Digging deeper for sustainable mining

*Becoming more responsible
with digital transformation*

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Key
takeaways

The mining industry needs to embrace sustainability, transparency, and digital transformation to survive and thrive.

■ Social, financial, and technology trends are disrupting the mining industry

In an era of rapid change, mining leaders must focus on greater societal purpose as well as profitability to be relevant to all stakeholders.

■ Lack of transparency is tarnishing the mining brand

The mining industry needs to rebrand itself by sharing more information about its social and environmental impact, and its growing commitment to sustainability.

■ Technology, collaboration, and talent development can help mining become more sustainable and responsible

Mining organizations need to adapt advanced digital technologies, find new ways to work together, and develop their workforce for the future.

Seismic shifts are rocking the mining industry

The global mining industry, with over $2 trillion in annual revenue, is one of the world's largest and most visible industries. But its sheer size and its enormous environmental, economic, and social impacts also raise unique challenges.

Volatile commodity prices and markets, geopolitical risks, changing public attitudes, and sustainability issues—including deforestation, erosion, contamination, noise, dust, and emissions—are putting pressure on the traditionally conservative mining industry to change and evolve.[1]

The mining industry is responding. For example, with mining accounting for approximately 4% to 7% of worldwide greenhouse gas emissions, the members of International Council on Mining and Metals (ICMM) have committed to a goal of net zero Scope 1 and 2 emissions by 2050.[2] Mining organizations are also increasing the use of AI, analytics, automation, IoT, and other technologies. However, complete transformation requires more integration of digital technologies to increase efficiency, boost production, meet sustainability goals, and improve working conditions.[3]

Mining is brand-challenged with key audiences

Mining earns significant profits—$159 billion in 2021 for the top 40 global mining companies alone.[4] However, it hasn't earned commensurate levels of respect from key communities, such as investors or the millennial generation, where many believe that mining doesn't share their priorities. Mining must burnish its brand: it needs both new investments to grow and tech-savvy workers to fill its ranks.

High-profile incidents related to mining operations—such as the destruction of rock shelters held sacred by indigenous communities and a tailing mine disaster in South America that killed hundreds of people—diminished the "social license" of the mining industry. Concerned that the boom in renewable energy minerals will harm the environment and poor communities, investors are also pushing for tougher sustainability policies. In response, the Global Investor Commission on Mining 2030 plans to introduce sustainability standards by 2024, focusing on waste management, biodiversity protection, child labor, and the role that conflict minerals play in financing armed strife.[5]

Finally, established mining companies are being upstaged by newcomers with greener, more socially responsible mining models. For example, six-year-old Chilean Cobalt Corp. promises to be a more responsible supplier of cobalt and copper for batteries.[6] Incumbents need to step up their environment, social, and governance (ESG) efforts to compete in this marketplace.

Closing the gap between the lower brand value of mining and its higher essential value

In many communities, mining is perceived as an unsafe, unethical, and environmentally insensitive industry. These attitudes discount the value of the overall mining brand and do not reflect its essential value. However, when the industry takes steps to build its economic and social capital, the brand value of mining can be elevated. Making this transition requires a concerted effort toward digitization and democratization (see Figure 1).

As communities and governments increase emphasis on environmental issues, pressure builds on the mining industry to operate in a more environmentally sustainable way. According to mining CEOs, sustainability has risen to become their second highest corporate focus, right behind improving efficiency and profitability. Over half of these CEOs (53%) say that increasing sustainability is one of their highest priorities over the next two to three years. Sustainability is also the most frequently cited challenge, ahead of supply chain disruption, regulation, and geopolitical uncertainty.[7]

Yet, while 81% of mining and metals executives say they have a sustainability strategy, only 29% have acted on it. And even worse, only 16% of these organizations have strong board and C-suite commitment to sustainability, high effectiveness with environmentally sustainable business processes, and high alignment of sustainability strategy with digital and IT transformation strategy.[8]

To help close these gaps, we've identified three critical areas to help the mining industry evolve and thrive in the future: creating a more open and collaborative business culture, enabling digital transformation through integrated and intelligent workflows, and developing a workforce with the skills and knowledge to succeed.

Enabling the mining industry to survive and thrive

Source: IBM Consulting

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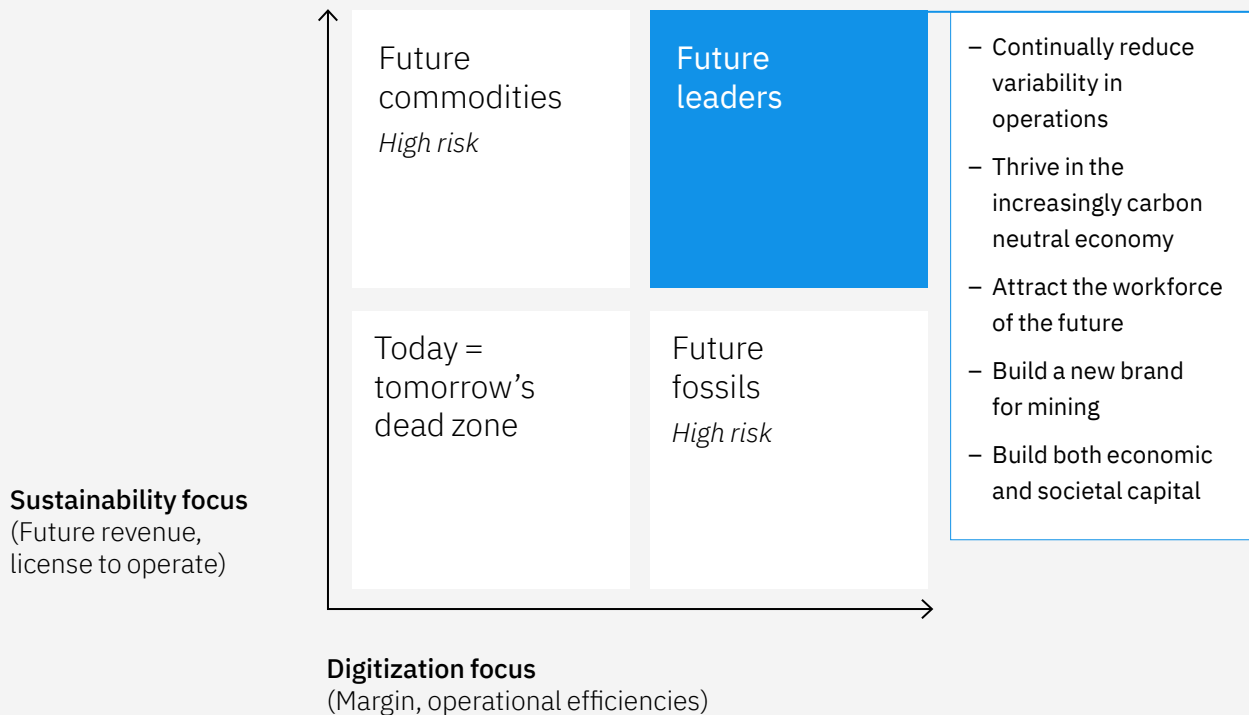
Building innovation, collaboration, and transparency

In an era of rapid change and unexpected disruptions, hiring outside experts to consult in every area that needs to evolve is not realistic. Instead, mining companies need to create an open business culture that is able to actively innovate and co-create as part of a community (see Figure 2).

By partnering across ecosystems and cooperating with peers, competitors, and other industries, mining companies can accelerate the creation of business platforms. This allows organizations to take full advantage of proprietary data to transform operations and shape markets.

To promote "co-opetition," the Global Mining Guidelines Group (GMG) is helping the mining community improve operations and implement new technologies. Focusing on industry advancement, GMG creates guidelines and standards, expands knowledge based in new fields, and partners with organizations worldwide.[9]

When partners collaborate and support the interoperability of data—a potential source of mining riches in the future—they can share knowledge and democratize practices to evolve the industry for all stakeholders.

For example, Sandvik Mining and Rock Technology, a global equipment supplier, taps AI, IoT, and predictive analytics to analyze and optimize underground hard rock mining and processes. Its open system architecture platform efficiently integrates data between mining systems and equipment from different providers. This eliminates bottlenecks, streamlines operations, and makes mining safer, smarter, and more productive.[10]

Advancing openness and collaboration

Partnering in "co-opetition"
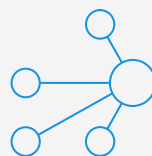
Open innovation + co-creation

The only response to continued volatility and disruption.

Collaborate on industry platforms

Digital + collaborate + sustainable

Demonstrate social responsibility and a culture of innovation.

Interoperate with ecosystem partners

Democratize + interoperate

To survive and thrive, data is the fuel of the mine of the future.

Source: IBM Consulting

Transformational transparency with ESG reporting

Research from the IBM Institute of Business Value (IBV) reveals that ESG reporting plays a critical role in putting sustainability into action. ESG data and insights can help leaders improve performance, especially in the environmental domain.[11]

However, there is currently no specific guidance on sustainability reporting for the metals and mining industry. The most widely used reporting system is the Global Reporting Initiative (GRI) Standards—a requirement for ICMM members. A drawback to GRI is that these standards do not capture the range of variance across the entire mining value chain.[12]

Mining companies need to advance in four key areas to convert ESG data into business value.[13] These include:

– Sourcing and managing ESG data across organizations and partner ecosystems.

– Designing enterprise architecture for ESG and making the data available in a clear dashboard.

– Integrating processes and business activities by embedding ESG metrics across functions.

– Adopting new practices to support decision-making and developing relevant ESG and sustainability skills in the workforce.

Market-making business platforms enable mining companies to transform business and operational processes and deliver new business and business models (see Figure 3).

Investments in technology platforms for geology, engineering, operations, maintenance, production planning, process control, and reliability also underpin internal business platforms. These platforms make sure that operations have the right information and metrics, the right instructions through workflows, and the right user experience to help staff members do their jobs.

Internal enabling platforms support operational competitiveness by introducing exponentially powerful technologies into typical workflows, creating new ways of working and new skills.

Internal strategic platforms embed differentiated workflows that define competitive advantage. Industry and cross-industry platforms allow miners to build economic capital and support sustainable mining by tackling difficult problems that can only be solved when competitors and other industries work together. And by combining digital sophistication with social responsibility, mining companies can help build a culture of innovation through their supply chain ecosystems.

Reinvent competitive positioning and create opportunities with market-making business platforms

Mining value chain

Exploration planning and development	Mining	Processing	Maintenance	Supply chain and logistics	Marketing and trading	Business support

Industry and cross-industry platforms

Mining marketplace	Smart projects	Responsible and traceable	Smart contracts	Logistics	Trading	Community and sustainability

Internal strategic and enabling business platforms

Cognitive exploration	Predictive blast	New materials	Lean production	Integrated asset	Autonomous fleet	IT/OT security operations center
Collaborative supply and demand	Sustainable tailings	Smart plant	Digital comminution	Smart energy	Workforce resilience	Integrated operations insights

Work and technology platforms

	Engineering and operations				*Commercial*	*Enterprise*	
Supply chain	Production excellence	Asset effectiveness	Operations excellence	Integrated planning	Trading	Finance and accounting	Customer relationship management
Engineering and reliability	Safety and process reliability				Treasury	Human resources	Enterprise asset management
Exploration and geology	Process control and automation				M&A and expansion	Procurement	Enterprise planning and budgeting

Source: IBM Consulting

Case study

Government of British Columbia: Trusted credentialing in the mining space

The government of British Columbia is creating a digital service and convening an ecosystem to increase transparency and trust. It also includes provenance-related attributes for supply chain tracing, and ESG reporting.[14]

Blockchain technology is part of the core infrastructure of this initiative. As a catalyst for sustainable development, it enables the trusted exchange and automation of minerals data between all participating members. A pilot digital trust ecosystem will allow natural resource producers to share evidence of where materials came from and certify the producer's ESG practices, including reduction of greenhouse gas emissions.

Case study

Responsible Sourcing Blockchain Network (RSBN): Environmental protection in mineral supply chains

The RSBN tracks cobalt across the supply chain from mine to smelter, to battery manufacturers, and ultimately to automotive OEMs. Ford Motor Company, Volkswagen Group, and Volvo Cars have joined the RSBN, as have industrial-scale cobalt miners in Congo to demonstrate their responsiveness to responsible sourcing standards developed by the Organization for Economic Cooperation and Development (OECD).[15]

Enabling integrated and intelligent workflows

Digital transformation can make a critical, enduring impact on mining operations by providing employees with tools to improve productivity, including changing the way people do their jobs by freeing up time to work on higher-value activities.

Intelligent workflows transform operations to be smart from the inside out, using data to generate a competitive advantage and provide insights to build greater efficiency and productivity. These workflows can be shared on proprietary or collaborative industry platforms to support the mining operations of the future (see Figure 4).

By orchestrating automation, AI, analytics, and skills, intelligent workflows change how work gets done across an enterprise. Until recently, leveraging AI in this process has been expensive, time consuming, and often difficult. However, the maturation of generative AI shows how pre-trained large language models can accelerate AI adoption.

Tapping intelligent workflows

+95%
Geological processing speed

Smart geology
Unearthing high quality deposits of ore.

+2%
Yield

Smart plant
Optimal plant operations.

-10%
Working inventory

Smart asset
Optimized inventory, effective assets, and capital deferral.

6 month
Speed to value

Smart operations
Sustainability, traceability and agility of mining value chains.

Source: IBM Consulting

A smart plant uses advanced analytics and AI to predict variability across key production metrics. When metrics fall out of range, algorithms prescribe parameters to correct processes and optimize performance. For example, ABB, a multinational heavy equipment and automation technology company, pioneered an advanced process control application that stabilizes and optimizes cement processes, helping plant managers achieve profitability and sustainability targets.[16]

Here are other examples of smart mining:

Reducing carbon dioxide emissions with "green" steel	Because steel manufacturing produces 7% of the global energy sector's carbon dioxide emissions, steelmakers have a strong interest in developing "green" or "zero carbon" steel. Direct reduced iron (DRI) and electric arc furnace steelmaking processes release 36% fewer CO2 emissions per ton of crude steel.[17] Rio Tinto, BlueScope Steel, and ArcelorMittal are investigating new technologies to use blast-furnace grade ore in DRI processes, which have traditionally relied on higher grade ores. In 2025, thyssenkrupp also plans to start replacing blast furnaces with DRI plants.
Responding to volatile energy markets and driving efficiency with data analytics	To protect profits, cut waste, and improve efficiency, ABM Investama wanted to adjust mining production rates according to rapidly changing energy prices. However, slow analytics and reporting systems limited responsiveness. To derive market insights more quickly, ABM Investama moved to SAP S/4HANA on AWS Cloud. Now, with 90% faster reporting, ABM Investama can rapidly respond to market changes and proactively protect margins.[18]
Going for the gold with AI and analytics	To help geologists spend less time managing data and more time exploring for gold, Goldcorp deployed AI at its former Red Lake facility to develop geological drill targets. Using spatial analytics, machine learning, predictive models, and a range of exploration datasets, the platform ingested more than 8 terabytes of structured and unstructured data.[19]
Collaborating on electric vehicles for mining operations	BHP, Rio Tinto, and Vale are the founding patrons of a collaboration called the Charge On Innovation Challenge. This global initiative for technology innovators develops concepts for large-scale truck haul electrification systems. It can help the mining sector reduce diesel fuel consumption and significantly cut emissions produced by surface mining operations.[20]
Achieving immediate decarbonization targets, operational efficiencies, and long-term net zero goals	OREN, a B2B digital marketplace platform created by Shell and IBM for mining companies, uses digital solutions to connect operational siloes and integrate technologies and data to increase operational efficiency.[21] Digital services and solutions are delivered through an integrated ecosystem with centralized insights that are actionable across an organization. The platform allows companies to address multiple business challenges with solutions for fuel efficiency, tailing storage facility management, and emissions management.

Developing new ways of working and new talent for future competitiveness

The male-dominated mining industry continues to be diversity-challenged. Women account for only 14% of the global mining workforce, 18% of company boards, and 3% of CEOs. In addition, mining has the second-largest median gender pay gap globally, behind only the construction industry.[22]

Mining companies need to co-create, co-execute, and cooperate in transitioning skills to create a culture of diversity and close the talent gap within the industry (see Figure 5). Agile, multidisciplinary teams loaded with T-shaped talent—people with a broad range of skills and interests as well as expertise in select niches—will greatly accelerate this effort.

Mining needs workers with advanced technology skills, but these skills are lacking in local labor markets. In addition, almost half of current mining employees will need to learn new skills within the next four years. Increasingly important roles include AI and machine learning specialists, data analysts and scientists, process automation specialists, robotics engineers, software and applications developers, digital transformation specialists, remote sensing scientists and technologists, management and organization analysts, IoT specialists, and big data specialists.[23]

New ways of working

Design thinking + Garage + innovation hubs + research

Co-locate to create value with the speed of a start-up and scale of an enterprise.

Culture

Agile + multidisciplinary + T-shaped talent

Brand permission to attract new talent and create a culture of diversity linked to the transition to a sustainable future.

Talent transition

White and blue collar = new collar

Create and assess diversity across skills, thinking styles, and ways of working. Implement strategies that foster diversity.

Source: IBM Consulting

Public-private collaboration will help the mining industry navigate these challenges and advance more quickly. For example, ICMM has contributed to the World Economic Forum's Mining and Metals Future of Work Taskforce. Industry representatives, academic experts, and civil society organizations are exploring how to incorporate technology while promoting diversity, equality, morality, and safety in workplaces where the next generation of skilled employees wants to work.[24]

To build a more diverse workforce, hiring managers need to look beyond candidates with college degrees and previous job experience on their resumes. Organizations will also benefit from considering nontraditional candidates to fill mid-career and "new-collar" positions.

Preparing students for new-collar jobs with P-TECH

Pathways in Technology Early College High Schools (P-TECH) addresses the global skills gap and strengthens regional economies by giving workers the academic and technical skills needed for new-collar jobs. P-TECH also provides underserved youth with innovative educational opportunities and a direct pathway to college attainment and career readiness.

In 2015, Australia launched P-TECH schools at Newcomb Secondary College in Geelong and at Federation College in Ballarat. Since then, P-TECH has grown to more than 300 schools in 26 additional countries.[25]

Action guide

Mining leaders acknowledge that transforming technology and talent is critical to the future of the industry, even as capital constraints, profit pressures, and supply chain disruptions continue. These challenges are further amplified by the siloed organizational structures inherent in mining organizations, making change and cooperation even more difficult.

Nevertheless, positioning your mining company to lead in the future requires concerted action across your organization—how you create value, tap the transformative power of digital technologies, and enable people to realize their potential.

Here is an action guide to support these efforts:

01

Prioritize collaboration and interoperability

Leverage human cognition and build intelligent workflows, shared as smart services, on industry platforms and actively participate in public and private partnerships.

02

Reimagine workflows by infusing AI and automation

Digitize where possible into intelligent workflows. Use data—the "new natural resource"—to create the mine of the future and build economic and societal capital.

03

Foster new ways of working, with a focus on skills

Create and assess skills, thinking styles, and ways of working to implement strategies that support a diverse and inclusive workforce, which will support the recruitment of the next generation of employees.

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