

The state of digital transformation in the South African mining industry

Ten insights into 4IR

2023



The Fourth Industrial Revolution

The Fourth Industrial Revolution — 4IR — as we will address it in this study, was named as such because of the current period of rapid technological growth, which is fundamentally changing the way we live and work. New technologies such as artificial intelligence, cloud computing, automation, 3D printing, the Internet of Things (IoT), robotics and faster wireless technologies are blurring the lines between the digital, biological and physical worlds.

Acknowledgements

The Minerals Council expresses its sincere appreciation to PwC and the thought-leadership assistance provided by Mr Jean-Jacques Verhaeghe of the Mandela Mining Precinct.

Foreword

The mining industry employs nearly 72,000 women out of a workforce of 475,500 people, which equates to 15%. While the number seems low, consider that no women were employed in the sector before 1998 by law. The growing participation of women in mining will be encouraged by the transition of our industry into a modern, safe, and healthy environment for everyone both physically and emotionally.

The Minerals Council South Africa, in collaboration with PwC and the Mandela Mining Precinct, launched its first study into ‘the State of Digitalisation and 4IR in SA Mining’, in 2020. The study’s findings were summarised in ten insights. These insights were globally well received and disseminated.

Many mining companies referenced that report to either kick off or accelerate their digitalisation and 4IR preparedness journeys. The onset of the COVID-19 pandemic also played a role in the industry embracing digitalisation and 4IR technologies at their operations. Attention was given to key strategies for maturing companies’ modernisation and digitalisation programmes. Furthermore, the Minerals Council’s Board mandated PwC’s smart mining team, and the Mandela Mining Precinct’s real-time information management systems programme, to perform this study every two years.

The 2020 report was presented to the original equipment manufacturers’ community that supplies the mining industry. These equipment developers and suppliers used the findings to understand their client’s needs, priorities, and focus areas better.

Digital transformation is imperative for mining – a non-negotiable if you like – as it serves as the seamless thread through all the mining value chain processes, and enhances safety and health, security, production, and workforce and leadership capability. The implementation of these processes needs to be executed with care and responsibility. This formed the basis for the 2022 study, which included the environmental, social and governance (ESG) aspects of mining, which are so important to mining companies’ boards, investors, communities, and stakeholders.

The 2020 Study focused purely on digital transformation and 4IR readiness. The 2022 study was expanded to include ESG aspects into the study to bring the industry in line with what is expected of companies in the modern world. Furthermore, the target respondents for the survey were predominantly CEOs, and/or nominated senior leaders from their companies. We also interviewed organised labour representatives. The study was anonymised. The aim was to search for a broad range of opinions to extrapolate the implications of digital transformation on South African mining and ESG – thereby formulating impact statements and addressing the ‘so what’s’.

Many insights – in fact more than 30 – were extrapolated from the study, but again summarised into ten (as you can see from the slide) – thereby addressing the categories of vision, priorities and strategy, workforce, business sustainability, ESG imperatives, and stakeholder collaborations.

A striking difference from the previous study is how prolific and integrated all these issues have become. We can no longer speak or think about these issues in silos – they are integrated, holistically connected, and comprise systems.

The ten insights are:

1. Mining CEOs and their executives are being deliberate.
2. Technology is being applied where it has the greatest measurable benefit.
3. The hunt for value requires cooperation and compromise.
4. Digital tools don't just measure, they contribute.
5. The imperatives for sustainability, and the crown jewels.
6. We are up to the challenge and have the tools to win.
7. Mining is about people – and we need to fight globally for talent.
8. ESG – critical for business survival or tick-box?
9. Regulation's shape ESG (for better or worse).
10. ESG drives long-term value.

What is glaringly obvious though, is that our miners have distinctly moved on from pondering 'the why' in terms of digital transformation, to 'the how' and 'the what'. This is encouraging and so mining is moving firmly away from the perceived notion that it is a laggard in adopting 4IR and digitalisation.

Our industry leaders are driving the digital transformation vision and expect to enjoy the results in the next few years. They are also very clear about their companies' role in meeting the ESG expectations but have powerful and thought-provoking insights to share and enact.

Our miners recognise the opportunity to leverage technology infrastructures, such as ICT, to improve their ESG control systems, especially with the use of data across the entire mining value chain and its processes, and disciplines. It also

becomes clear that the move away from distinct point solutions is increasingly becoming the preferred option. Use, re-use, optimise and re-use again is how one CEO framed it. And so, some miners emphasise the importance of 'data-mining'.

Modern integration requires new approaches – new ways of thinking – out-of-the-box engineering, and hence demands new skills to be enacted. The executives expect more up-to-date expertise from their technical teams, ICT departments, and ESG functions such as risk, governance, environmental, and social. What applied and worked 10 years ago no longer suffices to meet the goals of modern mining. The factors of uncertainty, complexity, and plurality need to be managed differently, and so mining is learning from other industries.

The opportunity to leverage digital better for the purposes of ESG exists – this notion is supported by organised labour – and our CEOs intuitively know (and expect) that dataflow and information-sharing will occur for the ESG functions by means of the digital systems. They, and their technical teams, are exploring the mechanics, which are the standards and reference architectures, of how this will be improved and materialised.

Indications to date and from the feedback of our respondents point to the notion that digital transformation and ESG practices are paying off – qualitatively and quantitatively. Improvements are being noted. They are also seizing opportunities to solve problems that other entities cannot, such as Eskom and Transnet – with a 'we can wait no longer – we will get things done' attitude.

Our CEOs and mining operations across the nation are taking on the mantle of becoming 'eco-system' leaders where they operate. Having said that, they also strongly appeal to all stakeholders to play an increasingly profound and meaningful role in business sustainability and impact. This is at a national government level, and inherent expectations of a sound regulatory environment, as well as at a local government level for stable, functional service delivery and community upliftment. The ecosystem includes collaboration and public-private-partnership entities such as

the Mandela Mining Precinct, and academia to prepare the next generation in the workplace.

The report captures important recommendations by CEOs – namely that enhanced and real collaboration between parties in the mining industry is paramount for success. Furthermore, it states that the existing mechanisms that enable such collaboration need to be leveraged by willing stakeholders. The CEOs specifically noted the Minerals Council's programmes and those of the Mandela Mining Precinct.

Tools and systems have been developed – or underdeveloped – to enhance executives' abilities to make better decisions with regards to their digital transformation efforts, such as the RTIMS digitalisation business case and benefits tracking methodology and toolset, which is available on the Mandela Mining Precinct's Knowmore public portal.

Our expectation is that this study and its results will have a profound effect and influence on how we mine metals and minerals for the future and continue **#MakingMiningMatter**.

Roger Baxter

Chief Executive Officer

Minerals Council South Africa

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Executive summary

In our second survey on The state of digital transformation in the South African mining industry, we interviewed 20 mining organisations CEO's and members of their executive teams most of whom are members of the Minerals Council of South Africa. They represent a cross-section of South Africa's most prominent coal, platinum group metals, gold, iron ore, manganese, and other mined raw materials producers. We identified ten key insights that we believe are consistent with other international studies and can be used by mining company executives and other decision makers to chart the course of their organisations' digital transformation journey.

Key insights

1. Mining CEOs and their Executives are being deliberate

CEOs continue to drive fit-for-purpose digital transformation in various ways. It is expected to be an enterprise-wide effort calling for trust, innovation, new thinking, holistic design, dealing with nuances, and the seamless use (and re-use) of systems, data, and resources. Stakeholders such as OEMs are encouraged to step-up. A modernised workforce with relevant skills, owning new specialisations, and prepared to explore the 'unknown', is sought. CEOs believe that more can be done.

2. Technology is being applied where it has the greatest measurable benefit

New mines are intentionally designed and managed with digital embedded in every process, and most evident in open cast and processing plants. Underground (and older mines) struggle. However, notable adjustments and implementations are being made in the integration of core mining processes, logistics, supply chain, HR systems and skills development (training). Architectural solutions and design provide the basis from which the expected value and benefits realisation is measured and achieved.

3. The hunt for value requires cooperation and compromise

With an emphasis on measurable returns executives are focusing on cost leadership, efficiency, and profitability. Sometimes we find that a leap of faith is required because the indirect value is difficult to quantify. The part of the digital program delivering the most value is the information management system itself. The most value-for-money investments are:

safety, security surveillance, supply chain, payroll (function automation), reporting, community sentiment tracking (predicting protests), and maintenance.

4. Digital tools don't just measure, they contribute

Organised labour expects digital transformation to improve workforce health and safety, and communications – in real-time. Organised labour wants to play a role and contribute to the implementation of new technologies which is deemed to be a powerful enabler for improvements, target achievement, and attaining and sustaining an open culture. They also believe that more can be done at R&D, technology, and skills development levels, e.g. academia.

5. The imperatives for sustainability, and the crown jewels

The world is changing and potentially de-globalising trade. Against the backdrop of rising living costs, questions arise as to the move to a green economy. Data is the answer – seen as the most intensely managed part of mining over the next 10 years.

We face challenges in attracting digital natives to remote mines – some are considering the remote operations centre concept. VR & AR are at the forefront of safety training – demonstrating 30% improvements over traditional methods. We need breakthroughs in cost, energy, and water to stay competitive. Technology must help mining solve climate change.

6. We are up to the challenge and have the tools to win

South African miners are not satisfied with their progress in digital since 2019 – despite great leaps forward we are struggling with generating and consuming information. Safety remains a major issue for South African mines against the global norms, and our operations are ‘archaic’, using decades old mining methods. OEMs are not leading the charge – miners have taken the initiative. We have great ideas, but require a way to collaborate and save on ‘school fees’. Safety, projects (digital twins) and processing have benefited the most from 4iR to date. Policy is required to enact real change.

7. Mining is about people – and we need to fight globally for talent

Digital transformation is changing mining and so Mining needs modern leaders, fresh talent and adoption of specific values. People-centricity is a priority but people are expected to deal with the necessitated change and accept accountability that comes with empowerment. To address the shrinking talent pool, common opportunities for improvement were noted. Collaboration hubs such as the Mandela Mining Precinct play a distinct facilitation and thought leadership role.

8. ESG – critical for business survival or tick-box?

ESG is not about compliance – its about developing a long term sustainable business. It requires a fundamental re-think of strategy. This starts with the right structure and resourcing. Sharing information and being part of global councils also helps to direct ESG efforts through best practice. Reporting and embedding ESG in KPIs is the best way forward practically. Some miners see ESG as a business risk while the majority see it as part of core business strategy and their operating model.

9. Regulations shape ESG (for better or worse)

Regulatory requirements drive ESG, however ESG works best when you embed it in strategy. To get value out of ESG we cannot stop at regulation. Unions agree that ESG has had a positive benefit in mining – and that digital has a role to play in ESG. Unions do argue that there is less focus on social and governance issues than to environmental protection. The voluntary reporting frameworks are not suitable for mining – and self selecting criteria and weighting is not adding value.

10. ESG drives long-term value

Embedding ESG in the mining business has to be centred on contributing to long-term value. Value determination is sometimes blurred. ESG’s categories and opportunities were identified and ranked, and include:

- job creation and upskilling;
- greater trust and fewer community disruptions;
- new ‘green’ market opportunities;
- increased security and lower borrowing costs;
- business and digital systems resilience;
- improved Brand recognition;
- and responsible technology innovations.

Glossary of terms

Term	Definition
4IR	The Fourth Industrial Revolution
4IR ecosystem	Integration of two or more silos' information and processes which improves operating model efficiency
AI	Artificial intelligence
AR	Augmented reality — a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view
CDO	Chief digital officer
CEO	Chief executive officer
CIO	Chief information officer
Digital twin	A simulation modelling a real-world plant, operation or piece of complex equipment that can simulate real-world outcomes.
ERP	Enterprise resource planning
ESG	Environmental, social and governance
IEEE	Institute for Electronic Electrical Engineering
IIoT	Industrial Internet of Things
IIRA (IIC)	The Industrial Internet Consortium's Industrial Internet Reference Architecture
IoT	Internet of Things
ISA-95	International standard for developing an automated interface between enterprise and control systems

Term	Definition
IT	Information technology
MCSA	Minerals Council of South Africa
MRM	Mineral resource management
NPV	Net present value
OEM	Original equipment manufacturer
Operating model	How an organisation runs itself — the process of delivering value to a customer
OT	Operational technology — hardware and software that monitors and manages the operation of machines
PdM	Predictive maintenance — the process of addressing problems before they cause equipment failures by means of analytics
PdM 4.0	Predictive maintenance involving the application of machine learning to identify meaningful patterns in vast amounts of data to generate new, actionable insights for improved asset availability
ROI	Return on investment
RPA	Robotic process automation (cognitive intelligent automation) — automating repetitive tasks via a bot (an autonomous program that can interact with systems or users)
SLO	Social licence to operate
SLP	Social labour plan
VR	Virtual reality — a simulation of a three-dimensional environment that can be interacted with in a seemingly real or physical way

Study insights

Insight 1: Mining CEOs and their executives are being deliberate

Key points:

- The CEO guides while the C-suite searches for value
- Digital must be fit-for-purpose
- Digital champions do it on purpose

The CEO guides while the C-suite searches for value

Since 2021, mining CEOs have focused on innovation rather than top-down initiative-based approaches. We're now seeing digital and 4IR as de facto parts of mining, instead of having to prove its value through top-down initiatives. According to this survey, 100% of respondents are on the digital journey – including leveraging technology for ESG programmes. CEOs own the strategic perspective, seeing digital and 4IR as enablers of achieving strategic and digital ambitions, and setting the pace, direction, and expectations around digital initiatives.

The CEO is the strategic steward – delivering on commitments made to shareholders and communities. They are seeking to define work in the new digital world across the mining value chain – finding, mining, treating and trading. Carbon neutrality, renewable mines, improved resource use, and data-driven business strategies all involve digital elements. We have seen a persistent focus on measurable value creation – mining is after all about tracking the benefits on the bottom line.

Equal participation in the digital transformation journey for all in operations came up as a strong leadership theme. This is key to getting buy-in across the enterprise. Trust in the leadership team is essential to the success and adoption of these tools. In 2023 the entire management team is involved in the digital programme. Using a 4IR lens, the executive and senior management teams focus on reducing and preventing duplication, expanding and achieving the roadmap, and embedding an environment for prediction and analysis and real time insights.

The key here is the *roadmap, and realising you are on a journey*. Digitalisation and 4IR are not isolated activities. Our respondents identified the roadmap as critical – you must have a vision and a plan for how to get there. They told us that it is necessary to develop standards for connecting enterprise architectures, which relates back to the need for economies of scale to contain costs. Developing the *right culture*, setting up the *right enabling environment*, and *trusting* the leadership team is the key to success and adopting these tools.



Transformation relies on trust as a key theme – the vision must be accepted as sound for people to adopt it.

Our previous study successfully predicted that digital would move beyond ICT or a single owner per unit, to being embedded in every business function. It's not a specialisation so much as a vital tool to help senior leadership achieve their objectives. The specialisation lies in being able to holistically design, implement, and integrate information systems optimally – so we see the rise of the chief data officer, chief digital transformation officer, and similar roles. This is an acknowledgment that mining is modernising its workforce, engineering practices, and standards.

Some leaders indicated that mining companies are now able to drive innovation based on their vision of the future rather than original Equipment Manufacturers (OEMs) and Original Technology Manufacturers (OTMs) that historically drove innovation.

Digital must be fit-for-purpose

Table 1: Priority fit-for-purpose projects

Real-time data driven safety programmes	Real-time workplace notes	Project monitoring and viability in real-time (digital twins)	Automation of plant high value (advanced process control)	Digitally optimised supply chains
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The executives are exploring and finding their own niche and nuanced portfolios for ESG and digital transformation (DX) projects – a common theme though is that these need to be fit-for-purpose. There is some experimentation, but we are not seeing a ‘see what sticks’ philosophy – in fact some executives indicated that they’ve gone so far as to revamp their business case and benefits realisation tools/systems to be far more specific and accurate.

From a global perspective, mining is lagging in the digital space compared to other industries. Mining’s digital transformation is a major priority, but miners admit that more can be done to make mining more digital.

According to the survey respondents, mining has been at the forefront of technology advances for many decades. Unlike the powerful and traditionally established Operational Technologies (OT) we use in mining and engineering, 4IR and digital technologies are an enabler of our workforce transformation and business strategy rather than operating physical processes.

We must be aware that South African conventional and shaft-based mines are typically older and closer to the end of their life cycle. Mines with shorter expected life spans of three to seven years struggle to digitise since they don’t have enough time to achieve ROI. The new mines emerging in South America are considered (by the same scale we have used) to be 75% digitised at the start – proving that digital infrastructure can be built in at a much earlier stage.

Our favourite quote in context:

“ Make sure reality is close to the theory
 – Strategic Integration Executive.

In South Africa, we are not necessarily able to digitise to that extent, but more than half of our miners ensure their organisations have digital capabilities embedded in every single project. Miners are building digital elements that provide visualisation and coordination of activities as an additional layer to all mining projects to keep an eye on business fundamentals.

A handful of miners tell us they are drawing inspiration from other industries like oil, gas and manufacturing and ‘adapt the digital technologies to mining’.

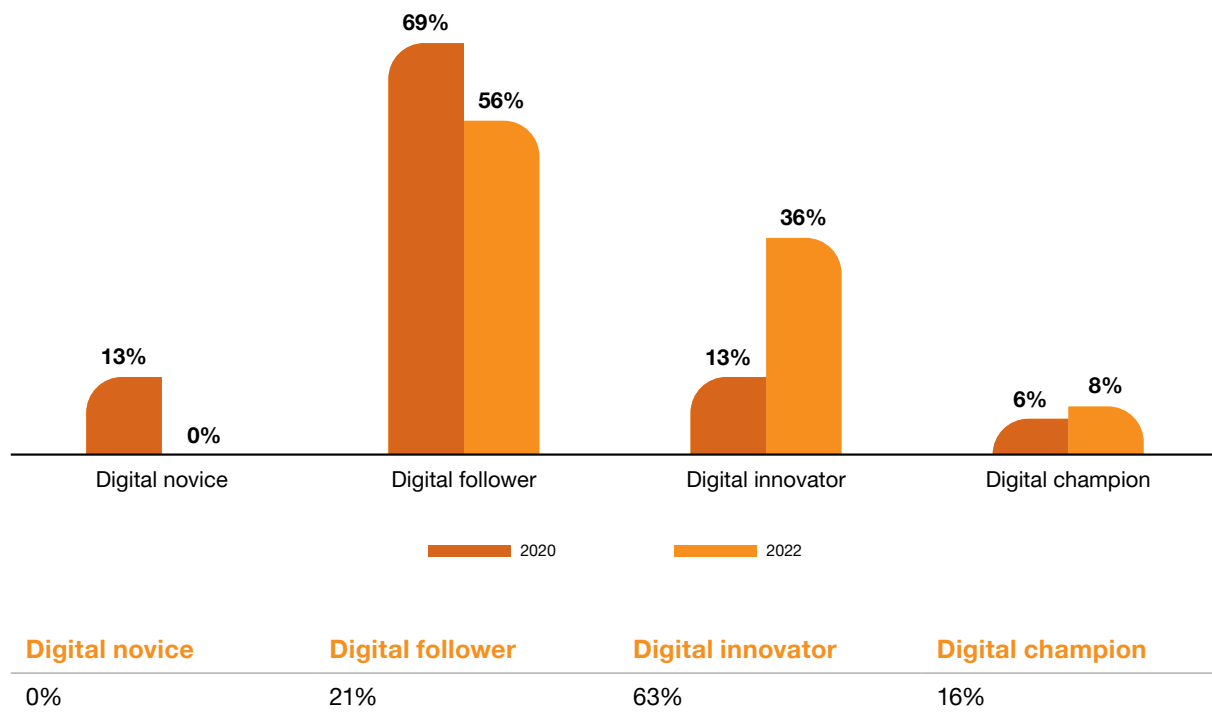
A third of respondents address this issue in a fundamentally different manner – they see digital, 4IR and innovation technologies as the critical elements of the future of mining. They are not adding digital capabilities to their projects – they are thinking through the implications of carbon neutrality, renewable mines, optimised use of resources – they are looking with fresh eyes at the mining process and asking the question, “How can I use data to drive my business forward?”. These miners are looking at data in a different way – instead of something to collect for future data mining, they are using it to design their businesses for the future.

In the previous 4IR survey, we found that digital projects driven by the technical side of the business had the greatest ROI and that is unchanged, with some elements of plant and processing approaching 85% achievement of their digital transformation goals by 2025 for multiple respondents. This follows as a 1% plant performance improvement could flow directly to bottom line results; however, we are seeing digital programmes across the value chain including supply chain and logistics – an area that mining self-declared was behind its peers in manufacturing, oil, and gas in our previous study.

Digital champions do it on purpose

Comparing the levels of digital maturity between the survey from 2020 and late 2022 we find a very different, more specific picture.

Figure 1: Levels of digital maturity



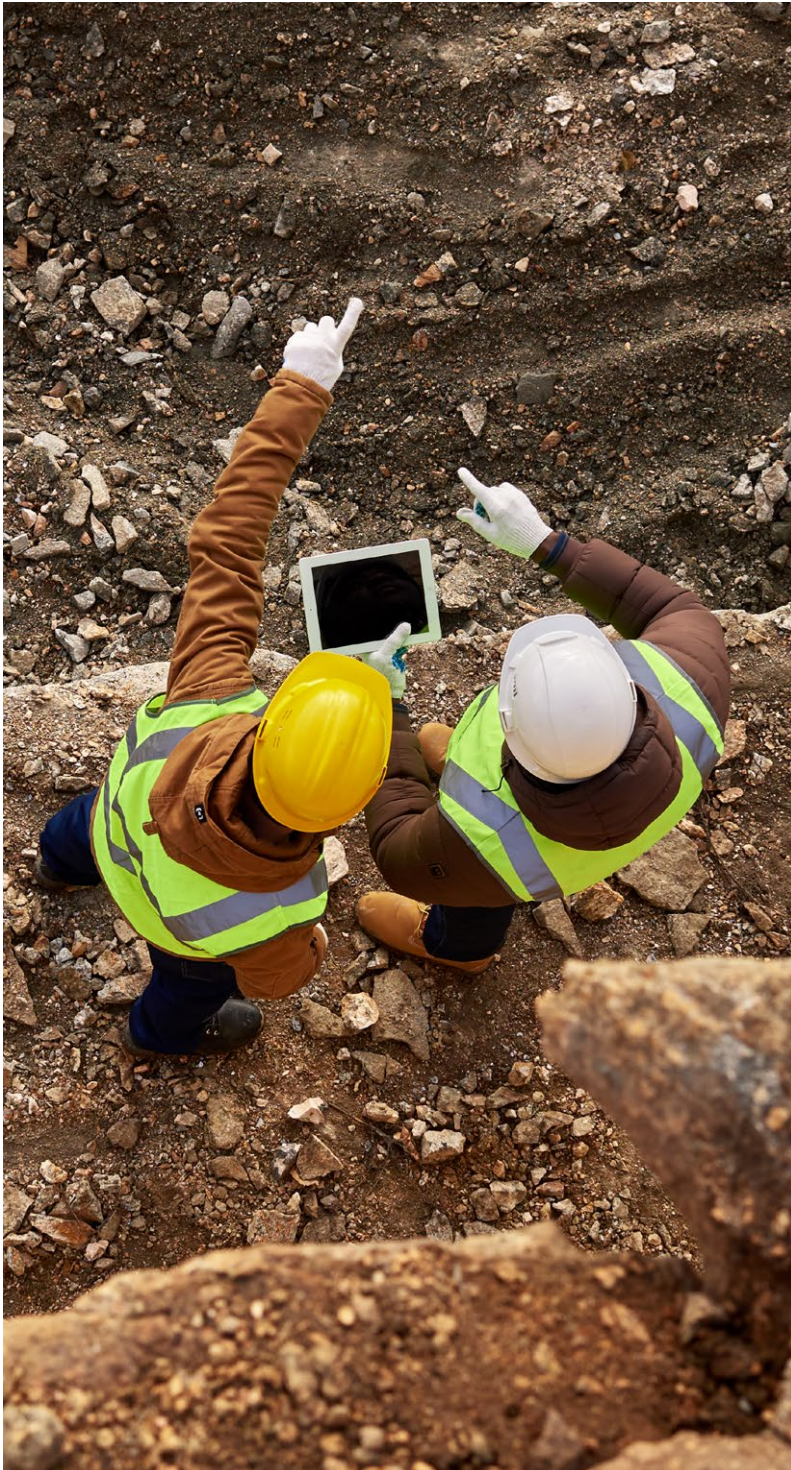
Compared to the 2020 study, it was more difficult to distinguish and categorise the four groups from each other. In most cases our respondents have programmes at various levels of maturity along their value chain – and nearly all have at least a portion of their program at a digital champion level.

Miners have led the way in technology for a century and they are not stopping now was the clear message. Variations arise from different business models (open caste as opposed to deep-level conventional) – with a lot more technologies available above ground like Long Term Evolution (LTE) as an example. Business model and data collection capabilities are also key determinants, and the complexity of integrating new technologies into legacy systems has forced miners to identify new revenue models that leverage existing infrastructure.

The road is also changing underfoot – as leaders grapple with new functions, roles, business models, data models, engineering practices and the need for new skills, new opportunities arise in the world of technology for us to adapt to. Large language models are the most recent – with Chat GPT creating a wave of unanticipated impacts around the world – so much so that its own chief technology officer (CTO) has called for its independent regulation. Such models, when freed of their plagiaristic origins and trained in a specific context, have the potential to once again revolutionise our human interface with technologies. In this context, our respondents told us that while they may have planned a roadmap until 2025 – that is really just a chapter and the journey continues with additional roadmaps having already been envisaged for the next five years.

Digital novice (2023)

Miners have significantly shifted the goalposts for their digital programmes since 2021. Where 13% of miners in 2020/1 had no digital programme to speak of, today 100% of the miners surveyed focus on digital and see it as a critical tool for business sustainability. We are seeing a change from ‘digital only’ projects to ‘every project embeds digital’ – in other words it’s now embedded as one of the tools we use to demonstrate the value of projects. None of the miners surveyed classified themselves as new entrants to the world of digital.



Digital follower (2023)

The biggest category of our previous survey, the digital followers are still a significant group due to the digital novice (2020) group moving up into this category. This accounts for 56% of respondents.

Several mining leaders have pointed out that miners are unwilling to learn lessons from other industries – in their estimation miners typically ask the question ‘Where has this been successfully rolled out in mining before?’ when confronted with new technologies, as opposed to seeking successful benchmarks in complementary industries.

We are seeing the 2020 digital novices and newer commodity businesses in the follower space – i.e., they are following the example of others and starting to understand the value of digital and 4IR but only in isolated silos – not yet across the whole business or as part of strategy. Typically starting out with point solutions, safety programmes and visualisation of the value chain, we have heard of the removal of manual spreadsheets, the use of properly integrated systems and a drive towards standardisation of software and hardware among the followers – they are typically copying successful ideas from other miners.

Digital innovator (2023)

Several followers have graduated to digital innovators as we had promised in our previous survey. They have cross-functionally connected practices and, as indicated above, are embedding digital in everything they do and linking it back to existing systems. We are not rid of the point solution focus entirely – but we are seeing the rise of ecosystems and connected practices backed by a strategy that explicitly utilises digital tools to visualise work in progress, communicate to and educate employees. This group now constitutes 36% and is set to grow quickly.

One-third of respondents are well advanced in their data programmes with expectations of those platforms further transforming their business as they reach maturity between 2025 and 2027. All of these particular miners were in the follower space in our previous survey, and having achieved some success at the functional level are now thinking bigger. Data is at the centre of this gradual transformation, i.e., we are not seeing dramatic change however they are building the data led decision-making infrastructure. They are anticipating change – but they are waiting for the maturity of their data to tell them what to change.

There has been a step change in the type of digital programmes the more advanced innovators have undertaken since our previous survey; from a point solutions focus, and using digital to create dashboards and visibility of operations in 2020 we are now seeing larger, data centric strategic programmes that take many years to come to fruition. The C-suite are focusing on enabling architectures, economies of scale and getting the best value for money out of operational and information technology systems.

Despite this investment, they are not quite digital champions as yet with these programs typically taking five to eight years to reach maturity. We do anticipate at least two more miners to reach champion status with fully integrated people, production and cost ecosystems by 2025.

One third of respondents expect their businesses to be guided by data in the future, and some are telling us that they anticipate changing the ways of working and the ways of future mining based on this information. Though not yet complete and in the digital champions space, these innovators are set to challenge the assumptions behind mining in the coming years.

Another comparatively underdeveloped area of value according to our miners is supply chain. When we looked at the difference in the digitisation journey between manufacturing and mining in our 2020 study, supply chain and logistics stood out for all the wrong reasons – i.e., it was not a focus of very many digital programmes at all. Today this has shifted somewhat, and the members of the digital Innovators are starting to focus on it out of necessity. Lack of alternative suppliers, ordering from silos, and the management of increased working capital are typical issues here and we expect this to become a major value driver going forward in mining.

Digital champions (2023)

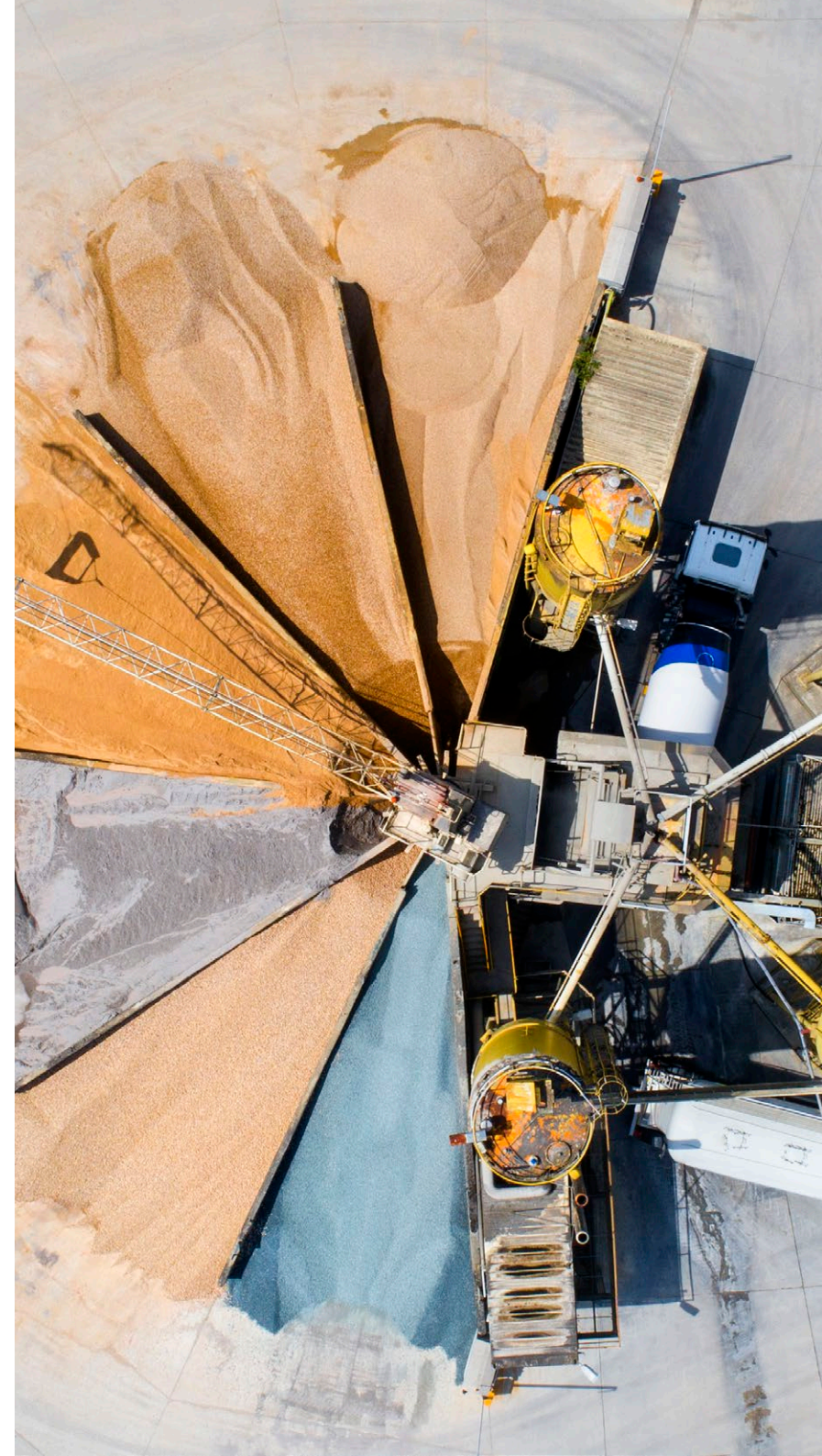
South Africa has many miners that could become digital champions and several that are already digital champions in other geographies – especially South America where the new mines are built incorporating the latest thinking in digital and 4IR. But it is important to note that they may never become digital champions here in South Africa for the simple reason that the life of mine does not necessarily support the business cases. A simplistic example would be an investment into underground Wi-Fi when the mine will be closed in three to five years.

Unfortunately, that characterises a lot of our mines. The lack of investment in exploration, the lack of incentives to invest in mining in South Africa, the lack of young mines in development, the growing ESG compliance expectations and the unfortunate collapse of our energy grid come into focus here. We have only a handful of mining companies with assets that will last long enough to justify this level of investment. This doesn't mean that they aren't world beating-mines – just that they cannot expect the same level of investment in integrated long-term technology.

Our three digital champions in 2023 all see digital, 4IR, innovation, and technology as the critical elements of the future of mining in their companies. They are all challenging how mining can and should change throughout the value chain. Central to their thinking is carbon neutrality, the potential for renewable mines and how we can best use our limited resources and data.

That is where the data comes in. These digital champions are looking at their data in different ways, really applying effort to using their data and getting value out of it. The key to their success is intention – for each of the three they had well-defined measures of success, clear guidelines as to the business case and tracking of benefits, and a clear intent to make it of value in the future. All three started their digital programmes in 2017/2018, and all three say they will only get the very best out of their data in 2-3 years from now.

Another thing they all have in common is that their roadmaps never stopped – they are now on the next horizon of the roadmap, they all motivate projects through business cases, and they all believe that the data we are collecting will inform the future ways of work in mining. These companies are already optimising and then iteratively reworking opportunities by redesigning and integrating – hence exploiting and leveraging 'the new' continuously.



Insight 2: Technology is being applied where it has the greatest measurable benefit

Key points:

- Mining is embracing key technology initiatives that provide ROI
- We are still defining value when it comes to digital transformation

Mining is embracing key technology initiatives that provide ROI

Our older mines struggle with digital transformation due to technical and technology debt (legacy systems). Retrofitting where it was not designed for purpose is costly. Several CEOs made the point that their newer (typically overseas) mines were designed with digital in mind, upfront, and are 75% along the roadmap after just a few years. When asked why we could not replicate this in South Africa they told us that the key drivers – aside from the age and retrofitting requirement – is firstly the lack of qualified resources, and secondly the resistance to change from a low-skilled low educated workforce. There is also some confusion and uncertainty as to how the new technologies will function and scepticism regarding ROI.

This is not to say we do not have cutting-edge technology in use – it is applied in specific areas of the value chain. We see a concentration of technology initiatives within the processing areas of the business which are on average 20% closer to the transformed vision at 50% (with one at 80%). Open pit operations are typically also connected and initiatives in that area are about 40% complete, according to the executives. South Africa's underground mining lags at best at 30%. This plant and processing focus makes a lot of sense when you consider the implications of even a 1% improvement in processing that will largely fall to the bottom line.

The key technology initiatives we heard included Miners looking to *integrated reporting*, *integrated mine planning*, *logistics automation*, *digitally optimised supply chains*, *integrated source-to-pay and finance* functions, supported by *HR standardisation*, *digital training and skills development*, as well as *platforms* within the businesses that are used to promote and *share innovations*.



No more spreadsheets, fully SAP integrated

Architecture is a stronger theme than in our previous study in 2020 – as miners determine which solutions are allowable in the landscape, what key activities must be supported and identify functions where no changes should be permitted. Looking for economies of scale in software and solutions is important to counter the inflationary pressures in the external environment and is being undertaken by a third of respondents.

Table 2: Start year for respondents digital programmes

<2016	2017	2018	2019	2020	2021
7%	21%	29%	21%	7%	14%

What value is there for labour?

One of the most powerful transformation stories we heard came from a Union – where they discussed a 15 year digital transformation that had no retrenchments or importation of new skills – yet achieved major benefits. When asked about their perception of digital tools and their importance they told us that digital does three things – it gives us a large boost to real time safety systems, provides instant communications, and perhaps most importantly – it is an enabler for developing people. Its not just about giving an instruction – its about helping the worker to make the right decisions in real time. Contrast this to the historical approach of short interval controls that hold workers accountable – now the tool helps you to make the decisions to reach those targets.



We are still defining value when it comes to digital transformation

When we asked CEOs and their executive teams about how they define value from their investments in digital we received *qualitative* responses including ‘*proper integration – driving for value*’, and ‘*return in value either through cost saving or increasing returns. Not only short-term returns.*’

Many of our mining houses have not yet fully quantified non-financial value from the perspective of stakeholders, employees, and community members. This is a slow process according to our survey because stakeholders perceive value differently – we as an industry need to understand the value of digital transformation to each stakeholder group.

Further to that, one CEO – of one of the biggest investors in digital 4IR transformation in South Africa – told us that the *financial value of digital transformation has not been quantified and identified as yet* (speaking to the data-led decision models expected to mature from 2025-2027 with these answers).

So where does that leave us with respect to the value of digital transformation? The unequivocal response was *visibility and transparency* – allowing stakeholders to know what’s going on and be able to connect the dots in real-time. *Reduction of bureaucracy* was identified as a clear value and of course, the ability to make better decisions as well.

So why don’t miners fully know the value? Because they are not there yet – they are mostly in the early stages and need to digitise more processes to get to the point where they have real-time live data.

We certainly still have the need to *move away from mining’s historic siloed ways of working* according to these leaders – and that is in itself one of the great benefits of digital tools that share information. *Digital tools can change the way people think* – from just focusing on their own process to understanding their role within the larger value chain. This empowers people and illustrates how the whole business needs to perform *so that we are all successful together*.

A critical combination of people, process and technology using the data that emanates from the systems in these areas will be able to support business decisions, create business value and drive the business forward. At present, siloed operations and the absence of evidence as to the value of digitalisation means we are yet to unlock the full value of transformational technology and digital capabilities for conventional mining.

So back to the value question – could you put a value on your mine running like a Swiss watch? Probably not in financial terms, but is it valuable?

Insight 3: The hunt for value requires cooperation and compromise

Key points:

- Cost containment is king, closely followed by survival
- Five-year forecasts show the ongoing upside of digital and 4IR

Cost containment is still king, closely followed by survival

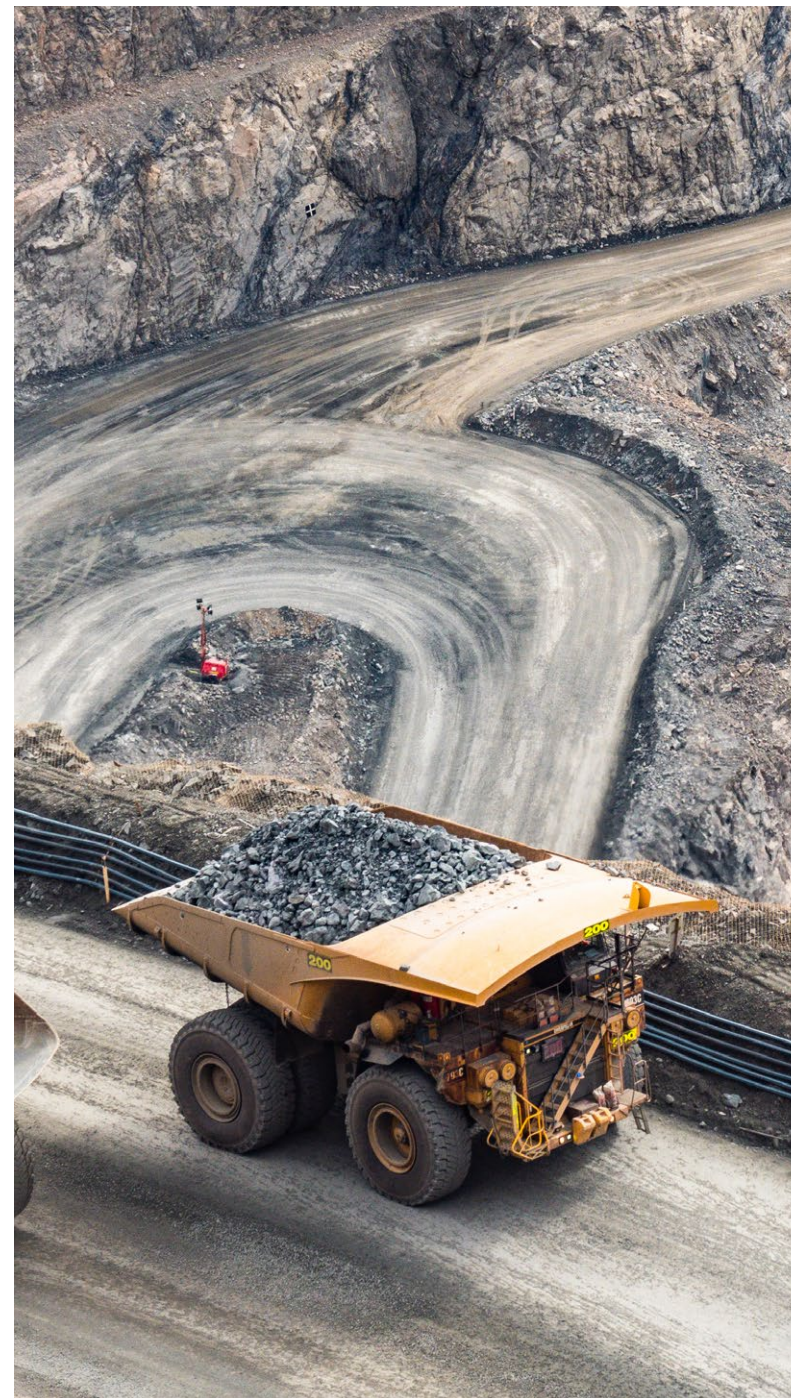
Table 3: Business priorities 2023

Criteria	# 1 Priority	# 2 Priority	# 3 Priority	# 4 Priority
Cost leadership and efficiency and profitability	38%	11%		
Resilience, flexibility and transparency	11%	11%	5%	
Sustainability leadership	5%	17%	5%	
Environmental, social, and corporate governance assurance mechanisms	5%	5%		
Key stakeholder impacts (workforce, community, ecosystem/partners)	11%	5%	5%	5%
Overall business sustainability and longevity (Will my business survive?)	22%	17%	5%	

Looking at the themes in Table:2 above, we asked respondents what was the most important of these themes in 2020 versus today. For reference, the most dominant themes in the prior study were **cost leadership, efficiency and profitability**.

In our recent 2022 interviews, the situation has become more complex – but with mining as a price taker, it follows that 38% of respondents put **cost leadership, efficiency, and profitability** as their number one concern, with another 11% stating it was their second highest concern. The biggest change is that **overall business sustainability and longevity** is the second highest result with 22% selecting it as their pre-eminent concern.

Sustainability leadership was selected as dominant by only 5%, but 17% of the respondents noted it as their second highest priority. Some specifically chose sustainability leadership over ESG assurance mechanisms because their ESG assurance program is combined with or led by sustainability leadership. One went so far as to indicate that sustainability leadership means potentially repositioning the business – to both adapt to ever-changing ESG requirements and remain competitive in the future.



The biggest surprise was **ESG** – or the *lack of it*. Only two companies selected ESG, and neither was selected as first priority. For one it was their second priority (after sustainability leadership), but they noted that ESG is a big factor for them and is applied in every investment decision. We will go into depth on ESG in a dedicated section below.

Key stakeholder impacts are the first priority for 11% of respondents and another 15% of the miners interviewed selected it as a second, third or, fourth priority. The argument here is that digital and 4IR are critical to facilitate effective stakeholder management and collaboration. A tighter integrated ecosystem with partners in the technology space and an increased emphasis on your strategic relationship with your ICT providers will be required.

Resilience scores are strong with it being selected as the *first priority* by 11% and a *second priority* by another 11% with another 5% as the *fourth priority*. By way of comparison, this was the *first priority* of global manufacturing firms in 2022 as identified in the PwC Global Manufacturing Study¹, with manufacturing struggling with material inputs from steel to computer chips and energy availability.

Mining houses are measuring the value they get from investments in digital and 4IR because these initiatives are fighting for capital allocations. Initiatives from all over the business compete for capital and there is a need to get the balance right, mining executives tell us.

This is not a simple undertaking – the common example being a digital programme versus a new dump truck. A physical dump truck is directly linked to additional tons and the business case is apparent to all stakeholders. Its maintenance, servicing, and fuel needs are measurable and easily budgeted into the future because we have experience.

Digital is different in that respect. CEOs are telling us that although they want to make decisions based on ROI, it's not always ROI in hard metrics. Sometimes you need a *'leap of faith'* we are told. *We need to understand how to measure the indirect value of 4IR initiatives*, which a third of respondents indicated is a challenge. Some see digital as an *enabler of future value* – also a *challenge to quantify* prior to execution.

A quarter of respondents are tracking benefits from all the digital 4IR technologies they have put in place. These outcomes are tested against

the original business case, and they assert that all their 4IR initiatives have business cases and tracking tools. The most frequently mentioned *value-for-money* investments in order of popularity were:

Safety, security surveillance, supply chain, payroll (function automation), reporting, community sentiment tracking (predicting protests), and maintenance.

Interestingly when we asked respondents what part of their digital programme they feel is delivering the most value – we were told that the *information management system* itself was the investment with the greatest value. In other words, the ability to track benefits and the effect those enablers are having on the business for all of the programmes was in itself the greatest source of value to the executives. This follows from the statements above where some 'faith' may have been required in early digital and 4IR initiatives – and provides evidence that digital and 4IR are true contributors of value to business operations.

Five-year forecasts show the ongoing upside of digital and 4IR

When we asked miners to tell us what they expected from the next five years in terms of throughput, cost, efficiency gain, and safety we could only get a full set of responses from around 40% of our respondents. The drivers here are important – unlike the previous survey, the miners were unwilling to estimate their progress going forward. Instead, they would only provide numbers if they were in their management information systems – i.e., planned or implemented on their roadmap.

We have therefore taken a like-for-like comparison between the 2020 study and this one – i.e., a smaller sample size that compares directly to their answers in 2020.

Throughput improvement		Efficiency gain		Cost reduction		Improved safety	
2021	2023	2021	2023	2021	2023	2021	2023
30%	14%	30%	14% (Mining) 1% Concentrator	10%-20%	15%	30%	30%

¹ PwC Global Manufacturing Study, 15 February, 2023.



Throughput improvement expected in the next 5 years

In our previous study, the majority of predictions of future benefits from digital were higher than today. This is to be expected for several reasons. Firstly, miners have already taken the low-hanging fruit so there are fewer ‘easy’ short-term benefits to be had. Secondly, because miners have had more experience and are measuring the benefits more effectively so their predictions are more accurate and realistic.

Throughput improvement over the next five years sits at 14% in the latest survey. It was also tied to specific programmes – not to a general impact of digitisation as per the previous result in 2020. The same miners in our previous survey had selected > 30% throughput improvement over five years. As it was tied to specific programmes these values were taken from systems and are expected benefits.

This is logical – since 2020 the expectation for the next five years has halved from 30% to 14%. There is less opportunity left on the table now as miners have implemented digital programmes, and we are seeing a more reasoned, precise response based on their data, instead of perceptions.

Efficiency gains expected in the next 5 years

With fewer responses from smaller miners, we have focused on the comparison between those miners that answered both interviews to make valid comparisons.

In 2020 the selected respondents ranged between 20%-30% and >30%. Today this has fallen to 15% on average with very little variance. This time around the responses were based on experience and data – i.e., who could draw the data from their information management systems. The fact that just over half could not find the data and refused to guess illustrates the change in digital projects we discussed earlier in the study – they are driven by business cases and benefits are formally tracked now.

In some cases the lack of available data came back to the level of maturity of their data platforms – we expect this data to be more easily accessible in future studies as the platforms come online, many between 2025 and 2027 per our respondents. By way of example, one challenge in providing us with the numbers here, is the impact of advanced process control. One miner said they were struggling to answer as a 1% improvement in the context of a processing plant flows to the bottom line and can make an enormous impact despite being just 1%.

Cost reduction expected in the next five years

We are seeing the general adoption of digital in South Africa, but it is often limited for good reasons. Several respondents made it clear that in South Africa there are challenges that result in no digital investments at all – such as when the life of mine is three to five years from today. We have a lot of old mines reaching the end of their economic life, and the industry does not see the value in modernising only to close operations shortly thereafter.

This is exacerbated by the age and scale of operations – it is just not feasible or cost-effective to provide connectivity in many conventional underground mines. Those global miners we interviewed told us that their new mines are built with digital in mind and start out at 75% progress on their digital roadmap. So digital certainly provides measurable value – that is very clear from the effort put into new mines. It is more of a challenge to retrofit technology to our old mines, but that is not stopping our miners from using technology to maintain their competitiveness.

Similar to the questions above those respondents that could not take specific numbers from their systems felt unable to provide an estimate. Those that did respond were very precise – all within the 10-20% range. The average sits at 15% and these figures were tied to specific programmes, i.e., they were not estimates but represent expected returns on a digital programme.

Other category:

In the other category, the most important advances from digital programmes over the next five years predicted by our respondents were:

1. reduction or elimination of fatalities;
2. improved metal accounting linked to improvements in control and measurement systems in the processing environments; and
3. diesel particulate matter reduction.

Measure	Average
1. Cumulative throughput increases over the next five years by ___ %	14%
2. Total efficiency ___gain %	14% Mining Ops+ (1% Concentrator outlier)
3. Cost reduction over the next five years by ___%	15%
4. Improved safety over the next five years by ___%	30%
5. Other	Improved metal accounting, DPM (Diesel Particulate Matter) reduction or elimination of fatalities



Insight 4: Digital tools don't just measure, they contribute (the union perspective)

Key points covered:

- Digital has a real impact on health and safety
- Data & Tools help workers succeed
- Collaboration is required to implement new technology

Labour unions are key stakeholders in the mining industry and have a unique perspective on the value of digital and 4IR. The two unions interviewed have indicated that digital technology is essential in enhancing their health and safety, and it performs a vital role in communications. This aligns with the CEOs insights that emphasised safety and communications as an essential value of digital and 4IR tools.

The unions stated that there must be a balance between productivity and health and safety. In their minds, there is a strong link between digital transformation and safety – with real-time or near real-time communications, sensors, automated machine stoppages and safe zone monitoring with instant reactions in the case of an incident.

They emphasised that data can be used to improve the health and safety of the miners. They further contended that labour has a significant role to play in the implementation of the new technologies – ensuring that where the rubber meets the road there is practical benefit for all parties. One union emphasised the need for access to the real-time data to improve their productivity, health, and safety. Mining houses can use real-time data and analytics to improve end-to-end value chain systems by improving the performance of their workers while monitoring their safety and health. However, it is not all about productivity and cost savings.



Perhaps the most important aspect was enablement – two of the three unions felt that digital had another, greater purpose – and that is to educate and to enable. They spoke of tools that instead of measuring output in a period like a log sheet made digital, the tools can advise the workers, and provide them with insights and better ways of working given a specific set of circumstances. It has the potential to bridge the digital divide and provide workers with holistic solutions otherwise invisible to them – showing them how to succeed instead of just marking their homework.

The Unions expressed the need to use digital technologies as an enabling tool to resolve the current mining challenges. Thus far the new digital technologies have assisted them to organise themselves better, citing that during COVID-19 pandemic they were able to organise through using digital platforms. Digital transformation can help mine workers and their bosses to align and work towards the same goals we were told – here, the unions stipulated that mines could enhance collaboration and communication by promoting an open culture using technologies that facilitate communication and collaboration.

The union members asserted that the importance of data to them is accessibility. They need the information on time – and the ability to interpret it and immediately adjust operations accordingly.

However, the unions highlighted that the mining houses have not in their view done enough with digital tools with the exception of data and communication where they saw improvements during COVID-19 pandemic. They believe that there has not been enough work done to improve the new technologies to prepare them for implementation at operations – despite the advanced research and development going on at the mining houses. We heard examples from unions citing university studies on illumination and underground Wi-Fi, as well as discussing technologies that could improve the 'air purity' underground.

Insight 5: The imperatives for sustainability, and the crown jewels

Key points covered:

- What got us here won't necessarily get us there – the world has changed again
- Data is at the centre of business success and sustainability
- The mining skills mix will change over time as technology adoption matures
- Asset management leads the way as the greatest contributor of measurable value from digital programmes
- Miners do not need to be data scientists, and data scientists need to learn mining
- ICT infrastructure and data are more effectively re-used and the goal is real time information

What got us here won't necessarily get us there – the world has changed again

After seven decades of peaceful trade, the world is starting to de-globalise in 2023. China has entered a new phase of low growth and is struggling with a number of challenges – not least demographics – that have all but ended its run to become the world's largest economy. The USA is preventing Chinese access to high technology and rebuilding its manufacturing sector with large government-backed investments. Sanctions prevent energy, fertiliser, and food exports from Russia and Ukraine which will impact food security as far away as Brazil, one of the world's largest consumers of fertilisers.

We could go on – but the implications of a world gripped by food shortages and splintering into blocs is not one that miners can ignore. Nearshoring and friend-shoring mean that integrated trade blocs such as the North American Free Trade Agreement (NAFTA) will prefer to trade with one another or with friendly nations. Add to this the green metals premium and the move to a green economy – enough of a challenge on its own – which is already being questioned at Davos 2023 in the context of rising costs of living that are impacting the first world – never mind us in Africa.

We have less certainty about the future in 2023 than in many decades. Take one small example of supply chains – in the previous survey we heard that during the COVID-19 pandemic the supply chain assumptions that had worked for the previous decade had failed, and in this edition, we have heard of a unanimous move from just in time to more predictable ways of sourcing – which ties up more working capital. Spot price takers suffered while those that had the foresight to contract benefited from a guaranteed supply of raw materials.

Our miners are tackling this set of complex challenges head-on. A significant amount of groundwork has taken place since 2021 with miners establishing project management offices specifically geared to deliver climate change initiatives, energy programmes, and transformative technology projects.



“ No think-through of the business engineering needed to get value from technology.

Data is at the centre of business success and sustainability

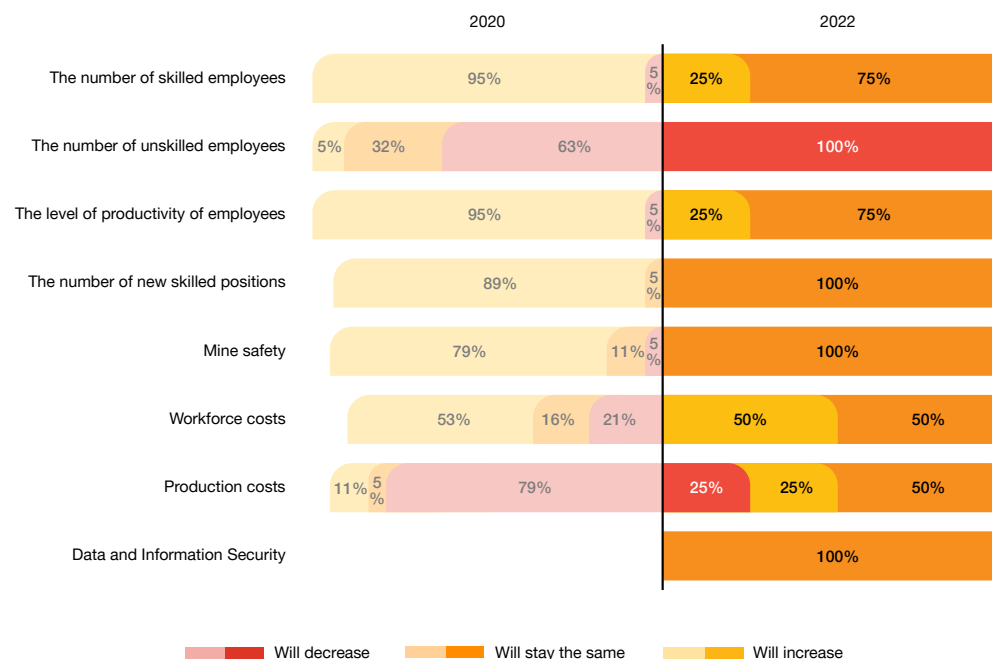
Data and information flow are seen as the most intensely managed part of mining over the next 10 years by our mining executives. Miners want to drive asset utilisation, drive decision-making based on data produced **at the site**, automate and integrate reporting (including ESG) and other functions to **proactively manage the business**. In order for one version of the truth to work, we need to trust our information (in real-time if we want to be successful).

This is a large shift from reactive management and requires a different set of skills. Mining needs **digital natives** that are tech-savvy and **embrace digitisation** to achieve production goals. To be **deeply data-driven** has implications throughout the mining value chain – and it starts with needing to attract those scarce skills to the mines or develop them in local communities as a long-term strategy. Several miners did indicate that we can use this technological approach to attract digital skills into mining – promoting mining as an employer of choice. This is not a view shared by all – some miners have told us they had to hire those scarce skills in urban centres so as to retain them – there is an issue attracting talent to the rural mines. This is not a unique problem for South Africa – Australia and South America have established remote operations centres to accommodate these new knowledge workers such as data scientists in cities far from operations. One copper miner in Chile has taken this concept to the extreme – even using their Remote Operation Center (ROC) to operate machines nearly 1000 km away in the Atacama desert.

Following this, several of the CEOs indicated that as we move towards **automation in approximately 10 years**, we can expect to see a decline in **human presence in the workplace**. Digital tools providing visibility will allow for better supervision done from the safety of a control room in a mechanised mine for example, so some of that labour is moving to safety.

The mining skills mix will change over time as technology adoption matures

Figure 2: Digital transformation on the workforce



When looking at the impact of digital transformation on the workforce (figure above), it is immediately apparent that there is an expected impact on the type of workforce required. This has been a common theme in both the current and previous studies.

75% of respondents believe the number of skilled workers will increase in the next five years. With the digital transformation of mining, we expect new roles to emerge that may not require traditional mining skills or may require traditional mining skills to be supplemented; this is also a widely held belief, with 75% of respondents expecting an increase in the number of new skilled positions. Furthermore, with 75% expecting a decrease in the number of unskilled employees, we anticipate an increase in efforts aimed at upskilling, taking advantage of technology such as Virtual reality (VR) and Augmented reality (AR). It is important to note that this is not necessarily talking about new workers – it is often about upskilling or using digital tools to educate and enable the workforce we have, as in the union examples discussed above.

Mining is expected to become safer as we move towards **Zero Harm supported by technology** and digitalisation in critical business areas. Tracking and tracing employees to gather data on shift cycles and work cycles will provide the data sets we need to optimise our ways of working. Plant processing is undergoing a quiet revolution as advanced process flow models supported by live data maximise our returns and margins.

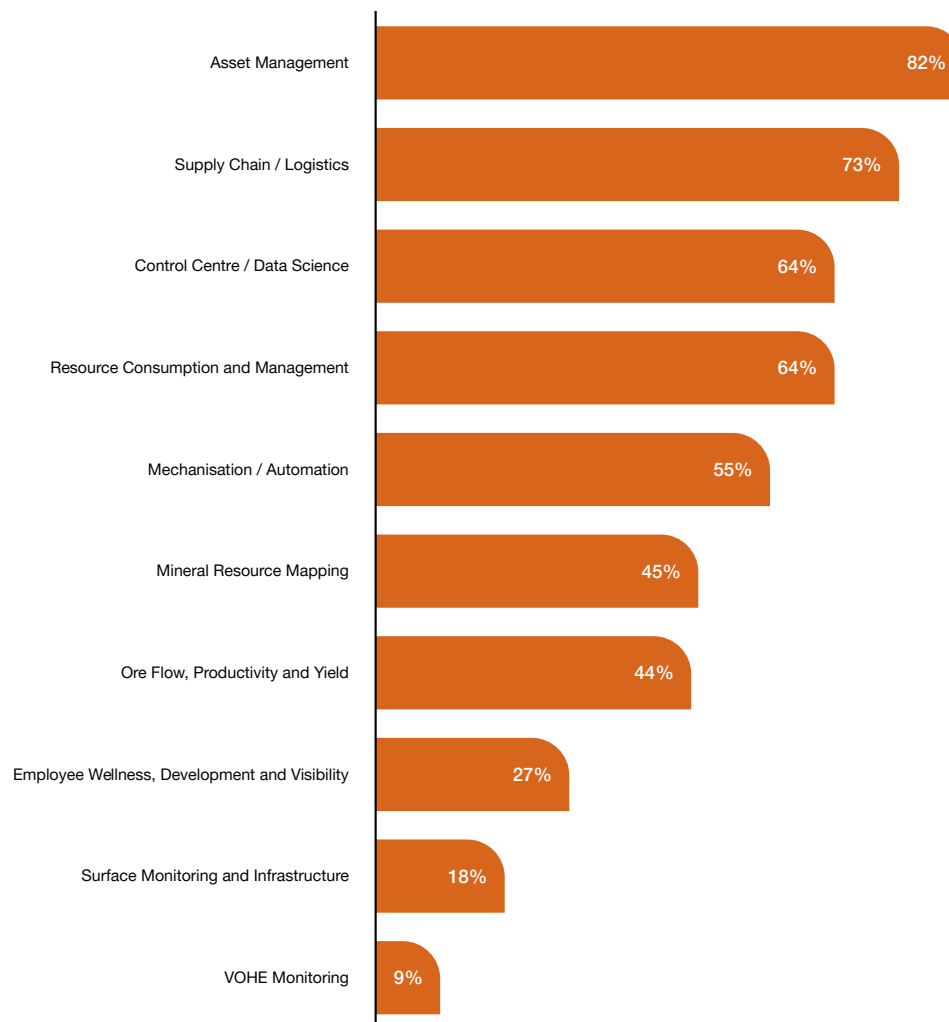
Some miners indicate that digital tools are improving their ability to define, extract and process the ore body – providing a competitive edge to offset cost inflation. It is clear though that our miners need breakthroughs not just in technology but in **water and energy** to remain competitive. The CEOs want to move people away from dangerous areas – so having the best possible low-profile equipment that limits people’s exposure to the face is critical, as is the move to mechanising mining where appropriate.

Progressive mining leaders see technology potentially changing the whole mining value chain, using technology to **discover new resources**, and **convert non-economic resources into economic resources in an environmentally conscious way**. Using digital technology to rethink operating models and discover new ways of mining is a topic on several mining group agendas. Many CEOs commented that we have not actually changed the way we mine for a century, and hold out the hope that technology will open up new alternatives and ways of work.

Following on from that concept – respondents clearly indicate that **technology must help mining solve climate change and decarbonisation**. This is not to say we must report on it better – society wants us to be safer and less impactful on the environment – if we are more efficient in the use of raw materials and resources we can lower the cost of operations and better leverage our resources. A CEO suggested that this would improve how people work – providing them with better work-life balance as a consequence of better management.

Asset management leads the way as the greatest contributor of measurable value from digital programmes

Figure 3: What are the dominant value drivers that are being measured?



When asked what the dominant drivers are being measured, we see that most of our respondents are looking for value in asset management (82%); followed by supply chain and logistics (73%). Asset management has grown in stature and value with the data it generates being utilised to inform real value-generating programmes – leading on from the Internet of Things (IoT) being the biggest investment back in 2020.

Data science and control centres equals resource consumption and management at 64%. This reflects an increased focus on our ability to use scarce resources (water, electricity) efficiently and effectively. The data science portion shows the increasing importance of the digital data gathering platforms themselves in the view of miners, several of whom believe these platforms themselves to be the most valuable asset stemming from digital and 4IR.

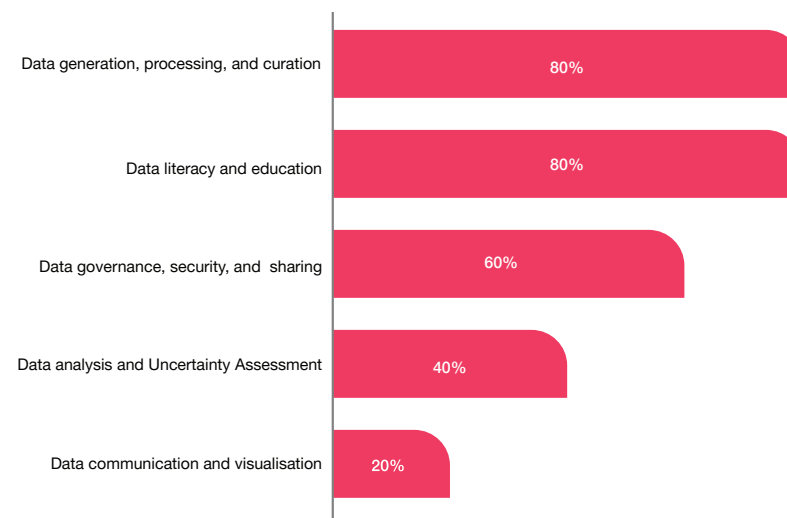
Mechanisation and automation are next – we have heard of automated drilling programmes becoming more prevalent in mining, and we heard from the executives that mechanisation is a key option to extend the useful life of South African mines. It is important to note the divergence between open cast and conventional mining here – automation in the context of the drilling example above will only emerge in conventional mining in around 10 years according to respondents. Similarly, automated dump trucks are starting to emerge in open cast, but as yet no underground equivalents are seen as commercially viable.

Mineral resource mapping benefits from new and emerging technologies and can change the fundamental economics of a mine for the better. Ore flow, productivity, and yield (44%) are seeing benefits but have decreased in overall importance relative to asset management, supply chain and data science in this study. Employee wellness development and visibility are now prevalent across most mining companies to some extent. It is non negotiable for South African mines, but this illustrates the relative increase in value identified from other areas since 2020.



Miners do not need to be data scientists, and data scientists need to learn mining

Figure 4: Top challenges in implementing Data Science and Data Management



Data generation, processing, curation, literacy, and education are the most difficult challenges in implementing data science and management in mining operations. As observed in the previous study, data collection and management remain a challenge in mining. The future reliance on real-time decision-making emphasised by leaders appears at first glance to necessitate a workforce that is data literate and capable of contextualising the data and information received, supported by scarce skills that do not want to live out in typically remote operations.

The flip side of this view is that some mining leaders think we need to focus on communicating only what is important to the worker there and then – i.e., context-sensitive data bytes that make a real difference. Arguably, we do not require scarce skills to read and act on the data – we need miners. The challenge is to provide workers with the right information at the right time to help them in their present situation. This links back to the unions' digital success stories – by providing the worker with the context they need to make the right decision and advising them in terms of options – we grow our digital workforce. The data scientists' role is key in terms of management of data and turning that into actionable information, but they will not be replacing miners. We see these as complementary skills – not in opposition to one another.

Data governance, security, and sharing of data are viewed as a challenge by 60% of respondents. This is a similar finding to the previous study. Mining companies are more trusting of data that comes from trusted sources, such as SAP, because those sources have better governance and security, and the data is less likely to be manipulated. One mining company stated unequivocally, **“no more spreadsheets, fully integrated SAP”** as their biggest step towards a single point of truth.

Mining executives told us that what they want from digital technology is to be **more efficient in allocating and deploying capital**. Using data to deploy capital efficiently is the goal. To do so, some CEOs indicate, we will have to digitise and digitally integrate with other industries on which we depend – such as farming, rail, water, and municipalities to truly optimise capital efficiency. Many miners already integrate with Transnet and the ports, so we are familiar with the concept of external operational technology integration – the challenge is to do the same with universities, farms, water suppliers and communities to ensure that we work in harmony and do not create unexpected disruptions to supply.

ICT infrastructure and data are more effectively re-used and the goal is real time information

We asked the ICT executives and CEOs how they are combating the business silo and/or shadow IT effect, and how they are ensuring they incorporate the learnings from the past in their current decisions.

The CEOs goals are on-time, real-time data availability. They told us that investments are in place and that the capital budget for it is increasing.

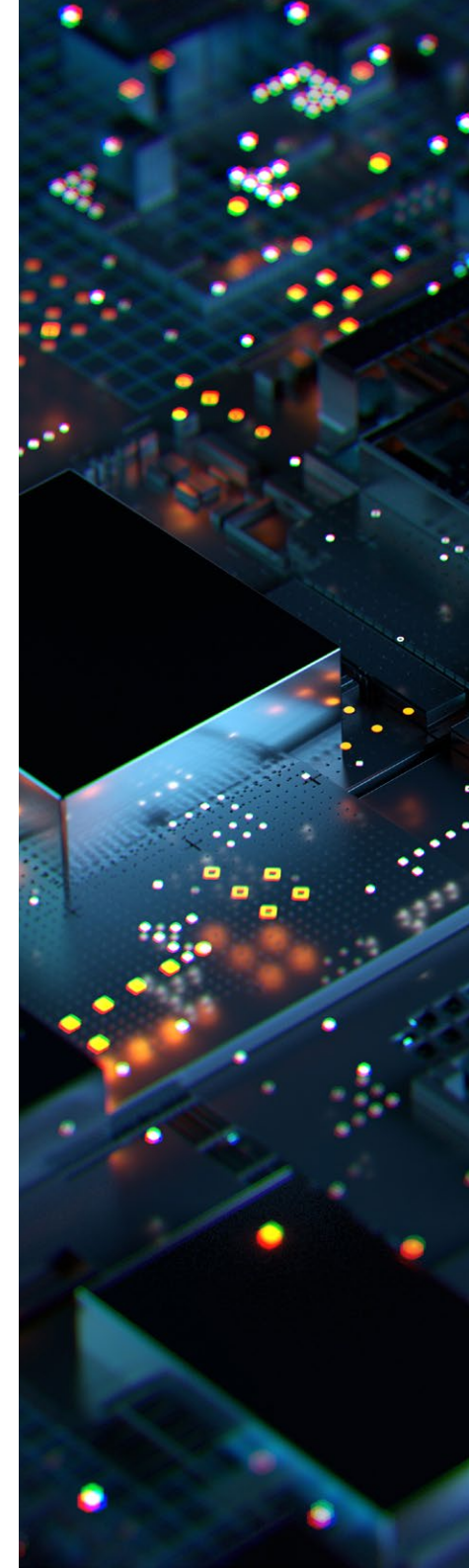
More than one respondent reiterated that their strategy for ICT is being driven by skills availability and location. Several respondents have responded to the skills situation by accumulating those scarce skills at an urban location from which they can provide remote support while minimising the need for travel to sites. We are seeing these support centres as far afield as Stellenbosch – which speaks directly to the fundamental issue of attracting technical skills to the sites in South Africa today.

At the same time, we are seeing a greater need for these skills at the sites – the benefits of monitoring mining systems, processes, and operations from a centralised control centre are clear as they improve performance while removing people from dangerous areas. It has been noted that this will be a challenge due to the unwillingness of technical graduates to live and work at the mines, and it is not clear to those surveyed if the remote technical team approach will work effectively or introduce further problems.

From a chief information officer (CIO) perspective, our miners are talking about improved governance, using tools like an enterprise architecture board (and or project management office (PMO) in some cases) to think through new systems before they are implemented. They are asking where they can re-use infrastructure, and where they can share services across the business. This could lead to standardisation of applications and the adoption of key platforms to reduce the complexity of duplicate systems and applications for mining operations. Benefits such as economies of scale for licensing, standardised support services for standard applications in both the production and operational environment can reduce the complexity of running multiple technologies and processes across different operations for the same mining entities.

From an analytics perspective we heard about several different approaches – from self-service analytics platforms where there is a higher expectation of staff and management analytics capability in a large, diversified miner, to an emphasis on minimising the information presented to personnel – i.e., just what you need to know right now – in more operationally focused operations. The latter approach calls to mind the short interval control paradigm and speaks to a focus on getting the operations cycle right with hourly check-ins. The former speaks to the future world of work in the sense that it empowers management to make decisions based on data and helps them to challenge the way we work at a macro level.

Don't get the idea that this kind of approach is pervasive – only 45% of respondents have a plan in execution to ensure they are getting value out of their data, and of that 45% only one third have designed a program that is actually underway today. The others discuss wanting to move to a more homogenous system environment or call for a single business strategy supported by digital and technology enablers. We read this as **‘still thinking about what it practically means’**.



Insight 6: We are up to the challenge & have the tools we need to win

Key points covered:

- South African miners are not satisfied with progress in digital and 4IR transformation since 2019
- Adoption remains a challenge and the traditional mining process persists
- We need one voice to enact real change
- We are all feeling anxiety as we address South Africa's challenges

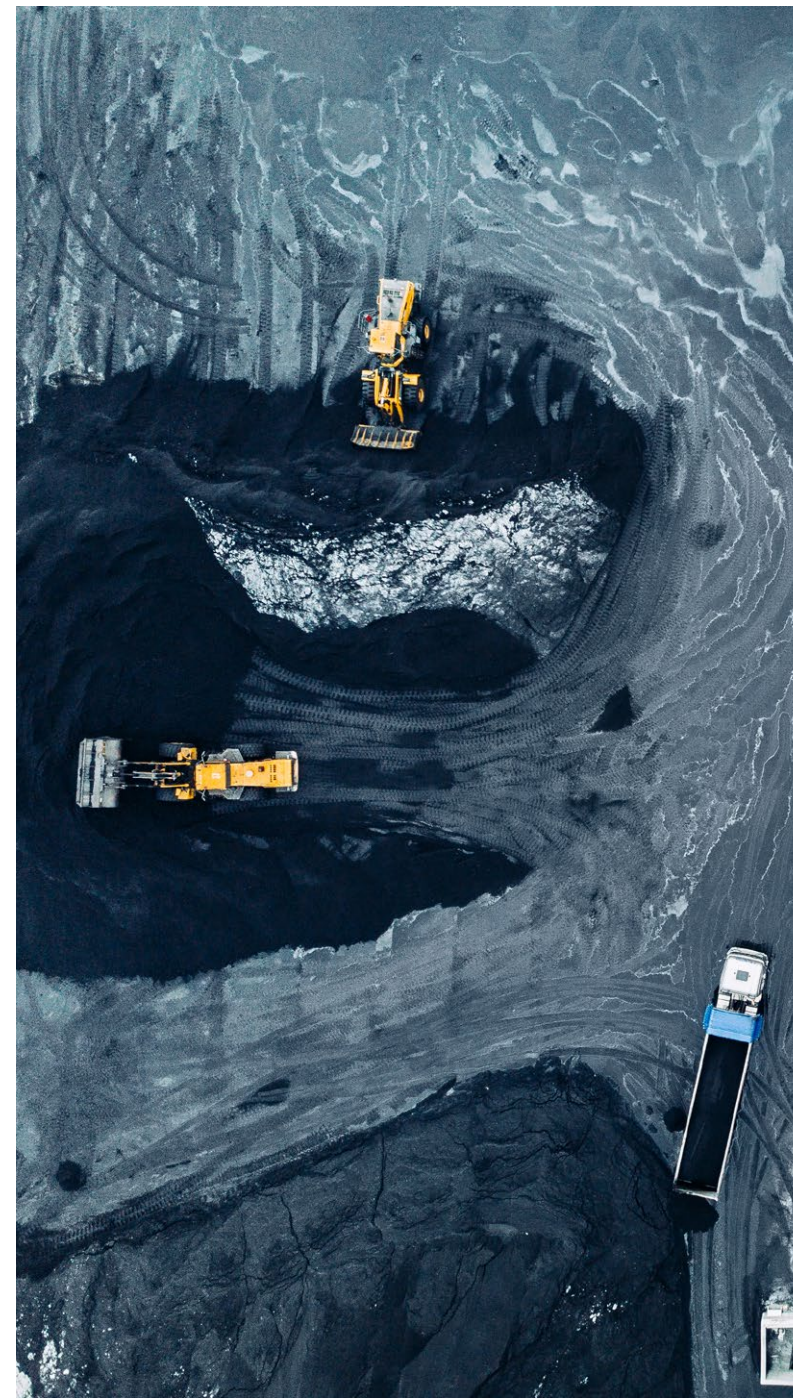
SA Miners are not satisfied with progress in digital – there is more to be had from the 4IR

South African miners are not satisfied with the progress in digital and 4IR transformation since 2019. The CEOs agree for the most part that the past three years have spurred on the development, use, and understanding of technology in the mining space, but unanimously agree that we could have done better. Miners are struggling to quickly consume information. It must be in a form that is quickly consumable by leadership. That search for a practical way to generate information that is accurate, consistent, and easily read is non-trivial.

Leaders agree that mining worked through the COVID-19 pandemic innovatively and eloquently compared to other industries and that the pandemic accelerated thinking toward 4IR technologies and tools. A quarter of respondents regard South African mining as lagging compared to its peers in these key areas:

- Safety** is a major issue with fatal accidents (at around 108 per annum) 50% higher than the global mining average among the International Council on Mining and Metals (ICMM) members.
- Operations are still **'archaic'** – people-dependent, behaviour dependent, and nowhere near autonomous decision making which would be aided by digital transformation.
- OEMs are being **slow in adopting** 4IR technologies such as proximity detection and other safety systems which should be offered along with the hardware and equipment in their opinion, i.e., it should not be left up to the mine to procure and integrate.

“ We have spent the last three years gatekeeping and getting people to go to work and get to the face for production



Internally, we struggle to generate actionable information that is quickly consumed by leadership (consistent, accurate, easy-to-read information, for decision-making is key in this regard). It is immensely complicated to distil the information down to short, meaningful pieces that are useful in a specific context.

New tools like artificial intelligence and machine learning give us the ability to make sense of huge amounts of data through data management and statistical analysis, linking behaviours and systems, and looking for interdependencies such as mining with a complex ore body. Advanced process control and online measurement, predictable plant performance, recipe optimisation in processing, and adjustment of control systems can transform processing environments. Insight one noted that miners are seeking these advantages, but they aren't yet within reach for most – hence the comments about data-driven decision-making platforms maturing by 2025 to 2027. These are complex data models and it takes data and time to start achieving meaningful results – and that is only after you have identified the correct data to include in your model.

Miners are not short of ideas on how they could get more out of their digital and 4IR toolkits. We have heard of miners linking information between planning and production – for instance, the drill could measure penetration rate and automatically link that data to rock hardness in planning. New drone mapping tools can scan and map complex 3D spaces in real-time even underground, and then compare the actual to the planned model – obtaining accurate survey data more frequently at a lower cost. Blasting accuracy and fragmentation, high wall maintenance, and safety calculations based on real-world events such as rain are making pits safer and more efficient.

Some South African miners focus on using 4IR in safety and intelligence – i.e., using it on social platforms as an indicator of community unrest to enable proactive management of the situation. This has proven to be effective at providing advance warning and proactively avoiding incidents.

From the interviews, we learned that many miners want to collaborate but feel they lack the mechanisms to do so. They say we could be collaborating to save on 'school fees' and collectively benefit from experience in the technology space, and they also think they are not collaborating enough outside of technology in addressing communities.

One clear reality that emerged was that mining cannot do it all alone – we need supporting ecosystems around mining to support transformation such as manufacturing facilities, service companies, and the skills and technologies to operate and run them effectively need to be in place and sustainable – i.e., it will require incentives from the government and the setup of appropriate business incubators.

Adoption remains a challenge and the traditional mining process persists

We still get the sense from a handful of miners that they are not yet able to get the best out of technology adoption. In their view, the mining process itself is ignored and nothing is done to change the traditional mining process because digital transformation is perceived as “eating up production time”. Without enough internal mature capabilities in the digital space, these programs drive dependency on external experience which in turn complicates change management and adoption of technology.

At the CEO level, we were told that South African miners are utilising the 4IR suite of technologies primarily in these three areas:

- **Safety** (real-time data around working operations, the visibility of anything that happens in the organisation, safety officer reports, and improved workplace annotation).
- **Projects** such as **digital twinning** (visibility around assessing feasibility of projects, use of drone technologies for accurate incremental billing in construction, optimisation of physical assets).
- **Processing** (automating and digitising processing plants).

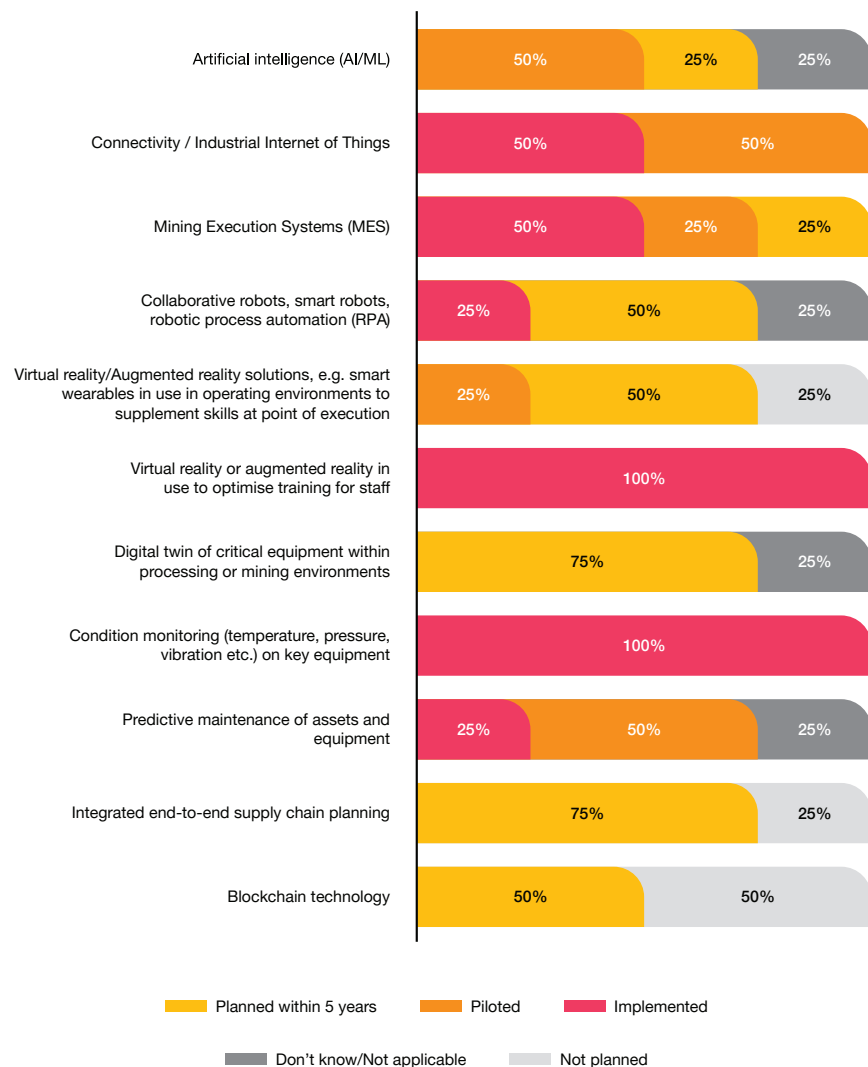
When we asked to what extent the following technologies had been implemented, piloted, or planned within five years we found two clear areas of success – Virtual Reality (VR) and Augmented Reality (AR) to train staff, and condition monitoring within asset management.

Asset management has transformed due to the availability of data and provides measurable returns to our miners. The prevalence of AR/VR training tools greatly emphasises the use of digital as an educational and enabling tool and directly impacts on job safety.

The Industrial Internet of Things (IIoT) is noted by half the respondents as having been implemented already and is in the pilot phase with the other half. This reflects the process of adding data points to the business and supports initiatives such as asset management. Modern real-time photogrammetry tools and 3D scanners are being added to the network and have the potential to provide mines with additional points of measurement i.e., a point of truth in the value chain. Many of these more complex system-oriented sensors are still in the pilot phase, but promise to help us close the loop for fully modelling our mining environment in the digital space.

Predictive maintenance is not yet pervasive with 25% of the respondents having implemented predictive maintenance and 50% piloting and testing new solutions. This is still a challenging area, as observed in the previous study, as predictive maintenance is dependent on the availability of sensors, data infrastructure, real-time data collection, and OEM **partnerships and collaboration** (the latter being highlighted as a challenge by respondents, with one mentioning that they are “Not sure if OEMs are playing ball or are just slow in adopting 4IR technologies”). Another told us that “partnerships and/or collaboration with OEMs and the mining industry are crucial to technological advancement within mining.” At the heart of the problem is access to data – and it will require a different level of engagement with OEMs to make more progress or the rise of ecosystems of service businesses outside of mining that can deliver turnkey solutions on OEM equipment.

Figure 5: To what extent have you implemented the following technologies within your company?



“ No think through of the business engineering needed to get value from technology

We need one voice to enact real change

In general, our miners feel there is a bad perception of how mines operate, poor legacy, and taking profits without restoring the environment. The good that mines have done in terms of supplementing and even in some cases supplanting municipal services is not recognised by the public, and this has given rise to the expectations of mining to do even more – ‘unrealistic expectations’ in the words of several respondents.

There is a need to define modern mining in the right context – the South African context – and sign it off with the right social partners including labour unions, communities, and regulators to prevent the perceived scope of mining responsibilities from continually expanding to fill the spaces left by municipalities and government. When asked how mining could do a better job of ‘marketing’ the good that we do for communities and the country the miners said we need to speak with one voice – not quietly deal with our issues in isolation.

The chosen medium for this outlet would be the Minerals Council of South Africa as the trusted face of South African mining – this was echoed by all the respondents. Furthermore, the labour unions and a couple of the mining companies indicated that technical challenges could be better resolved through the combined and collaborative efforts of industry with entities such as the Mandela Mining Precinct.

We are all feeling anxiety as we address South Africa’s challenges

Perhaps the biggest challenge we face as South African miners is acknowledging that due to our pervasive issues with energy, rail transport, water, security, and port facilities, we are simply less attractive for international mining investment than other international destinations.

The lack of political will to deal with crime – especially organised crime around cable theft and illegal miners; the failing legal system where we lack effective coordination between police, intelligence, the justice system, and prosecution; social and digital tension as we transform into new ways of working; all of these factors loom large in the thinking of our mining CEOs.

This is an enormous source of anxiety for our miners, who cannot just be concerned with normal business realities like their global peers. We face the need to get involved in South Africa to keep the lights on – literally.

In reality, South Africa is busy privatising a lot of its infrastructure by default as municipalities and local governments fail to deliver. Our mines hold the fabric of rural South Africa together to some extent. They provide services like water and help to keep the roads functioning. Not surprisingly our mining leaders think the solution is to let businesses participate more aggressively and commercially in the management of infrastructure. Business can bring competence, global perspectives, governance, innovation and forward thinking that the government lacks.

South Africa needs practical policy formulation that puts employment at the forefront. And that policy would have to be preceded by a serious government that addresses South Africa's truly enormous obstacle to progress. At this point, it is clear that it would take more than a decade to repair or replace our generation capacity. At the time of writing this report, we are told that stage six loadshedding will continue indefinitely, or it will end in 6-12 months, or it will persist for a decade as capacity is built – all from different government sources that appear to have conflicting views.

Despite this, mining is one of the few industries left in South Africa that might just keep the lights on. It is our mining industry that is building capacity while Eskom struggles to address the energy crisis, and it is our mining industry that is providing potable water and economic life for rural South Africa. This is not an easy leadership role. We cannot expect the mines to take over government functions – a great example being post-mine closure economics in rural hubs which is a long-term government role.

It is clear we need to agree on the roles played by various stakeholders going forward and we need to hold them to account. Digital has a role to play in how we can accomplish that goal – one suggestion from our mining community is to digitally integrate the systems to coordinate the flow and consumption of energy and water, to manage it minute by minute, and ensure it performs to the requirements of each stakeholder.



Mining skills are behind, we need skills to drive new business models

– Mining CEO

Regulations were selected by one respondent as their number one challenge – in their eyes, safety, and regulation are linked and we need strengthened regulations to 'force' long-term thinking – i.e., sustainable activities.

Another selected the cost of labour – stating that South Africa was 'losing its competitive edge on the international stage'. High levels of unemployment drive civil and community unrest which poses security risks to operations. Another told us that proper education and a responsible approach to optimise for value (but not at the expense of communities) were required. These feel like requests for a new social contract. Do we as a country need to sit down with stakeholders and set rules and expectations with everybody?

In economics, the market is the mechanism to allocate capital efficiently. People are rewarded according to what they contribute in a perfect world. But does that mean we should ignore people that aren't in the market? Do we need to start with upskilling the workforce and making them of more value to the economy, i.e., more suited to the jobs that exist today?

When we asked these difficult questions the CEOs discussed working together through a common industry body – the Minerals Council – to effect change. They also talk about the integration of the worlds of mining, bulk water, energy, transport, education, and labour. These are formidable goals and cannot be addressed in isolation by miners. Given the issues we face as an industry and the somewhat tone-deaf approach of the government, should we take the initiative?

When it comes to making South Africa work and grow its GDP, mining may be our best route to surviving the impact of the country's unsustainable economic trajectory over the next decade. They are leading our country in a sense – predicting energy needs and building capacity in generation, addressing core social issues with communities, investing in the safety, and security of our export value chain, and so on in the course of business. Miners stimulate the rural and export economy and make a difference.

By contrast, the recent actions of Transnet including the threat of giving rail capacity used by South Africa's largest exporters to emerging miners seems to have no economic business case for it according to mining leaders.

Some mining CEOs see this as Transnet 'throwing big businesses under the bus'. This is galling after the work that mining businesses have put into secure rail. The private sector has invested millions towards security services and systems around our rail infrastructure which has led to a 50% decrease in security incidents after the government failed to invest in security. They have spent hundreds of thousands of rands improving logistics processes to streamline them.



All of the above issues will impact our ability to digitally transform our mining industry and embrace ESG to its fullest extent in a positive way (mandatory vs. voluntary) and we are aware that these other stakeholders are struggling with issues not relevant to the mining industry – like cable theft, vandalism, and community unrest which have impacted Transnet.

For human resources to support the business with building and developing the skills of the future, miners need to ensure that the organisational structure as well as the management roles are put in place and aligned with the company strategy. Visioning for the future requires specific skills to be in place to support the transformation or it will not work.

So, it is very clear that we require a very agile talent management framework to support our business strategy. The business model should be such that leadership capabilities and competencies are aligned with the organisations' strategic objectives. We have to ensure that we have leaders who will drive succession, career development, and talent attraction and retention. To put it plainly, we need leaders with the requisite emotional and intellectual capacity to deal with a changing world – able to test and renew assumptions, able to absorb large quantities of information and demonstrate ambidexterity in terms of complexity and plurality management.

That can be a challenge – we have heard from miners that one of their biggest challenges is to attract young, technically skilled workers to operations. From data science to application developers, there is a reluctance to work out at the mines. This is generally being addressed by onboarding the correct skills in an urban centre, usually the head office, but in one notable exception located in Stellenbosch with access to the university skills base. The current high asking price for technical skills was noted as an issue – mines need to consider a premium given their typically remote locations.



Insight 7: Mining is about people – and we need to fight globally for talent

Key points:

- Leadership is key, while culture can replace scarce skills
- Google, Tesla, and SpaceX are competing for the skills we need in mining

This is an important point that the leaders reiterated during the interviews. Resistance to change is a large issue for our miners, and one CEO went so far as to say that we need changes in leadership to be able to operate in a digital environment because:

“ Our leadership and workforce of the future are not in sync with the changes digital is bringing to mining. ”

It is certainly not an issue that miners can deal with in isolation. The future of work, and what changes need to happen to deal with modernisation at all levels (school, university, workplace) involves a wider set of stakeholders in South Africa. It was interesting to note that the majority of CEOs bemoan the lack of cooperation between mining houses in this respect – with each having their own future world of work concept.

Within one mining company, we are told that leadership-required capabilities have changed. They see the younger generation getting appointed to leadership roles sooner than before. When asked what is driving this we were informed that it is the ‘bad reputation’ of mining. In short, fewer graduates are coming to the mining industry, and out of a smaller talent pool, people are promoted earlier in their careers.

Digital is also bringing leadership into a new space – providing real-time data that make the jobs easier to manage while holding people to account. One respondent called this the ‘don’t impose’ – let them find it’ approach – but did add that while effective, this approach was, in his words, ‘a bit slow’. We did get a lot of praise for this approach from several unions – who emphasised that the value digital brings to supervision and management is that instead of just holding you to account for hourly targets, we are seeing the rise of digital tools that suggest the optimal ways to achieve or exceed the target, i.e., they educate and expand the capabilities of the workers in real-time.

One union provided the example of a 15-year digital transformation at their mine – which today stands out as a very successful example of technology implementation – where they achieved the entire transformation with the same team, i.e., they didn’t have to hire people with special skills – they instead used the educational power of digital to provide the staff with the knowledge they needed. Over time this has developed all their teams’ skills in terms of short-interval control and the use of digital tools. So one of the best examples we heard stood in direct contrast – and they didn’t go get scarce skills, they didn’t hire external Subject Matter Experts (SMEs), instead, they digitised the mine and developed their capabilities as a team. This goes to show how powerful the right culture can be.

Our mining houses are ‘future skilling’ their current and future leaders and creating that needed pipeline of internal skills because the tools we will use in the future to run the business will be different. The ability to understand the data and details of what’s happening in the organisation will change – and systems need to highlight problem areas and outliers. Our respondents tell us that with so much information we need to create systems that provide for management by exception. This is a key area of focus for leaders of digital programmes – they are working to understand where that balance point sits – an iterative, time-consuming process.

It must be noted here that this is the primary driver for our respondents saying they want to collaborate and work together through a common forum like the Mandela Mining Precinct. Standards will make this iterative process a lot easier and more transparent, save miners time and effort and create a consolidated skills base around agreed technologies from which the mining industry could draw skills.

In order to sustainably over the medium to long term address mining’s human resources constraints we need to change the courses offered at universities and technical colleges to reflect the skills needed at the mines. Our respondents noted that we must either get existing students to travel to the mines, or we need to build skills capacity in the communities where we mine and offer them bursaries. The challenge is to build a reliable pipeline of future skills that will provide us with people that are willing and able to live remotely at the mines.

We are struggling to attract engineers to mining shafts as a whole based on this survey feedback, so much so that it dictates the approach to even systems provisioning – with one respondent citing that their central systems provisioning approach was dictated by the ability to concentrate scarce skills.

From an engineering perspective 4IR does help with optimising engineering practices, and is especially useful in terms of visibility of information. A common concern here is the ever-increasing speed at which business value and outcomes must be delivered in order to match expectations.

Google, Tesla, and SpaceX are competing for the skills we need in mining

To further explore the desirability of the mining industry to young engineering and technology graduates we looked at the student survey run by Universum in 2022 with 9192 engineering and technology students.²

Top preferred industries include education, banking, hospital and healthcare, legal services, management, and strategy consulting. The top 10 most attractive employers were:

- Transnet
- Sasol
- Microsoft
- Google
- Tesla
- Eskom
- BMW Group
- SpaceX
- Amazon
- Anglo American

Only two mining company appears in the top 10 most attractive employers for engineering and technology graduates in South Africa with tech companies taking half the top 10 spots. We are therefore not competing on the local or regional stage for our graduates anymore – we are competing in a global marketplace. The global options further offer remote working by default – making them attractive to younger people ‘with a social life’ as the five mining and technology graduates we further interviewed told us.

From a preference standpoint, our graduates are looking for some interesting values from their prospective employers:

- ethical standards;
- professional training and development;
- leadership opportunities;
- respect for its people;
- security of employment;
- a friendly work environment;
- inspiring leadership;
- a good reference;
- high future earnings;
- leaders that support individual development.

We built on this by interviewing five young mining engineers within PwC to ask them why, given what they studied, they are not working in the mining industry. We received some unexpected answers.

Firstly, there are limited opportunities and positions for mining graduates available in the mines – the group we interviewed told us the majority of their peers that did enter mining did so as ‘general workers’ with the intention of working their way up into mining positions. One of the graduates interviewed told us the industry was ‘tricky to penetrate’ due to the mining companies’ preference for taking in bursary students that effectively are contracted for a length of time. ‘Too much red tape for too little improvement’ was a theme here and one graduate pointed out that the red tape between you and promotion is formidable – giving us the example of having to get permission from their superiors to write exams to get a promotion as the reason they had to leave the situation.

Secondly, the curriculum exposes graduates to different ways of thinking – with modules such as investment, politics, and law. It is made clear that there are opportunities for mining graduates in other industries as well. In fact, they said there are many opportunities to expose graduates to mining without being a mining engineer at a mine.

Thirdly, several graduates mentioned that working at a mine limits your exposure to work done in the rest of the mining value chain. Specialisation is seen as a negative – i.e., becoming a specialist in a field is seen as closing them off to other skills in the value chain – as well as emerging opportunities, new technologies and innovation, different types of work, and travel opportunities to other projects or mines. They do recognise that the growth rate of your career in mining is initially quicker and more versatile than corporate – along with higher initial pay – but the ladies in the group mentioned that this persists only until you reach the glass ceiling where you may remain in the same salary bracket for a long time. The advantage of the corporate environment is that you start from ground level but you are less limited on the up-side, they told us.

The fourth one is a culture shock – and difficult to hear. Universities are teaching 4IR and new technologies, but the mining environment is still lacking significantly – the gap between university and mine is ‘shocking’ and many young people struggle with that. They also do not enjoy the hard labour requirements as they would rather lift with their brains than their knees. The comments also extend to mental health. Euphemisms such as “mentally challenging” mask a notoriously toxic work environment. In one graduate’s words – “young people will simply opt out of mining because of its toxic nature”. Part of this is the ‘boring’ mining town issue – ‘dirty, potholes, and heavily underdeveloped’ – but the worst aspect is behaviour. This is graduating but still being told they “do not know anything about mining” when they go mining. They cannot tell a mining foreman or miner how to do their job better when they have been in those roles for decades. The culture of mining is rough – and the requirement for a ‘thick skin’ to tolerate the remarks made about the mining graduates is not acceptable to many mining graduates.

The fifth insight the group gave us is that in recent years there have been concerns over job security in mining – specifically in the mining of metals such as platinum that have, due to Industry 4.0 been replaced by other forms of catalytic converters or alternatives in automobile production and industry. Coal has similar issues – the studies around job security are not encouraging for young people looking to begin a career.

The last insight is about the nature of the work itself. While they are trained at university to think like engineers – qualitatively and analytically – in mining these behavioural competencies can only be applied to a certain extent – such as in mine planning and optimisation, or areas like mine ventilation and climate control. Planning, drilling, charging, blasting, cleaning, and hauling are routine – it is not intellectually stimulating to engineers. Some graduates want more than an everyday, same-sequence job even if it is highly paid. It must be competitive and intellectually involved.

² Universum ZA, 2022 “Universum the most attractive employers in South Africa, students rankings 2022” Universum ZA, 15 February 2023. <https://universumglobal.com/za/students-rankings-2022/>.

Insight 8: ESG – critical for business survival or tick-box?

Key points:

- Preparing for the big ESG
- ESG drives strategy, but the application is fragmented
- **ESG is more than good intentions** – those serious about ESG add it to KPIs

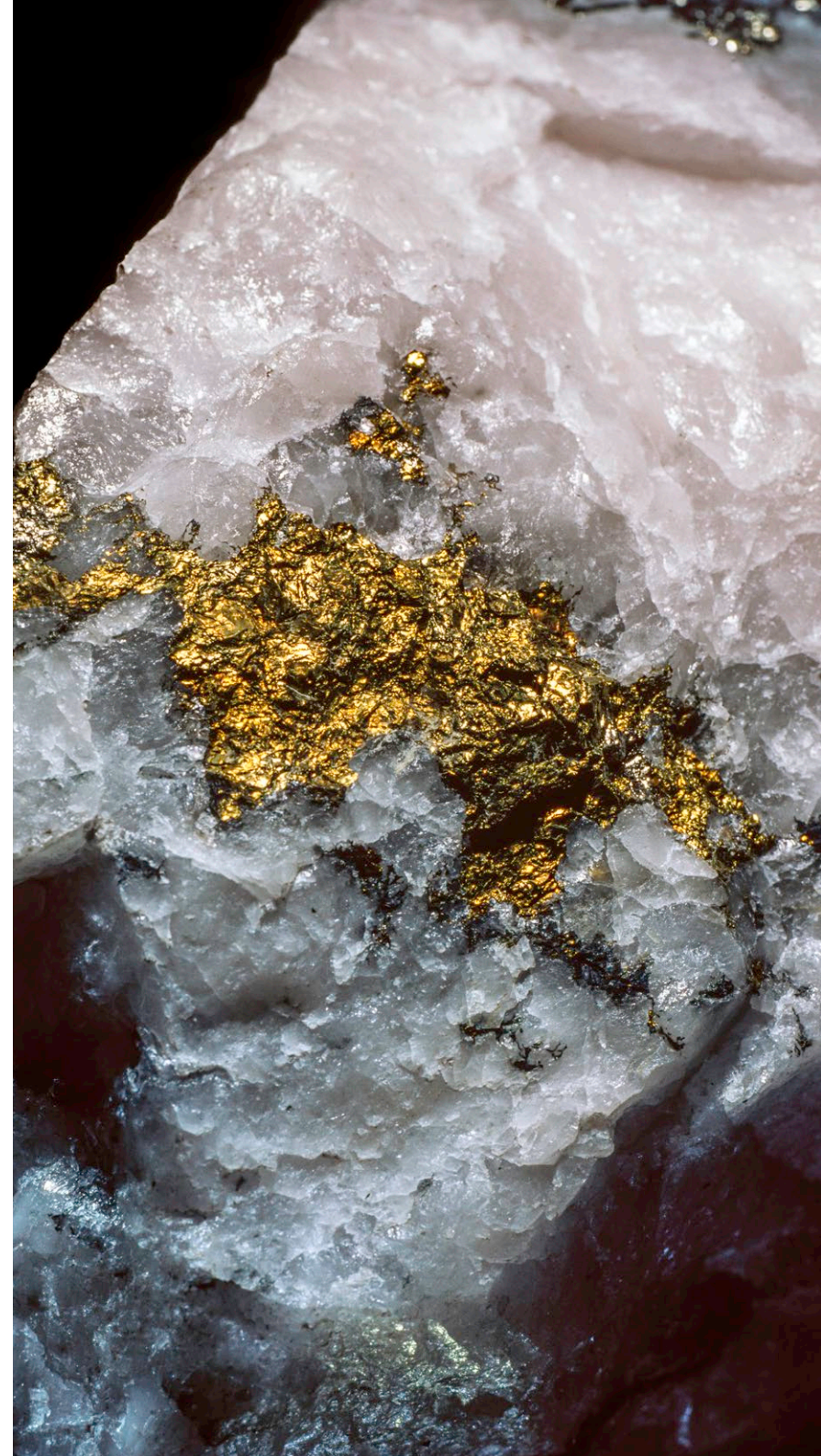
Preparing for the big ESG

While “ESG” may be one of the latest buzzwords related to business and sustainability, the response to environmental, social, and governance drivers is not in any way new to the mining sector. However, the way in which mining companies in South Africa need to engage with these drivers is changing. That requires a fundamental rethink in terms of the risks and opportunities presented by these drivers and the underlying system changes they demand.

When we asked respondents how they have had to organise themselves in response to ESG they came back with several distinct views on how to practically deliver on ESG, and how to embed it as a strategic driver:

- One of the respondents highlighted that delivering an ESG strategy starts with the right structure and resourcing. Although their perspective was more focused on the social pillar, it gives a view of how the correct structure can enable and provide for the detection and management of social risks associated with social performance, security, and human rights. There is also a view that building strong relationships with local businesses is a practical driver for delivering your ESG strategy.
- Another view highlights that being a part of international societies/councils where best practices are shared and applied by member companies, goes a long way in driving the practicality of delivering on ESG imperatives.
- Reporting to management helps to drive the process forward practically for all respondents, i.e., reporting on it has resulted in changed behaviours we are told by the majority of miners. This is further supported by accountability from the management team and board of directors, either through reporting lines or remuneration structures which embed delivery even more.

While for some organisations, there might be a direction in terms of how an ESG strategy can be practically delivered, one respondent indicated that for their organisation, the structure is still a bit loose and that they are becoming organised by necessity. They further added that this is still the beginning of the journey for them to meet the world’s changing expectations, adding to the complexity of using and understanding different reporting frameworks.



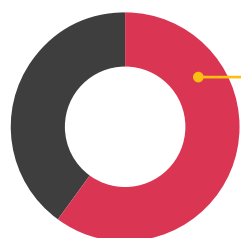
ESG drives strategy...

The business and its ICT environment is continuously being challenged due to ever-evolving reporting and ESG requirements. According to our interviews, this is made especially challenging when the environment, social, and governance levers, and their functions are managed in silos. Mining companies are focusing on specific requirements associated with each of these pillars – driven by changes in output requirements. We have heard that this ‘compliance-led’ approach is complex and difficult to manage.

The majority view was that as a result of the silo problem businesses need to actively avoid the temptation to view ESG in silos and just for compliance – the way to truly tweak the levers of future value in your favour is to adopt an integrated value-led approach.³ ESG is recognised as having the potential to add risks or opportunities to your business – getting this wrong can pose an existential threat, but getting it right means competitive advantage and suggests strategic differentiation.

Our study found that mining companies do see ESG as a driver for a corporate business strategy with 86% confirming that ESG is embedded in the organisational strategy. However, organisations differed in how ESG was integrated.

PwC’s Executive Pulse Survey taken in January 2022 shows that executives across the globe regard ESG and sustainability as integral to long-term planning in 2022.⁴ From our study we find that to be even more the case for mining in South Africa with >80% regarding it as a critical element of business strategy going forward.



60%

Executives say digital transformation is the most important growth driver in 2022. 60% of executives say that ESG and sustainability will be integral to longer-term planning in 2022.

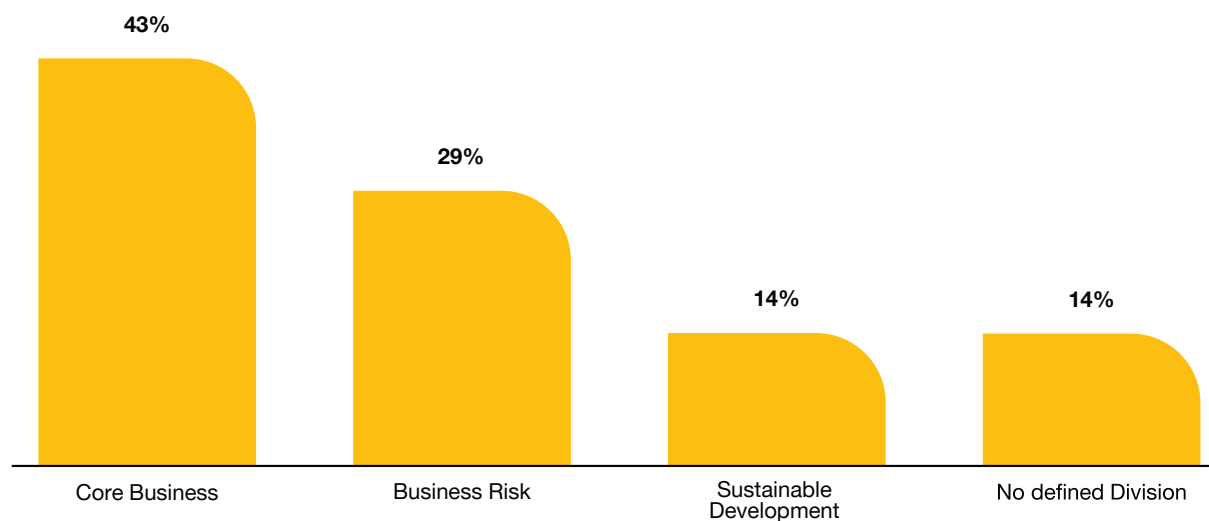
...but the application is fragmented.

We asked where ESG was housed in the company functions and received a variety of responses:

29% of respondents highlighted that ESG issues are incorporated into the business risks while 43% of respondents indicated that ESG is part of the core business strategy and organisational operating model.

14% view ESG as a measure of sustainable development as informed by value overlap from the E, S, and G pillars; and the remaining 14% are of the view that there is still a lack of a common, standard, unified definition of what ESG means for organisations as well as what goals are to be achieved.

Figure 6: Where does ESG Reside in Business



It is clear that miners are still to some degree wrestling with the implications and consequences of ESG as a way of doing business and as a way to report. But it is clear from the respondents that ESG is more than ticking boxes. It’s about making a difference and creating a better, brighter future for generations to come. We heard that mining companies need to create sustained outcomes that drive value and to be able to do that, they must have a defined vision.

There is fragmented thinking on the application of ESG and that the lack of a “blueprint” or clear guidelines for the execution of ESG could dilute our efforts as an industry. For now, regulations might be the best option we have to organise our thinking and actions and provide some direction on how to achieve the best results from our ESG efforts. With this in mind, technology might be our saving grace and should play a bigger role in guiding the direction of practical ESG management and reporting in the interim, until everybody has found their feet.

³ Mine 2022. <https://www.pwc.com/gx/en/industries/energy-utilities-resources/publications/mine.html>

⁴ PwC US Pulse Survey. <https://www.pwc.com/us/en/services/esg/esg-technology.html>

Those serious about ESG add it to their KPIs

- Is ESG going to shorten the life of our mines?
- If ESG was working properly, would it not be producing sustainable businesses?
- Is it a Social Licence to Operate with extra E and additional G?
- If we did the minimum to comply would that be sufficient?

These are the typical questions our executive teams are having to address as they confront ESG. It is important to note that when we asked people what the driving themes in their business were, we framed the ESG question around Environmental, Social, and Governance assurance mechanisms and it was not a priority for any respondents. It is important to note the word assurance mechanisms here – what we heard was that our executives do not want to just report on ESG to satisfy the letter of the law. They see it as a culture in the business, a core part of the strategy and envision that it will culminate in a real sea-change in mining – similar to the digital revolution of the past five years. In other words, a true strategic shift.

That means KPIs cutting through the organisation – and it is here that our respondents told us unequivocally that the significance of ESG and its success in being part of the strategy relies on ESG being embedded in KPIs at the individual level. In fact, they asked, without these individual KPIs, how credible is it (our ESG strategy)?

In PwC’s Mine 2020 study only 28% of the top 40 mining companies “are setting public ESG commitments and targets, reporting consistently against them, and linking executive and management performance to achieving them”.⁵ More than two years later, it seems like we are still just talking about it as mining companies are still struggling to show their real commitment.



Key factors:

- 01 Sets detailed and defined ESG commitments and targets
- 02 Links to KPIs and reports consistently against them
- 03 Links to executive and management performance

ESG may be time-consuming and costly to undertake, but it will be worth the time, effort, and money in the long run our South African miners tell us.

⁵ PwC Mine 2020 Resilient and resourceful. <https://www.pwc.com/gx/en/energy-utilities-mining/publications/pdf/pwc-mine-2020.pdf>



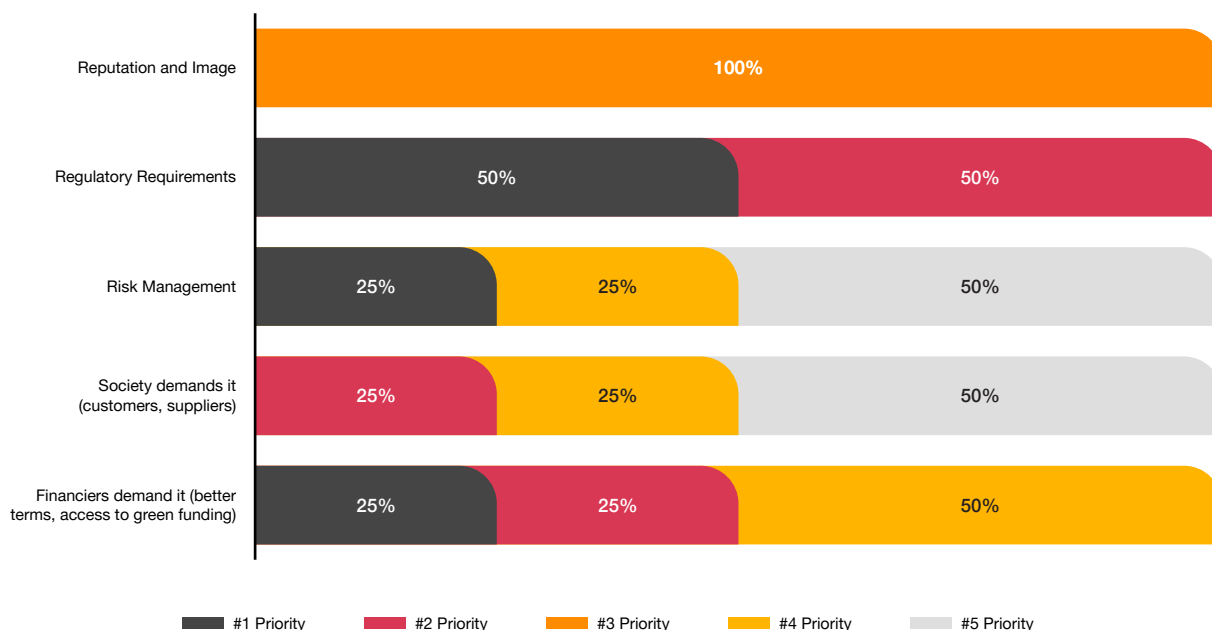
Insight 9: ESG – Regulations shape ESG requirements (for better or worse)

Key points:

- ESG Priorities Among mining houses
- Siloed legislative reporting

When asking the ESG-responsible mining executives which factors have strongly influenced their ESG commitments to date, regulatory requirements were chosen as the number one priority by 50% of the respondents and the number two priority by the remaining 50% of the respondents. Given this stance, it becomes critical to define and standardise the regulations through which the mining industry is governed, otherwise, there is a misalignment in terms of what metrics are being reported, the mechanism used to calculate these metrics, and ultimately, the interpretation of the reporting.

Figure 7: ESG Priorities for Mining Houses



The other number one priority items were each selected by 25% of respondents – equally weighting risk management and financier demand.

As much as there is the inclusion of ESG as part of the broader risk management business processes, risk management has been selected as the lowest priority in terms of drivers of ESG commitments by 50% of respondents. Only 25% selected risk management as the first priority.

100% percent of the respondents selected reputation and image as the third choice of factors influencing ESG commitments. This is fair considering the environment in which mining takes place – multiple stakeholders such as the employees, communities, investors, and government are impacted and require assurance of quality, reputation, and image of related organisations.

Society is rapidly changing. Workers are becoming more conscious of their environmental and social impact, including the environmental and social impact of the mining sector. This is felt so strongly that it affects the choices of employers and industries for engineers. Workers have shown a deep understanding of ESG in relation to their industry; only two unions responded to the ESG-related questions in the survey. The respondents succinctly highlighted that there is a confluence of mining operations and sustainability. Therefore, mines must integrate their operations with sustainability through the focus on ESG. The respondents expressed that digital incorporation into mines has improved sustainability based on environmental protection.

In relation to the communities surrounding mining, the respondents argued that there is less focus on social and governance issues as larger attention is given to environmental protection. The respondents contended that for ESG to be fully achieved there is a need for key stakeholders such as the workforce, community, and social partners to collaborate in developing mining communities. Again, miners argue that ESG can be realised through embracing digital transformation.

Siloed legislative reporting

Mining companies have a crucial role to play to protect their social licence to operate and to uphold their brands in the face of public and private interest groups. Some are more transparent than others – part of which stems from the nature of the ESG frameworks themselves.

Publicly listed companies must submit an annual report on their ESG performance. At the core of ESG reporting are the reporting frameworks, of which there are four main reporting frameworks:

- Global Reporting Initiative (GRI)
- Sustainability Accounting Standards Board (SASB)
- United Nations Global Compact (UNGC)
- Task Force on Climate-related Financial Disclosures (TCFD).

The first and most obvious observation here is that all these are referred to as “voluntary” by their creators. A number of respondents find themselves asking why, when the South African mining industry is governed by a single body of law and overseen by governing bodies, one would ask why should the reporting frameworks be voluntary and different.

It doesn't end there of course. Miners select the framework they want to use, and they can adapt it to their needs including the weighting of criteria. Our respondents picked this up immediately and told us that this undermines progress towards consistent ESG goals across the industry as two groups might have exactly the same overall scoring but have a completely different approach to shareholding and Black Economic Empowerment (BEE), different environmental timelines and criteria for restitution, etc. To put it bluntly – our miners are asking if this is adding value or if we are wasting money and effort on lip service?

This is not helped by the fact that we are importing these frameworks from other industries so they do not – in the opinion of our respondents – serve us in mining as they could or should.

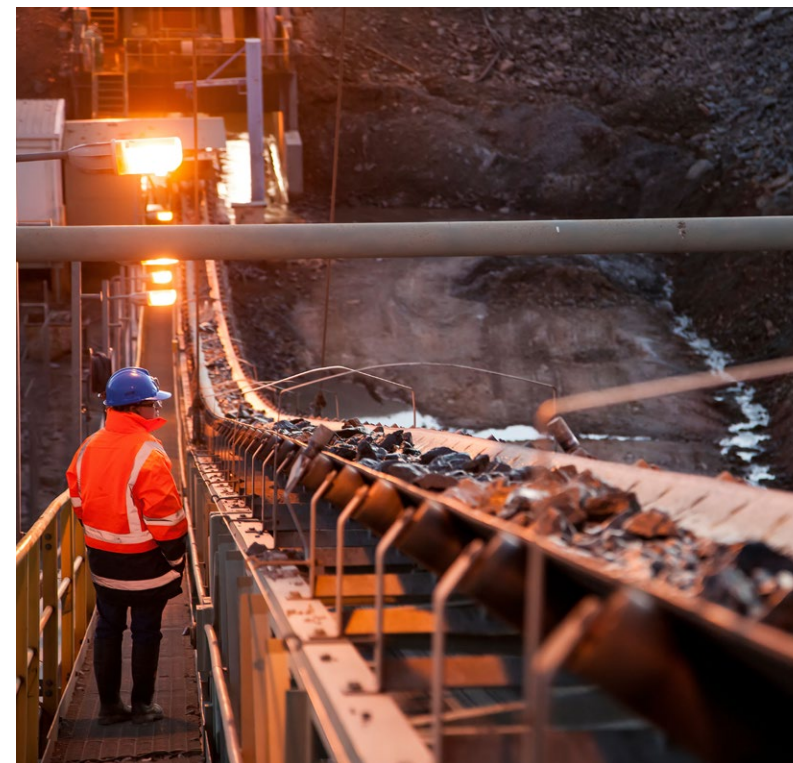
As much as the choice of which ESG reporting framework to use is dependent on the individual organisation's ESG objectives as well as the stakeholders involved, it should be an industry-wide imperative to strive for a uniform and consistent reporting framework – one developed by the mining industry for the mining industry. Not only will this drive informed decision-making amongst stakeholders, but it will drive accountability and shared responsibility towards a sustainable industry while holding us equally to account.

We have heard several compelling reasons to embark on this journey as an industry:

- Firstly, the South African mining industry has its own set of stakeholders to speak to – the primary being the country's citizens as defined by the Mineral and Petroleum Resources Development Act (MPRDA) – however, the mechanism and standards used to report to these stakeholders vary. The difference lies in the frameworks being regarded as “voluntary” as well as the extent of adoption of a specific framework which is dependent on the organisation itself.
- Additionally, there is an allowance that multiple ESG reporting frameworks can be used in conjunction with one another – by one organisation – because no single framework covers all the metrics we need as miners. While there is an appreciation that these frameworks cover different reporting elements and metrics, this does open gaps in interpretation by stakeholders involved, i.e., it is not an apples vs apples comparison.
- Given that the frameworks encompass different elements from multiple industries, there is a lack of consistent and standardised definitions of material issues and information pertinent to the mining industry. To put it simply, we can't compare them with one another and get a straightforward answer.
- There are differences in the weighting applied to metrics, depending on the framework used as well as the rating agency contracted for reporting purposes. It makes it a challenge to compare two businesses when they each have subjective ESG criteria, metrics and weightings.

Looking at the above gaps as well as the general view from the respondents that ESG adoption and compliance are yet to be properly defined, we can conclude that this is a challenge that the mining industry should take upon themselves in order to realise value and impact stakeholders positively. The present somewhat vague and self-determined outcomes are ‘more of a marketing brochure than true investor community insights’, is the message we heard from several interviewees. This does not sit well – we are taking the time and putting in the effort but the question we heard raised repeatedly was whether the current ESG reporting has any value at all to our stakeholders.

Another key word around reporting ESG from our respondents was automation. Generating that much data manually is not feasible or accurate, we are told. Nearly all of our respondents struggle with the ‘one version of the truth’ issue – where manually entered data in spreadsheets can slow down progress and add to accidental errors, and as a consequence, many CEOs and their executives are focusing on eliminating data silos, outdated back-end systems and slow data processing systems while automating data inputs where practical.



Insight 10: ESG drives long-term value

Key points:

- Miners see ESG as more than just compliance
- Environmental Opportunities
- Social Opportunities
- From point solution to integration – how miners are tackling ESG and their ICT
- Unions support ESG, but see more E than S and G

While legislation drives the responsible business agenda for our mining industry, embedding ESG into your organisation is more than just compliance – it is centred on the ability to create long-term value.

There are various environmental, social, and governance opportunities that can be leveraged:

Environmental opportunities

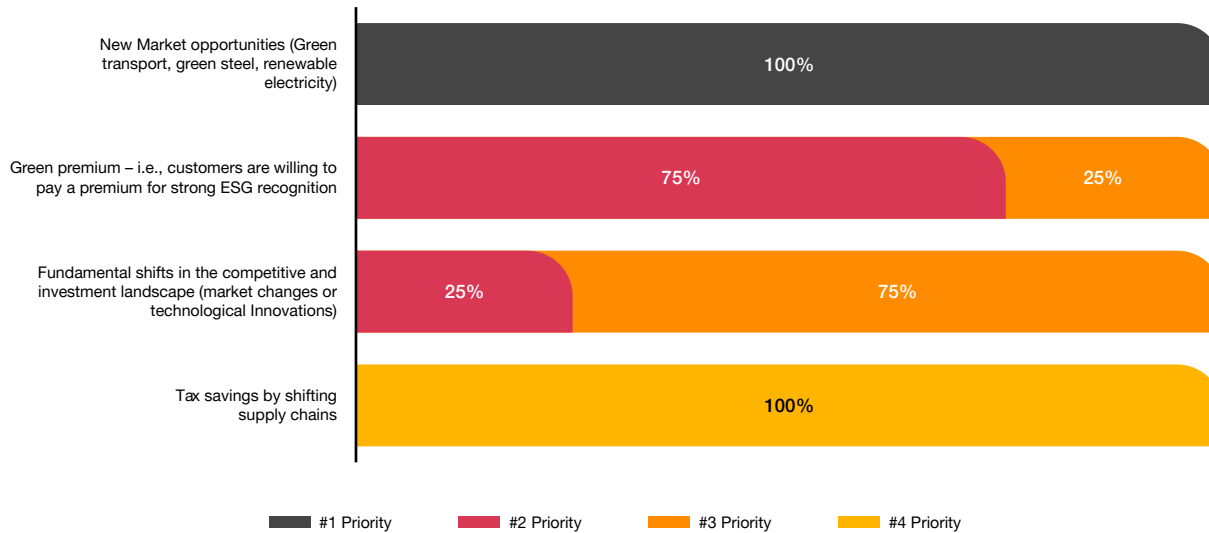
We asked ESG-responsible executives how they would rank opportunities under the environmental pillar of ESG 100% of respondents selected New Market Opportunities as their first choice. This speaks to future demand around green transport, green steel and renewable energy for miners and aligns well with many of our miners' products.

75% of respondents selected green premiums as the second option with the remaining 25% going for fundamental shifts in the competitive and investment landscape. While this is a clear indication that miners are focused on factors that impact the bottom line, it also sheds some light on their willingness to transition business models in the direction that benefits adjacent environments and communities.

75% of the respondents selected fundamental shifts in the competitive and investment landscape as a third opportunity to leverage, while the remaining 25% chose green premiums as their third option. This is clearly top of mind for miners now.



Figure 8: How would you rank opportunities under the Environmental Pillar of ESG?



100% of the respondents placed tax savings by shifting supply chains as the last opportunity for consideration, highlighting that miners are currently putting the focus on their core, internal business and placing the impact that supply chains might have as a factor to consider in the future.

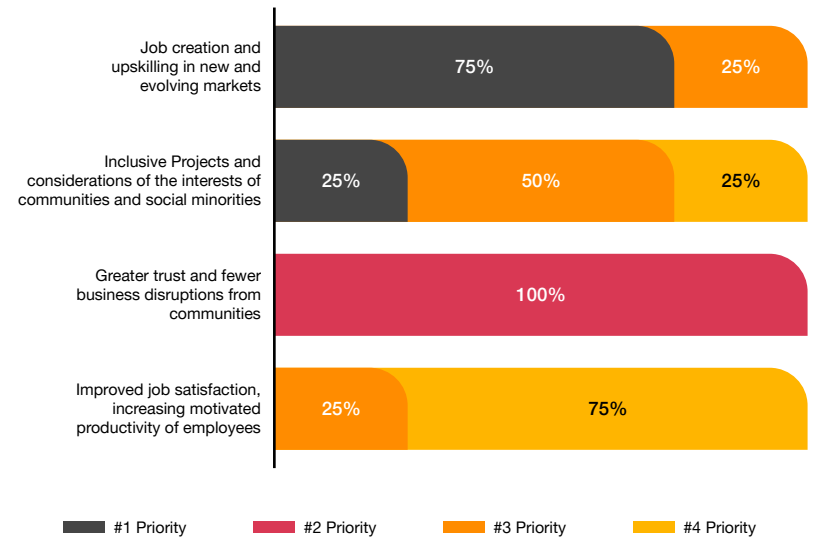
Social opportunities

When asked how they would rank opportunities under the social pillar of ESG, 75% of respondents selected job creation and upskilling in new and evolving markets as their number one priority.

The remaining 25% chose inclusive projects considering community interests and social minorities as their first choice to create long-term value. The conclusion that may be drawn here is that people are still at the core of the mining business. Their involvement and the roles they play are what is changing based on the various ESG requirements – and this is seen as a great opportunity by South African miners.

100% of the respondents chose greater trust and fewer business disruptions from communities as their second greatest priority. This comes back to the point of people being core to the mining business and aligns with their top priority of job creation and community upskilling.

Figure 9: How would you rank opportunities under the social pillar of ESG



There is a split in terms of the selection of the third priority, with 50% of the respondents choosing inclusive projects, 25% choosing job creation and upskilling, and the remaining 25% choosing improved job satisfaction. It is also interesting to note that 75% of the respondents chose improved job satisfaction, increasing motivated productivity of employees as the **least** vital opportunity to take up, indicating a more outside-in focus for miners.

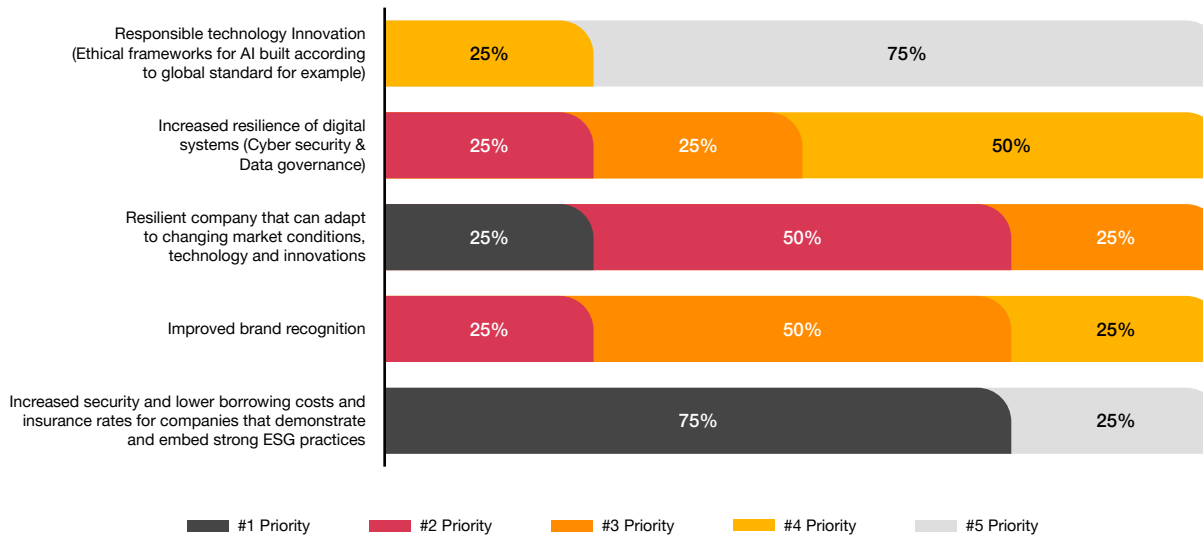
ESG improves our governance which increases security and lowers borrowing costs

Surveyed ESG-responsible executives see increased security and lower borrowing costs and insurance costs as their biggest governance opportunity with 75% of respondents ranking this first.

The remaining 25% are of the view that the greatest opportunity lies in having a resilient company that can adapt to changing market conditions, technology, and innovations. This was selected as their second highest priority by 50% of respondents. Like environmental opportunities identified, miners are looking to create and gain value from new markets opened due to ESG requirements and imperatives.

The remaining 50% is split equally between increased digital systems resilience and improved brand recognition as a second priority opportunity. As an indication that there is still a long way to go yet for miners to become digital champions, a point acknowledged by respondents, 75% of ESG executives regard responsible technology innovations as only the last opportunity to leverage.

Figure 10: Governance priorities in ESG



From point solution to integration – how miners are tackling ESG and their ICT

During the interview process, it became clear that without a blueprint or clear regulations, miners have chosen a variety of paths to ESG and its reporting in their ICT environments.

As an example, several miners spoke of the idea of looking at separate issues within the environment, social and governance buckets and identifying standalone digital technology tools to address these with the idea being to link all the elements at a later stage for reporting.

Examples given include dust monitoring in operations (environment), rehabilitation (environment), blasting (governance), and automated tailings dam monitoring using drones (environment). While there is an understanding of what ESG means, and what the individual pillars stand for and encompass from an operational point of view, there is still misalignment in terms of the application of the ESG concept as a value creation enabler more holistically.

For example, outside of digital technologies being used as a convergence mechanism, the general sentiment shared amongst the respondents was that ESG cuts across the business. As such some mining organisations have now started incorporating ESG as part of the risk management function. However, fragmented data in this space still presents a challenge, one which 30% of respondents think can be solved with a consolidated reporting tool.

When asked how 4IR technologies are currently enabling South African mining to achieve significant improvement in ESG performance from a functional lens, we found that half of the miners surveyed focus on functional drivers of ESG (displaying the point solution stage of maturity) including:

- Digital tools for life cycle costing, life cycle impact assessment, material passports, and circularity measurements.
- Shift from planned to predictive maintenance by using various detectors and monitors.
- Remote sensing in environmental monitoring and Geographic Information Systems (GIS)
- AI cameras for dust level detection in operations.
- Use of drones for tailings dam management.

33% of the respondents looked at enablers of reporting on ESG performance as some of the drivers to achieving improvement. This included monitoring and reporting proactively on social and environmental goals using digital tools as well as providing a feedback platform between all involved parties through these.

Unions support ESG, but see more E than S and G

The unions asserted that some mines are extremely progressive concerning ESG. They told us that they had seen the relationship and interdependency between sustainability, community development, economic progress, stakeholder relationships, and production. While some mining groups have a ‘great approach’ in their minds some of our mines do not have integrated solutions to address communities’ issues – leading them to focus disproportionately on production without addressing the surrounding community’s needs in the view of two of the three unions interviewed. The other union did not comment on ESG matters.

Society is rapidly changing. Workers are becoming more conscious of their environmental and social impact, including the environmental and social impact of the mining sector. In their minds, ESG can help to make mining operations more sustainable. They cited examples where digital programmes have improved sustainability by improving the environment and protecting workers from the environment.

In relation to the communities surrounding mining operations, the unions argued that there is less focus on social and governance issues as larger attention is given to environmental protection. The respondents contended that for ESG to be fully realised there is a need for key stakeholders including the workforce, the community itself, and social partners to collaborate in developing mining communities.

Interestingly, the two responding unions argue that ESG can be realised through embracing digital transformation.

Appendix: The state of the art of digital mining (in graphs)

Figure 1: Where is digital most needed to improve our performance?

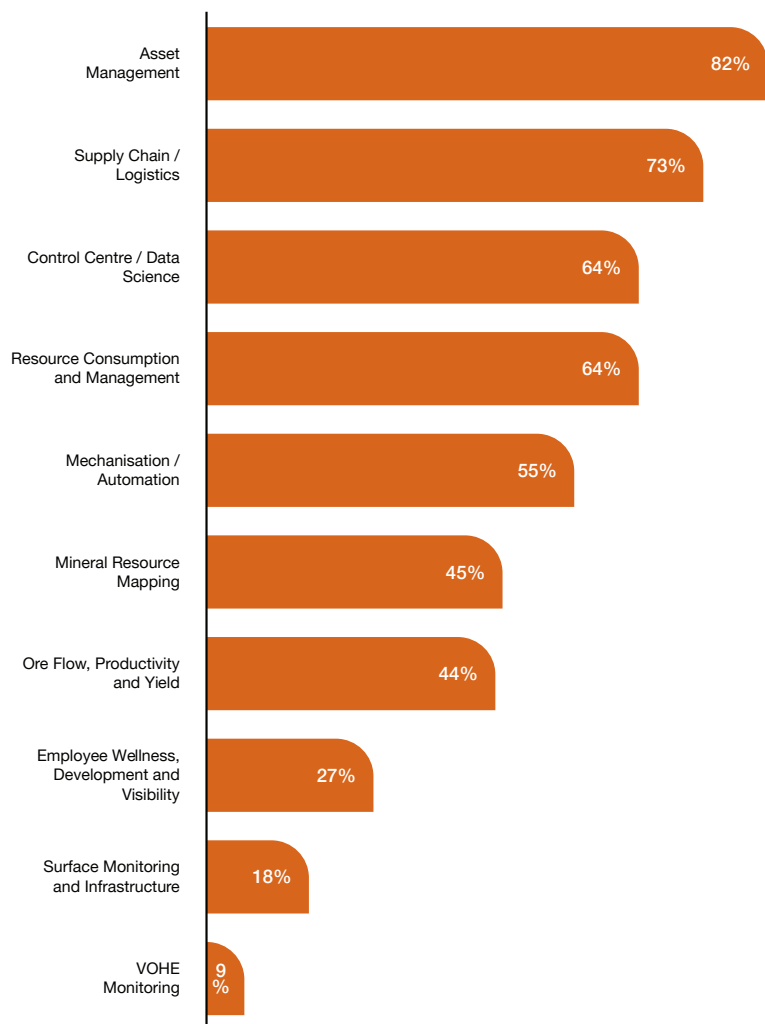
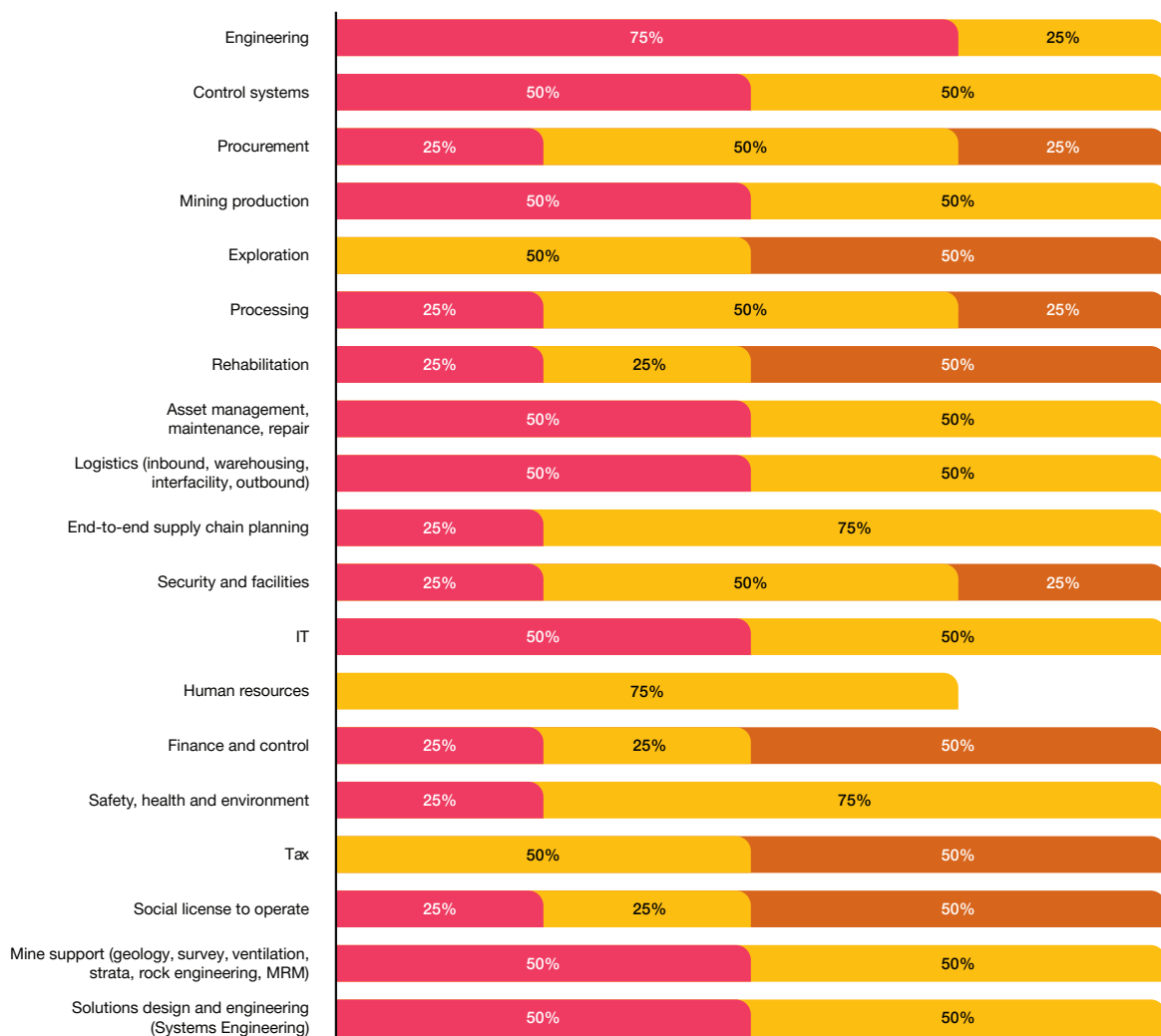
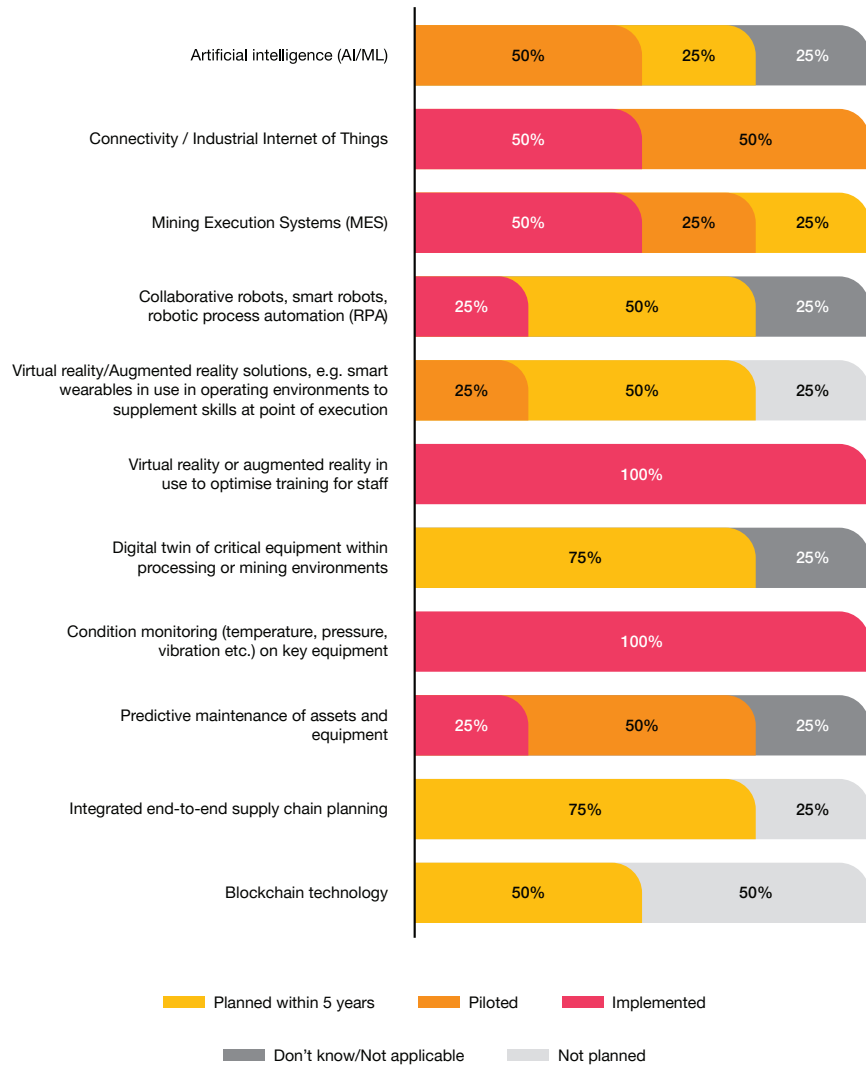


Figure 2: In which area of the business do you believe digitalisation/4IR will make the biggest impact?



Very significant Somewhat significant Neither significant nor insignificant

Figure 3: To what extent have you implemented the following technologies within your company?



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