

Monitor
Deloitte.



**Innovation in mining
Latin America 2017**
Focus. Collaborate. Transform.



A study covering innovation
in key Latin American
geographies

- Argentina
- Brazil
- Chile
- Colombia
- Mexico
- Peru

Contents

Foreword	1
About the study	2
An inside look at innovation	4
Key findings	10
A vision for the future	24
For further reading	31

Foreword

Over the last few years, Deloitte has engaged with mining executives around the world on the topic of innovation. This started with a belief that innovation is key for the industry to transform, not only in terms of how it mines and extracts minerals, but how it engages with communities and stakeholders around the world.

When we launched these studies, first starting in Canada in 2015, the industry was still in the midst of a price slump and firms were desperately trying to survive the cycle. These firms had taken out significant portions of their cost base, but recognized that making a step change would require innovation and not just incremental performance improvement. As a result, innovation started gaining traction as executives began to recognize the need for it to feature on the corporate agenda and align with strategy.

Over the last two years, as we have rolled out these surveys in Canada, Africa, Australia, and now in Latin America, we have seen how innovation has moved forward in the mining industry and have been privileged to work with many firms in developing their innovation strategies, building innovation capabilities, and helping them find innovative solutions to complex operational challenges. We are now at a critical point in the industry's evolution. As the cycle has turned and prices have risen across many commodities, the industry needs to maintain the momentum on innovation and resist reverting to the old ways of doing business. While lower commodity prices created an imperative to innovate, we hope executives will recognize the need for longer-term industry transformation in order for it to be sustainable—not just across commodity cycles, but across the key stakeholder, community, and government issues the industry faces around the world. The industry has to transform or it will be disrupted.

We would like to express our sincerest appreciation to the following associations in Latin America—Sociedad Nacional de Minería, Petróleo y Energía (SNMPE), Valor Minero, Instituto Brasileiro de Mineração (IBRAM) and the Colombian Mining Association (ACM)—that have worked closely with us to help field this study and drive the innovation conversation in Latin America. We would also like to thank the many individuals from participating mining and service companies who shared their time and their perspectives. We hope you find value in the effort, and welcome your feedback.

Glenn Ives
North and South America Mining Leader

Andrew Swart
Global Consulting Mining Leader

About the study

The *Innovation in mining: Latin American 2017* study was conducted by Deloitte to gain an understanding of how mining companies in Latin America are innovating.

This is the fourth such study examining current perspectives on innovation within the global mining industry. By conducting executive interviews and using the Innovation Scorecard survey methodology developed by Doblin, the Deloitte innovation unit, the aim of these studies was to:

- Assess participants' current innovation efforts
- Build a deeper understanding of key pain points and gaps in companies' innovation capabilities
- Explore the broader issues the sector faces and hopes to resolve by becoming more effective at innovating
- Assess the role of innovation in the mining industry
- Pinpoint where innovating in different areas (or types) can unearth greater business value

Like the previous surveys in the series, this study explored how mining companies are innovating in a bid to identify ways to strengthen and enhance their efforts.

This report also builds on the findings of the prior studies, which were undertaken in Canada in 2015 by Monitor Deloitte and the Prospectors and Developers Association of Canada (PDAC), in Africa in 2016 by Monitor Deloitte and Mining Indaba, and in Australia in 2016 by Deloitte, Diggers and Dealers, and the Association of Mining and Exploration Companies (AMEC).

Unlike the Canadian and Australian studies, which adopted a single-country focus, this study solicited responses from 17 mining companies (both majors and juniors) in six countries: Argentina, Brazil, Chile, Colombia, Mexico, and Peru. While there was some divergence in national responses, the findings were aggregated to create regional results for all of Latin America. These results were then benchmarked against global responses to provide a comparison between the innovation activities undertaken by mining companies in Latin America and around the world.

The findings reveal that, in the past several years, mining companies in general have become more mature innovators.

This is reflected in the level of innovation maturity demonstrated by mining companies across Latin America—and it comes as no surprise. Given the global nature of most majors, innovation maturity in the sector continues to rise internationally. As mining companies work to address the industry's endemic challenges—such as declining grades, longer hauls, and water and energy shortages that are driving costs higher, they have also come to understand that the sector's long-term prospects hinge on the effectiveness of their innovation efforts. Despite this consensus, however, the sector still lacks systemic consistency and strategic focus when it comes to innovation. Before true step change can be realised, companies will need to expand their innovation focus beyond efforts to improve existing technologies or optimise existing processes.

The remainder of this report presents the findings of the Latin American study, explores what they may mean for the sector, and considers how companies can improve their innovation effectiveness.



“The suggestion is not to pursue innovation for its own sake, but to look for ways that innovation can unleash the next wave of productivity and growth. Right now, the mining industry is at a tipping point as it tries to identify strategies to make innovation deliver bottom-line value.”

Andrew Swart, Global Mining Innovation Lead, Deloitte Canada

An inside look at innovation

Declining grades. More complex geologies. Shrinking margins. Spiralling stakeholder expectations. More stringent regulations. With each passing year, Latin America's mining sector is assailed with tougher operating conditions. Although commodity prices have climbed from their recent lows, companies remain rightfully concerned about spending wastefully and increasingly require stronger business cases to support their capex and opex spending. Given the opportunities for productivity improvement in Latin America's mining industry and the difficulties attracting talent, combined with particularly vocal community demands, these challenges threaten to disproportionately affect regional mines.

At the same time, margins have already been cut to the bone—leaving precious little opportunity for additional cost cutting. Clearly, new approaches are needed—and miners understand this imperative. This explains why mining companies have been adopting innovation more readily. In fact, according to this study, the industry is on track to becoming significantly more proficient at innovating, and ultimately generating more bottom-line value from innovation.

To date, however, most of that innovation remains focused on achieving short-term returns rather than creating long-term, sustainable benefits. Mining companies are still struggling to drive organization-wide change by setting a clear vision for—or adopting a culture of—innovation. They lack incentives to motivate new behaviours among employees and metrics to measure progress. Most initiatives remain funded by operating or capital budgets—forcing prospective innovators to pursue innovation haphazardly, rather than as part of their day-to-day jobs. Most critically, they continue to approach innovation in an insular fashion rather than fostering the collaboration required to minimise risk and develop solutions that accrue to the entire company's—or the entire industry's—benefit.

Part of the issue is that, at heart, the design of mines and processing plants hasn't changed in decades. Although the equipment is more modern, miners from 50 years ago would find little has changed if they entered today's mines—a situation that certainly doesn't hold in other industries. That means true transformation requires

a new vision for the future—one bold enough to drive a step change in performance and enable more ambitious results from innovation. Is the vision to become the lowest cost operator? To minimise the footprint of the mine? To become the partner of choice for local stakeholders? To develop fully autonomous mines? Ultimately, it is this longer-term vision for transformation that will help companies determine the extent to which they should embrace automation, reduce their carbon footprint, find different ownership structures that empower local stakeholders, partner with stakeholders generally, develop new and unthought-of ways to process minerals, or meet other bold goals.

The takeaway is that Latin American mining companies can only achieve true innovation maturity if they go beyond the basics of operational improvements to embrace innovation in a broader sense. Fortunately, they understand this imperative and recognise that incremental operational improvements will not enable long-term transformation. This report chronicles their efforts to date and suggests strategies they can adopt to enhance the returns on their innovation investments.

Defining innovation

One of the difficulties associated with discussing innovation is that the concept itself is both fluid and widely open to interpretation. To provide greater clarity, Doblin offers the following definition:

Innovation is the creation of a new, viable business offering. Simple enough, but more to the point: **Innovation [as separate from invention] is the creation of a new [to our market or the world], viable [creating value for both our customers and ourselves] business offering [ideally going beyond products to platforms, business models, and customer/stakeholder experiences].**

Of course, the application of this definition is complicated by the fact that innovation is too often asked to solve both the problem of the day (reducing capital

intensity, for instance) and every other problem at hand—which ultimately dilutes an organization’s ability to derive true value from it. That’s why Doblin also promotes a multi-faceted approach to innovation designed to help companies generate innovations that earn disproportionate returns and are more difficult to replicate. This approach begins with a simple framework, whereby innovation occupies one of three “ambition levels” (see Figure 1), which define its purpose or result:

- **Core** innovations optimise existing assets, products, and services
- **Adjacent** innovations incrementally expand existing business into “new to the company” business
- **Transformational** innovations are breakthroughs and inventions that are new to the industry or the world

Ambition levels serve not only as a useful way to align activities with the goals and objectives that innovation aspires to achieve, but also as a framework to manage innovation investments.

Our research suggests that the most successful innovators manage their innovation efforts and investments as a portfolio of activities that is balanced across the levels. While every company’s circumstances are unique, the world’s leading innovators in the industrials sector have on average 70% of their innovation investments and activity occurring in the Core, 20% in the Adjacent level, and 10% in the Transformational level. The expected returns on the innovation investment tend to work in the reverse order: 70% from Transformational innovation, 20% from Adjacent, and only 10% from Core.

Figure 1. Innovation ambition levels

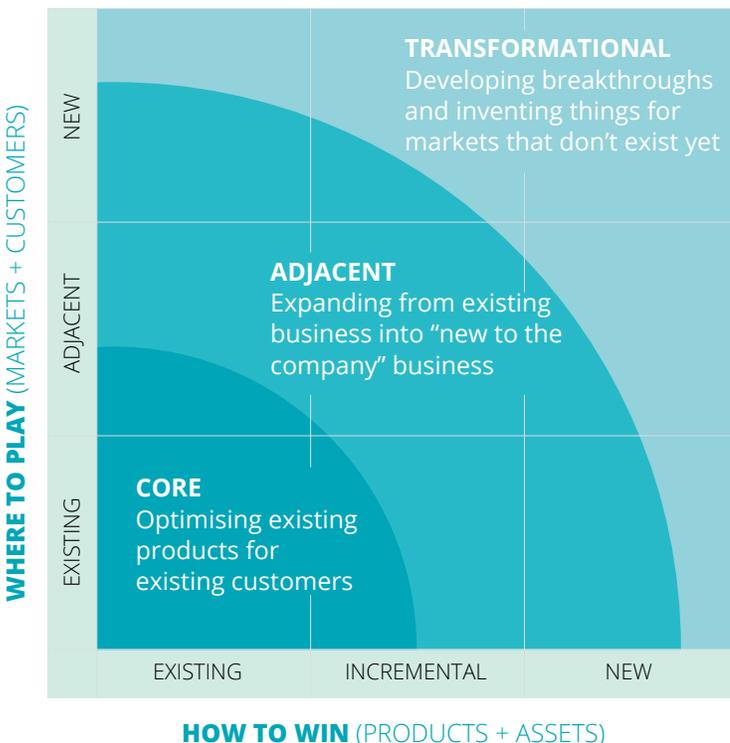
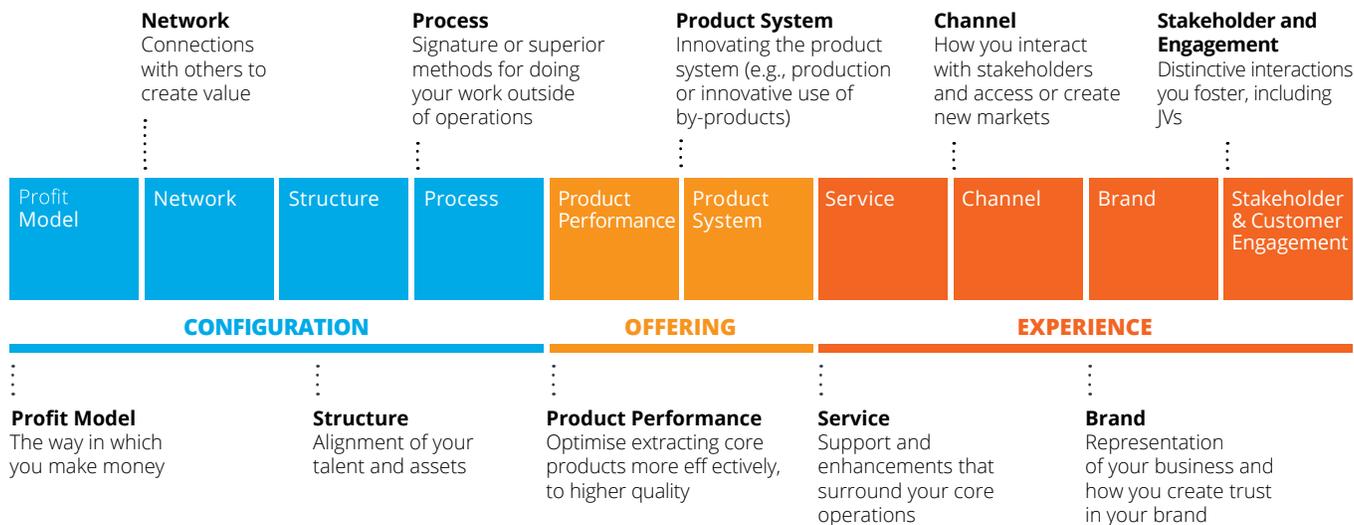


Figure 2. Ten types of innovation



Source: Doblin ten types of innovation strategy.

In your own words

“Our focus is on core innovation, not transformational, but this is a slowly maturing process.”

“We do not have systems in place for transformational innovation.”

Ten types of innovation

The second part of our multi-faceted approach can help in this regard by identifying ten distinct types of innovation that companies can pursue across three categories (see Figure 2):

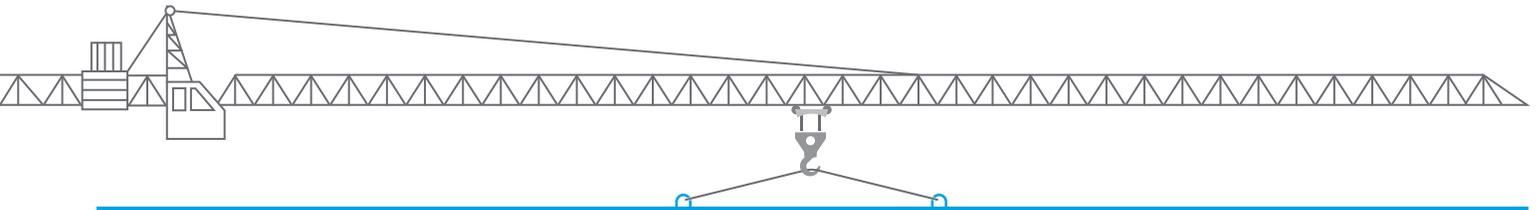
- **Configuration** innovations apply to profit models, networks, structures, and processes. This comprises the “back of the house” activities needed to develop the offering.
- **Offering** innovations apply to product performance and product systems. This is what companies produce and how they extract resources from the ground.
- **Experience** innovations apply to services, channels, brands, and stakeholders. This is how an offering is delivered to customers and how stakeholders are engaged as a company performs its business activities.

Notably, our research shows that the more types of innovation companies pursue, the greater the return to shareholders. Even more critically, shareholder return is further maximised when companies pursue Configuration and Experience innovations, rather than confining their focus to Offering innovations, which are typically easier to replicate.

This explains why leading mining companies have begun to pursue innovation more broadly. Examples include Rio Tinto using driverless trucks (Offering), BHP Billiton launching its ‘World-class Supplier’ program in Chile¹ to challenge suppliers to resolve key business problems while helping them develop their capabilities to do so (Configuration and Experience), Antamina’s advanced controllers for their crushing and processing facilities (Configuration and Offering), and Vale enhancing both its environmental performance and community outreach through its S11D project² (Configuration, Offering, and Experience).

1. <http://www.bhpbilliton.com/society/ourcontribution/world-class-supplier-program>
 2. http://saladeimprensa.vale.com/en/Paginas/Articles.aspx?r=Vale_inaugurates_the_largest_project_in_the_history_of_the_mining_industry_&s=Mining&rID=979&slD=6





Innovation in action

In December 2016, Vale opened its largest iron ore mine, in Brazil. The Eliezer Batista S11D Complex includes a mine, plant, railroad, and port logistics designed to vastly reduce the company's environmental impact. By locating in an already-deforested area outside the Carajás National Forest, Vale reduced vegetation clearance in the forest by roughly 40%. The company also adopted a range of technological innovations that promise long-term environmental benefits. For instance, rather than using trucks to transport ore to the plant, Vale installed mobile excavators and crushers—a system that will reduce fuel consumption by over 70% and reduce waste from used tires, oil filters, and lubricants. Additionally, the ore is being processed using the moisture it naturally contains, cutting down water consumption by 93% relative to the conventional process. The company also anticipates saving 18,000 MW of electricity per year—enough to power roughly 10,000 homes.

Source: http://saladeimprensa.vale.com/en/Paginas/Articles.aspx?r=Vale_inaugurates_the_largest_project_in_the_history_of_the_mining_industry_&s=Mining&rID=979&slD=6

Building blocks and capability levers

To deliver the kinds of innovations required to outperform the competition and drive growth, mining companies must increasingly expand their innovation focus beyond technological improvement and operational excellence. Doblin notes that leading companies typically exhibit capabilities across four key building blocks (see Figure 3). Each of these four building blocks is associated with specific capability levers (12 in total) that organizations need to focus on to embed innovation into their structures.

A closer examination of how successful serial innovators use their building blocks and capability levers suggests:

1. They employ a tailored Approach built around clear definitions and methodologies for the work to be done in generating innovations—phases, activities, deliverables, and decision rights.
2. They structure the Organization to house the innovation competency—teams, divisions,

leadership—and establish interfaces for connecting it to the broader enterprise and the world.

3. They acquire and nurture the appropriate Resources and Competencies, i.e. the people who perform the work of innovation; the skills, tools, and training they need to do it capably; and the funding and time to fuel it.
4. They have developed the right Metrics and Incentives with targets to guide performance, i.e. measures to evaluate progress, and incentives (monetary and non-monetary) to drive the supporting behaviours.

The investments companies make in each building block will hinge on their individual strategies, the types of innovation they hope to pursue, and their innovation ambition. Pursuing Transformational innovation, for instance, requires a different innovation process and skills to pursuing Core innovation. That said, organizations that fail to systematically build the requisite

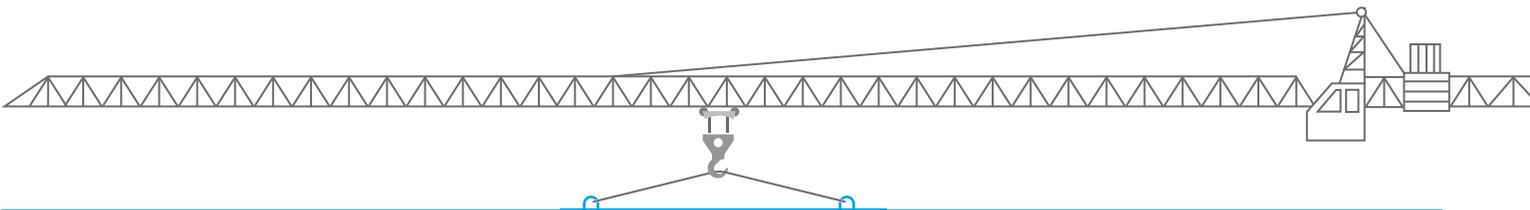
organizational systems, capabilities, and metrics cannot hope to gain the traction required to become serial innovators. To innovate at will, companies must manage their innovation efforts as a portfolio, adopt organizational structures to support innovation across business units, engage personnel beyond the technology and R&D groups, and compensate them appropriately.

In your own words

“Some of our key innovation drivers include cost (lean process, failures, capacity) and environmental regulations (sustainability, safety, regulation, stakeholder relationships).”

Figure 3. Innovation building blocks

 APPROACH	 ORGANIZATION	 RESOURCES AND COMPETENCIES	 METRICS AND INCENTIVES
<ol style="list-style-type: none"> 1. Innovation strategy Goals for innovation and thematic opportunities to pursue 2. Pipeline and portfolio management How the collection of innovation initiatives are managed in a pipeline and portfolio 3. Process How innovations move from abstract hypotheses and ideas to launched businesses 	<ol style="list-style-type: none"> 4. Senior leadership How senior leaders engage with innovation 5. Governance How and by whom innovation decisions are made 6. External connection Mechanisms for identifying and leveraging external capabilities, partnerships, and solutions to deliver innovations 	<ol style="list-style-type: none"> 7. Funding The amount of financial resources devoted and the mechanisms for accessing the funding 8. Talent management Attracting and deploying those with the right skills at the right time to do the work of innovation 9. Innovation tools Specialised protocols, software, techniques, etc. for different aspects of innovation 	<ol style="list-style-type: none"> 10. Financial and non-financial rewards Monetary incentives, formal and informal recognition of contributions to innovation 11. Innovation metrics Targets and indicators to guide innovation decisions and measure progress 12. External attraction How you foster and incentivise other organizations or groups to participate in innovating on your platforms



Innovation in action

Six ‘robust’ drones, specially designed to survive in altitude, will be flying over Antamina’s operation in Ancash in the coming months. From the top, the drones will monitor 120 giant trucks and stream the image to a closed-circuit system that authorized executives can access on their cell phones anywhere in the world. Below, no one will control the drones in the air—instead they will be operated automatically while still giving users the ability to zoom out to a certain area. Although the company first experimented with commercial drones, they couldn’t survive the air density at 4,300 meters above sea level. In fact, they grounded after seven minutes of flight and could fly only 50 meters from their point of departure. Rather than waiting for the technology to mature, Antamina decided to develop an innovative drone proprietary technology through Qaira, a Peruvian start-up. The company plans to use its new drones to improve equipment maintenance and reduce downtime—ultimately boosting profits.

Source: <http://semanaeconomica.com/caso/los-drones-de-antamina-van-a-la-caza-de-la-eficiencia/>

Key findings

In Latin America, innovation among both majors and juniors remains mostly focused on the Core level. According to study participants, the lack of a well-defined innovation strategy results in sporadic innovation efforts confined largely to uncovering operational efficiencies and driving short-term performance improvement.

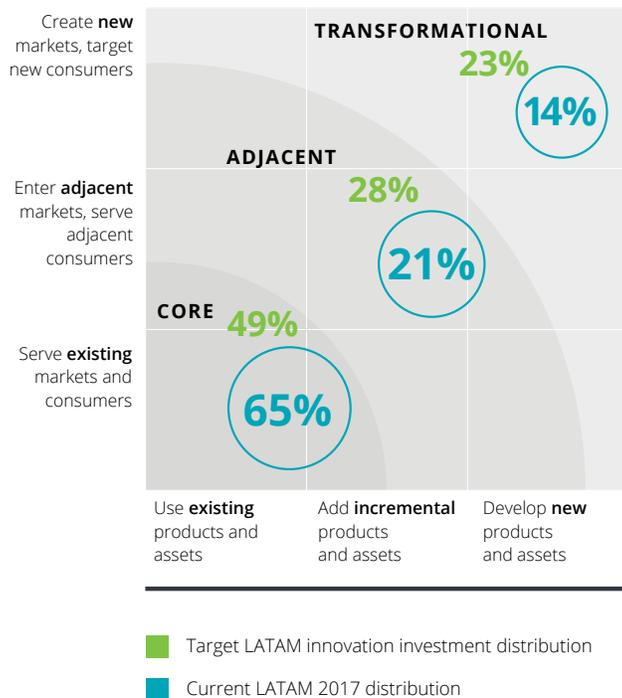
Based on the responses from study participants, the current breakdown in the region's mining innovation was 65% Core, 21% Adjacent, and 14%

Transformational. Despite this emphasis on Core innovation, Latin America's mining companies explicitly aim to engage in more Adjacent and Transformational innovation in the years to come. Specifically, they are targeting an ambitious portfolio of 49% Core, 28% Adjacent, and 23% Transformational (see Figure 4).

The trend line within the region's innovation matrix generally parallels those revealed in the Deloitte Canadian, African, and Australian surveys (see Figure 5). Around the world, mining companies acknowledge

that they must look beyond Core-level product innovations and aim much higher, ultimately aspiring to more Adjacent and Transformational breakthroughs. This will, however, require a shift in thinking. Currently, Latin America's mining companies remain reluctant to adopt Adjacent innovations in-house or to make long-term investments in Transformational innovation given its perceived risk levels. To overcome these barriers, companies will likely need to increasingly leverage external ecosystems and collaboration networks.

Figure 4. Innovation ambition matrix



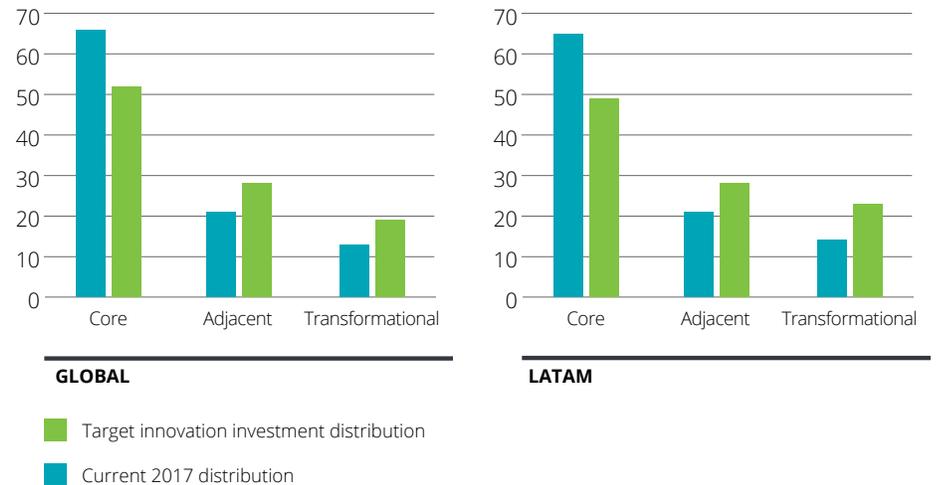
In your own words

“We focus on improving our current processes and systems, not on transformational innovation.”

“Most companies find innovation challenging and daunting. They do not know where to start or what will drive the most value.”

“Transformational innovation is needed in order for our company to survive, improve, and stay competitive.”

Figure 5. Innovation ambition comparison (global vs. Latin America)

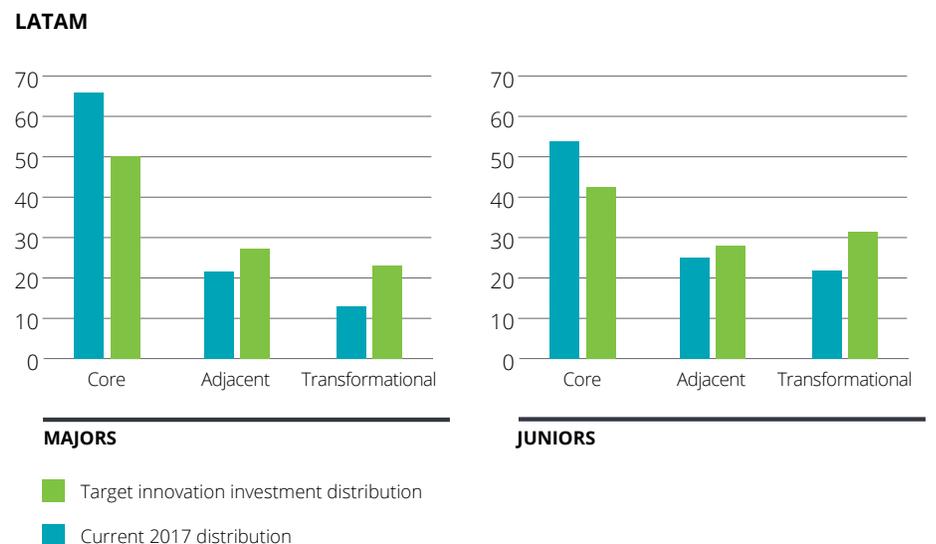


Global results include 2015 and 2016 research data, based on the publishing of past Canadian, South African and Australian reports.

While the industry’s aspirational targets hold true among both majors and juniors, juniors believe that they are currently more focused on Transformational innovations than majors, and expect to remain so (see Figure 6). This comes as no surprise given the propensity of both juniors and

service companies to push the boundaries around innovation. Whether out of necessity due to a historical lack of resources or as a result of innate adaptability, they have adopted a culture of open innovation that has enabled them to find unconventional solutions to complex problems.

Figure 6. Innovation ambition comparison (majors vs. juniors)



Innovation importance by type

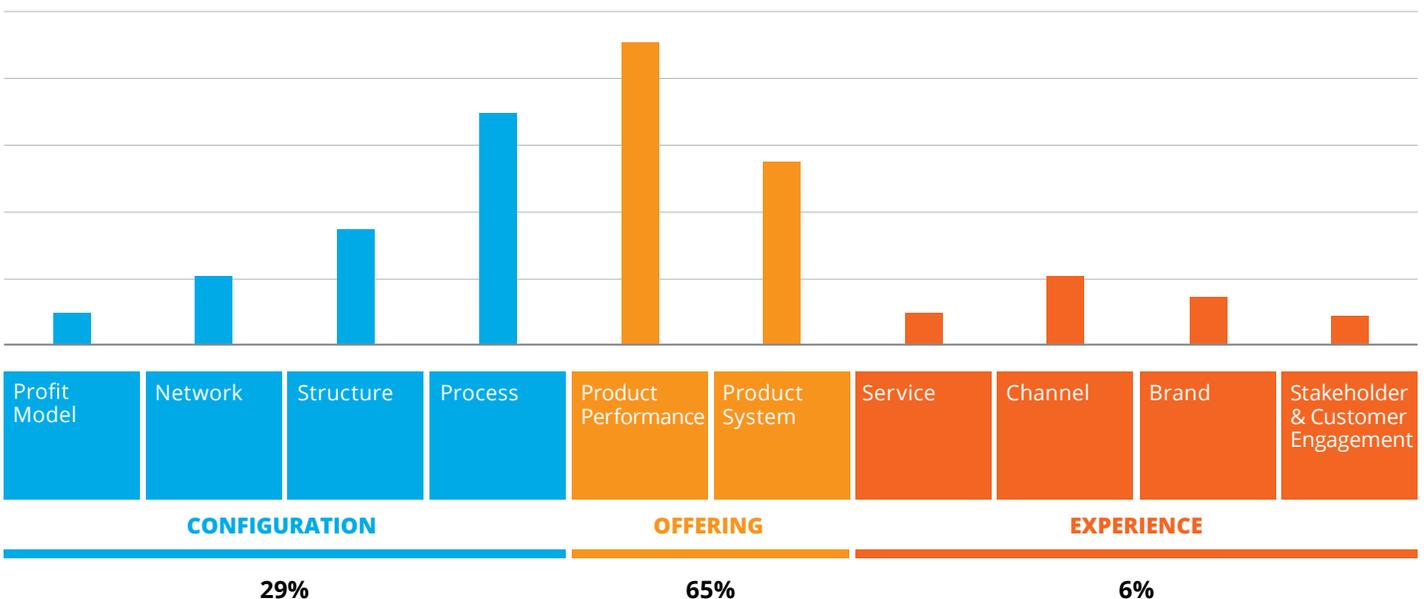
As noted earlier, Doblin identifies ten types of innovation. Survey participants were asked to rate the importance of each type to the competitiveness of their companies. They were also asked to consider how effective their companies were at producing innovations within each type. By a wide margin, respondents identified Product Performance (i.e. optimising the extraction of core products more effectively, and to a higher quality) as the type of innovation most critical to maintaining their competitiveness (see Figure 7). This mirrors the responses of both the Canadian and Australian studies. In comparison, respondents to the African study rated Profit Model (i.e. the way in which companies make money) as the most important.

Second and third in importance in Latin America were Process (i.e. signature or superior methods for doing work outside of operations) and Product System (i.e. the production or innovative use of by-products). Taken together, these rankings indicate a continued focus on Offering

innovations, reflecting the ongoing challenge mining companies face to drive innovation beyond their technical, IT, and R&D groups and into the wider organization.

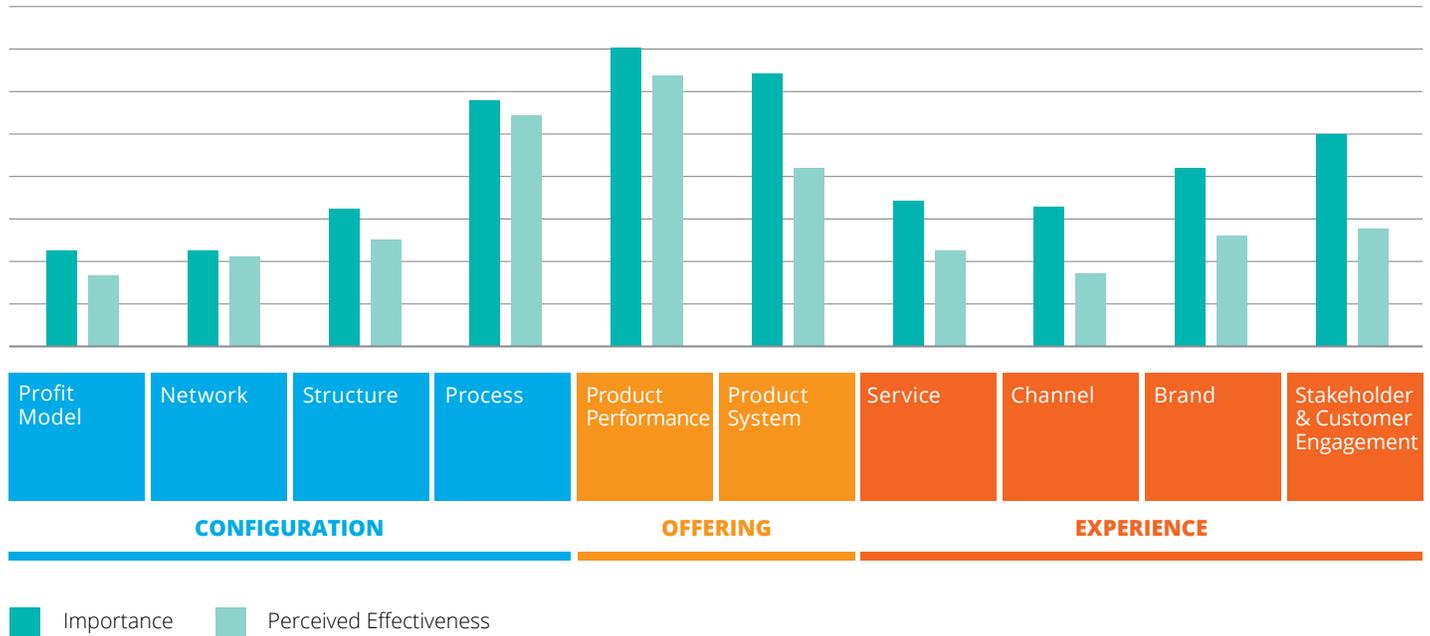
Interestingly, although Stakeholder/ Customer Engagement (i.e. distinctive interactions, including joint ventures) was not considered among the most important types of innovation to competitiveness, it ranked higher in Latin America than it did globally. This is almost certainly due to the region's difficult stakeholder environment and social license pressures. As mining companies continue to compete with local communities for access to scarce resources—including land rights, water, and electricity—opposition from environmental groups, NGOs, and community stakeholders has mounted. Over the years, these conflicts have been known to spill over into violence. Most recently, they even spurred El Salvador to ban all metal mining in the country. In light of these challenges, it makes sense that Latin America's mining companies are looking for ways to innovate around Stakeholder and Customer Engagement.

Figure 7. Current Innovation focus across the ten types of innovation



Source: Doblin ten types of innovation strategy.

Figure 8. Innovation importance and effectiveness across the ten types



Source: Doblin ten types of innovation strategy.

In your own words

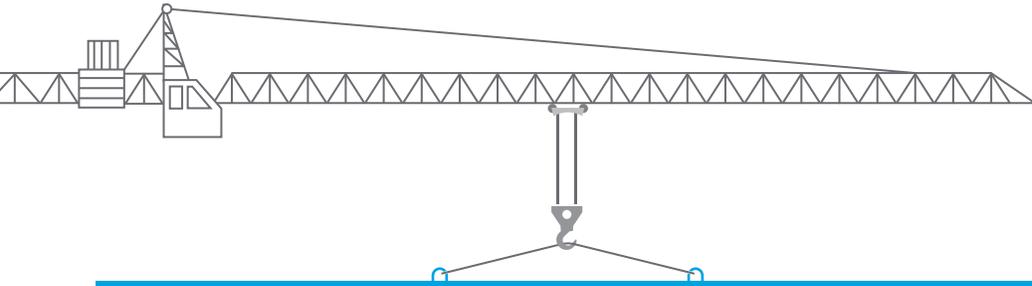
“Stakeholder involvement and engagement are key factors of success for innovation.”

Yet, despite these priorities, there is still a large gap between the perceived importance of these various types of innovation and companies’ effectiveness at them (see Figure 8). On the one hand, this suggests that Latin American organizations feel they still have a way to go before they can achieve their innovation ambitions. On the other hand, this gap underscores a considerable opportunity for the region’s mining companies to become partners of choice by engaging in innovation that strengthens environmental performance, delivers social value, and improves the livelihoods of local community stakeholders.

Innovation drivers

Respondents were asked to identify what drives innovation within their companies and to rank the importance of each factor. Of the top five drivers in Latin America, the first four mirror the results of the previous three surveys in this series, while the fifth is unique to the region. According to respondents, Latin America’s top five innovation drivers in the mining industry are:

1. Reducing costs to operate
2. Reducing risk
3. Safety
4. Improving asset productivity
5. Improving sustainability/reducing environmental footprint



Innovation in action

As part of its inclusive recycling project, Gerdau—a miner and leading supplier of long steel—helps legalise and increase the income of recyclable waste pickers and cooperatives in regions where it operates. Annually, the company recycles more than 14 million tons of scrap metal—resulting in improved product and service quality, improved quality of life for local employees, and stronger environmental practices. In fact, the World Steel Association chose Gerdau as the winner of the Steelie Awards in the Excellence in Sustainability category. Its project was also recognised by the Brazil Benchmarking program as one of the best environmental practices in the country.

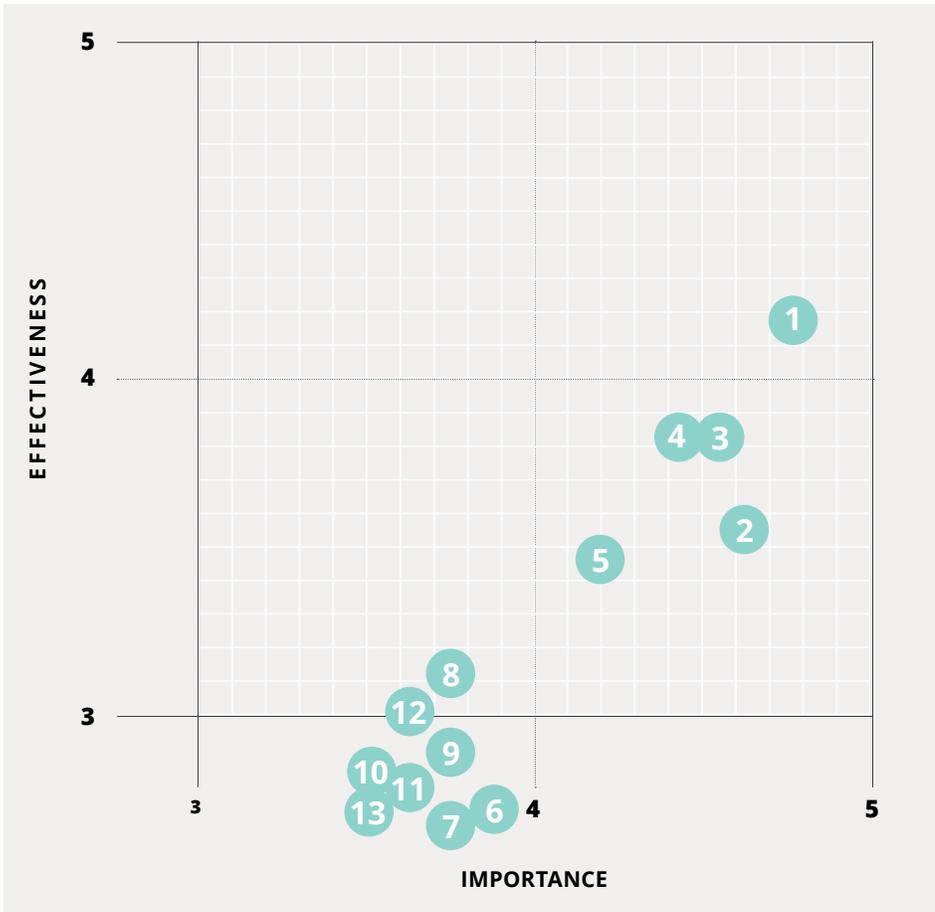
Source: <https://www.gerdau.com/br/en/environment-and-social-responsibility/social-responsibility/creating-shared-value>

In Canada, Africa, and Australia, the fifth most important driver was reducing costs to develop assets—which ranked eighth in Latin America. Encouragingly, the region's focus on sustainability and environmental performance heralds a positive direction for an industry working to continue earning a social license to operate.

Respondents were also asked to identify how effective they believe they are at innovating relative to each of the drivers (see Figure 9). Of note, perceived effectiveness generally lags behind

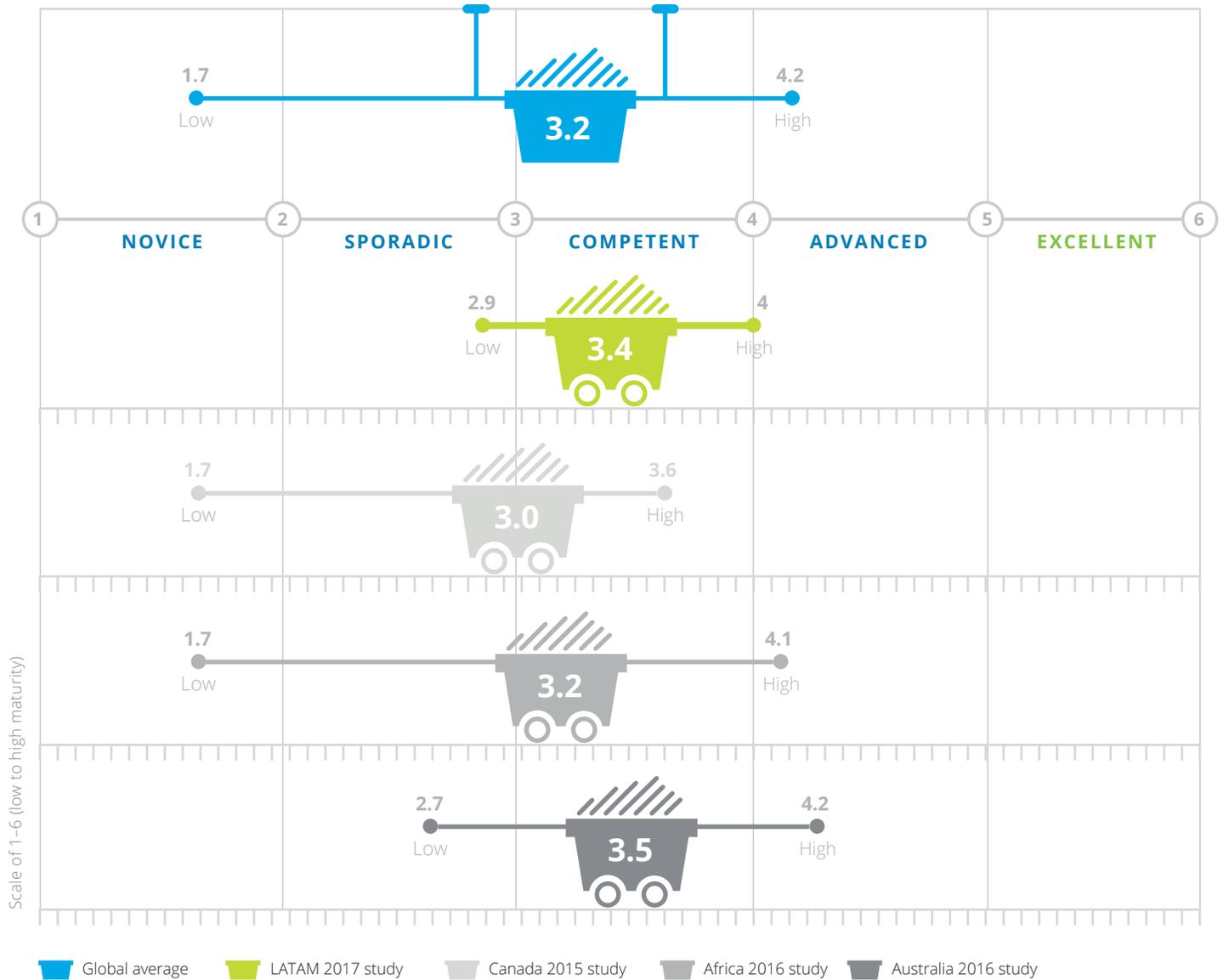
importance across most of the drivers. In fact, despite ranking as important drivers such as improving license to operate (indigenous, environmental, and landowner relationships) and improving employee relations and retention, Latin American mining companies feel they are not innovating effectively in these areas. Given the socio-economic and political realities of many countries in the region, it is apparent that companies will need to strengthen their performance in these areas if they hope to thrive into the future and gain competitive advantage.

Figure 9. Innovation drivers: importance vs. perceived effectiveness



- ① Reduce costs to operate
- ② Reducing risk
- ③ Safety
- ④ Improved asset productivity
- ⑤ Improving sustainability / reducing environmental footprint
- ⑥ Improving licence to operate / aboriginal environmental and landowner relationships
- ⑦ Improving employee relations and retention
- ⑧ Reducing cost to develop asserts
- ⑨ Improving licence to operate - regulatory relation and compliance
- ⑩ Adding more high value asserts
- ⑪ Improving time to develop asserts
- ⑫ Improving vender/contract management
- ⑬ Back office function effectiveness

Figure 10. Industry maturity scale: global comparison



Novice
Highly random efforts

- Innovation capability is not considered a key strategic imperative.
- No disciplined approach to innovation; haphazard processes, governance, and resourcing are the norm.

Sporadic
Fragmented efforts

- Need for systemic innovation capability often recognised.
- Pieces of an innovation system begin to emerge.

Competent
Increasingly repeatable

- Systemic innovation capability is nascent. Leadership is taking action to develop maturity.
- Pockets of reliable and repeatable processes, governance and resourcing are surfacing.

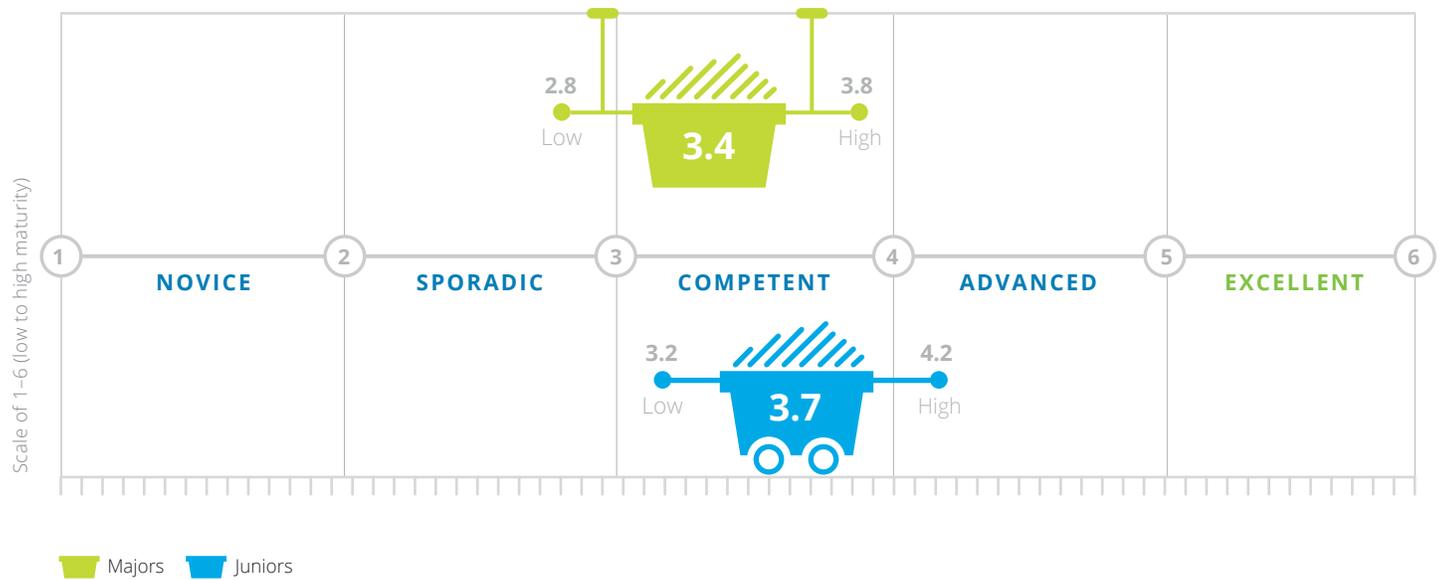
Advanced
Systematised efforts

- Critical capabilities for innovation functioning as a cohesive system are being developed.
- Clear innovation strategies are emerging and an innovation system is well defined.

Excellent
Adaptive capability

- Innovation becomes an organizational core capability.
- Innovation systems are refined and specialised capabilities are created to adapt to new opportunities and accelerate outcomes.

Figure 11. Juniors see themselves as more mature innovators than majors



Industry maturity

Figure 10 shows the scale Doblin uses to measure the extent to which companies have integrated innovation into their organization—their relative innovation maturity. Scoring low on the scale (1-2) suggests innovation efforts are more random, haphazard and lacking discipline—characteristics of a novice. Scoring at the other end of the scale (5-6) are those who regard themselves as truly excellent innovators, demonstrating adaptive capabilities that are ingrained within their organizational cores and supported by refined innovation systems.

The results reveal that the Latin American industry sees itself as competent in its innovation capability, and that the global industry as a whole has become progressively more mature over time—which makes sense, given the global nature of mining majors. While Canada appears to rank as least mature, this is more a function of the years that have passed since the

Canadian survey was conducted. Since that time, the mining industry has become more proficient at innovating—which explains why industry maturity has been rising with each consecutive study in this series.

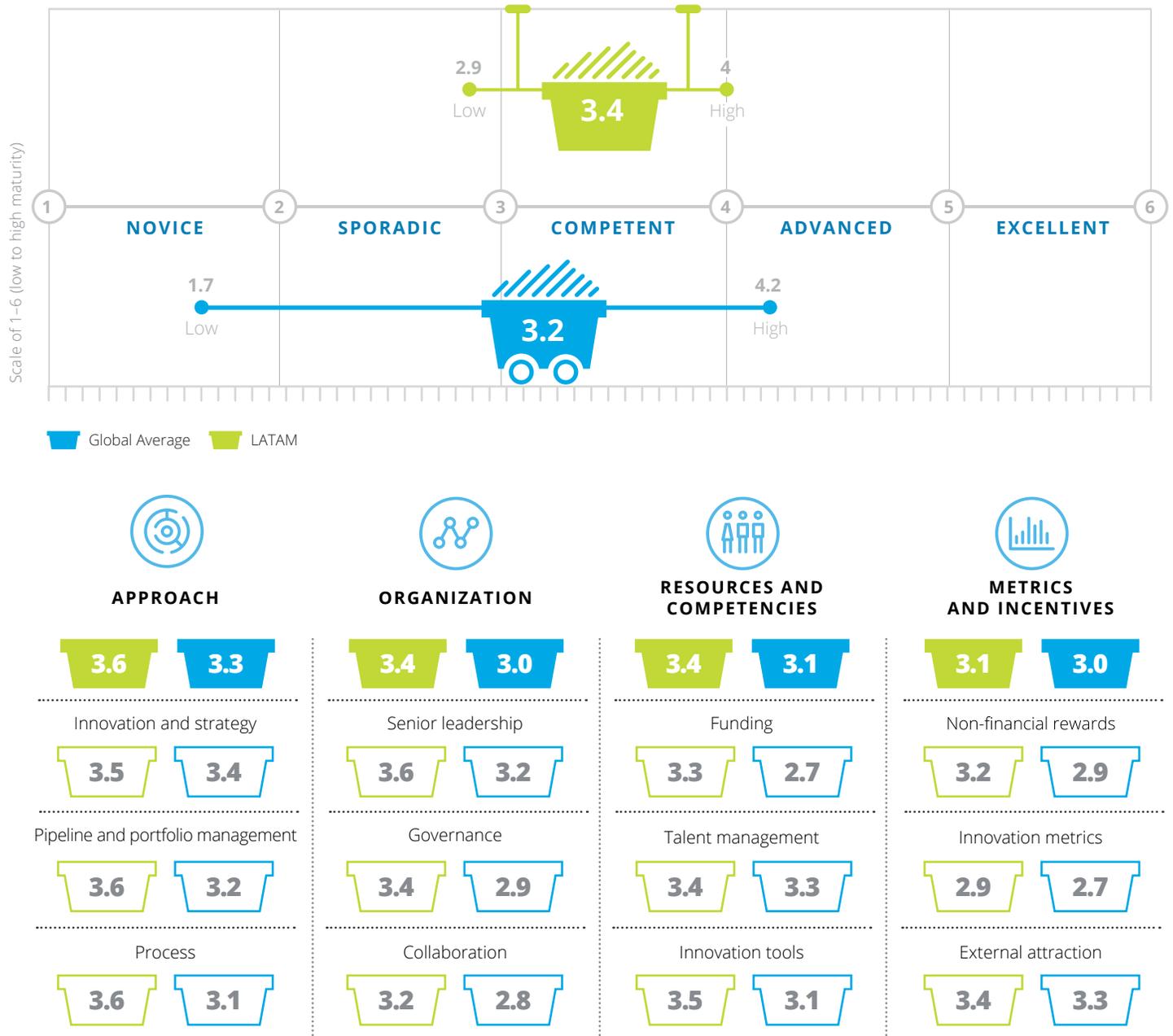
Yet, while mining companies scored themselves in the mid-range of competent across all our studies, we believe they consistently over-estimate their capabilities as effective innovators, particularly in comparison to other industries. In our experience, innovation in the mining industry tends to be more sporadic than similar efforts in other industries.

The preponderance of majors surveyed also affects the maturity rankings, as majors tend to have centralised innovation programs they roll out to different geographic regions in sequence. As a result, innovation capability tends to be more mature at sites where innovation programs pilot, rather than reflecting regional maturity.

Consistent across all regions is that juniors see themselves as more competent innovators than the majors (see Figure 11). However, the study also found—not surprisingly—that both majors and juniors still have some way to go before their innovation capabilities can be considered fully mature. On the plus side, the relatively tight spread in the results shows that the majors and juniors are largely moving forward together—a trend that may indicate that majors are beginning to adopt some of the more agile traits of juniors and service providers.

Finally, the 12 capability levers identified earlier were also scored on the maturity scale (see Figure 12). While Latin America’s mining sector shows particular strength in process and innovation tools, there is still room for improvement, as respondents consider themselves merely competent in these areas. The lowest score for Latin America was around innovation metrics, suggesting that respondents feel they lack appropriate metrics and do not yet encourage behaviours that will lead to them becoming successful innovators.

Figure 12. Maturity of innovation building blocks and capability levers



On a global basis, Latin America’s industry identifies itself as an emerging competent innovator across all 12 innovation capability levers. The largest challenges companies face in their attempts to become systematic innovators are in the areas of innovation metrics, financial and non-financial rewards, and collaboration. This suggests that Latin American respondents question their maturity relative to providing their people with incentives to pursue innovation, and that they believe that they must improve internal and external collaboration to achieve successful innovation outcomes.

On the flip side, however, the region’s companies score relatively lower than their global counterparts when it comes to long-term innovation strategy. Although innovation is on organizational radars, its objectives are generally not aligned or integrated with the company’s overall strategic goals, and innovation strategies are not sufficiently robust to respond dynamically to external shifts. Executive interviews confirmed these results: without a clearly-defined vision, companies lack a wider strategic context for their innovation decisions, resulting in a fragmented approach and hampering

APPROACH



With ore grades slowly declining, companies are under mounting pressure to improve operational excellence. This is a particularly thorny issue in Latin America, where there remains opportunity to improve labour productivity. While most mining companies understand that innovation is required to close this gap, their approach to innovation remains haphazard. On the one hand, respondents feel they are effective when it comes to both pipeline/portfolio management and process. They believe they are selecting the right innovation areas to focus on, and that they have knowledge of the strategic capabilities and assets they need to succeed. Similarly, they are confident in the processes they’ve adopted for the launch of their innovation initiatives, as well as those used post-launch to integrate customer insight and feedback.

the ability of the innovation groups to get buy-in from operations. Many companies also lack a disciplined approach to monitor innovation initiatives from concept to prototype to pilot. As a result, they remain focused on short-term, lower-risk Core innovation (such as the adoption of already-proven digital technologies), rather than embracing Transformational innovation potentially capable of delivering longer-term larger returns.

The crux of the matter is that there is significant room for improvement in framing an innovation strategy around the opportunities and industry shifts that matter most. Companies need to be agile in managing their innovation portfolios, which requires trying new things, adjusting quickly, and not being afraid to fail. Currently, this type of rapid trial and error is not happening broadly.

In your own words

“There is no company-wide program to direct innovation initiatives.”

“We have no organized approach to innovation. We’re very creative, but not disciplined. As such, our ideas have difficulty gaining traction.”

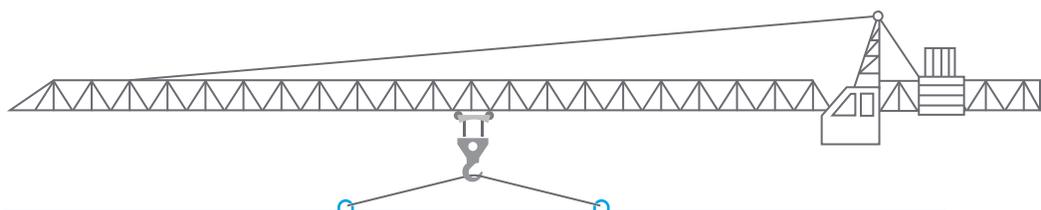
“We don’t have systems in place for incremental innovation, which makes it difficult to drive long-term innovation.”

ORGANIZATION



Compared to their global peers, Latin American companies ranked their governance systems as relatively strong, with formal structures in place to enable innovation—a result that makes sense given the region’s more hierarchical operating structures. Similarly, respondents believe that the right internal stakeholders are involved in the innovation decision-making process and that senior leaders are communicating a compelling innovation vision. Yet, despite this support, decision-making processes remain sluggish. Collaboration is also typically weak, both internally among business units and functions, and externally among the sector at large.

To progress towards more mature innovation, a cultural shift is required. For instance, companies must empower an entire team of leaders to champion innovation by enabling them with the right processes, technologies, and know-how. They need structured innovation processes that cut across business units and support innovative ideas that arise from every level of the business. Additionally, they must be willing to collaborate across the mining value chain—both within and among internal functions, and externally throughout the ecosystem of majors, juniors, suppliers, start-ups, governments, educational institutions, and other stakeholders.



Uncovering greater value

Driving Adjacent and Transformational innovation, which is where the greatest value typically lies, often requires new organizational structures and interfaces. These can include immersive innovation environments, or “greenhouses”, that both retain knowledge and stimulate innovation; service centres that use distinct expertise to support the innovation efforts of different business units; and highly distributed systems where most employees have some innovation responsibility. The two constants are: (1) the preferred structure(s) must foster collaboration across functions and divisional silos without being impeded by internal bureaucracy or politics; and (2) they must interact well with the existing business units.

In your own words

“We need to make more efficient decisions when it comes to innovation.”

“There is a low availability of internal teams to support the innovation process. This ends up demotivating our people from pursuing innovation.”

“There are no clear roles and responsibilities around innovation. As such, it is seen as a heroic effort people need to accomplish in addition to their day job.”

RESOURCES AND COMPETENCIES



Although Latin American respondents perceived that internal resources are being allocated and used efficiently, they still struggle to access timely funding for innovation. A big part of the problem is that innovation is often funded through operational or capital budgets, with few dedicated resources in place—resulting in innovation efforts that are largely focused on meeting short-term goals that provide quick returns. As such, organizations have difficulty developing strong competencies around innovation—particularly in the area of talent attraction.

Although respondents believed that their cross-functional talent possesses many of the right skills for innovation, it remains challenging to attract and retain talent with the agility and creativity required to become more mature innovators. Similarly, while respondents felt that they regularly identify and leverage the most relevant innovation tools and technologies, they were less confident about the technology used to generate stakeholder and customer insights and explore new business models—hampering their ability to use innovation to drive business value.

In your own words

“One of our stronger innovation capabilities revolves around the way we deploy our human capital. We are committed to engaging all of our people across the organization.”

“We invest a lot in innovation. We have a department that is focused on innovation that is constantly looking for improvements and new forms of automation.”

METRICS AND INCENTIVES



There is no question that corporate innovation initiatives must begin with the development of a robust business case. Given the ongoing focus on cost efficiency, mining executives must still justify their innovation expenditures. However, even the best business case will not spur innovation if budgets are unavailable. To drive real transformation, companies also need to adopt new organizational approaches—ones that clearly define their strategic priorities, align with business needs, empower business units to take ownership over new innovations, and link enterprise-wide goals to appropriate operating models.

Similarly, to move up the innovation maturity curve, it is important for mining companies to set aside a dedicated innovation budget, separate from operating or capital budgets. This will allow them to manage their innovation as a portfolio across the company, rather than running isolated initiatives across different business units

and functions. It also enables more efficient capital allocation aligned to enterprise-wide innovation goals. At the same time, it is worth noting that these budgets do not have to be excessive. By scanning the external environment for new ideas (both within and outside the mining sector) and partnering with others to diversify risk, companies can position themselves to innovate on a budget—ultimately working smarter, rather than harder.

In keeping with global benchmarks, respondents in Latin America cited a lack of effective innovation metrics and KPIs, along with inadequate incentive systems to motivate the pursuit of innovation opportunities. Despite a few outliers, innovation metrics largely remain underdeveloped and poorly integrated with overall management metrics. Most respondents felt that existing metrics do not encourage behaviours that will lead them to be successful innovators.

In your own words

“We tend to be weak at budgeting when it comes to innovation. Our primary weakness is accessing appropriate sources of financing.”

In your own words

“We do have some funding but it is mostly focused on short-term core innovation that has proven returns.”

“Our budgets seem to be used to solve short-term operational problems rather than to pursue long-term innovative solutions.”

Although respondents believed that current incentives encourage risk-taking and reward long-term innovation, these results are not being realised in practice. With no clear guidelines or direction from leadership, employees do not feel empowered to explore new ways of doing things. Notably, before innovation can be delivered as a discipline, organizations must have the ability to both measure its effectiveness and incentivise appropriate employee behaviours. One global company is tackling this challenge by setting aside small portions of its mine sites as innovation testing grounds where operators are not held to stringent quota and production requirements. This frees them up to think big, test small, fail fast, and iterate quickly before scaling proven innovations to other parts of the mine or to other sites.

A lack of government incentives is also a major hurdle to mining innovation. Most respondents felt that government programs were not easily accessible, inhibiting them from maximising all potential government incentives that relate to innovation.

With more work needed around internal alignment, some companies are turning to external sources for help in sparking new ideas, and many acknowledge that working within an innovation ecosystem is becoming increasingly important. Despite this recognition, Latin America lags global rankings in terms of attracting assistance from external partners.

In your own words

“We have no metrics in place to incentivise innovation.”

“We need good partners to guide us in challenging our current core processes.”

“We are still operating in an immature ecosystem where there are only isolated initiatives from individual companies.”

A vision for the future

Based on the definition of innovation set out in this report, it's clear that Latin America's mining companies have made advances in their innovation efforts in recent years. Through a focus on operational excellence, continuous improvement and the introduction of a variety of process and product improvements, companies have largely remained focused on Core innovations that do not require them to reconceive their approaches, organizational structures, resource models, or incentive systems.

There are several reasons for this hesitance to move beyond the core. First, mining companies around the world are traditionally averse to take on new risks that may impact their cash flow or license to operate—reducing their propensity to pursue Transformational innovation. Although opportunities to innovate exist—such as government-sponsored hackathons and prizes awarded to innovators—companies remain unlikely to participate until they fully understand the value of less conventional innovation.

Second, mining companies' propensity to favour short-term cash flow generation often works to the detriment of creating longer-term net present value. As such, innovations that may reduce costs over a product's or process's lifecycle are often dismissed if certainty around short term returns are not there. The imperative to operate within tight budgets and meet aggressive production targets makes many mining companies unwilling to take new risks or try unproven processes. Often procurement practices are so

focused on lowering per unit costs that there is an unconscious bias against innovators whose costs exceed the lowest cost competitors—even if they're delivering superior offerings. This has become a sticking point among service companies and juniors that have developed potentially business-altering innovations that majors resist adopting given the challenges associated with calculating the lifetime value of new innovations.

Third, mining companies often lack a clear vision to guide and enable longer-term transformation. Without this vision (i.e. to become the lowest cost operator, minimize the mining footprint, build a fully automated mine, etc.), they struggle to tackle and derive value from innovation. To determine the types of innovation they will pursue to realise transformational change, mining companies must define the dimensions of their vision. Only in this way can they assess the extent to which they will reduce their carbon footprint, pursue automation, uncover new ways to process minerals, develop innovative in-situ leach processes, and/or partner with key stakeholders.

Fourth, mining companies are historically inclined to operate in isolation. Concerns around intellectual property (IP) rights and competitive advantage make companies distrustful of collaboration and hamper the juniors' and service providers' efforts to co-create or co-invent in partnership with the majors—despite the fact that this type of collaboration can accrue to the benefit of shareholders.

In your own words

“We are limited on how innovative we can be because we are only one component of a greater value chain. Too often, the operations units do not want to be disturbed by innovation.”

“We don't always have the courage and certainty to take risks related to innovation.”

“In order for us to become better innovators, we will have to assimilate the mind set into day-to-day activities across the company.”

In your own words

“It is hard to drive long-term innovation where returns will only be realised in three to five years.”

“Our innovation focus is on realising short-terms returns.”

“We have a mix of innovation types that we focus on, however it becomes difficult because operations is resistant to any innovation that will disrupt production.”

The collaboration conundrum

The challenge is that collaboration does not seem to be within mining companies’ DNA. There are several reasons for this. In some cases, legal agreements become so complex that their value is diluted—making collaboration more difficult. In other cases, organizations have not clearly defined which innovations to collaborate on and which to retain in-house. The very structure of many mining companies also makes it difficult to drive synergies across mine sites—resulting in siloed operating approaches rather than fostering a culture of collaboration.

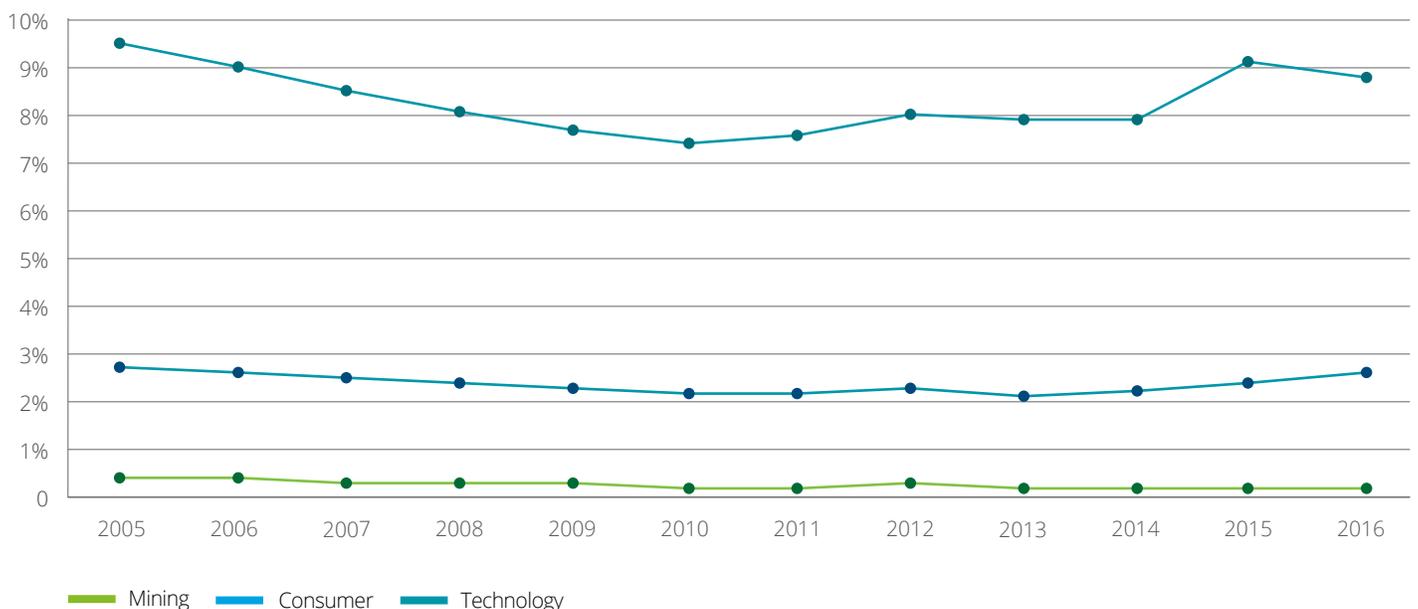
Critically, the nature and scope of the industry’s challenges increasingly make this approach less viable. The R&D groups at most mining majors have been hollowed out—both in terms of human resources and budgets (see Figure 13)—since their apex in the 1990s, when many miners had large research groups and budgets. As a result, the model for innovation has fundamentally shifted. Today, majors must increasingly rely on service and supply companies and juniors to take the lead by acting as catalysts for innovation.

In short, to thrive into the future, Latin America’s mining companies must be willing to collaborate and embrace strategic alliances with suppliers, service companies, governments, educational institutions, industry associations (e.g. Peru’s Sociedad Nacional de Minería, Petróleo y Energía), and research institutes (e.g. Fundación Chile). These types of collaborative ecosystems are essential enablers of the Adjacent and Transformational innovations needed to drive the industry forward—innovations that are desperately required to meet rising shareholder demands to develop more inclusive and sustainable approaches to mining.

In a similar vein, companies must take strides to invite more diversity into their organizations. Diversity of thought can do more than create a foundation for enterprise-wide innovation. It can also help companies gain a broader understanding of stakeholder concerns—which can position them to attract much-needed funding, diversify their risk, and improve their returns.

Figure 13. Mining R&D spending is declining and lags other industries

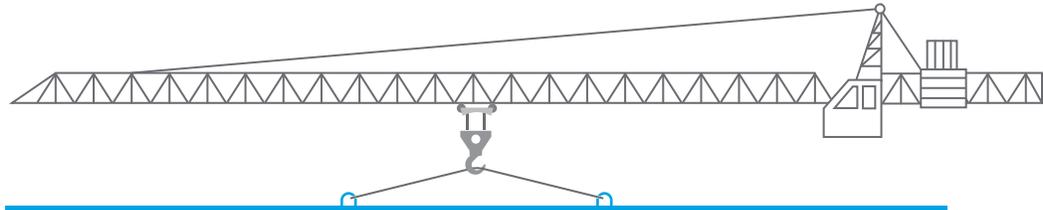
R&D / Sales



In your own words

“We need strong partnerships to guide us in challenging our current core processes.”

“We have good relationships with some institutions and universities, but we need to work further on collaboration.”



Innovation in action

The Sociedad Nacional de Minería, Petróleo y Energía (SNMPE), through its Innovation and Technology Committee, is promoting the development of a Peruvian innovation ecosystem focused on the key priorities of leading mining companies. In 2016 and 2017, SNMPE organized two mining hackathons that attracted the participation of more than 45 public and private universities in Peru. Together, the teams developed 48 solutions focused on environmental management, community relationship management, operational excellence, and safety. The winners are now involved in an incubation program, where they are receiving support and guidance to improve their business proposal and are testing their solutions with mining companies interested in adopting them.

Source: <http://www.hackaton.snmpe.pe/snmpe-hackaton-ganadores.htm>

Collaboration models

Notably, there are several different collaboration models mining companies can adopt:

- **Venturists** have a clear vision of their intended mid- to long-term mining model, which allows them to take stakes in carefully-vetted start-ups capable of helping them address their predefined goals.
- **Outsourcers** create collaborative arrangements with suppliers and start-ups to jointly solve fully-disclosed problems by testing small and scaling fast.
- **Team players** foster industry collaboration among peers, juniors, suppliers, and research institutes to jointly solve common problems by developing open innovation systems and platforms.
- **Fraternists** foster close ties with a rival company to develop mutually beneficial resolutions to common problems by establishing clear rules surrounding IP, dedicating resources, and empowering teams to solve audacious goals.

While collaboration is not the only approach to resolving the innovation conundrum among Latin American mining companies, it can go a long way towards encouraging the steady stream of innovations needed to build sustainable business models over time. Structured deliberately, collaborative ecosystems allow mining companies to de-risk the innovation process.

Through open industry forums, for instance, suppliers and other members of the mining ecosystem can work together to resolve mining company issues—enabling companies to reap the advantages of diversity of thought. Similarly, hackathons encourage large numbers of people to engage in collaborative development projects—a process that reduces innovation costs while empowering industry stakeholders. Collaborative ecosystems can even enable cross-border collaboration by uniting mining clusters with similar challenges across geographical boundaries.

These types of ecosystems make it clear that innovation does not require prohibitive budgets. In fact, as service companies and juniors have amply demonstrated, it can often be accomplished with constrained funds, particularly when external partnerships are leveraged. The key now is to bring more structure and support to the process in an effort to develop large-scale mining innovation hubs.

To work effectively in an ecosystem, however, all participants must make concessions. Each party will likely have different perspectives on the appropriate control environment, capital allocation processes, and the end-use of IP, making it imperative to adopt clearly-defined rules around the partnership's approach, organization, resources and competencies, and metrics and incentives.

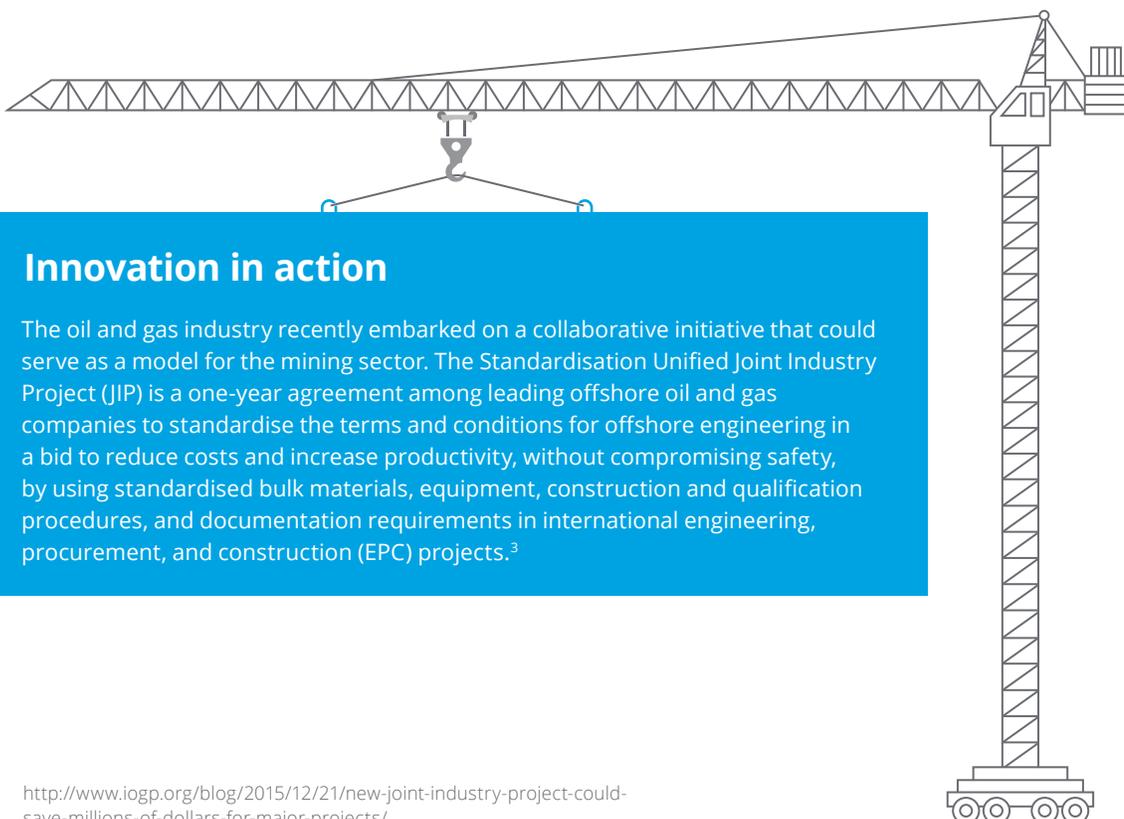
Similarly, to develop robust mining clusters, Latin America's mining companies must differentiate their individual competitive advantages (core strengths that should

remain in-house) from the comparative advantages available to them should they choose to compete as a region. This can help them assess which innovations can and cannot be developed collaboratively, and position them to work together to create a shared vision for the sector—one that ties business success to the prosperity of local communities and stakeholders.

In fairness, there is no simple solution for fostering enhanced collaboration among majors, juniors, suppliers, communities, labour unions, governments, and special interest groups. What is clear, however, is that it requires more than a financial investment in isolated projects. Instead, it mandates all stakeholders to work together to create a shared vision for the sector and agree on how the ecosystem will thrive as a whole. To develop joint audacious goals and move towards more open innovation, it is imperative to tie business success to the prosperity of all stakeholders in the ecosystem, including host communities and countries.

In your own words

“We have found that we can resolve very specific issues by partnering with innovative start-ups.”



Innovation in action

The oil and gas industry recently embarked on a collaborative initiative that could serve as a model for the mining sector. The Standardisation Unified Joint Industry Project (JIP) is a one-year agreement among leading offshore oil and gas companies to standardise the terms and conditions for offshore engineering in a bid to reduce costs and increase productivity, without compromising safety, by using standardised bulk materials, equipment, construction and qualification procedures, and documentation requirements in international engineering, procurement, and construction (EPC) projects.³

3. <http://www.iogp.org/blog/2015/12/21/new-joint-industry-project-could-save-millions-of-dollars-for-major-projects/>

Concluding view

It can be tempting to think of innovation solely in terms of products and technologies. Indeed, it's now widely accepted that exponential technologies—big data, the Internet of Things, 3D printing, wearables, etc.—will disrupt how most sectors operate. Dealing with this disruption—along with increasing environmental mandates, growing community concerns, and mounting shareholder demands to develop more sustainable approaches to mining—will require a broader, more structured approach to innovation. It also requires an innovation vision that

is fully aligned with business strategy and integrated into corporate planning cycles. Whether they're seeking to develop a new technology, process, or business model, or to find new applications for existing ones, companies are encouraged to embrace three key principles:

1. Be explicit about your innovation ambition, then organize and execute accordingly.
2. Build an innovation discipline—because innovation almost never fails due to a lack of creativity.

3. Look beyond product innovation and explore the full 10 types of innovation, in particular leveraging the configuration and experience categories
4. Foster a culture of internal and external collaboration and learn how to operate effectively in an ecosystem

The following recommendations are offered in that vein to help companies set targeted priorities for maturing their distinct innovation capabilities:

MAJORS

APPROACH	ORGANIZATION	RESOURCES & COMPETENCIES	METRICS & INCENTIVES
<ul style="list-style-type: none"> • As part of the corporate planning cycle, clearly articulate an innovation strategy, vision and roadmap dynamic enough to respond to external shifts, and rally your people around it. • Manage innovation as a portfolio, implementing governance structures and aligning metrics and incentives to drive outcomes. • Develop a clearly defined governance model and process that enables multi-site piloting across business units and the replication of innovations that drive synergies. 	<ul style="list-style-type: none"> • Set the tone—innovation needs to be driven from the top and shouldn't be an unstructured effort from middle management. • Think beyond just R&D— assess how you collaborate on common issues with a wider set of partners, including service companies and even competitors. • Adopt structured innovation processes that cut across business units. • Explore the establishment of a multi-stakeholder collaboration hub to encourage the sharing of successful approaches and/ or the workings of new technologies. 	<ul style="list-style-type: none"> • Set aside a dedicated innovation budget. • Allocate capital across various innovation initiatives to achieve pre-defined business outcomes. • Recognize that different types of skills are required for different kinds of innovation • Adopt a strategy and model capable of securing required skill sets and retaining acquired knowledge. 	<ul style="list-style-type: none"> • Monitor innovation from concept to prototype to pilot. • Align the metrics and incentives across the organization to drive innovation. • Incentivise partners outside of the company to collaborate and innovate.

JUNIORS

APPROACH	ORGANIZATION	RESOURCES & COMPETENCIES	METRICS & INCENTIVES
<ul style="list-style-type: none"> Where possible, function as a pilot site by providing partners with a platform to think big, test small, and fail and scale fast 	<ul style="list-style-type: none"> Preserve your nimbleness as you grow. Stay flexible and adaptive to change Create a scanning function to leverage the thinking and successful projects from other industries 	<ul style="list-style-type: none"> Make the most of your limited resources and tap into incentives available at local and national levels 	<ul style="list-style-type: none"> Collaborate with other juniors and work with service providers who are struggling with many of the same issues

Success, is about thriving, not merely surviving. That means adapting to an increasingly complex and challenging operating environment—where the value of innovation is apparent. It also means working more collaboratively to solve mutual problems for mutual gain. It's simple strength in numbers: together, we're more powerful.



For further reading

Ten Types of Innovation

The Discipline of Building Breakthroughs is the culmination of thirty years of analysis and research. The innovation framework was built around a seminal Doblin discovery, that there are ten distinct types of innovation that need to be orchestrated with care to make game-changing innovations.

(Learn more: <https://doblin.com/ten-types/#the-book>)

Tracking the trends

Tracking the trends takes a look at the issues miners will face in the coming year and outlines a wealth of potential responses proposed from mining professionals at Deloitte member firms around the world.

(Download the report here: <https://www2.deloitte.com/global/en/pages/energy-and-resources/articles/tracking-the-trends.html>)

The digital revolution

Bringing together Deloitte's understanding of shareholder value, mining operations, technology and analytics, this report lays out an approach to developing the "digital mine." This approach helps mining organizations make the most of the digital opportunity and avoid the many potential pitfalls that come with the adoption of new technologies.

(Download the report here: <https://www2.deloitte.com/global/en/pages/energy-and-resources/articles/gx-digital-revolution.html>)

Managing Your Innovation Portfolio

People throughout your organization are energetically pursuing the new. But does all that activity add up to a strategy? Firms that excel at total innovation management simultaneously invest at three levels of ambition, carefully managing the balance among them.

(Read more here: <https://hbr.org/2012/05/managing-your-innovation-portfolio>)

Contacts

To learn more about how your organization can benefit from these insights and more, please contact:

Andrew Swart

Global Consulting
Mining Leader
Tel: +1 416 813 2335
aswart@deloitte.ca

Patrick Hall

Chile Consulting
Mining Leader
Tel: +5 622 729 8825
pathall@deloitte.com

Argentina

Alejandro Jaceniuk

Tel: +54 11 4320 2700
Ext. 4923
ajaceniuk@deloitte.com

Colombia

Julio Berrocal

Tel: +57 5 360 8306
jberrocal@deloitte.com

Brazil

Andre Joffily

Tel: +55 21 3981 0490
ajoffily@deloitte.com

Mexico

Cesar Garza

Tel: +52 871 7474401
Ext. 4401
cgarza@deloittemx.com

Chile

Christian Duran

Tel: +56 22 729 8286
chrduran@deloitte.com

Peru

Karla Velasquez

Tel: +51 1 211 8559
kvelasquez@deloitte.com

About

Monitor Deloitte

To grow with confidence, organizations need to make clear choices about where to play and how to win. And in a world where the pace of change is rapid and sometimes unexpected, leaders need to act nimbly and decisively. Monitor Deloitte strategy consultants employ cutting-edge approaches embedded with deep industry expertise, working with leaders to resolve critical choices, and drive enterprise value.

Doblin

Doblin, the Deloitte innovation unit, is a global practice deeply committed to helping clients innovate with confidence while advancing the frontiers of strategy and innovation leadership. Doblin possesses an ever-evolving set of multi-disciplinary capabilities and diverse perspectives, which are effectively integrated in highly collaborative teams and client programs. Taking a user-centric approach, Doblin practitioners combine design, research, and strategy expertise to help organizations innovate more boldly and effectively.

Monitor
Deloitte.



Deloitte.

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee (“DTTL”), its network of member firms, and their related entities. DTTL and each of its member firms are legally separate and independent entities. DTTL (also referred to as “Deloitte Global”) does not provide services to clients. Please see www.deloitte.com/about for a more detailed description of DTTL and its member firms.

© Deloitte LLP and affiliated entities.

Designed and produced by the Deloitte Design Studio, Canada. 17-5195H