilitator may refer to, to guide the discussion (Center for Community Health and Development, 2023).

Best Practice:

In order to allow for an effective workshop to be conducted, clear objectives and outcomes for the workshop should be defined (Hoek, 2019).

Implementation Tool: Workshop Slide Packs

Annexure A provides a template/proposed layout for the slide packs that the MQA may look to develop in preparation for the validation workshops.

In addition to preparing the material to be used to guide the discussion, the MQA should also look to identify individuals to fill the following key roles required for the workshops:

Table 4-4: Validation Workshops: Key Roles

Role	Description
Lead Facilitator/Workshop Leader	The role of the lead facilitator/workshop leader is to ultimately lead the workshop, manage the agenda and guide the discussion. This includes ensuring the session stays on track and on-time, providing context to the workshop, introducing the topics for discussion and encourage participation and input from attendees
Co-Facilitators/Assistants	The role of the co-facilitator/assistant involves providing key support to the lead facilitator. This may include managing logistics, addressing individual queries and moderating or guiding the discussions during breakout groups or smaller segments of the workshop. The co-facilitators may also assist with managing the practical aspects such as room setup and materials arrangement should face-to-face workshops be planned.
Note-Taker	The role of the note-taker will be to capture the key points and inputs being raised by participants during the workshop. Following the session these points should be summarised and the key outcomes and discussions summarised.
Technical Support	Should workshops be conducted virtually, the MQA may consider assigning someone to provide technical support during the workshop. This individual should assist any participants that may experience any technical difficulties to facilitate a smooth discussion.

Source: Pmmajik (2022)

In assigning the above-mentioned roles to various individuals, the MQA should ensure that clear instructions and guidelines are provided to each of the individuals to ensure they understand their roles and are able to fulfil them effectively.

4. Conduct Validation Workshops

The final activity to be undertaken as part of Step 2 of the Forecasting process is the conducting of the various validation workshops. The way these workshops should be conducted will differ per workshop and should be customised in order to facilitate maximum stakeholder participation.

Critical Success Factor:

In order to facilitate the gathering of sufficient and relevant information during the validation workshops it is important to ensure that the stakeholders that join the workshop are engaged and actively participate in the session. In order to promote this, the MQA may consider sharing the slide pack prior to the session to allow stakeholders to familiarise themselves with the content and prepare accordingly. Furthermore, tools such as break-out rooms may be used to encourage participation from all stakeholders in the session.

The following table provides an overview of the suggested format that may be applied for each workshop.

Table 4-5: Validation Workshops: Proposed Agenda and Format

Agenda Item	Time Allocation	Format	Detail
Future Drivers Workshop			
Introduction, Background & Session Objectives	10 minutes	Presentation	During this agenda item, the MQA should introduce the session and provide the background and context to the session, including the session objectives. During this time, meeting participants should be provided with the opportunity to introduce themselves
Future Drivers Overview	20 mins	Facilitated Discussion	As part of this agenda item the MQA should look to explore the potential future drivers impacting the sector. The facilitator from the MQA should lead this discussion and should invite stakeholder input regarding the changes occurring in the sector, including any opportunities available or challenges that organisations are facing
Discussion of Individual Future Drivers	30 mins per Future Driver	Facilitated Discussion	This agenda item should involving delving into each future driver identified and should take the form of a facilitated discussion that looks to understand stakeholder perceptions regarding: • How organisations are currently or how they may be

Agenda Item	Time Allocation	Format	Detail
			planning to respond to the identified future driver • What technologies, if any, may be adopted by organisations or may be implemented in the sector as a result of the change driver • What other changes may occur in organisations as a result of the future driver that may impact the workforce • Whether the future driver is likely to affect the sector in the Short-, Medium- or Long-Term
Value Chain and Emerging Skills and Occupations Workshop			
Introduction, Background & Session Objectives	15 minutes	Presentation	During this agenda item, the MQA should introduce the session and provide the background and context to the session, including the session objectives. During this time, meeting participants should be provided with the opportunity to introduce themselves
Future Drivers & Emerging Technologies	30 mins	Facilitated Discussion	As part of this agenda item the MQA should look to present the potential future drivers and emerging technologies, identified through desk-based research and the workshop with key industry informants, that are believed to be impacting the sector. The facilitator from the MQA should lead this discussion by providing an overview of these drivers and technologies and should invite stakeholders' to provide their input regarding whether the future drivers and technologies

Agenda Item	Time Allocation	Format	Detail
			presented resonate with them and whether there are any future drivers and technologies that they have seen.
Impact of Emerging Technologies on the Value Chain	45 mins	Break-out Session	During this agenda item, the MQA facilitator should split the broader group into several smaller groups (to encourage active participation and meaningful interaction, these groups should be made up of around 4 to 8 people, depending on the number of people attending the workshop and the number of smaller groups required) (Center for Community Health and Development, 2023). The purpose of the smaller groups will be for each group to discuss a phase of the sub-sector's value chain, e.g. "Initial Processing/ Beneficiation", with a focus on which of the anticipated technologies do they believe are going to be implemented at this phase of the value chain and what skills and occupations do they believe are going to emerge as a result of the implementation of these technologies at the respective phase of the value chain. The assignment of individuals to the smaller breakout rooms or to the smaller groups should be done strategically, with the facilitators taking into account expertise, roles and the specific discussion topics to be covered. Once individuals have been assigned to their respective groups, the lead facilitator should

Agenda Item	Time Allocation	Format	Detail
			provide clear instructions to the participants regarding the purpose of the breakout sessions, the expectations and goals in terms of what should be discussed and the allocated time. Furthermore, the facilitator should provide guidance regarding how participants should document their input (e.g. on a slide if in a virtual workshop, or on a flipchart if in a face-to-face workshop) and should note that each group should appoint a scribe (i.e. an individual to document notes) as well as a presenter (i.e. an individual or individuals who will report the findings from their group back to the broader group) (Center for Community Health and Development, 2023). Once the participants have been split into their groups, the lead and co-facilitators should alternate between the groups to provide guidance and direction, as required.
Report back regarding the Impact of Emerging Technologies on the Value Chain	1h45mins	Report back presentations & discussion	Once the breakout sessions are complete, the final item on the agenda should be focused on providing each group to report back on their discussion and share key insights or outcomes (Center for Community Health and Development, 2023). Each group should be provided with up to 15 minutes to report back on the technologies and emerging skills and occupations that they identified for their phase of the

Agenda Item	Time Allocation	Format	Detail
			value chain. Following each report back, the broader group should be provided with an opportunity to add any additional input they may have regarding that phase of the value chain.

Critical Success Factor:

During the pilot study conducted, to promote a focused and relevant discussion, when discussing the future drivers and emerging skills, occupations, and technologies, participants were requested to indicate examples that they had seen either in South Africa or internationally, for example, if a participant indicated that virtual reality could be used to provide training on jewellery manufacturing, the participant was requested to indicate where they had seen this being adopted before. The MQA may continue to adopt a similar approach during the workshops conducted to ensure a focused and realistic discussion is conducted. Furthermore, where respondents indicate that they have seen something occurring internationally, the MQA may look to further unpack the country where they have seen this, to understand any potential countries that the South African industry may look to benchmark themselves against.

The key outcomes of these workshops should be a validated view of future drivers, emerging technologies and anticipated future skills and occupations that will be required as a result of these future drivers.

4.3 Step 3: Conduct Validation Survey

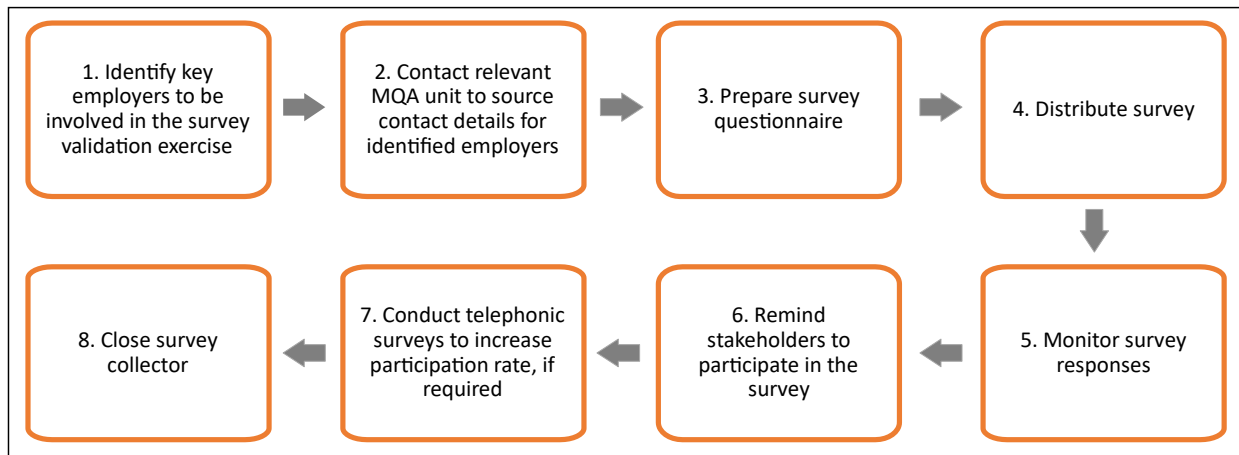
As highlighted above, following the validation workshops conducted, the MQA should have a validated view of the future drivers and emerging technologies as well as a view of the potential future skills and occupations. In order to ratify the future skills and occupations identified in the workshops, the MQA should conduct validation surveys. This validation survey, to be conducted with representatives from mining organisations (also known as employers), aims to provide a broader understanding of the following:

- The extent to which the identified future change drivers will impact mining organisations
- The segments of the MMS value chain which respondents believe will be impacted as a result of the identified future change drivers
- The time period in which organisations are intending to adopt the identified emerging technologies as well as the list of technologies which have already been adopted
- The quantity of emerging skills or occupations that will be required by organisations in the sector in the short-term (i.e. 1 – 2 years) and medium-term (2 – 5 years)

- The qualifications employers believe would be required to meet the relevant emerging skills and occupations in the MMS

Subsequently, the following activities, summarised in the figure below, should be adopted in Step 3:

Figure 4-2: Validation Survey Process



1. Identify key employers to be involved in the survey validation exercise

The first activity to be conducted as part of the validation survey relates to the identification of key employers to be targeted for this exercise. Based on the data gathered from the validations workshops, the MQA can select key sub-sectors to be included in the validation survey (for instance, if input from the validation workshops indicate that only 3 of the 9 sub-sectors will experience significant changes in the next 2 years, then employers from only these 3 sub-sectors can be included in the validation surveys). However, it is recommended that all sub-sectors are included in the survey.

Critical Success Factor:

In order to facilitate the collection of input from all stakeholders and avoid bias in terms of the future change drivers, emerging skills, technologies and occupations, the MQA should conduct the validation survey with mining organisations from all sub-sectors.

2. Contact relevant MQA unit to source contact details for identified employers

Prior to the distribution of the validation survey, the contact details for the identified employers must be sourced from the relevant unit and cleaned. Given that electronic surveys will be distributed, it is important that valid email addresses are sourced. Contact numbers should also be sourced in the event telephonic surveys are conducted.

As part of the Framework process, it is recommended that the MQA strive to gather input from as many employers as they are able to in order to facilitate an understanding of the top emerging skills and occupations required across the sector. The MQA should

also ensure that any research conducted is done according to the provisions of the POPIA Act.

Critical Success Factor:

As in the tool provided by Redflank, the MQA should ensure that POPIA requirements are met throughout the data collection phase.

3. Prepare survey questionnaire

Once the relevant stakeholders have been identified and the contact details for said stakeholders sourced, the MQA should look to finalise the survey questionnaire to be used. This may include coding the survey on the online platform to be used by the MQA, as well as updating the survey tool proposed by Redflank, where relevant. Key areas to be updated in the questionnaire will include the list of future change drivers, the list of emerging technologies, and the emerging skills and occupations in the MMS. These are marked with an asterisk in the survey tool provided.

Implementation Tool: Survey Questionnaire

Annexure B provides an example of the survey tool that can be used and updated by the MQA when preparing for and conducting the validation survey.

Following the updating of the survey questionnaire and in order to ensure the survey questionnaire is an accurate and robust tool, the following quality control checks should be conducted:

- Check for duplicates in options provided (for e.g. to ensure the same emerging technology is not listed twice in a survey question)
- Conduct a sense and grammar check to check for inconsistencies

4. Distribute survey

Once the survey has been finalised, it can be distributed to identified stakeholders. As mentioned above, prior to distribution the MQA should code the survey onto an online platform and should distribute the survey using a link or alternative method that will allow the stakeholders to complete the survey online. The use of an online platform should allow the MQA to collect responses anonymously and efficiently.

Best Practice:

It is recommended that the MQA populates the survey questionnaire on an online survey platform, such as, Survey Monkey. Using an online survey platform facilitates the distribution of surveys, monitoring of survey responses and the compilation of a database of the raw data gathered from the respondents. An online platform also makes it easier to reach the target audience (Smart Survey, 2023).

Critical Success Factor:

Utilising an online survey platform will ensure that responses gathered are anonymous, this may make respondents more comfortable to provide their input.

While the specific process of distributing may differ based on the online platform used, it is recommended that in order to distribute the survey, the MQA look to generate a survey link that stakeholders may click on to complete the survey (if the online platform used allows for this). This link should be inserted into an email that provides context and requests stakeholder participation in the survey. Furthermore, a deadline by which stakeholders should complete the survey should be provided.

Best Practice:

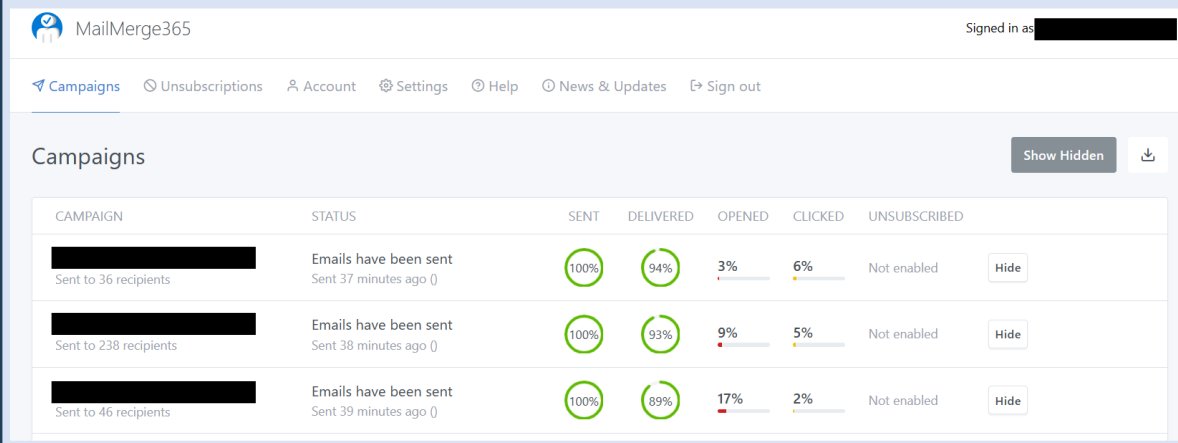
It is noted that survey participation tends to stagnate after a week, with almost half of all responses being received within the first three days following the initial distribution of the survey. In light of this, the MQA may consider giving respondents up to a week to complete the survey, with the potential to extend, should this be required in order to gather sufficient responses (Zheng, 2023).

To allow for the efficient distribution of the survey to multiple stakeholders, tools such as Mail Merge may be used. This tool may also be used to facilitate the tracking of survey responses, discussed further in the next activity.

Implementation Tool: Mail Merge

Mail Merge is a feature that allows users to send personalised emails to multiple recipients (of up to 5 000) at the same time. This is particularly useful for sending bulk emails with personalised content, such as newsletters, announcements, or a unique survey link in the context of this project. The process begins with the incorporation of the Mail Merge add-in onto the Microsoft Outlook account. An email template is then created in Outlook and connected to a data source, often from Microsoft Excel or another database, using the Mail Merge add-in, using it to insert individualised information like names and the unique survey link for each recipient.

The software also allows for the tracking of email delivery, including the number of emails returned unsent, emails opened, and the number of people who click on the survey link, as illustrated below.



In an attempt to encourage a higher participation rate from stakeholders, the MQA should ensure that targeted stakeholders are aware of the survey.

Critical Success Factor:

It is important that the MQA creates awareness of the validation survey amongst its stakeholders so that they are aware of the importance of the survey and are encouraged to respond. This can be done by distributing a communiqué regarding the Framework on platforms such as the MQA website and ongoing engagement workshops/forums.

5. Monitor survey responses

Once the survey has been distributed, the MQA should look to regularly monitor the completion rate. Monitoring of survey responses is the process through which the MQA will track and review the survey responses received from respondents. This should include checking the number of survey responses received via the online survey platform as well as checking the email inbox from which the surveys were distributed to confirm if there are any responses or emails being received from stakeholders indicating difficulties with completing the survey or other survey-related matters. The monitoring process should begin once the survey has been distributed and should continue until closing of the survey. The following key aspects should be observed during the monitoring process:

Table 4-6: Survey Monitoring

#	Key Aspects of Survey Monitoring	Relevance
1	Response Rates	Monitoring the influx of responses regularly to measure the overall response rate is essential. This practice aids in assessing the advancement of data collection and progress towards attaining the intended sample size.
2	Participant Demographics	Observing the demographic attributes of participants (for instance, the province the organisation is based in, the respondent's company size and the MMS sub-sector represented by the organisation) to verify the representativeness of the sample is crucial. This entails assessing whether the demographics align with the target population.
3	Data Quality Checks	Consistently reviewing the data for quality issues, including verifying for incomplete responses is important. This practice allows for the early identification and resolution of errors that could potentially impact the validity of the collected data.
4	Technical Glitches	Observing potential technical glitches which may impede data collection will include assessing compatibility problems with regard to accessing the survey questionnaire/survey link on various devices and browsers.

The above monitoring of survey responses can be conducted by manually verifying the number of responses received via email or verifying the number of responses gathered on the online survey platform.

Critical Success Factor:

Survey responses should be monitored daily to observe any trends in the survey response rate as well as to identify key challenges as mentioned in the table above as soon as they occur, to allow for these challenges to be addressed immediately.

6. Remind stakeholders to participate in the survey

Reminders to complete the survey can be distributed to stakeholders in the following instances:

- The survey response rate seemed to be inadequate when monitored in the above step
- The target demographics have not been reached. In this instance, reminders can be sent to selected groups of the population, for example, reminders can be sent to organisations having less than 50 employees if the majority of responses were received from organisations from organisations having more than 50 employees

Reminders can be regularly distributed to stakeholders until the target survey responses have been received. It is recommended that between 3 and 5 reminders are distributed to stakeholders, following which, stakeholders may be considered unresponsive. In order to ensure that stakeholders have adequate time to respond to the surveys, it is recommended that the survey reminders be sent at least 3 days after the questionnaire was first distributed.

Critical Success Factor:

It is recommended that stakeholders be provided with at least 3 days to complete the survey prior to sending the first reminder. This will ensure that stakeholders have adequate time to respond to the survey.

It is essential for the MQA to ensure that stakeholders are comfortable with the data collection process and do not feel pressured to respond to surveys, especially if they have already attempted to complete the survey or if they have indicated that they would not like to participate in the survey. Some key considerations that the MQA could adopt is to avoid sending reminders to stakeholders who have already completed the survey or the MQA could thank stakeholders for completing the survey and may request them to ignore the request to complete the survey.

7. Conduct telephonic surveys to increase participation rate, if required

Some stakeholders may be unresponsive via email, thus it may be beneficial for the MQA to attempt to conduct telephonic surveys with these stakeholders. Should the MQA wish to conduct telephonic surveys, a shortened version of the survey will be required for the exercise.

Implementation Tool: Survey Tool for Telephonic Survey

Annexure C provides an example of a shortened version of a survey tool which can be used for the telephonic surveys.

Critical Success Factor:

In order to increase stakeholder participation in telephonic surveys, the MQA should consider utilising a shortened version of the questionnaire. Research finds that as the length of the survey increases, the dropout rate increases (Kantar, 2023). It is, therefore, recommended that the MQA aim to adjust the telephonic survey to be, preferably, no longer than 15 minutes.

It is worth noting that both electronic surveys and telephonic surveys have their advantages and disadvantages. The table below highlights some of these advantages and disadvantages. It is recommended that the MQA considers the below table prior to making an informed decision on which survey method to adopt or when to start conducting telephonic surveys.

Table 4-7: Electronic vs. Telephonic Surveys: Advantages and Disadvantages

#	Survey Type	Advantages	Disadvantages
1	Electronic Survey	• Cost-effective: online surveys are budget-friendly due to the absence of live interviewers and phone-related expenses, making them more economical than phone surveys. • Increased reach: online surveys have a broad audience reach, accessible to anyone with an internet connection or mobile device. • Quick results: offers fast completion • Increased response rate: the cost-effectiveness and convenience of online surveys contribute to higher response rates, as respondents can answer questions at their own pace and schedule. • Convenience: respondents have the flexibility to answer questions on their own schedule, enabling	• Less personalisation: online surveys offer limited personalisation, potentially leading to less detailed and accurate responses from respondents. • Technical issues: challenges like slow internet connections and software compatibility problems may affect online surveys, causing incomplete responses or data errors. • Higher chance of spam: the presence of professional survey takers and survey bots poses a risk, as they may rush through surveys for rewards without providing genuine feedback. Implementing testing and quality checks can mitigate this issue. • Limited sampling and respondent availability: certain populations with limited internet access may be excluded,

#	Survey Type	Advantages	Disadvantages
		rapid deployment and quick feedback Design flexibility: online surveys offer design flexibility, allowing for the programming of complex surveys with intricate skip patterns and logic, ensuring a hassle-free creation process for layout, questions, and answer choices.	affecting the sampling pool and respondent availability based on email addresses or website visitations.
2	Telephonic Survey	- Gather In-depth feedback: phone surveys facilitate personalised communication, enabling more detailed and accurate responses from respondents. - Two-way communication: live interviewers in phone surveys can provide clarification and additional context, enhancing participant understanding—an advantage not available in online surveys. - Improved validation of respondent: direct contact in phone surveys ensures better validation of respondent qualifications, especially reaching fewer active individuals in online channels and ensuring they meet specified criteria.	- Higher costs: phone surveys incur greater expenses due to the need for live interviewers and associated phone costs, making them generally more costly than online surveys. - Limited reach: phone surveys face restrictions based on phone availability, potentially excluding specific demographics, such as those without landlines or within certain age groups. - More time-consuming: phone surveys are typically more time-consuming than online surveys, as they rely on live interviewers for administration. - Risk of swaying respondents: phone surveys may be susceptible to "social desirability bias," where respondents unconsciously provide answers they perceive as socially acceptable, posing a challenge to the survey's objectivity.

Source: *The Farnsworth Group (2023); Howard (2021); Rodgers (2023)*

From the above insights and from the results received during the pilot process, it can be deduced that the electronic surveys may be the more efficient and effective method to collect data for this purpose. However, as mentioned above, telephonic surveys,

with its ability to explore further details on stakeholders' perceptions is recommended as an option to be utilised to gather additional input from stakeholders or to increase survey participation. Other methods that may be used to enhance participation from stakeholders include providing a survey incentive as a reward for the survey completion.

8. Close survey collector

Once the target survey responses have been achieved, the MQA can close data collection and compile the survey data received.

Given that the MQA will use the proposed Framework multiple times to identify skills needs in the MMS, it is crucial that the SETA constantly improves the survey as well as the engaging methods used to approach the target audience. Consequently, in an attempt to continuously improve its method of engaging with its key stakeholders, the MQA could request for participants' feedback on their survey completion experience.

Critical Success Factor:

The MQA should actively request participants' feedback on the survey completion experience. This may provide valuable insights into improvements the MQA can implement in the next round of survey or while sending reminders to the participants.

4.4 Step 4: Analyse Data Gathered Through Surveys

As mentioned above, the intention of the validation surveys is to gather input regarding the extent to which identified future drivers are anticipated to impact the sector, the segments of the value chain that will be impacted by these change drivers, the planned adoption of emerging technologies as well as the anticipated emerging skills and occupations. Following the distribution of surveys and collection of survey responses, as per Step 3 above, the MQA will need to analyse the data received in order to assess stakeholders' views regarding the above-mentioned themes. The following table provides an overview of the manner in which the MQA may look to analyse the various questions posed in the survey.

Table 4-8: Survey Analysis Guideline

Question Reference		Purpose of Question	Analysis Guideline
1	Participation in this survey is voluntary, however your input would be greatly appreciated. By participating in this survey, you consent to Redflank using the data provided in summary form, for research purposes. Your individual details will not be	To obtain consent from participants to process the information provided through the survey	N/A

Question Reference		Purpose of Question	Analysis Guideline
	shared with anyone. Do you consent to participate?		
2	To what extent do you believe the below future drivers will impact the Mining and Minerals Sub-sectors?	To ratify the future drivers identified and understand the extent to which stakeholders believe these future drivers are going to impact the sector	Percentage of respondents who selected to a low, medium and high extent per future driver e.g. percentage of people who selected “to a low extent” for “political unrest”
3	To what extent will each of the following phases of the Mining and Beneficiation Value Chains be impacted by the above-mentioned future drivers?	To understand which areas of the value chain stakeholders expect to be impacted by the identified future drivers	Percentage of respondents who selected to a low, medium and high extent, per value chain phase, e.g. percentage of people who selected “to a low extent” in the Exploration phase
4	Which of the following technologies have you heard of or seen implemented locally/in South Africa? Please select all that apply	To determine which technologies are already being adopted within the South African MMS, which may assist in providing a view of which technologies are more likely to have an impact in the shorter-term	Percentage of respondents per option selected, e.g. percentage of people who selected “cloud computing”
5	When does your organisation intend to adopt the following technologies?	To understand when organisations are likely to adopt the identified technologies, thereby providing an indication of when these technologies are likely	Percentage of respondents who selected, “already adopted”, “less than a year”, “in the next 1 – 2 years”, “in the next 2 – 5 years”,

Question Reference	Purpose of Question	Analysis Guideline
	to impact workforce requirements	“more than 5 years”, “do not intend to adopt”, per technology, e.g. percentage of people who selected “already adopted” for cloud computing
6	In the short-term (i.e. the next 1 - 2 years), how many people in your organisation will require the following emerging skills?	To understand whether the quantity of emerging skills required by organisations in the next 1 – 2 years will be in the tens, hundreds, thousands or hundreds of thousands
7	In the medium-term (i.e. the next 2 - 5 years), how many people in your organisation will require the following emerging skills?	Average quantity of people that require identified emerging skills, calculated through a weighted average whereby the number of respondents per option (e.g. the number of people who said they need “Tens of people”) is multiplied by the weighting assigned to each option (i.e. a weighting of 10 should be applied for the option “tens of people”, a weighting of 100 should be applied for “hundreds of people” etc.). An example analysis to illustrate how this may be done has been included below.

Question Reference	Purpose of Question	Analysis Guideline
	thousands or hundreds of thousands	respondents per option (e.g. the number of people who said they need “Tens of people”) is multiplied by the weighting assigned to each option (i.e. a weighting of 10 should be applied for the option “tens of people”, a weighting of 100 should be applied for “hundreds of people”). An example analysis to illustrate how this may be done has been included below.
8	In the short-term (i.e. the next 1 - 2 years), how many people in the following emerging occupations will your organisation require?	To understand whether the quantity of emerging occupations required by organisations in the next 1 – 2 years will be in the tens, hundreds, thousands or hundreds of thousands Average quantity of people required in the emerging occupations, calculated through a weighted average whereby the number of respondents per option (e.g. the number of people who said they need “Tens of people”) is multiplied by the weighting assigned to each option (i.e. a weighting of 10 should be applied for the option “tens of people”, a weighting of 100 should be applied for “hundreds of people”). An

Question Reference		Purpose of Question	Analysis Guideline
			example analysis to illustrate how this may be done has been included below.
9	In the medium-term (i.e. the next 2 - 5 years), how many people in the following emerging occupations will your organisation require?	To understand whether the quantity of emerging occupations required by organisations in the next 2 - 5 years will be in the tens, hundreds, thousands or hundreds of thousands	Average quantity of people required in the emerging occupations, calculated through a weighted average whereby the number of respondents per option (e.g. the number of people who said they need "Tens of people") is multiplied by the weighting assigned to each option (i.e. a weighting of 10 should be applied for the option "tens of people", a weighting of 100 should be applied for "hundreds of people"). An example analysis to illustrate how this may be done has been included below.
10	Are there any other occupations that may emerge as a result of the abovementioned future drivers?	To understand other potential occupations that may emerge for which skills development interventions should be developed	Conduct thematic analysis on qualitative data received in order to identify key themes emerging
11	Which existing occupations, if any, do you think will experience significant	To understand if the nature of existing	Conduct thematic analysis on qualitative data

Question Reference		Purpose of Question	Analysis Guideline
	change as a result of the future drivers impacting the sector?	occupations may change	received in order to identify key themes emerging
12	What qualifications, if any, do you think need to be introduced/ developed in order to respond to the above emerging skills and occupations?	To assist in gaining a sense of what new qualifications may need to be introduced in light of the changing skills needs in the sector, in order to ensure these skills needs are met	Conduct thematic analysis on qualitative data received in order to identify key themes emerging
13	Please provide the following details: - Name of Organisation - Position/Role in Organisation	To establish the nature of participants from whom input is sourced	N/A
14	Which of the following sub-sectors does your organisation most closely align to?	To allow for cross-tabulation of results regarding the nature of future skills needed per sub-sector to allow for focused interventions	Filter by answer to allow for cross-tabulation of results
15	In which province are your organisation's operations conducted?	To allow for cross-tabulation of results regarding the nature of future skills needed per province to allow for focused interventions	Filter by answer to allow for cross-tabulation of results
16	How many employees are there in your organisation?	To allow for cross-tabulation of results regarding the nature of future skills needed per organisation size to allow for focused interventions	Filter by answer to allow for cross-tabulation of results

To provide an illustration of how the analysis for some of the key questions may be done, some sample analysis was conducted for the study. The analysis was conducted for question 8 of the questionnaire which sought to determine the total number of people required per emerging occupation. The process illustrated below, however, would also be applicable to question 6, question 7 and question 9. The figure below illustrates the survey responses as received from participants, that were used to inform the sample analysis.

Figure 4-3: Sample Results

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	MQA - Future Skills Needs Survey													
2	In the short-term (i.e. the next 1 - 2 years), how many people in the following emerging occupations will your organisation require?													
3		None		Tens (10) of people		Hundreds (100) of people		Thousands (1000) of people		Tens of thousands		I don't know		Total
4	Virtual Reality Graphic Designers	22,22%	2	55,56%	5	0,00%	0	0,00%	0	0,00%	0	22,22%	2	9
5	Solar Technologists/Solar Technician	22,22%	2	44,44%	4	11,11%	1	0,00%	0	0,00%	0	22,22%	2	9
6	Incident/accident investigator	0,00%	0	77,78%	7	11,11%	1	0,00%	0	0,00%	0	11,11%	1	9
7	Drone pilots	11,11%	1	88,89%	8	0,00%	0	0,00%	0	0,00%	0	0,00%	0	9

Source: Pilot Survey (2023)

In order to analyse the above data, a weighting was assigned to each response option according to the value indicated in the response option (e.g. weighting of 10 was assigned for the response option “Tens of people”) as illustrated in row 3 below.

Figure 4-4: Sample Results with Weighting

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	MQA - Future Skills Needs Survey													
2	In the short-term (i.e. the next 1 - 2 years), how many people in the following emerging occupations will your organisation require?													
3	Weight				10		100		1000		10000			
4		None		Tens (10) of people		Hundreds (100) of people		Thousands (1000) of people		Tens of thousands		I don't know		Total
5	Virtual Reality Graphic Designers	22,22%	2	55,56%	5	0,00%	0	0,00%	0	0,00%	0	22,22%	2	9
6	Solar Technologists/Solar Technician	22,22%	2	44,44%	4	11,11%	1	0,00%	0	0,00%	0	22,22%	2	9
7	Incident/accident investigator	0,00%	0	77,78%	7	11,11%	1	0,00%	0	0,00%	0	11,11%	1	9
8	Drone pilots	11,11%	1	88,89%	8	0,00%	0	0,00%	0	0,00%	0	0,00%	0	9

Source: Pilot Survey (2023)

Following the assignment of the weighting, the average quantity of people required per emerging occupations is calculated. This is done by multiplying the number of respondents per option (e.g. the number of people who indicated that they need “Tens of people”) by the weighting assigned in row 3 (as per above step) to each option. This is illustrated below.

Figure 4-5: Sample Formula

	Tens (10) of people	Hundreds (100) of people	Thousands (1000) of people	Tens of thousands (10000) of people
Virtual Reality Graphic Designers	=E5*E3	=G5*G3	=I5*I3	=K5*K3
Solar Technologists/Solar Technician	=E6*E3	=G6*G3	=I6*I3	=K6*K3
Incident/accident investigator	=E7*E3	=G7*G3	=I7*I3	=K7*K3
Drone pilots	=E8*E3	=G8*G3	=I8*I3	=K8*K3

Source: Pilot Survey (2023)

Executing the above formulas will result in the calculation of the average number of people required per occupation, as indicated in the second to fifth columns below. This is then followed by summing the average number of people required per emerging occupation (i.e. per row) to get the total number of people required per emerging occupation across the MMS, as in the sixth column.

Figure 4-6: Sample Calculation of Number of People Required

	Tens (10) of people	Hundreds (100) of people	Thousand s (1000) of people	Tens of thousands (10000) of people	Total no. of People Required
Virtual Reality Graphic Designers	50	0	0	0	50
Solar Technologists/Solar Technician	40	100	0	0	140
Incident/accident investigator	70	100	0	0	170
Drone pilots	80	0	0	0	80

Source: Pilot Survey (2023)

The calculated data can then be sorted in descending order in order to identify the top emerging occupations, as illustrated below:

Figure 4-7: Sample Calculation of Number of People Required - Sorted

	Tens (10) of people	Hundreds (100) of people	Thousand s (1000) of people	Tens of thousands (10000) of people	Total no. of People Required
Incident/accident investigator	70	100	0	0	170
Solar Technologists/Solar Technician	40	100	0	0	140
Drone pilots	80	0	0	0	80
Virtual Reality Graphic Designers	50	0	0	0	50

Source: Pilot Survey (2023)

These questions will assist in providing an indication of whether tens of people, hundreds of people, thousands of people or tens of thousands of people will be required in the emerging occupation. Step 5 provides further detail regarding how these results should be presented.

In order to obtain a segmented view of the emerging occupations per sub-sector, size or province, the survey results must first be filtered according to the specific criteria under investigation (e.g. size, province, sub-sector), and the above-mentioned process repeated for each criteria.

Overall, through the analysis of the survey data, the MQA should be able to gain an understanding of the extent to which organisations believe the identified future drivers will impact the MMS as well as the technologies that organisations plan to adopt in order to respond to these future drivers. Furthermore, the analysis of the survey data should assist in providing the MQA with a list of priority skills and occupations that are anticipated to emerge in the Short- and Medium-term.

4.5 Step 5: Document Findings

Once the MQA has analysed the survey data to understand when organisations intend to adopt key technologies as well as to get a sense of the priority skills and occupations in the short- and medium-term, as per Step 4, the following activities should be adopted to in Step 5.

1. Compile key findings from analysed data

Based on the graphical, quantitative and qualitative analyses conducted in Step 4, the MQA can compile key findings. These key findings may include details such as the trend of organisations who are able to adopt technologies (depending on organisation sizes) as well as the quantities of emerging occupations and skills, in terms of whether the number required are in the tens, hundreds, thousands or tens of thousands. The tables below provide illustrations on how the key findings stemming from the Framework may be compiled. When compiling these findings, an explanation of the estimated quantity required should be provided, to note that an indication of whether tens, hundreds, thousands, etc. of people will be required.

Table 4-9: Compiled Key Findings – Top Emerging Skills in Short-Term

#	Top Emerging Skills	Estimated Quantity Required in Short-Term
1	3D Printing	Tens of thousands
2	AI	Tens of thousands
3	...	...

Source: Pilot Survey (2023)

Table 4-10: Compiled Key Findings – Top Emerging Occupations in Short-Term

#	Top Emerging Occupations	Estimated Quantity Required in Short-Term
1	Incident/accident investigator	Hundreds
2	Solar Technologists/Solar Technician	Hundreds
3	Drone Pilots	Tens
4	Virtual Reality Graphic Designers	Tens
5	...	...

Source: Pilot Survey (2023)

Table 4-11: Compiled Key Findings – Top Emerging Occupations in Medium-Term

#	Top Emerging Occupations	Estimated Quantity Required in Medium-Term
1	Incident/accident investigator	Hundreds
2	Solar Technologists/Solar Technician	Hundreds
3	Drone Pilots	Tens
4	Virtual Reality Graphic Designers	Tens
5	...	...

Source: Pilot Survey (2023)

2. Documenting key aspects of exercises undertaken

Given that the MQA will implement the Framework several times in the future, it is important that key areas such as challenges, methodologies adopted in each forecast be documented. This will facilitate reproducing the implementation of the Framework.

In light of the above, the MQA could consider documenting the following:

- Key findings from analysis, including list of technologies to be implemented in the MMS and list of top 20 emerging skills and occupations in the MMS
- Location of where to find the metadata or annexed raw data gathered
- Sources of data used in primary and secondary data collection, as well as data collection tools
- Statistical methods used (e.g. sampling)
- Timeframes planned and used for each step of the Framework

Critical Success Factor:

Documenting key aspects of the Framework implementation, including the key findings and the methodology adopted will facilitate re-implementing the Framework in the future.

3. Share documented findings with key stakeholders

The documented findings in the above activity can then be shared with key MQA stakeholders, for instance, the Skills Development and Research unit, which will use some of the key findings from the forecast to update the SSP as listed in Step 6 below.

4.6 Step 6: Update SSP

It is anticipated that ultimately, the key findings stemming from the Framework process, namely, the top 20 emerging skills and top 20 emerging occupations will be documented and incorporated into the MQA's annual SSP update so that they can be accounted for as part of the skills needs of the sector. The key output of the final stage of the Framework process will be for the MQA to undergo their standard SSP process, taking into account the key findings from the forecast.

Note:

A list of top 20 emerging skills and top 20 emerging occupations is proposed above. Nonetheless, should the MQA have a list of emerging skills and occupations stemming from the Framework implementation that is shorter than 20, then it is recommended that the SETA publishes the full list of emerging skills and occupations, sorted based on quantity required.

5 Summary of Critical Success Factors

The table below provides a summary of the critical success factors necessary for the successful implementation of the Framework, as discussed in Section 4 above.

Table 5-1: Summary of Critical Success Factors

Imple m- entati on Step	Detail	Critical Success Factor
1	Conduct Desk-Based Research	• Ensure sources used for desk-based research are credible and up to date. This will aid in ensuring that data collected on rapidly evolving fields such as key future drivers and skills needs is also up to date. Sourcing data from credible sources also provides a level of comfort regarding the research materials' validity and reliability. • Update desk based research regularly (with each forecast conducted) to incorporate new and relevant insights. • Maintain record of all sources consulted during implementation process in order to allow for traceability for the MQA researchers who will reproduce the desk-based research undertaken. Moreover, having a record of sources allows stakeholders to verify and confirm the validity of the research material.
2	Conduct Validation Workshops	• Ensure that enough time is scheduled for each validation workshop to allow for in-depth discussions and sufficient input to be gathered. The time to be scheduled will be dependent on the content to be covered during the workshop. • Ensure that relevant and engaged stakeholders, who are able to provide adequate input on the topics being discussed, are included in the validation workshops. • Ensure that the stakeholders that participate in the workshops are engaged and actively contribute to the session in order to facilitate the gathering of sufficient and relevant information. To promote this,

Implementation Step	Detail	Critical Success Factor
		the MQA may consider sharing the slide pack prior to the session to allow stakeholders to familiarise themselves with the content and prepare accordingly. Furthermore, tools such as break-out rooms may be used to encourage participation from all stakeholders in the session. • Ensure participants provide examples of technologies, skill and occupations emerging either in South Africa or internationally in order to promote a focused and relevant discussion. For example, if a participant indicates that virtual reality could be utilised in providing training on jewellery manufacturing, the participant may be requested to indicate if and where they had observed this being adopted before. Furthermore, where respondents indicate that they have made any observation occurring internationally, the MQA may look to further unpack the country where they have seen this, to understand any potential countries that the South African industry may look to benchmark themselves against.
3	Conduct Validation Survey	• Conduct the validation survey with mining organisations from all sub-sectors in order to facilitate the collection of input from all stakeholders and avoid bias in terms of the future change drivers, emerging skills, technologies and occupations identified. • Ensure that POPIA requirements are met throughout the data collection phase. • Utilise an online survey platform in order to ensure that responses gathered are anonymous. This may make respondents more comfortable to provide their input. • Ensure awareness of the validation survey is created amongst stakeholders in order to facilitate an understanding of the importance of the study and

Implementation Step	Detail	Critical Success Factor
		to encourage stakeholders to respond. This can be done by distributing a communiqué regarding the Framework on platforms such as the MQA website and ongoing engagement workshops/forums. • Monitor survey responses daily to observe any trends in the survey response rate as well as to identify key challenges as soon as they occur, to allow for these challenges to be addressed immediately. • Provide stakeholders with at least 3 days to complete the survey prior to sending the first reminder. This will ensure that stakeholders have adequate time to respond to the survey. • Consider utilising a shortened version of the questionnaire to increase stakeholder participation in telephonic surveys. Research finds that as the length of the survey increases, the dropout rate increases. It is, therefore, recommended that the MQA aim to adjust the telephonic survey to be, preferably, no longer than 15 minutes. • Actively request participants' feedback on the survey completion experience. This may provide valuable insights into improvements the MQA can implement in the next round of survey or while sending reminders to the participants.
5	Document Findings	• Document key aspects of the Framework implementation, including the methodology adopted and key findings in order to facilitate the re-implementing of the Framework in the future.

6 International Best Practices

In developing the Framework, it was crucial to study successful international practices adopted in order to respond to changing skills and occupational requirements within the Mining sector, that the MQA may look to learn from. The table below outlines these international best practices, categorised into skilling, reskilling and upskilling as well as collaboration initiatives.

6.1 Skilling, Reskilling and Upskilling

Skilling, reskilling, and upskilling refer to different types of learning and development activities aimed at acquiring or enhancing specific skills and knowledge, in this case related to addressing emerging skills needs of the MMS (Cornerstone, 2023). The table below summarises the international best practices related to skilling, reskilling and upskilling the workforce in response to the skills and occupations emerging as a result of the future drivers.

Table 6-1: International Best Practices: Skilling, Reskilling and Upskilling

#	Best Practice	Country	Description
1.	Availability of Training and Reskilling Programmes to Prepare Workforce for Digitalisation	Australia	Australia, known for its mining innovation, led the Mine of the Future initiative by Rio Tinto in 2008. This initiative introduced cutting-edge technologies like remote operational management, self-driving trucks, autonomous trains, and automated drilling. A notable aspect is the emphasis on investing in technical and vocational training to bridge the gap between industry plans and government responses in preparing the local workforce for the digital revolution in mining (Ramdoo, 2018). Rio Tinto committed \$2 million to develop vocational automation qualifications, introducing certifications like the Autonomous Workplace Operations certificate. These initiatives, including training for autonomous workplace and remote centre operations, along with courses on working in automated environments, have proven successful. The skilled workforce resulting from these efforts has effectively utilised automated technologies, leading to enhanced safety and operational efficiencies in the mining industry. (Businesswire, 2020). The initiative's success is credited to consistent funding for ongoing worker training, partnerships between key stakeholders like private corporations

#	Best Practice	Country	Description
			and educational institutions, and the introduction of Australia's first nationally recognized qualifications in automation. The collaborative development of these qualifications involved government departments and private corporations, including Rio Tinto. (Rio Tinto, 2020).
2.	Availability of Enabling Policies and Strategies encouraging Skills Development	Canada	In Canada, there is a strong commitment within the mining industry to responsible operations, sustainable sourcing, and environmental care. As the country shifts towards a clean economy, the demand for responsibly sourced minerals and metals is expected to increase. Recognising the pivotal role of a diverse, skilled, and educated workforce in ensuring the sector's competitiveness and sustainability, the Mining for Skills ("M4S") initiative has been launched. This collaborative effort involves multiple stakeholders, including employers, education providers, and communities, with the goal of attracting, recruiting, and developing a diverse, skilled, and safe Canadian mining workforce to support the sector's contribution to building a clean economy (Mining Industry Human Resource Council, 2023). The M4S encompasses several specific objectives. These include producing timely labour market information ("LMI") to support the industry, providing wage subsidies for meaningful work placements, updating National Occupational Standards ("NOS") to reflect changing skill requirements, establishing National Occupational Training Standards ("NOTS") to standardize training, creating the Canadian Mine Training Recognition Program ("CMTRP") for aligned training programs, implementing the Canadian Mining Certification Program ("CMCP") for worker credentials, offering industry-specific upskilling for trainers and supervisors, enhancing career perceptions among youth and equity-deserving groups, and leading national collaboration for equity and inclusivity in building a skilled and sustainable

#	Best Practice	Country	Description
			Canadian mining workforce (Mining Industry Human Resource Council, 2023). Through these initiatives, M4S aims to support the mining industry in meeting the challenges and opportunities of a clean economy while ensuring responsible practices and a skilled workforce for long-term competitiveness and sustainability. These initiatives, while specific to developing a clean economy, may be adopted to facilitate changing environments such as the 4IR in the mining sector.

6.2 Collaboration

Effective collaboration in the mining sector is crucial for addressing skills shortages and achieving sustainable development amidst the rapidly evolving MMS. It involves fostering partnerships among governments, mining companies, local communities, and civil society organisations. Learning from best practices in collaboration is essential to ensure the successful and seamless adaptation of MMS organisations to the changing landscape.

Table 6-2: International Best Practices: Collaboration

#	Best Practice	Country	Description
1.	Partnering with Government to Train Workers in Emerging Skills related to Future Drivers	India	Collaboration between mining organisations and government entities has emerged as a crucial strategy for training workers in the mining sector (Ramdoo, 2018). In India, a notable instance of this collaboration involves Siemens partnering with the Ministry of Industries and Mines, the government of Gujarat, and the Steel Authority to provide workers with crucial digital skills, preparing them for employment in industries undergoing the digital revolution (Ramdoo, 2018). The initiative involved setting up Centres of Excellence equipped with cutting-edge design, digital manufacturing, simulation, and lifecycle management software. These centres provided training services to personnel involved in Steel Authority projects and maintenance. Upon completion of the training, certificates would be awarded by industry partners

#	Best Practice	Country	Description
			and Siemens, aiming to enhance employment opportunities for the participants (Siemens, 2013). This collaboration demonstrated a proactive approach towards ensuring the workforce remains adept with the skills required in an evolving technological landscape, by giving the workers sufficient training and skills to tackle the fast-growing technological advancements within the mining sector (Ramdoo, 2018).
2	Promoting Collaborative Mineral Literacy Partnerships with Indigenous Communities	Canada	Within the Canadian government's M4S strategy, the establishment of mineral literacy partnerships with indigenous communities and organisations is a pivotal component. These partnerships are designed to cultivate a deeper understanding and awareness of the mining industry within indigenous populations. By fostering collaborative efforts, the overarching goal is to empower indigenous communities to not only understand the mining sector but also to actively engage in and contribute to mining activities (Government of Canada, 2023). Through this approach, the Canadian government aims to create a more inclusive and mutually beneficial relationship, allowing indigenous populations to access economic opportunities arising from the mining industry while preserving their cultural values and environmental concerns. The emphasis on mineral literacy is a step towards ensuring that indigenous communities are equipped with the knowledge and agency to make informed decisions and actively participate in the mining sector on their terms (Government of Canada, 2023).

7 Conclusion

This Framework Report provided an overview of the MMS and the future drivers currently influencing skills, occupations and operational changes within the sector. Some of these include increased modernisation within the sector, which entails the adoption of technologies to perform certain activities, as well as economic factors such as the declining demand for minerals, which require organisations within the MMS to develop adequate responses in order to remain relevant. Other drivers highlighted included environmental factors such as the push to adopt sustainable and environmentally friendly mining operations, as well the transitioning to renewable sources of energy nationally which has negative connotations for the coal mining sector in particular. As a result of the impact of these and other future drivers, it was necessary for a Framework to be developed that would assist the MQA, with whom the responsibility lies to ensure adequate skills provision within the MMS, to forecast these future skills needs so as to be able to develop relevant interventions and proactively respond to the skills needs of the sector.

The process of developing the Framework commenced with conducting desk-based research and initial interviews. This included studying the ILO's STF, a skills forecasting guide developed by key foresight experts globally. This was followed by the conducting of workshops and surveys with three sub-sectors, including PGM and Coal mining, as well as Jewellery Manufacturing, as part of a pilot process. The pilot process was conducted in order to validate key steps proposed as part of the Framework. Participants in the initial interviews and workshops included Employers within the MMS, Training Providers and key industry informants such as the Minerals Council and SATCAP. Once the above steps were finalised, the Framework was updated and finalised accordingly. Furthermore, in developing the Framework, successful international practices adopted in order to respond to changing skills and occupational requirements within the mining sector were studied and outlined in order to assist the MQA in responding to the emerging skills needs. These may broadly be categorised into skilling, reskilling and upskilling factors such as ensuring the availability of training and reskilling programmes and enabling policies and strategies encouraging skills development, as well as collaboration activities such as partnering with government to train workers in skills related to future drivers and promoting collaborative mineral literacy partnerships with indigenous communities.

The Framework proposed comprises 6 steps, including conducting desk-based research to gain a deeper understanding of the prevailing and upcoming changes occurring in the sector, as well the innovations and technologies that organisations are implementing in response to these future drivers that are pertinent to the skills needs in the MMS. This step should be followed with the conducting of validation workshops and surveys in order to validate findings made in Step 1. Following the conducting of the validation surveys in particular, analysis should then be conducted on the findings to gain input on the extent to which identified future drivers are anticipated to impact the sector, the segments of the MMS value chains that will be impacted, the planned

adoption of emerging technologies as well as the anticipated emerging skills and occupations. The findings may then be documented and incorporated into the SSP update.

In order to ensure that the Framework achieves its intended objective, several critical success factors need to be taken into account. These include factors such as ensuring the credibility of desk-based research by using reliable sources, updating the desk-based research regularly with each forecast conducted, and maintaining a comprehensive record of sources for traceability and stakeholder verification. Additionally, it is critical to ensure that validation workshops allow for thorough discussions and that the relevant stakeholders who are able to provide valuable input are included. Furthermore, examples from participants should be encouraged in order to foster a focused and relevant discussion on future drivers and emerging skills, occupations, and technologies. When conducting surveys, key is ensuring the POPI Act requirements are adhered to, as well as ensuring the surveys are kept short and precise and participants are allowed enough time to complete the surveys. Lastly, key aspects of the Framework implementation, including the methodology adopted and key findings should be documented in order to facilitate the re-implementing of the Framework in the future.

8 Recommendations

The table below highlights key recommendations related to solutions and actions which the MQA may consider when implementing the Framework. The proposed recommendations below should be considered with the critical success factors highlighted in Section 5.

Table 8-1: Recommendations

Implementation Step	Recommendation
Overall Framework	- It is recommended that the MQA implement the full Framework process once every two-years, however, specific steps being conducted on an annual basis. It is recommended that Step 1 (the desk-based research) and Step 2.1. (validation workshops with key industry stakeholders) are conducted annually to identify any potential change drivers that may be emerging which may impact the sector - Should any significant changes be identified through the desk-based research or workshop conducted annually which may require an immediate response, then it is recommended that the MQA consider implementing the full process
Step 1: Conduct Desk-based Research	- It is recommended that the MQA conduct desk-based research as part of Step 1 of the Framework, in order to develop an understanding of prevailing and upcoming changes occurring in the sector as well as the state of the MMS in South Africa and internationally - It is recommended that the desk-based research is conducted annually and that this step is conducted each time the Framework is implemented, to ensure new and relevant insights are incorporated and that they most up-to-date is accounted for
Step 2: Conduct Validation Workshops	It is recommended that validation workshops are conducted with key stakeholders such as; the Minerals Council, DMRE, CSIR, Nelson Mandela Mining Precinct, Universities, MEMSA, Council for Geoscience, Affiliation Bodies, the MHSA, Mintek, representatives from mining organisations and organised labour representations

Implementation Step	Recommendation
	• The information to be validated in each workshop is dependent on the information gathered as part of the previous step or previous workshop. It is recommended that the MQA update the data (e.g. the future drivers) post each workshop. For instance, should new future drivers impacting the MMS be identified in the first workshop, the slide pack for the second workshop to be conducted with employers from a particular sub-sector should include the newly identified future drivers. • The MQA should provide stakeholders invited to the sessions the opportunity to indicate whether they believe that are not suitable for the workshops or to propose alternative colleagues to attend on their behalf. This will ensure that accurate information is gathered during the workshops. • It is recommended that invitations for the workshops be distributed to stakeholders 2 to 3 weeks prior to the sessions in order to increase the participation rate. • It is recommended that the workshops include sections whereby discussions are held with the entire group of attendees as well as sections whereby discussions are had with smaller groups of attendees (i.e. through break-out rooms) in order to encourage enhanced participation. These break-out sessions will also enable the MQA to assess different areas at the same time, for instance, each group can discuss one segment of the mining value chain, thus potentially allowing for more input to be gathered within a shorter span of time.
Step 3: Conduct Validation Survey	• It is recommended that the MQA utilises the survey validations tools provided in Annexure B for the validation survey given that the tool has been tested during the pilot process and modified based on the findings stemming from the process. • The survey pilot process conducted as part of this Project consisted of both electronic and telephonic surveys. Given the higher response rate gathered through electronic surveys, it is recommended that the latter be used as the

Implementation Step	Recommendation
	main method of collecting survey responses when implementing the Framework. • It is recommended that an online survey platform, such as Survey Monkey, is adopted when conducting electronic survey responses to allow for efficient distribution and capturing of data • Nonetheless, it is recommended that the MQA uses telephonic surveys to increase survey response rates (if required), as it was highlighted by the MQA internal personnel that some respondents may have no/limited access to electronic means of communication. Should telephonic surveys be required, it is recommended that the MQA utilises the shortened version of the survey provided in Annexure C for telephonic surveys. This should limit survey fatigue from respondents conducting the survey telephonically. • It is recommended that stakeholders are provided with at least 3 days to complete the survey • Stakeholders could be encouraged to participate in the survey by providing an incentive such as a prize through a lucky draw as part of the survey. • In order to encourage participants to provide input on key content-related questions, it is recommended that questions such as the demographic questions be kept at the end of the questionnaire (as currently positioned in Annexure B). This may assist with ensuring that if respondents complete only part of the survey, the probability of them providing key input on content-related questions prior to closing the survey is higher.
Step 4: Analyse Data Through Surveys	• The MQA should use both quantitative (electronic survey) and qualitative (desk-based research and open-ended survey questions) methods when analysing the data. Quantitative data will provide statistical validation, while qualitative insights will assist the MQA to contextualise the quantitative results. • In addition to using the data analysis calculations proposed in section 4.4, the MQA may consider creating visualisations

Implementation Step	Recommendation
	in the form of graphs and charts to represent the survey data. The illustrations will provide a clear trend in the data. • It is recommended that the MQA use thematic analysis when analysing qualitative data
Step 5: Document Findings	• The MQA should clearly highlight the key findings stemming from the analysis. • In addition to documenting the key findings and recommendations from the Project, the MQA should also highlight any limitations observed during the implementation of the Framework. This will provide guidance in terms of how to avoid these concerns in the future. • It is also recommended that the MQA actively seeks feedback on the Framework's findings from stakeholders to identify areas of improvement.
Step 6: Update SSP	• It is recommended that the findings from the Framework process be incorporated into the MQA's annual SSP update

9 Annexure A: Workshop Presentation Packs

Annexure A consists of the slide packs drafted for the following 2 workshops conducted as part of the pilot process:

- Annexure A1: Future Drivers Workshop
- Annexure A2: Value Chain and Emerging Skills and Occupations Workshop

The above slide packs are attached to this report.

10 Annexure B: Proposed Electronic Survey Tool

Annexure B includes the pdf version of the electronic survey questionnaire drafted and distributed as part of the pilot process.

The survey tool is attached to this report.

11 Annexure C: Proposed Telephonic Survey Tool

The following provides the proposed telephonic survey questionnaire that the MQA may use should they wish to conduct telephonic surveys as part of the forecasting process.

Date:

Interviewee Name:

Interviewee Organisation Name:

Good day,

I am [name of interviewer], from the MQA and I am calling you with regard to research we are currently conducting to understand the future skills needs of organisations in the Mining and Minerals Sector. The primary objective of this research is to understand key changes that are affecting organisations in the sector, the manner in which organisations are responding to these changes and the future skills and occupations that may emerge as a result of these changes.

As part of this process, we would like to conduct a short telephonic survey with you.

Would you be available to conduct the survey now?

[If yes], Proceed to Question 1 below

[If no], May you kindly advise on another suitable timeslot or day that we should call you back for the telephonic survey?

[If not interested] Thank them for their time and end the call.

Question Reference		Response Option
1	Before starting the survey, we would like to inform you that although your participation in this survey is voluntary, your input would be greatly appreciated. Do you consent to MQA using the data provided in summary form, for research purposes? Your individual details will not be shared with anyone.	• Yes • No
2	What are the key future drivers which will impact the Mining and Minerals Sub-sectors? [Interviewer's Note: Provide examples of future drivers to interviewee, as identified through desk-based research and validation workshops. Some examples	Open-ended

Question Reference	Response Option
may adoption of 4IR-related technologies, political unrest, changes in demand for minerals...]	
3 The next question assesses the extent to which different phases of the Mining and Beneficiation Value Chains will be impacted by the key future drivers discussed previously. I will list out the key phases of the value chains, kindly respond with “To a low extent”, “To a medium extent”, “To a high extent” or “I do not know” to indicate the extent you believe these phases will be impacted by the future drivers. The key phases of the value chains are: • Exploration • Development • Production/Extraction • Transportation of Mineral Ore • Initial Processing/Beneficiation • Transportation of Processed/Semi Processed Minerals • Rehabilitation and Mine Closure • Further Beneficiation • Transportation of Manufactured Jewellery • Recycling/Repurposing of Jewellery/Diamonds	• To a low extent • To a medium extent • To a high extent • I do not know
4 The next question assesses the various skills that are anticipated to emerge as a result of the future drivers and the quantity of these skills that your organisation requires in the next 1 – 2 years. I will list out the key skills identified, kindly respond with “None”, “Tens of people”, “Hundreds of people”, “Thousands of people” or “Tens of thousands of people” The key skills identified include: • <Include list of key skills identified based on validation workshops>	• None • Tens (10) of people • Hundreds (100) of people • Thousands (1 000) of people • Tens of thousands (10 000) of people
5 Similar to the above, this question looks at the skills that are anticipated to emerge as a result of the future	• None

Question Reference	Response Option
drivers and the quantity of these skills that your organisation requires in the next 2 – 5 years. As above, I will list out the key skills identified, kindly respond with “None”, “Tens of people”, “Hundreds of people”, “Thousands of people” or “Tens of thousands of people” The key skills identified include: • <Include list of key skills identified based on validation workshops>	• Tens (10) of people • Hundreds (100) of people • Thousands (1 000) of people • Tens of thousands (10 000) of people
6 In addition to skills, we also want to understand if there are any occupations emerging that will be required by your organisation in the next 1 – 2 years. As above, I will list out the key occupations identified, kindly respond with “None”, “Tens of people”, “Hundreds of people”, “Thousands of people” or “Tens of thousands of people” The key occupations identified include: • <Include list of key occupations identified based on validation workshops.	• None • Tens (10) of people • Hundreds (100) of people • Thousands (1 000) of people • Tens of thousands (10 000) of people
7 Similarly, in the next 2 – 5 years, how many people will you require in the following occupations? • <Include list of key occupations identified based on validation workshops.	• None • Tens (10) of people • Hundreds (100) of people • Thousands (1 000) of people • Tens of thousands (10 000) of people
8 Which of the following technologies have you heard of or seen implemented locally/in South Africa? • Cloud computing • AI Powered Drilling Systems • Drone Technology • Robotic Drills and Loaders • 3D Printing • Big Data • Real Time Monitoring of Equipment • Optical Sorting	Multiple choice

Question Reference	Response Option
• Virtual Reality • Predictive Maintenance • Renewable Technologies (e.g. Solar, Wind) • Self-driving Trucks • Precise Positioning Technology e.g. GPS • Biometrics • Blockchain • Augmented Reality • Carbon Capture & Utilisation • Cybersecurity • Production Forecasting • Smart Sensors	
9 From the list of technologies we just identified, are there any that your organisation intends to adopt? [if yes] When does your organisation intend to adopt them? Will they be adopted in “less than a year”, “in the next 1 – 2 years”, “in the next 2 – 5 years”, “more than 5 years”?	Open-ended
10 What qualifications, if any, do you think need to be introduced/ developed in order to respond to the emerging skills and occupations?	Open-ended
11 Which Mining and Mineral sub-sector does your organisation most closely align to? [Interviewer’s Note: Do not ask question if information already available in contact database]	Open-ended
12 In which province are your organisation's operations conducted? [Interviewer’s Note: Do not ask question if information already available in contact database]	Open-ended
13 How many employees are there in your organisation? [Interviewer’s Note: Do not ask question if information already available in contact database]	Open-ended

We are now at the end of the telephonic survey. Once again, we would like to thank you for your time and input.

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