inmarsat

Research
Programme

The Rise of IoT
in Mining

Introduction

The Rise of IoT in Mining

This May 2020 report explores the levels of IoT maturity in the mining sector amongst organisations operating across the globe.

To understand the level of IoT maturity across the industry we have focused on six key areas that an organisation must consider as part of their IoT strategy.

IoT Maturity Tool

We encourage you to read this report and then use our IoT Maturity Tool to understand how your organisation compares with the rest of the industry.

You can get your free report at **research.inmarsat.com**.

Inmarsat Research Programme

The Inmarsat Research Programme is in its fourth year. Its focus is to understand how connectivity-related technologies are shaping global supply chains and economies. Previous research has investigated the Internet of Things (IoT) across the global supply chain and in key sectors such as agriculture, mining, maritime and logistics.

About Inmarsat

Inmarsat is the world leader in global, mobile satellite communications. It owns and operates the world's most diverse global portfolio of mobile telecommunications satellite networks, and holds a multi-layered, global spectrum portfolio, covering L-band, Ka-band and S-band, enabling unparalleled breadth and diversity in the solutions it provides. Inmarsat's long-established global distribution network includes not only the world's leading channel partners but also its own strong direct retail capabilities, enabling end to end customer service assurance.

The company has an unrivalled track record of operating the world's most reliable global mobile satellite telecommunications networks, sustaining business and mission critical safety & operational applications for over 40 years. It is also a major driving force behind technological innovation in mobile satellite communications, sustaining its leadership through a substantial investment and a powerful network of technology and manufacturing partners.

Inmarsat operates across a diversified portfolio of sectors with the financial resources to fund its business strategy and holds leading positions in the Maritime, Government, Aviation and Enterprise satcoms markets, operating consistently as a trusted, responsive and high-quality partner to its customers across the globe.

For further information, follow us on LinkedIn or on Twitter @InmarsatGlobal.

About Inmarsat Enterprise

Inmarsat Enterprise is focused on the provision of satellite connectivity and IoT solutions for commercial land businesses, globally across a diverse set of sectors including agriculture, aid and NGO, energy, media, mining and transport.
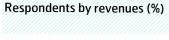
Methodology

In 2020 Inmarsat commissioned Vanson Bourne, a specialist technology market research company, to interview 200 respondents about their use of, attitude to and predictions for IoT within their mining organisation.

Respondents work for organisations with at least 500 employees and have either decision-making or influencing responsibilities for IoT initiatives.
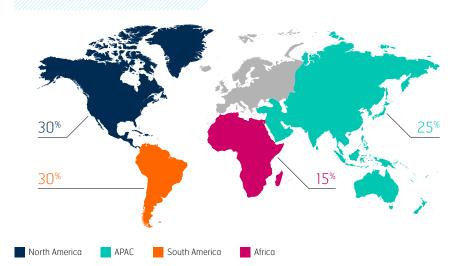
The research does not include respondents from European mining operations and intends to understand IoT maturity in the remotest regions where terrestrial connectivity is unlikely to exist.

Respondents by size of organisation (%)

- 101-250 employees
- 251-500 employees
- 501-1000 employees
- 1001-3000 employees
- 3001-5000 employees
- Over 5001 employees

15.5%
17.5%
13%
19.5%
15.5%
19%

Respondents by revenues (%)

$50m-$100m 6%
$250m-$500m 15%
$1bn-$5bn 23%
$10bn-$50bn 6%
$25m-$50m 2%
$100m-$250m 25%
$500m-$1bn 18%
$5bn-$10bn 7%

Respondents by region (%)

30% (North America)
30% (South America)
25% (APAC)
15% (Africa)

- North America
- APAC
- South America
- Africa

Respondents by sub-sector (%)

14%
13.5%
17%
20.5%
24%
11%

- Multi-commodity
- Iron ore
- Copper
- Gold
- Other bulk minerals
- Other

Other: Aluminium, Chrome, Concentrate, Chromite, Diamonds, Lithium, Magnesium Chloride, Manganese, Nickel, Cobalt, Platinum group metals, Silver, Tin, Titanium, Uranium, Vanadium, Zinc

Summary

In recent years the mining industry has been in the upswing of the commodity cycle, with relatively stable and rising prices. It is clear that even though the mining industry is not yet back in the heady times of the super cycle , seen just before the crash in 2008, that moods are positive. While the current impact of the Covid-19 crisis is not yet understood, the mining industry could be at another inflection point before a decline in demand, or this could merely be a blip on the current path, only time will tell.

One thing is evident though, the painful lessons in the last cycle have been hard learned. Many companies have had to clear a debt hangover, and now also have shareholders demanding better returns and stronger control of their balance sheets. This has meant the sector has been defined by much less excitement in the last decade, though strong cashflows, debt reduction and a "steady as she goes" attitude have prevailed. The industry appears well placed to weather the current storm.

Despite capital control and the lean years that have preceded the current time, the industry has been cautiously investing in the development and deployment of IoT-based projects with early benefits and return on investment being realised in some quarters. This has been borne out of the need to drive increasing efficiencies; to do more, with less, but often these projects have been relatively simple, and not all of the projects are getting through the trial phase.

There are significant challenges to overcome: connectivity is often unreliable, cybersecurity approaches are patchy, there are too few employees with digital skills and data is not being collected and managed in a way that would best empower organisations. The mining industry has historically been slow to adopt radical ideas and it is clear that although miners are keen on the benefits IoT brings, the largely unproven outcomes are hampering the industry's wide scale adoption. 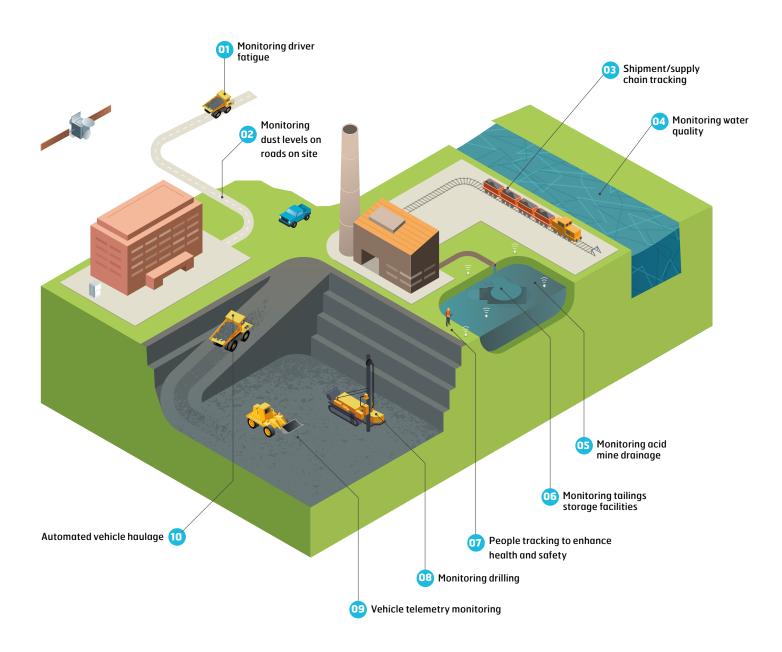This approach threatens to leave the industry with a two-speed market, early adopters who are benefitting from reduced costs and better efficiencies and laggards who risk losing market share as they are pushed up the cost curve of production.

However, the outlook for industry-wide adoption is bright. Mining organisations are looking to increase their investment in IoT and are overwhelmingly positive about the value of IoT to their operations and the benefits it is either already delivering or will deliver in the future. In summary we have found a sector beginning to embrace the use of IoT but still working out how to make the most of it.

Joe Carr
Global Mining Director, Inmarsat

IoT applications

01 Monitoring driver fatigue

02 Monitoring dust levels on roads on site

03 Shipment/supply chain tracking

04 Monitoring water quality

05 Monitoring acid mine drainage

06 Monitoring tailings storage facilities

07 People tracking to enhance health and safety

08 Monitoring drilling

09 Vehicle telemetry monitoring

10 Automated vehicle haulage

Adoption

Adoption

Our research found clear evidence that the mining sector is in the midst of a digital revolution. Nearly all respondent organisations (95%) are currently trialling IoT-enabled projects, and two thirds of these organisations (67%) have already fully deployed at least one IoT-based project. North America leads the way with the number of respondents who have fully deployed IoT projects (98%), with APAC (70%) next and Africa (50%) and South America (40%) following. In this section we investigate why there is such variance in successful deployment, what the differing motivations for adopting IoT are and how the reality compares to the intent.

Motivations for adopting IoT vary, though three of the top five predictably relate to leveraging IoT to drive increases in efficiencies and ultimately operating profits: improving the return on investment (39%), increasing staff productivity (39%) and increasing throughput (36%). The other two drivers in the top five were improving health and safety of staff (39%) and reducing the environmental impact of mining operations (32%).

Motivations also varied considerably by region. Interestingly, respondents from Africa and South America were keener than their North American and APAC counterparts in wishing to use IoT to

improve health and safety of staff, with a combined total of 53% versus 25%. North American respondents were most keen to use IoT to support environmentally sound mining with 40% and 30% prioritising the reduction of environmental impact and improving tailings facility management respectively.

Demonstrating regulatory compliance (18%) and demonstrating corporate social responsibility (16%) were further down the priorities list across the board but were much more likely to be considered as motivation for adopting IoT in North America and APAC.

What are the most important drivers for the deployment of IoT-based solutions in your organisation?

Improving return on investment in mining operations	39%
Improving health and safety of staff	39%
Increasing staff productivity	39%
Increasing processing throughput	36%
Reducing environmental impact of mining operations	32%
Reducing cost of extraction	27%
Improving tailing facility management	19%
Reducing cost of haulage	18%
Demonstrating compliance with regulations	18%
Demonstrating corporate social responsibility to external stakeholders	16%
Reducing downtime of machinery	10%
Reducing reliance of manual intervention in mining processes	8%
Reducing cost of exploration	2%

0%   40%

This brings us to an important point: IoT is starting to be adopted, but the use cases and associated data usage are generally relatively simplistic. Aggregating data and implementing those insights, outside immediate mine site operations, as with the two aforementioned use cases, is relatively nascent, as we shall cover later. Using IoT data to provide insights to external parties can be perceived as complex, can be tainted by data security and trust issues and is perhaps outside the scope for many mining organisations currently. However, driven by innovation teams at industry majors, as well as incoming regulations, this is predicted to change.
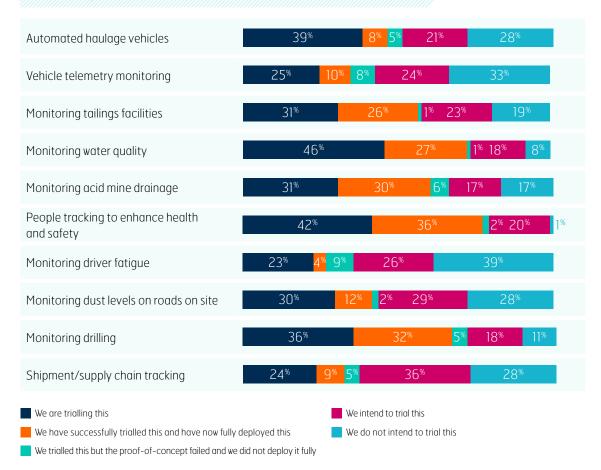
An examination of the different types of IoT projects that have been successfully deployed versus the drivers for adoption

yields interesting results. The use cases with the most successful deployments were monitoring the health and safety of mining personnel (36%), followed by the monitoring of drilling (32%), monitoring of acid mine drainage (30%) and monitoring of water quality (27%). Only one use case - drill monitoring - directly relates to efficiency and to the profit-centric drivers we mentioned earlier.

IoT use cases that could make a big difference to overall efficiencies and profits such as vehicle telemetry (10%), shipment and supply chain tracking (9%), and automated vehicle haulage (8%) are among the least developed areas of IoT deployment. So why don't the drivers for adoption and deployed projects tally up?

> "IoT is starting to be adopted, but the applications and associated data usage are generally relatively simplistic. "

What is your organisation's current progress when it comes to deploying the following IoT-enabled projects?

Project	We are trialling this	We have successfully trialled this and have now fully deployed this	We trialled this but the proof-of-concept failed and we did not deploy it fully	We intend to trial this	We do not intend to trial this
Automated haulage vehicles	39%	8%	5%	21%	28%
Vehicle telemetry monitoring	25%	10%	8%	24%	33%
Monitoring tailings facilities	31%	26%	1%	23%	19%
Monitoring water quality	46%	27%	1%	18%	8%
Monitoring acid mine drainage	31%	30%	6%	17%	17%
People tracking to enhance health and safety	42%	36%	2%	20%	1%
Monitoring driver fatigue	23%	4%	9%	26%	39%
Monitoring dust levels on roads on site	30%	12%	2%	29%	28%
Monitoring drilling	36%	32%	5%	18%	11%
Shipment/supply chain tracking	24%	9%	5%	36%	28%

■ We are trialling this

■ We have successfully trialled this and have now fully deployed this

■ We trialled this but the proof-of-concept failed and we did not deploy it fully

■ We intend to trial this

■ We do not intend to trial this

One factor is the perceived and experienced complexity of these projects. Those projects most likely to have been fully deployed are relatively straight-forward, with either static installations measuring relatively simple inputs, or else they use well-understood technologies and are therefore not prohibitively costly. Drill monitoring, given the relative stability of the asset and its lack of movement would be viewed as much easier to implement than a moving haul truck. Likewise, water monitoring requires static sensors and is simple to implement.
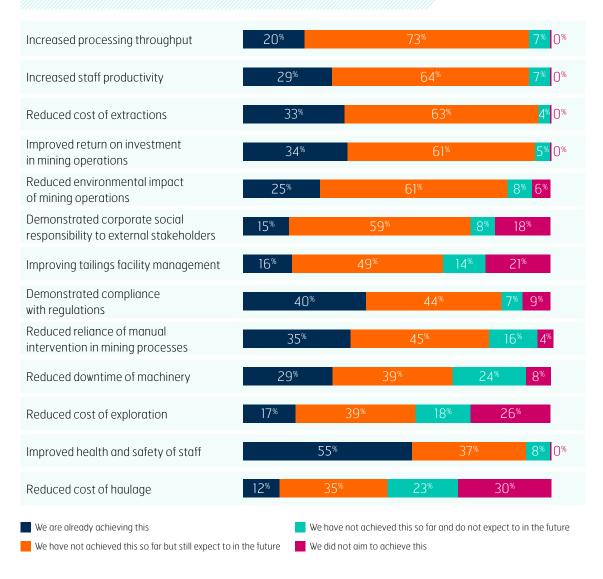
Some of the more complex projects on which we surveyed our respondents either hadn't been trialled or the trial was more likely to have failed. Monitoring driver fatigue and monitoring vehicle telemetry were joint most likely not to have been attempted, as well as the two least likely to have successfully passed a proof of concept (POC). Both of these projects relate to mobile assets — and when considering the low number of projects attempted trialling automated vehicles and supply chain tracking, a picture emerges with IoT projects involving mobility proving to be trickier to implement at the moment.

The principle challenge with mobile IoT relates to the differing connectivity methods that are needed to ensure the reliable transfer of data, which we will review in the next chapter. However; monitoring the health and safety of mining personnel was conversely the most successfully implemented project. This can be attributed to the relatively well-established technologies supporting this use case and the importance of the Zero Harm initiative.

"A clear majority (87%) stated that IoT is, or will play a role in maintaining their licence to operate, reducing environmental impact and improving the safety of mines."

How would you score your organisation's achievement of expected benefits of IoT-based solutions so far and for the future?

Benefit	We are already achieving this	We have not achieved this so far but still expect to in the future	We have not achieved this so far and do not expect to in the future	We did not aim to achieve this
Increased processing throughput	20%	73%	7%	0%
Increased staff productivity	29%	64%	7%	0%
Reduced cost of extractions	33%	63%	4%	0%
Improved return on investment in mining operations	34%	61%	5%	0%
Reduced environmental impact of mining operations	25%	61%	8%	6%
Demonstrated corporate social responsibility to external stakeholders	15%	59%	8%	18%
Improving tailings facility management	16%	49%	14%	21%
Demonstrated compliance with regulations	40%	44%	7%	9%
Reduced reliance of manual intervention in mining processes	35%	45%	16%	4%
Reduced downtime of machinery	29%	39%	24%	8%
Reduced cost of exploration	17%	39%	18%	26%
Improved health and safety of staff	55%	37%	8%	0%
Reduced cost of haulage	12%	35%	23%	30%

- ■ We are already achieving this
- ■ We have not achieved this so far but still expect to in the future
- ■ We have not achieved this so far and do not expect to in the future
- ■ We did not aim to achieve this

While it is clear IoT is being adopted, it is not yet proving to be the panacea that many believe it will be, as a result of the challenges hampering easy deployment. When asked to score whether their organisations had achieved their expected benefits from IoT deployment, in nearly every case the respondents reported being more likely to have not achieved the benefits from IoT deployment. Only in regard to the health and safety of staff did more respondents report having achieved their objectives (55%) versus having not achieved their objectives (45%).

Excluding health and safety of staff, of the four top priorities for IoT deployment cited above – improving ROI, staff productivity and processing throughput – all show large numbers not achieving their objectives – so far.

The good news is that they overwhelmingly expect to still achieve benefits in the future, if not now. A clear majority (86%) stated that IoT is, or will play a role in maintaining their licence to operate, reducing environmental impact and improving the safety of mines. This can be linked with the fact that 96% of respondents have either

achieved ROI in mining operations, or expect to in the future, showing the long-term gains to be achieved. Again North America is setting a high standard of success at 97%. So rather than a sign of failure, it is more one of delayed gratification, reflecting the industry's early stages of IoT adoption.

The fact that these objectives are failing or not fully deployed highlights that improving efficiencies such as productivity and throughput are reliant on this increasingly sophisticated matrix of workforce skills, infrastructure and connectivity. Once this has been achieved, mining companies will start to realise the financial rewards of successful adoption.

The barriers to faster adoption cannot all be put down to spending and the mining business cycle. While this is certainly one of the strongest barriers – as shown in our research, we also uncovered a range of equally important factors.
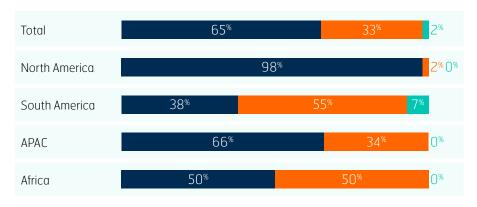
Barriers in the sector revolve around three areas – human, existing technology, and available capital. Our research shows that people are a big barrier to success, whether

it is having the right skills in place (46%), a culture that is open to change (36%), or even having the vision to understand the potential of IoT in the first place (36%) – in all of these areas mining organisations are struggling.

The human element is perhaps unsurprising when considering that traditionally technical innovation in the sector has focused on mechanical and engineering development, rather than in information technology and how data is collected, analysed, and used in decision-making. These are very different skills requirements for the next era of innovation in the sector. So, while the technology is ready for the sector, the sector workforce must adapt its thinking and skills base to take advantage.
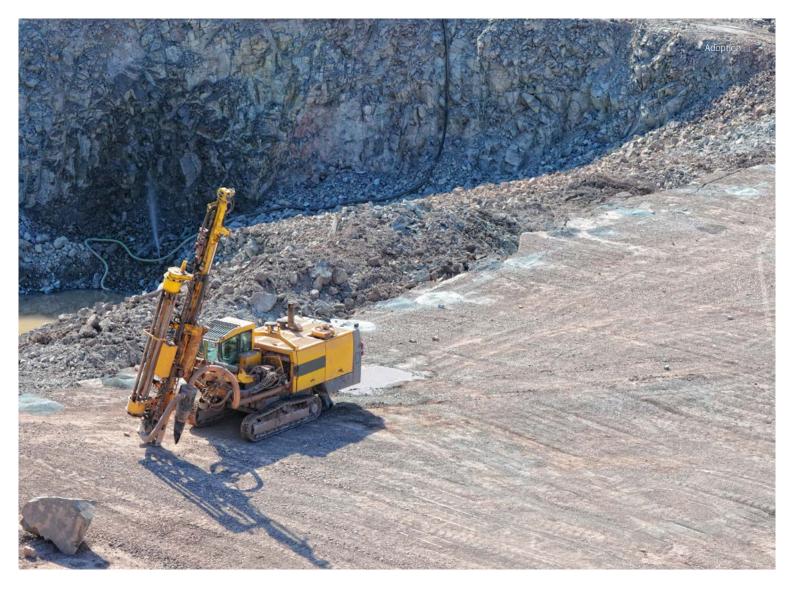
A lack of adequate IT infrastructure is also a significant barrier to adoption. Our research shows that infrastructure gaps exist from the edge, all the way to central control systems and the connectivity between them that allows data to be collected, shared and analysed.

All of these findings are explored in more detail later in this report.

What stage of IoT adoption has your organisation reached?

Region	Fully deployed	Trialling	Not used
Total	65%	33%	2%
North America	98%	2%	0%
South America	38%	55%	7%
APAC	66%	34%	0%
Africa	50%	50%	0%

■ Fully deployed at least one IoT project

■ Are trialling/have trialled at least one IoT project, but not fully deployed

■ Have not used/using or trialled/trialling any IoT projects

What barriers to adoption, if any, has your organisation encountered in the development and deployment of IoT-based solutions?

Lack of in-house skills	46%
Lack of available capital to invest in IoT-based solutions	45%
Lack of IT infrastructure to handle data generated by IoT-based solutions	43%
Business culture resistant to technical innovation	36%
Lack of vision into the potential for IoT-based solutions	36%
Lack of consistent connectivity across mine sites	34%
Concerns over cybersecurity	32%
Other	1%

0%   50%

"Barriers in the sector revolve around three areas – human, existing technologies and available capital."

02

Connectivity

Connectivity

IoT is essentially a network of networks and is dependent on reliable connectivity for its successful application. The remote, harsh environments found on many mines, the nature of a 24 hour operation and the challenge of numerous sites spread over great distances with varied and often changing topology all contribute to connectivity challenges, which can have a significant impact on progress in deploying IoT projects.

Only 16% of respondents stated that they always have reliable connectivity for IoT projects across their mine sites. This lack of reliable connectivity is pronounced even in North America and Asia where less than a quarter of respondents reported that they had access to reliable connectivity across their mine sites.

Indeed there is a clear link between those who have managed to fully deploy an IoT project and the level of reliable connectivity they can access. Of the 130 respondents who had fully deployed an IoT project just 22% struggled to access reliable connectivity across their mine sites. On the other hand, the 70 respondents who hadn't yet fully deployed solutions were much more likely to be struggling with connectivity (89%).

Connectivity and IoT success
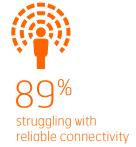
130 respondents who have fully deployed an IoT project

78% feel they have reliable connectivity

70 respondents have not yet fully deployed an IoT project

89% struggling with reliable connectivity

"Of the 130 respondents who have fully deployed an IoT project, just 22% struggled to access reliable connectivity across their mine sites."

Project failure is regularly directly related to poor user experience, which is often a direct result of unreliable connectivity. The relationship between reliable connectivity and successful deployment is further emphasised when it comes to the deployment of IoT projects where the data producer is mobile. Projects involving automated haulage, vehicle telemetry and supply chain tracking were less likely to be fully deployed than projects involving static data producers, when a respondent indicated they struggled with reliable connectivity.

One reason for this trend is related to the types of connectivity in use. Satellite was the most popular (80%), followed by radio (65%) and mobile LTE cellular (54%), while the least commonly used forms of connectivity are fibre broadband and edge connectivity, in the Low Power Wide Area Networks (LPWAN) family.

Of all of these technologies satellite has the broadest range and is therefore the natural choice for IoT projects in remote areas. It also reduces the need to invest in building expensive cellular or fibre infrastructure, as well as the ongoing costs in terms of additional headcount and systems to support any installed systems.

Aside from satellite, all of the other technologies have a more limited range, so if a mobile data producer exits a connected region it will cease transmitting data completely. A static data producer may suffer from poor quality connectivity, but once the communications link to that area is established it will generally continue to provide connectivity and therefore it is more likely that the project will get past the trial stage. Put simply, projects with mobile data producers are less likely to achieve success because the connectivity they require can be more difficult to access.

The role of satellite in both mobile and static deployments is an interesting one, and may go some way to explaining why even with satellite's supposedly ubiquitous connectivity, 85% of respondents complain that connectivity is hindering their ability to gather data from data producers.

The reality is that satellite services, like other connectivity types, differ depending on the service provider and are relevant for different use cases. Different satellite services use varying frequency bands and are also located nearer or further away from the earth. Some frequencies are more susceptible to weather conditions, impacting both static and mobile deployments, while some low earth orbit satellites nearer the earth drop connectivity as they orbit the earth, or suffer from delays between the data reaching the satellite and the satellite then being in range of the ground station to offload the data. This means they are not ideal for mobile applications where data is constantly being collected. So the key is choosing the right provider and satellite connectivity type for the IoT project.

Despite this, satellite is a key enabler of IoT projects on mine sites with 85% of respondents who have fully deployed an IoT project using satellite connectivity, while the number is 70% for those who are yet to fully deploy a project.
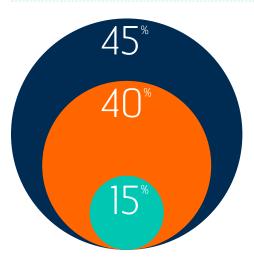
What connectivity types are you using on-site?

Connectivity type	%
Satellite	80%
Radio	65%
LTE (cellular)	54%
Fibre broadband	36%
Wi-Fi wireless connectivity	35%
Low Power Wide Area Networks (LPWAN) including LoRaWAN, NB IoT, Zigbee, Sigfox etc.	32%
Bluetooth Low Energy (BLE)	14%
Other	2%

0%   100%

"Satellite is a key enabler of IoT projects on mine sites with 85% of respondents who have fully deployed an IoT project using satellite connectivity, while the number is 70% for those who are yet to fully deploy a project."

"A broad mix of connectivity types is likely to indicate an organisation's consideration of resilience and the most appropriate connectivity type for a specific use case."

How would you best describe the reliability of your IoT connectivity on-site?
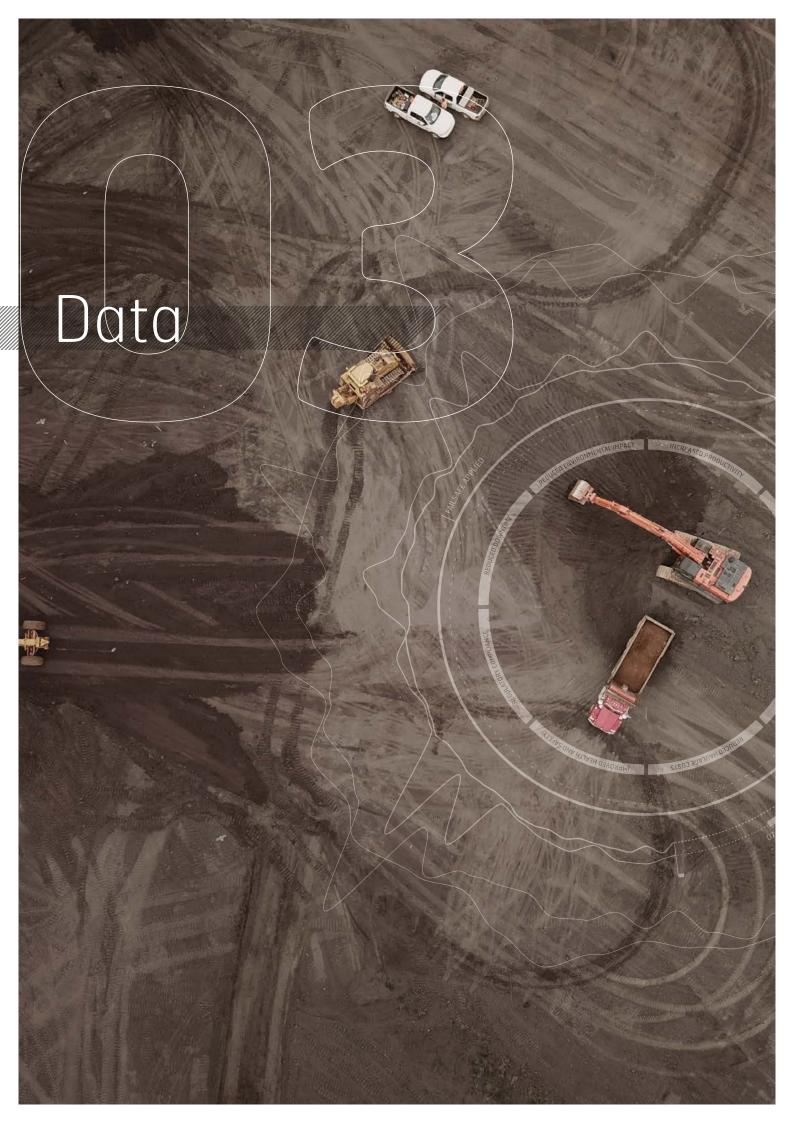

45%

40%

15%

● We struggle to access connectivity across our mine sites, and it hinders our ability to gather data from our data producers

● We can access connectivity across our mine sites, but it is often unreliable, and we sometimes struggle to collect data from our data producers

● We can access reliable connectivity across our mine sites and are able to collect data regardless of where our data producers are transmitting from

However; satellite is just one part of the necessary connectivity mix. A broad mix of connectivity types is likely to indicate an organisation's consideration of resilience and the most appropriate connectivity type for a specific use case. Indeed those respondents who had fully deployed IoT projects were likely to be using more connectivity methods across the board.

One grouping of technologies that is increasingly being used in conjunction with satellite, cellular or fibre backhaul, to aggregate multiple points, are edge connectivity technologies like LPWAN. Our research found those using edge connectivity were also more likely to have fully deployed an IoT project, which can be attributed to their unique capabilities such as reductions in costs related to data transfer, reductions in maintenance and network security and management ease.

In terms of how this varies geographically, the highest adopters of LPWAN were mining companies located in the North American (37%) and APAC (34%) regions. Although this is still a relatively low level, it does show their IoT connectivity maturity levels are more advanced than their counterparts in other regions, and they should be achieve success in a broader array of IoT applications.

These results suggest that industry leaders, predominantly located in the APAC and North American regions, are starting to think about not simply having connectivity, but how they're connecting and what the right connectivity method is for their specific use case. Where decision makers are getting these choices right, there is a clear link between successful deployment of their projects.

03

Data

REDUCED ENVIRONMENTAL IMPACT

INCREASED PRODUCTIVITY

REDUCED DOWNTIME

REGULATORY COMPLIANCE

IMPROVED HEALTH AND SAFETY

REDUCED HAULAGE COSTS

Data

The value of IoT is measured in the insights is provides a business. Data empowers decision-making at all levels of an organisation: from local team based decisions, right up to board-level corporate decisions around operational process, economically viable delivery of raw materials and even future investment strategies.

If data is not collected, shared, managed and analysed correctly, projects will not be deemed successful. So, as part of this research, we explored the proportion of IoT data being used in each area of the data use cycle: aggregation at the edge, analysis of data at a central point to create strategic insights for the company, and whether insights from data analysis have been actioned, resulting in improvements to operations.

IoT data production starts at the edge, on the mine site, so it is vital that companies get this stage right as they build their data management strategies. Currently not all data is being aggregated at the edge, with most mining companies reporting 30-40% of their data being treated this way. Edge aggregation allows mining companies to make decisions more quickly by analysing and sorting data between that which is useful on-site and that which needs to be shared back to a central point.

As more IoT projects are deployed, the optimisation, filtering and routing of data will become an increasingly important aspect; providing the right data in the right timeframe will empower better decision making both on site and for the business as a whole. Additionally efficiently analysing and routing data will help avoid network congestion and unnecessary data transfer costs.

This is where the benefits of edge connectivity technologies will be crucial to the sector, particularly in terms of real time data routing and transfers from multiple data points. Again, as North American and APAC mining organisations are more mature in their adoption of these technologies, these businesses will most likely be the first to benefit as IoT adoption increases.

However, with 44% of mining organisations reporting that they are not able to aggregate their data due to a lack of edge computing/intelligence infrastructure, it was no surprise to see the relatively limited adoption of the new wave of wireless data collection technologies like LPWAN. One reason for this may be related to the top inhibitor of edge aggregation, which was a lack of the relevant skills (48%). In the case that there aren't skilled, knowledgeable individuals presiding over this area, the adoption of the relevant technologies are bound to suffer.

"If data is not collected, shared, managed and analysed correctly, projects will not be deemed successful."

While edge aggregation and real-time data are incredibly important to operations at a mine site, IoT data also has a vital role to play in a company-wide capacity, as it allows for the comparison of data sets, and the understanding of macro trends, which can be distilled to create insights that guide company processes and direction. At a company level the highest proportion of respondents analysed 50-60% of data centrally to create insights. Some of this data could have been aggregated already at the edge and sorted, while some companies may have sent everything back to a central point, with the former approach having numerous advantages.

As it is to be expected, there are a variety of reasons that typically mining companies are analysing 50-60% of available data centrally. The top three reasons that inhibit all data being analysed at a corporate level are a lack of IT infrastructure to analyse all of the data (51%), the data is stored in an unusable or varying format (43%) and a lack of the skills to analyse data (34%).

Why do you think your organisation is not able to aggregate all of the data collected from your IoT-based solutions?

We don't have the skills to aggregate data	48%
We are unable to bring the data together from multiple networks	46%
We lack the edge computing/intelligence infrastructure to aggregate data	44%
Data is stored in an unusable format	42%
There is such a large volume of data we struggle to aggregate it	30%
It is not a priority for the organisation	15%

0%　　　　　　　　　　　　　　　　　　　　　　　　100%

Why do you think your organisation is not able to analyse all of the data collected from your IoT-based solutions?

We don't have the IT infrastructure to analyse all of the data	51%
Data is stored in an unusable format	43%
We don't have the skills to analyse data	34%
There is a lag between data collection and it being available for analysis	34%
We are unable to bring the data together from multiple networks	33%
There is such a large volume of data we struggle to analyse it	30%
It is not a priority for the organisation	10%

0%　　　　　　　　　　　　　　　　　　　　　　　　100%

Why do you think your organisation is not able to action the insights from all of the data collected from your IoT-based solutions?

We lack the investment to implement the insights	47%
We are concerned that implementing the insights will be risky	44%
The analysis is not well executed	42%
We lack the skills to implement the insights	39%
The insights are siloed and only available to certain teams	37%
The insights do not support our IoT strategy	9%

0%　　　　　　　　　　　　　　　　　　　　　　　　100%

However, there is a wide range of responses with five companies only analysing 10% of their data to produce insights, while at the other end of the scale 19 are analysing 100% of the available data centrally to produce insights. Naturally the companies only analysing 10% of their data are more likely to face inhibitive factors, such as a lack of skills.
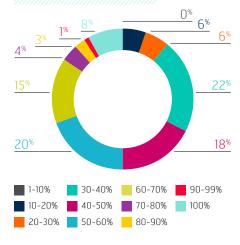
The final stage of the process is to look at what percentage of insights created at a company level are actioned to improve the way a company works. The largest proportion of companies (55) are actually using 30-40% of their insights to improve the operations of a company, while 17 companies boldly claim to be turning 100% of their insights into practical actions.

So, what are the reasons that insights are being turned into actions, or not as it may be? Unsurprisingly the biggest blocker to implementing insights from IoT projects is a lack of investment to implement the insights, which 47% of respondents cited. This was followed by concerns that implementing the insights might be risky (44%) and that the analysis in the stage before wasn't well executed (42%).
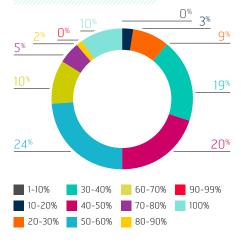
IoT only becomes impactful if the insights can be used to improve the way things work, so it can be expected that as more projects demonstrate ROI confidence the outputs will start to grow. However, a worryingly large proportion have pointed fingers at poor analysis as a roadblock, with this trend having the potential to destroy the credibility of IoT projects.

Overall, from data creation and collection, to aggregation, analysis and finally the implementation of insights, there are clearly a number of significant factors leading to suboptimal usage that need to be remedied if organisations are going to make the most of their IoT-enabled initiatives.
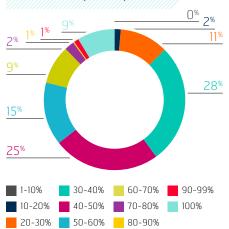
Approximately how much data being produced via IoT projects on your organisation's mine sites is being aggregated using edge intelligence?

1-10%	30-40%	60-70%	90-99%
10-20%	40-50%	70-80%	100%
20-30%	50-60%	80-90%	

Approximately how much data being produced via IoT solutions on your organisation's mine sites is being analysed centrally to create insights?

1-10%	30-40%	60-70%	90-99%
10-20%	40-50%	70-80%	100%
20-30%	50-60%	80-90%	

Approximately what percentage of the strategic insights are being actioned to improve operations?

1-10%	30-40%	60-70%	90-99%
10-20%	40-50%	70-80%	100%
20-30%	50-60%	80-90%	

Skills

04

Skills

A lack of skills to successfully develop, deploy and manage IoT is a continuing theme throughout our research into the mining sector. Indeed, this has been a consistent pattern throughout all our research into the sector since we began the research programme in 2017. Compared to other industries, the mining sector lags considerably when it comes to having the right skillset for a successful and effective IoT strategy.

It seems that things have not changed much, with 46% of respondents declaring that skill shortages are the most significant barrier in the development and deployment of IoT-based solutions. As such, our results again show that a lack of skills continues to rest at the core of most of the major issues acting as obstacles to growth and development in the mining industry today.

Overall, the results of our research indicated that skill shortages can be seen across all levels of seniority but become more pronounced at the strategic and delivery levels. Of most concern were the results at the strategic level, or where the objectives and priorities of mining organisations are set and any plans for future IoT use are being thrashed out. Only 17% of respondents believe that they have the skills that they need at this level, with

84% stating that they either lack the required skills or would benefit from additional strategic skills. In terms of how this varies geographically, Africa and South America were the clear laggards, with North American mining companies finding themselves with significantly less of a shortage at this level.
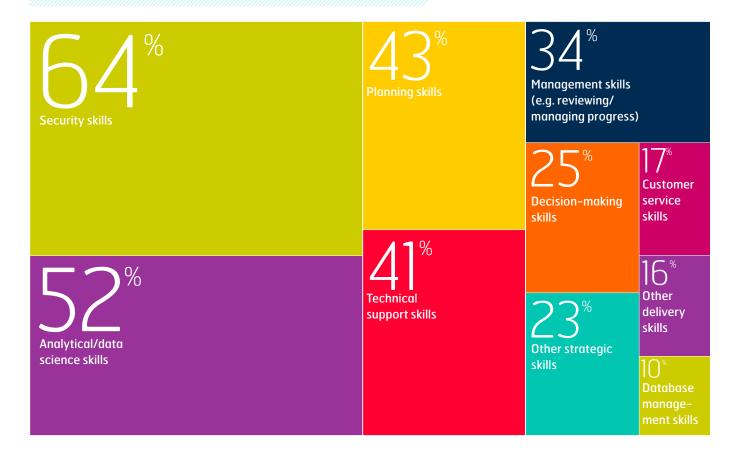
At the management level, or where the successful deployment of IoT-based solutions is managed, only 13% of respondents believe that they have the right people in place. This means that 87% of respondents feel that they could either benefit from additional skills at this level to augment those they have, or they are completely absent at the management level. Again, there were striking geographical differences, with 70% of African mining companies stating that they lack the skills they need at this level compared to 40% amongst APAC mining companies.

In terms of the delivery level, or ensuring any IoT deployments are working as intended, 67% of respondents stated that they lacked the skills for effective delivery. This is clearly a particular problem for African mining companies, where 93% of respondents reported that they lacked the skills at this level, considerably more than the 45% of North American companies.

The research also attempted to understand which skills are most in need to successfully deliver and manage IoT-based solutions. The high level of apprehension about security seen elsewhere in the survey also came through when exploring skill shortages, with 64% of respondents highlighting their desire to see increased security skills in their organisations. In addition, elsewhere in the survey it was revealed that the majority of mining companies are finding it challenging to effectively interpret and use the data that they are collecting. A possible explanation for this could be the lack of personnel with the appropriate skillset, with 52% of respondents stating that they need more employees with data science and analytical skills.

These results align with our previous research published in 2018, where there was also a clear pattern of both practical, hands-on experience of IoT-based solutions and the mining industry being in short supply. As 94% of respondents acknowledged, the biggest concern was the lack of staff with digital skills, which is hindering the industry's digital transformation efforts. It is an area where improvements will need to be made to get the most from a growing number of IoT-based projects, as the ongoing shortfall in skills across all levels of seniority will have an impact on translating the theory of IoT-enabled devices into reality.

What additional specific skills do you think your organisation needs to deliver IoT-based solutions?

64% Security skills

43% Planning skills

34% Management skills (e.g. reviewing/ managing progress)

25% Decision-making skills

17% Customer service skills

52% Analytical/data science skills

41% Technical support skills

23% Other strategic skills

16% Other delivery skills

10% Database manage- ment skills

However, closing this skills gap will be all the more difficult if the sector does not address its reputation and image amongst those who have the desired set of digital skills. The mining sector, when compared to other industries, is usually considered to be an old, established sector without the same level of cutting-edge innovation as some other sectors. Additionally, by requiring workers to travel to remote areas for long periods of time, the industry is also seen by many as less accessible than others. Interestingly, the large majority of respondents were acutely aware of this, with 94% either 'strongly agreeing' or 'agreeing' that the mining industry needs to change its image to attract the best tech talent. Unfortunately, very little has been done to alter this perception of the industry, which must change if it wants to prise away people with the required skills from the more 'fashionable' and accessible industries into moving and staying in mining.

Despite this, the research also provided some cause for optimism by offering some insight into possible solutions. 71% of respondents either 'strongly agreed' or 'agreed' that, when the sector shifts from the Fly In Fly Out model (for example transporting workers to mine sites for limited shifts before flying out for rest periods) to establishing Remote Operations Centres, facilities typically located in an urban area that allow employees to work regular hours without periods of time away from home, mining businesses will be able to recruit more staff with digital skills. What this indicates is that, should mining companies embrace smarter and more flexible ways of working, such as enabling IT teams to work off-site, they will be able to attract the skills that they need.

"As 94% of respondents acknowledged, the biggest concern was the lack of staff with digital skills, which is hindering the industry's digital transformation efforts."

In your opinion, to what extent does your organisation have the skills to make the most from IoT-based solutions at the below levels?

87%

of respondents feel that they could benefit from additional skills at an IoT management level.

1. Strategic level (e.g. setting objectives, priorities and future plans for IoT use)

We have all the skills we need	17%
We would benefit from additional skills at this level to augment those we have	36%
We are lacking the skills we need at this level	48%

Regional breakdowns:

North America: 32%, 45%, 23%
South America: 10%, 25%, 65%
APAC: 16%, 34%, 50%
Africa: 3%, 40%, 57%

2. Management level (e.g. ensuring successful deployment, monitoring performance)
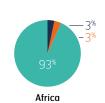
We have all the skills we need	13%
We would benefit from additional skills at this level to augment those we have	42%
We are lacking the skills we need at this level	45%

Regional breakdowns:

North America: 20%, 52%, 28%
South America: 10%, 37%, 53%
APAC: 14%, 46%, 40%
Africa: 0%, 30%, 70%

3. Delivery level (e.g. ensuring IoT deployment is working as intended)

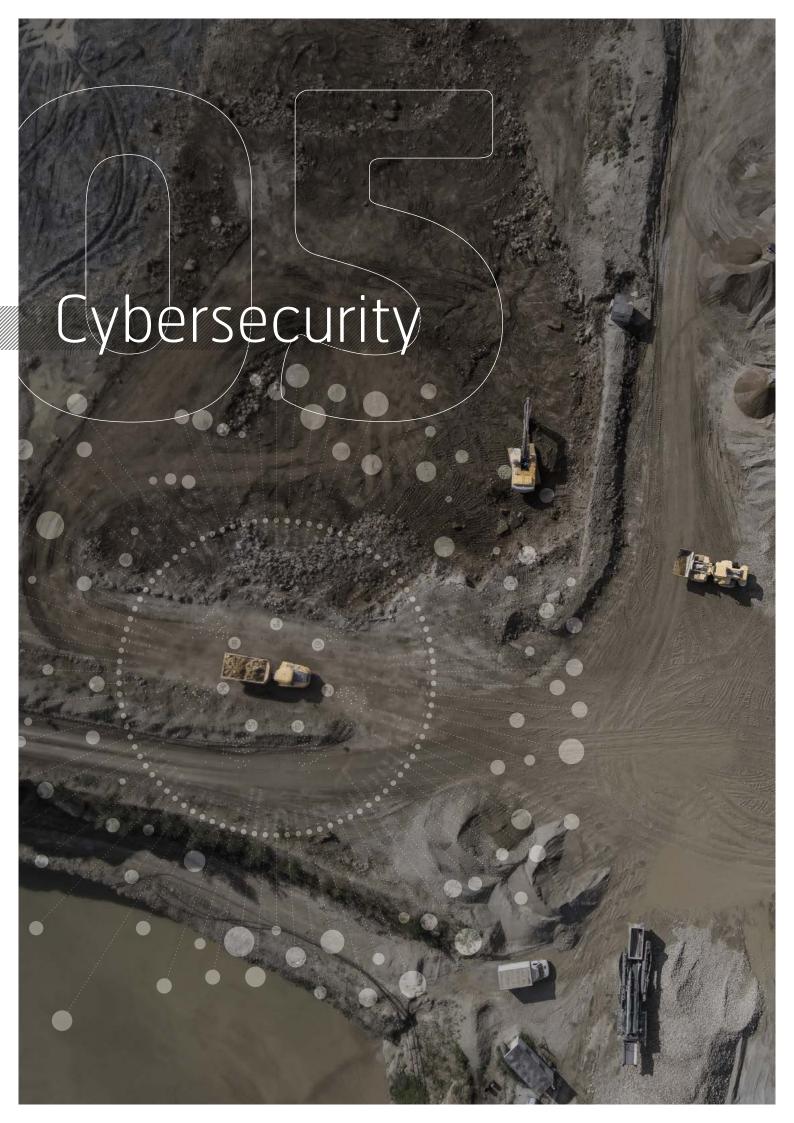|	
We have all the skills we need	13%
We would benefit from additional skills at this level to augment those we have	21%
We are lacking the skills we need at this level	67%

Regional breakdowns:

North America: 20%, 35%, 45%
South America: 12%, 15%, 73%
APAC: 10%, 20%, 70%
Africa: 3%, 3%, 93%

05

Cybersecurity

Cybersecurity

Security breaches are a huge concern for any organisation. However, mining companies are very attractive targets, in part because of their significant geo-political status, as well as the value of the commercial data that could be stolen. As such, with mining companies beginning to connect more of their operational infrastructure to networks and the internet through IoT-related technologies, it is inevitable that they will create more access points for potential cyberattackers to target.

As a strategically important industry, any attack on a mining company's infrastructure would not only be damaging for the organisation, but also the safety of employees working in remote parts of the world. It could also have an impact on the wider economy as a result of reduced production.

Unsurprisingly, the respondents were very aware of the damage that a cyberattack could trigger and the range of threats they are now facing as they increase adoption of IoT technologies. In particular, the insecure storage of collected data (56%), employees misusing data (54%), insecure network links to external infrastructure

(49%), and ransomware and malware (45%) were the most highly-ranked security risks to respondents' organisations. Additionally, when asked how their operations could be affected by a cyberattack, respondents emphasised their fears around sensitive commercial data being stolen (52%) and how an attack could mean the loss of visibility over staff location-tracking technology (42%), putting employee safety at risk.

What are the biggest IoT security risks to your organisation?

56% Insecure storage of data collected

49% Insecure network links to external infrastructure (cloud, off-premises)

43% Malware

43% Phishing attacks

54% Potential mishandling/misuse of data by employees

45% Ransomware

38% Insecure/unencrypted edge networks

However, despite awareness of the cybersecurity challenges and implications relating to IoT-deployment, it was concerning to see that the industry's response to these challenges has so far been too limited. In fact, 11% of respondents, located in South America, Africa or APAC have not take any steps to ensure their IoT solutions are protected. In addition, only 34% of all respondents stated that they are conducting regular patching and updating of their networks. This is a vital process to consider for organisations hoping to defend against the latest cybersecurity threats.

In terms of what organisations are doing to ensure their IoT solutions are protected, it is encouraging to see that some have partnered with cybersecurity specialists (50%), hardened edge network devices (42%) and implemented 24/7/365 network monitoring (41%). Yet, this does not escape the fact that the sector could be doing more to protect its IoT infrastructure. It is particularly worrying to see that 53% of

respondents highlighted that their cybersecurity defences have not been a priority for their organisation's IoT solutions and could be vastly improved.
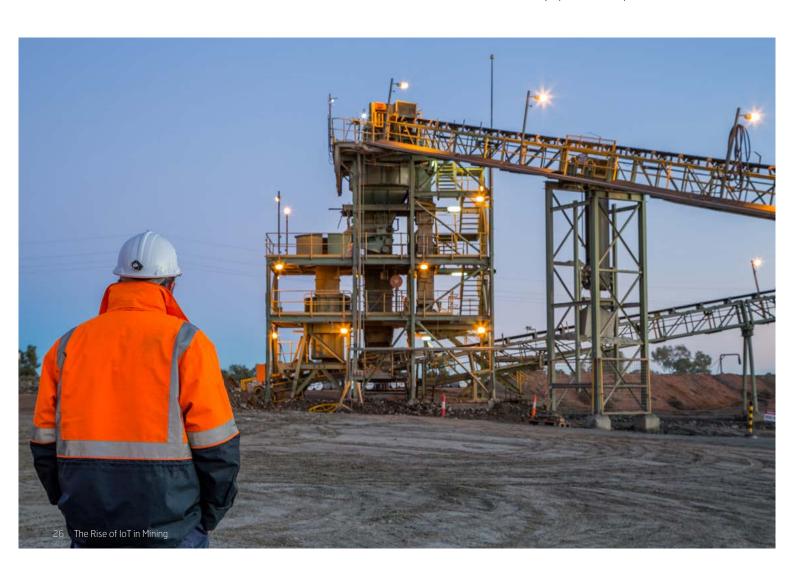
This is especially the case when it comes to African mining companies, with no respondents stating that their IoT solutions have robust cybersecurity defences and 73% highlighting that cybersecurity defences have not been a priority. Although African respondents are clearly the least advanced when it comes to hardening cyber-defences, even respondents based in the North American and APAC regions have a ong way to go if they want if they want to ensure the security of their IoT-related deployments.

A more general reason for the slow uptake in addressing IoT-related security concerns is that cybersecurity is still being viewed by mining companies as a cost, rather than a benefit. This view may be attributed to the lack of a sea change moment as with randsomware attacks targeting utilities and logistics companies.

However, our research also indicated that a probable explanation for the relatively low level of movement to address security vulnerabilities is the skill shortages across different levels of seniority and key stakeholder positions. As discussed, over half (64%) of respondents reported lacking the level of security skills required when it comes to successfully delivering IoT-based solutions. This indicates that mining businesses are not upskilling their staff to securely manage and deliver their IoT initiatives.

Furthermore, if there is a shortage of skills in key stakeholder positions, it is more than likely that there is an absence of awareness amongst mining organisations around the importance of cybersecurity for their IoT deployments.

There is still clearly a long way to go to ensure mining operations are secure and robustly protected. However, the priorities of mining companies may change as IoT solutions become more widely deployed, and they realise that the protection of digital assets is as important as, if not more than, physical security on site.

What steps has your organisation taken to ensure its IoT infrastructure is protected?

Partnering with cybersecurity specialists	50%
Hardening of edge network devices	42%
24/7365 network monitoring	41%
Maintaining compliance with relevant regulations (such as ISO 27030 and ISO 30141)	37%
Regular patching and updating networks	34%
Two-factor authentication	30%
Network redundancy	27%
Securing physical assets such as sensor nodes	18%
We have not taken any steps	11%
Don't know	1%

0%   50%

"11% of respondents, located in South America, Africa or APAC have not taken any steps to ensure their IoT solutions are protected."

How would you best describe your organisation's approach to cybersecurity with its IoT projects?

My organisation's IoT projects have robust cybersecurity defences from end to end in compliance with the relevant ISO standard	12%
My organisation's IoT projects would benefit from stronger cybersecurity defences	35%
Cybersecurity defences have not been a priority for my organisation's IoT projects and could be vastly improved	53%

Regional breakdowns:

North America: 20%, 53%, 27%
South America: 10%, 18%, 72%
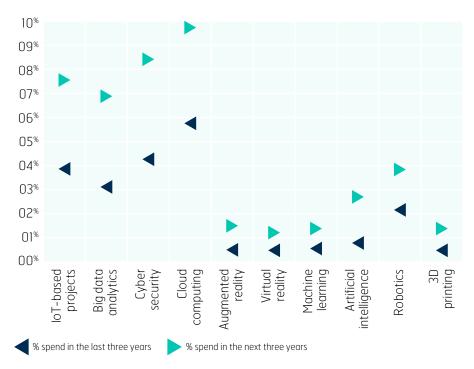APAC: 12%, 38%, 50%
Africa: 0%, 27%, 73%

06 Investment

Investment

The internet of things is not an isolated system but part of a wider group of interrelated technologies that need to be implemented correctly if mining companies are to be successful in digitally transforming their operations. Approaches to cloud computing, big data analytics, connectivity, cybersecurity and many other elements all need to be considered for mining companies to digitise successfully. How much of their budget mining companies have allocated into digitalisation and IoT is a good indicator of their current level of maturity. The amount they intend to invest over the next three years reveals how important these technologies will be for the future of their organisations.
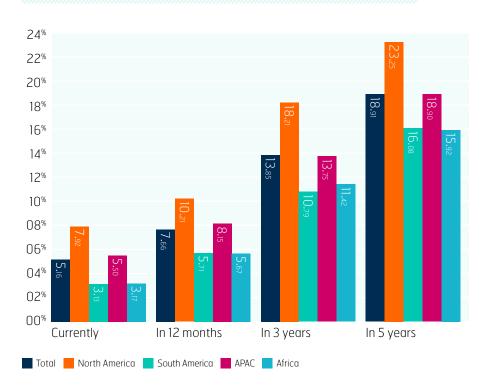
Over the past three years, cloud computing, cybersecurity and IoT have seen the highest percentage of budgetary investment, totalling 5.7%, 4.2% and 3.9% respectively. These three technologies are set to retain the highest percentage of investment in the next three years rising to 9.8%, 8.4% and 7.6% respectively. This reflects the wider increases across the other technologies surveyed, including machine learning, artificial intelligence and robotics.

How has your IT budget been spent in the last three years and how will it be spent in the next three years?

	10% 09% 08% 07% 06% 05% 04% 03% 02% 01% 00%

◀ % spend in the last three years   ▶ % spend in the next three years

"Over the past three years, cloud computing, cybersecurity and IoT have seen the highest percentage of budgetary investment, totalling 5.7%, 4.2% and 3.9% respectively."

What proportion of your organisation's costs are currently saved/ going to be saved from the use of IoT-based solutions?

Legend: Total | North America | South America | APAC | Africa

Currently: Total 5.16, North America 7.92, South America 3.13, APAC 5.50, Africa 3.17
In 12 months: Total 7.66, North America 10.21, South America 5.71, APAC 8.15, Africa 5.67
In 3 years: Total 13.85, North America 18.21, South America 10.79, APAC 13.75, Africa 11.42
In 5 years: Total 18.91, North America 23.25, South America 16.08, APAC 18.90, Africa 15.92

"Gold companies, who expect to double their investment in IoT over the next three years, expect to see a 14% increase in cost savings from their use of IoT-based solutions."

Encouragingly mining companies reported that their IoT deployments are already making a positive impact on their bottom line. Currently, cost savings amounting to an average of 5.1% are being reported, though hopes of a future impact are more pronounced, rising steadily to 7.7% in 12 months, 13.8% in three years' and a significant 18.9% in five years' time. This increase in cost savings is more than incremental and if they can be achieved it would mark a step-change in efficiencies across the sector.

We see a level of similarity in the increases in spending and forecasted cost-savings across mining sub-sectors. Gold companies expect to double their investment in IoT over the next three years (3.9% of their IT budget to 7.6%) and expect to see a 14% increase in cost savings from their use of IoT-based solutions over the next five years (6.4% to 20.2%). Iron ore miners expect to invest 7.8% of their IT budgets in IoT over the next three years and have a similar sense of optimism in their cost-saving predictions (14%).

A strong dose of caution should be highlighted at this point. As noted earlier in this report, many organisations are not making use of all the data they are gathering from their IoT deployments. This could be attributed to outdated infrastructure, poor connectivity, skills shortages or lack of capital expenditure required to make the necessary changes. Progress will need to be made across each of these areas if the sector is to achieve its cost saving objectives.

The emphasis on securing immediate results and ROI throughout the industry is affecting the balance between capex and opex when deploying IoT-based solutions. 41% struggled to secure up-front capital to invest in IoT solutions and 51% have opted to use a managed service model to reduce the financial pressure on IoT deployment. Only 17% of mining organisations reported preferring a capex approach and heavily relying on it for deployment.

Interestingly, the struggle to find up-front capital is more acute in South America (55%) and Africa (60%). These figures are unsurprising, particularly as capex has traditionally been precious to mining companies and anything viewed as a 'cost' is usually heavily scrutinised. Unsurprisingly, North America had the least amount of difficulty in securing up-front capital for IoT investment, with a clear majority (63%) enlisting a managed services model to reduce capital expenditure on IoT solutions. It seems that companies with enough budget to invest in an external services provider are securing the most ROI and will continue to do so in the future. According to the research, North American mining organisations expect to save an average of 23% of their costs in 5 years, considerably higher than South America (16%) and Africa (16%).

The results indicate that managed service providers will play a crucial part of the IoT landscape in the mining sector, as they offer an alternative to spread investment costs and achieve ROI sooner. Whether it is in the design/development of IoT, the rollout and successful deployment or the ongoing business-as-usual management, the majority of mining companies will plan on working more closely with managed services providers (MSPs) wherever possible.

The catch-22 of budget and ROI will continue to affect all mining companies and will obviously benefit those who have available capex to invest in IoT and MSPs. Those organisations that have a global annual revenue of between $5 billion - $10 billion are looking to benefit the most in five years from their use of IoT based solutions (an average of 24%). This is because they will have more available cash-flow to invest in the necessary skills training and connectivity solutions to make their IoT projects a success.

As the technology becomes increasingly adopted, smaller organisations will realise the long-term value of IoT deployment as a strategy that not only increases the bottom line, but significantly improves safety and compliance. As this becomes more prevalent, it is likely they will allocate a greater percentage of their IT budget towards IoT projects, hopefully reinvesting the savings to maintain a stable and efficient network infrastructure. According to the research this will ensure long-term success and profitability.
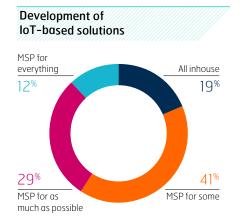
"Encouragingly mining companies reported that their IoT deployments are already making a positive impact on their bottom line. Currently, cost savings amounting to an average of 5.1% are being reported, though hopes of a future impact are more pronounced, rising steadily to 7.7% in 12 months, 13.8% in three years' and a significant 18.9% in five years' time."
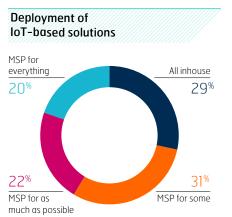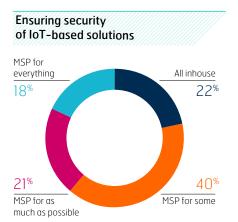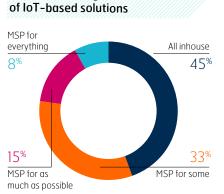
To what extent is your organisation using/planning to use external managed service providers (MSPs) in the development and deployment of its IoT-based solutions?

Development of IoT-based solutions

MSP for everything
12%

All inhouse
19%

29%
MSP for as much as possible

41%
MSP for some

Deployment of IoT-based solutions

MSP for everything
20%

All inhouse
29%

22%
MSP for as much as possible

31%
MSP for some

Ensuring security of IoT-based solutions

MSP for everything
18%

All inhouse
22%

21%
MSP for as much as possible

40%
MSP for some

On-going management of IoT-based solutions

MSP for everything
8%

All inhouse
45%

15%
MSP for as much as possible

33%
MSP for some