

Industrial IoT on land and at sea



Inmarsat
Research
Programme
2018


inmarsat

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ABOUT INMARSAT

Inmarsat plc is the leading provider of global mobile satellite communications services.

Since 1979, Inmarsat has been providing reliable voice and high-speed data communications to governments, enterprises, and other organisations, with a range of services that can be used on land, at sea, or in the air. Inmarsat has locations around the world, with a presence in the major ports and centres of commerce on every continent. Inmarsat is listed on the London Stock Exchange (ISAT.L).

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To find out how your business' IIoT readiness compares with the rest of your industry visit: [research.inmarsat.com](https://www.research.inmarsat.com).

METHODOLOGY

The Inmarsat Research Programme is now in its second year. This 2018 research is focused on understanding the ways that the Industrial Internet of Things (IIoT) is being adopted by organisations from the agriculture, energy, maritime, mining and transport sectors and the role of satellite connectivity as an IIoT enabler.

In May 2018 Inmarsat commissioned Vanson Bourne, a specialist technology market research company, to interview 750 respondents about their use of, attitude to and predictions for IIoT within their organisation and industry.

Respondents work for organisations with at least 500 employees and have either decision-making or influencing responsibilities for IIoT initiatives. However, the profile of maritime respondents is different, in that 46 per cent worked for organisations employing fewer than 500 people.

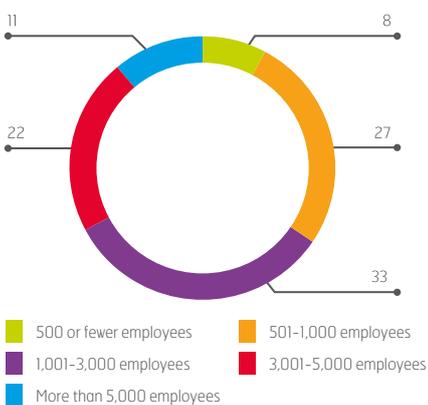
We included an 'other' category in our research base to ensure that the sample was representative of the wider business community and enable us to draw conclusions about the impact that IIoT is having on the global economy.

The other category is composed of the following sub-sectors:

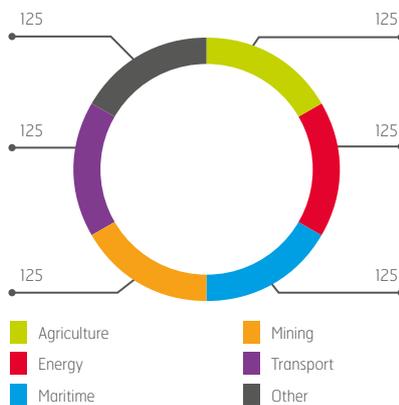
- Financial services
- Manufacturing
- Insurance/legal
- Construction/real estate
- Retail
- Telecommunications

DEMOGRAPHICS

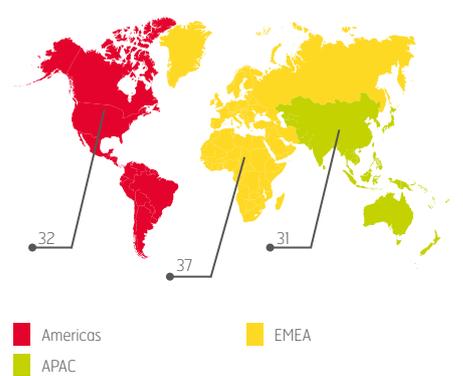
RESPONDENTS BY SIZE OF ORGANISATION (%)



RESPONDENTS BY SECTOR (750)



RESPONDENTS BY REGION (%)



RESPONDENTS BY REVENUES



*Organisations indicated their total revenues by banding, with each response treated as the median number in that banding and added together to produce totals.

EXECUTIVE SUMMARY

IIOT, CONNECTIVITY AND THE GLOBAL SUPPLY CHAIN

Global production and supply chains are increasing in complexity: they involve multiple industries, each with their own business models and processes, and encompass multiple jurisdictions and regulatory authorities.

With regulation governing the manufacture of products becoming tighter, provenance and traceability to point-of-origin are more important than ever. Climate change, a growing population and concerns around environmental sustainability are challenging our industries to produce more, while inflicting less damage on the world around us.

A sense of this complexity can be seen by looking at an industry such as mining, which lies at the start of many global supply chain partnerships. From the responsible extraction of raw materials, often in remote and environmentally challenging regions, millions of tonnes of material are then transported to processing sites, which may be thousands of kilometres away. From here, the refined product is then shipped to companies in many different industries for incorporation into their products before, eventually, reaching the customer.

Products from one mine could ultimately involve a supply chain spanning hundreds of countries and thousands of companies, with each step producing data, and requiring data, from the other steps. Factor in the need to protect employees, local people and the environment at every step and a complicated picture emerges.

IIoT is set to play a profound role providing end-to-end transparency across supply chains and improving their efficiency. We are reaching a point where all events in a supply chain will be captured as data by nerve-like sensors, before being routed for analysis and actioned.

This transparency will dramatically alter the pull-push strategies of supply chain businesses. Most currently work to balance the pull of demand-led production against the push factor from manufacturers delivering products to market based on previous demand. IIoT will allow for increasingly refined decisions, basing production on more accurate analysis of the market and its current need.

Companies that are able to use data to improve their own operations and to create a seamless partnership with all the other organisations in their supply chain have the opportunity to gain a significant competitive advantage. Those who are not moving to adopt this technology risk falling out of the supply chain altogether.

Manufacturers often use many suppliers to bring everything from raw materials to pre-manufactured parts into their production facilities. IIoT allows the volumes of material to be more finely calibrated to meet ever fluctuating demand. It can also be used to keep a close eye on sub-par suppliers and help organisations to improve the productivity of their supply chain relationships.

While it is important that no element of a supply chain act as an island, sharing data with third parties – even supply chain partners – can feel alien to many. Commercial confidentiality, security and a view that any external organisation could be a competitor, results in a natural inclination not to share data, which must be overcome.

With so many uses, data produced from sensors needs to be handled in different ways. It can be processed on the edge (adjacent to where the data is produced), or collated more centrally in the cloud, depending on its intended function. Communication networks allow for data to be seen in real-time across the supply chain, and to influence faster decision-making to ensure optimum outcomes.

A global, stable and secure communications network, which can only be achieved through the inclusion of satellite connectivity, is fundamental for the supply chain to be able to share information and capitalise on the benefits that IIoT brings. The combination of satellite with Low Power Wide Area Networks (LPWAN), RFID and other wireless data collection technologies is allowing the collation of more data points than ever before, anywhere on the planet.

Those that integrate satellite networks as part of a broader connectivity framework involving terrestrial connectivity will be able to ensure smooth data flows, better servicing of customer needs and increased turnover and profitability. Satellite's unique capabilities in terms of its global reach – especially when using a single global network – and the redundancy it offers; ensure that the supply chain is never broken through a failure in its connectivity backbone.

As the fourth industrial revolution proceeds, a host of complementary technologies will emerge along with IIoT. Blockchain, AI, machine learning, 3D printing and others will all become important elements of an increasingly automated supply chain.

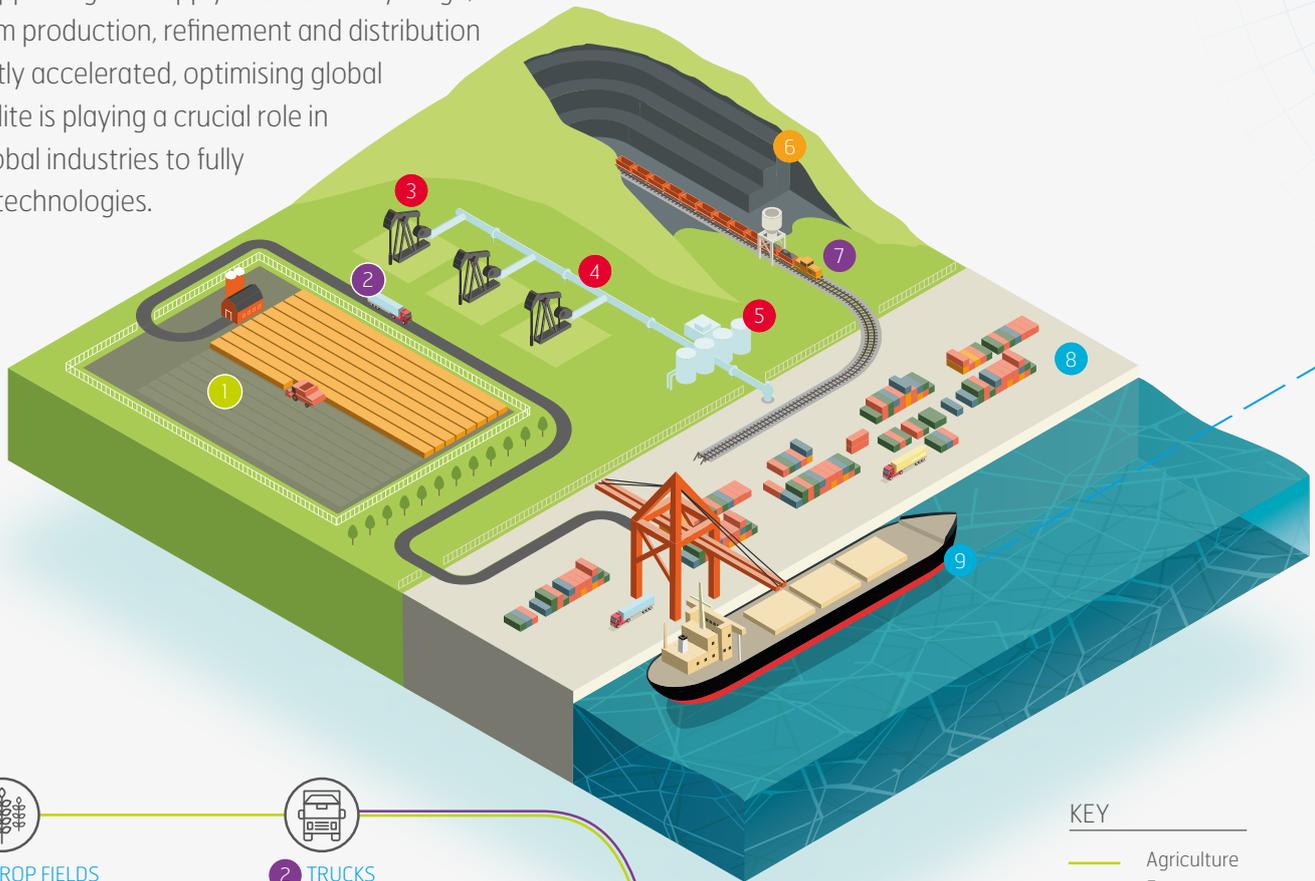
Businesses certainly have their work cut out to stay ahead of the curve. New people with new skills and new ways of thinking are needed to apply themselves to finding wholly new ways of running the supply chain. Not only will they need to be thinking about their own operations, but they must also consider how they will integrate with others in the supply chain to ensure evermore seamless ways of working.

A supply chain is only as good as its weakest link, and without all parts playing their role, sharing data, it will operate inefficiently. Our research shows where IIoT can improve the supply chain and where satellite connectivity is supporting this.



GLOBAL SUPPLY CHAINS

The global supply chain is only as good as its weakest link. With IIoT supporting the supply chain at every stage, the process from production, refinement and distribution is significantly accelerated, optimising global trade. Satellite is playing a crucial role in enabling global industries to fully exploit IIoT technologies.



1 CROP FIELDS
Sugarcane production – LPWAN sensors monitor environmental conditions and harvest data. Automated machinery optimises yields with data shared with farmers and further down the supply chain.

2 TRUCKS
Sugarcane transport – IIoT sensors gather vehicle data and location tracking to deliver accurate delivery forecasts, improving efficiency of supply chain.

3 ON-SHORE RIGS
Crude oil extraction – IIoT delivers real-time process monitoring and predictive maintenance, as well as production levels, providing vital data on energy supply.

4 PIPELINE
Crude oil distribution – Sensors gather data to monitor for leaks and optimise forecasting, enabling refinery to bring more production capacity online.

5 REFINERY
Crude oil processing – Analyses data received from pipeline and production equipment upstream to optimise refining process, integrated sensors inform transport partners in real-time of expected product quantities.

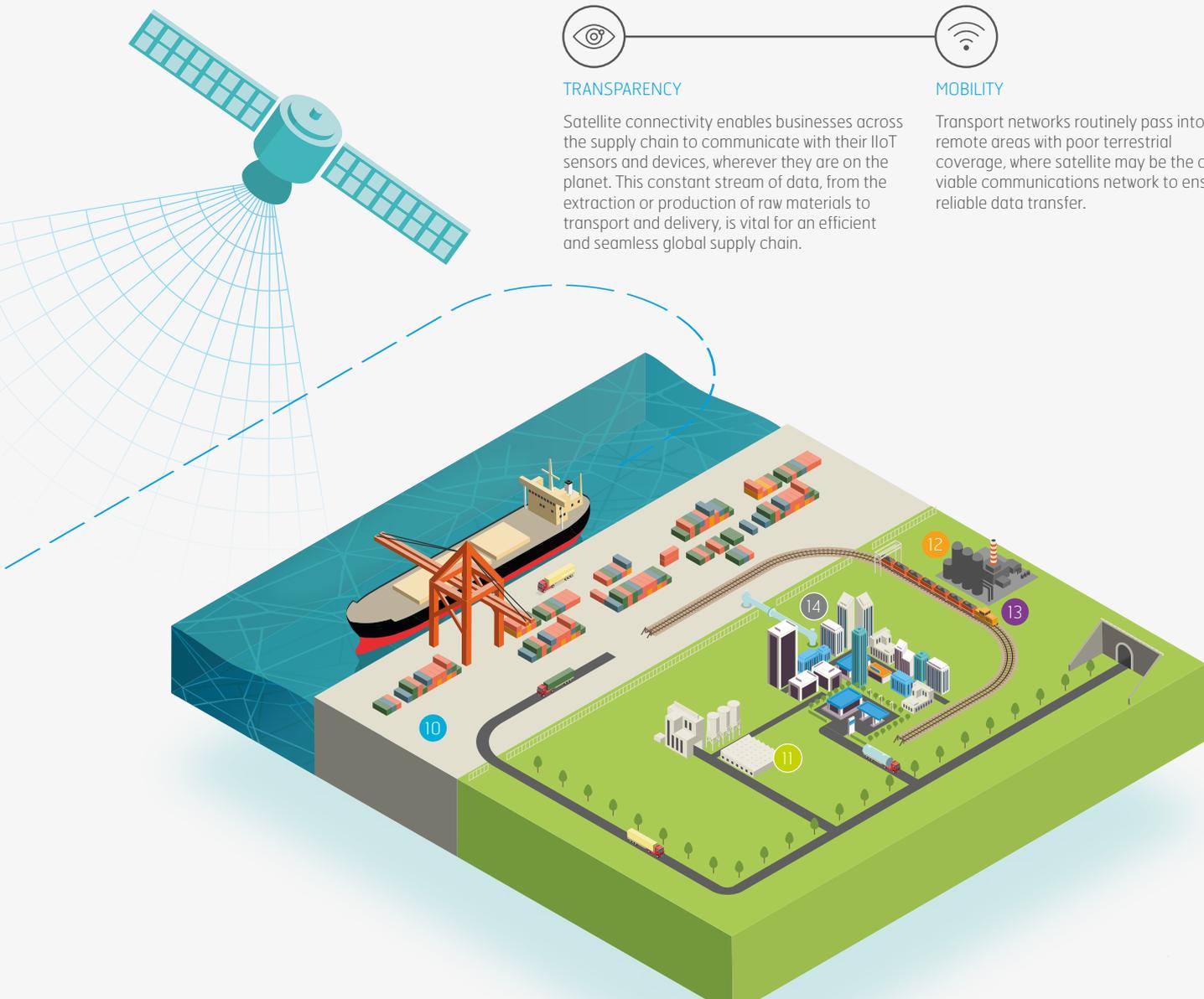
6 MINE
Iron ore extraction – Connected sensors ensure efficient and profitable extraction, improving sustainability and staff health and safety.

7 AUTONOMOUS RAILWAY
Iron ore transport – IIoT enables autonomous railways to reduce transport costs and monitors cargo loads, providing critical transparency over supply chain.

KEY

- Agriculture
- Energy
- Maritime
- Mining
- Transport

8 PORT
Connectivity technologies such as RFID enable fast cargo identification and processing, optimising passage through freight infrastructure to reduce friction in global trade.



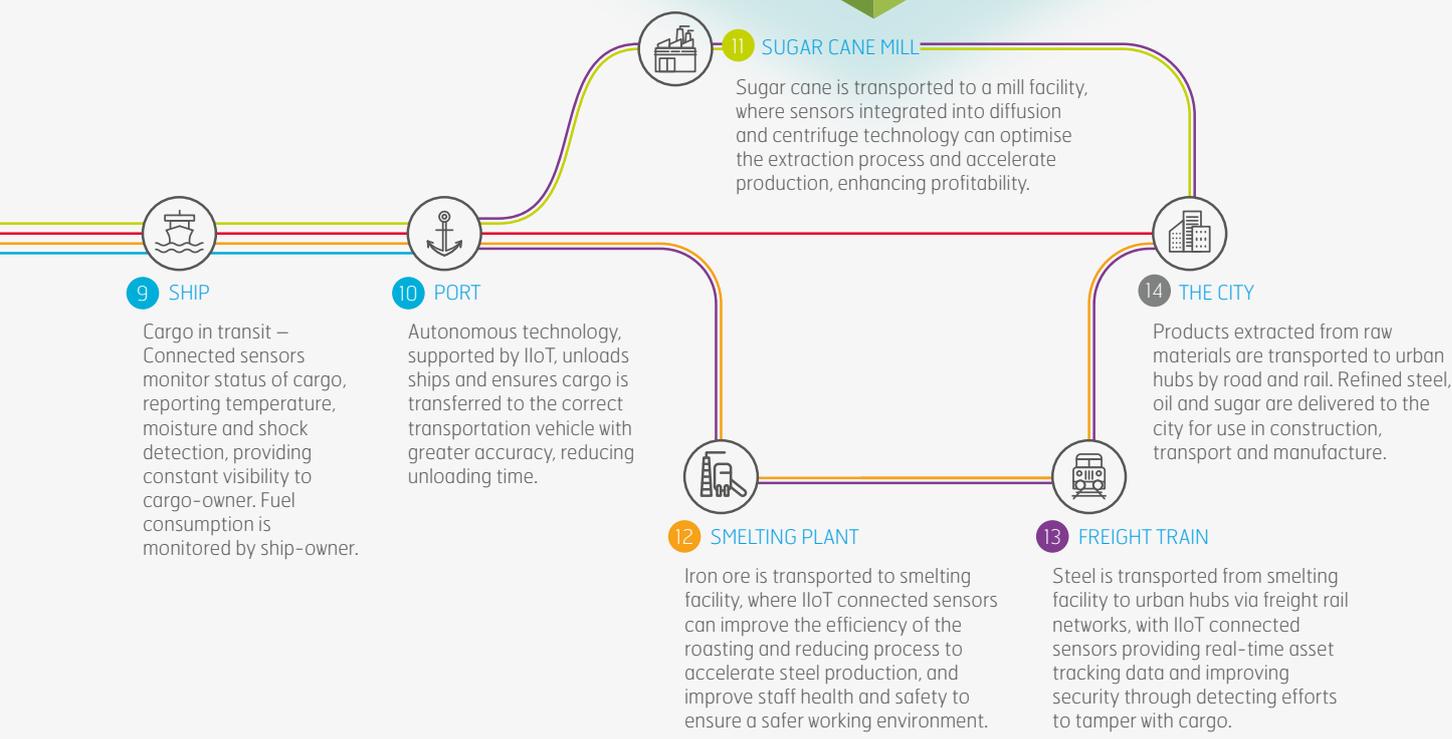
TRANSPARENCY

Satellite connectivity enables businesses across the supply chain to communicate with their IIoT sensors and devices, wherever they are on the planet. This constant stream of data, from the extraction or production of raw materials to transport and delivery, is vital for an efficient and seamless global supply chain.



MOBILITY

Transport networks routinely pass into remote areas with poor terrestrial coverage, where satellite may be the only viable communications network to ensure reliable data transfer.



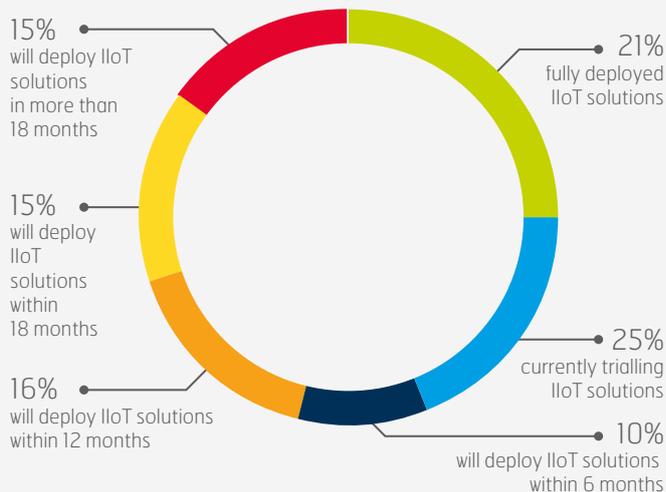
EMERGING TRENDS

Our key barometers for IIoT success consider organisational approaches to adoption, skills, security, data usage, connectivity and IIoT technologies and investment and ROI. Later in this report we will unpick the trends by sector, but viewing the supply chain as a whole enables us to understand its current status and where constituents need to collectively work together to improve its efficiency.

ADOPTION

IIoT adoption is accelerating rapidly. With over a fifth of businesses surveyed reporting full adoption and a further quarter reporting that they were in the trial stage of IIoT deployment, it is clear that the technology is a major focus for businesses across the global supply chain. There are a number of drivers for IIoT adoption, the most significant being improving resource efficiency, monitoring environmental changes and improving health and safety. These drivers will enable organisations to create leaner business models and operate with greater sustainability and less impact on the environment, as well as improving working conditions for their staff. However, adoption levels are inconsistent across the sectors surveyed, with energy and mining showing much lower levels of adoption than transport and maritime. Supply chains must be connected from end-to-end to operate with maximum efficiency, and if certain areas are not gathering the necessary data to identify these efficiencies, businesses will struggle to use IIoT to its maximum potential.

WHICH OF THE BELOW STATEMENTS DESCRIBES YOUR CURRENT STATUS WHEN IT COMES TO DEPLOYING IIOT-BASED SOLUTIONS?



TOP 3 IIOT DRIVERS



RESOURCE EFFICIENCY



IMPROVING HEALTH AND SAFETY

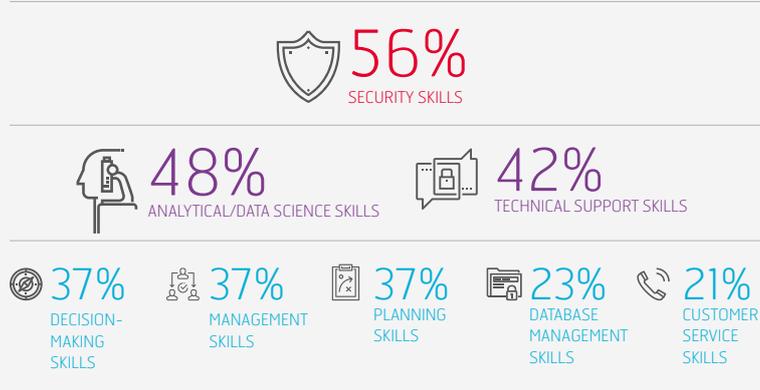


MONITORING ENVIRONMENTAL CHANGE

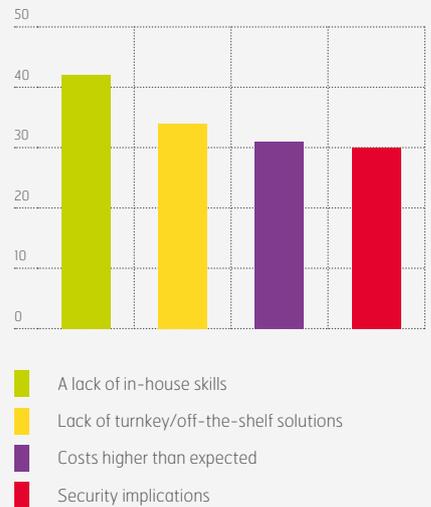
SKILLS

The skills gap has emerged as one of the key barriers to successful IIoT deployment. A lack of in-house skills was cited as the top barrier to IIoT deployment, higher than other issues such as cyber-security risks and high costs. The organisations surveyed reported requiring additional staff with expertise in security, data science and analytics and technical support, as well as staff to drive the strategic development, management and deployment of IIoT. Without these skills in place, organisations will struggle to make best use of the data they gather, which will ultimately hinder the transformative role that IIoT can play in the global supply chain, limiting the flow of data across multiple businesses and industries. To plug these skills gaps and ensure successful IIoT deployments, organisations must look to external partners with the specialist skills and expertise to provide the core competencies necessary for IIoT.

WHAT ADDITIONAL SPECIFIC SKILLS DO YOU THINK YOUR ORGANISATION NEEDS TO DELIVER IIOT-BASED SOLUTIONS?



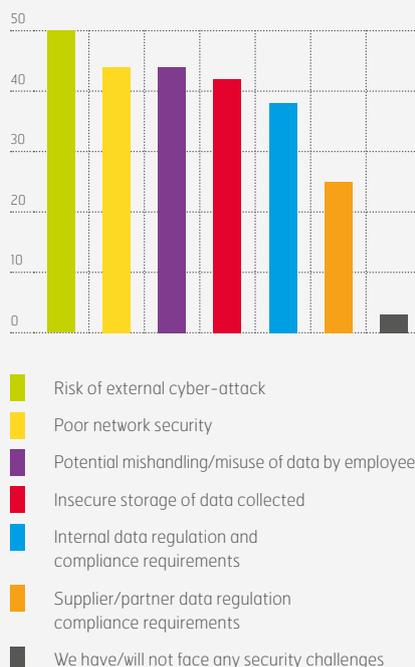
WHAT BARRIERS TO ADOPTION HAVE YOU ENCOUNTERED IN THE DEVELOPMENT OF IIOT-BASED SOLUTIONS WITHIN YOUR ORGANISATION? (%)



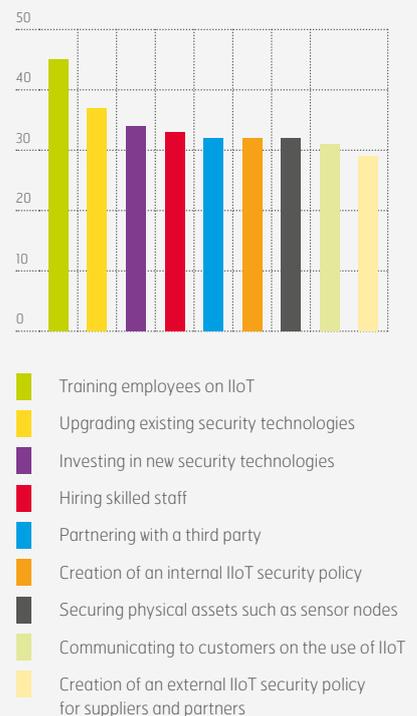
SECURITY

With almost all organisations facing security challenges in the deployment of IIoT solutions, it is critical that businesses take comprehensive action to bolster their defences. External cyber-attacks are causing most concern to businesses, followed by poor network security and data mishandling or misuse by employees. To protect against these threats, organisations are training their employees on IIoT security best practices, upgrading existing security technologies and investing in new security measures. However, some sectors are adapting to its challenges better than others. Energy and transport are the most confident in their approach to dealing with the IIoT security, while more challenged agriculture is looking to third-parties for help.

WHAT ARE THE BIGGEST SECURITY CHALLENGES ASSOCIATED WITH THE USE OF IIOT-BASED SOLUTIONS WITHIN YOUR ORGANISATION? (%)



WHAT CHANGES IS YOUR ORGANISATION MAKING TO ADDRESS IIOT SECURITY CHALLENGES? (%)



EMERGING TRENDS

DATA

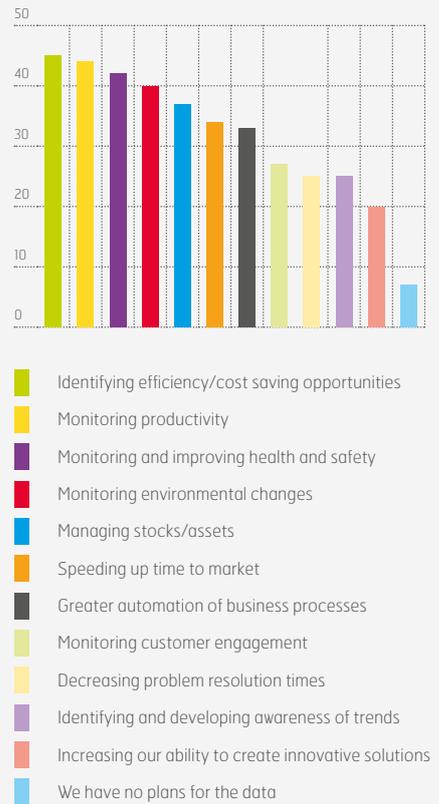
It is clear that while there is now plenty of appetite for the various benefits of IIoT-produced data, the reality is organisations are some way off where they want to be in analysing and using it. Better decision-making, increased internal visibility of data and greater supply chain insight are some of the potential data-enabled benefits with large disparities between what has been achieved so far, versus what organisations hope to achieve in the future. All three will be critical to an organisation's ability to thrive in the supply chain of the future. Our research found that generally the closer a business was to the consumer, the stronger its data strategy was. Organisations need to focus on developing their data strategies to foster effective sharing, analysis and security, to ensure that they achieve these goals.

HOW WOULD YOU SCORE YOUR ORGANISATION'S ACHIEVEMENT OF EXPECTED BENEFITS OF IIOT-BASED SOLUTIONS SO FAR AND FOR THE FUTURE?

- WE ARE ALREADY ACHIEVING THIS
- WE HAVE NOT ACHIEVED THIS SO FAR, BUT STILL EXPECT TO IN FUTURE



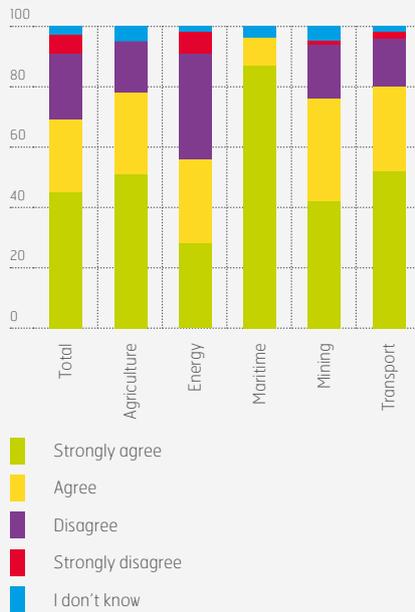
HOW DO YOU/WILL YOU USE THE DATA COLLECTED THROUGH YOUR ORGANISATION'S IIOT-BASED SOLUTIONS? (%)



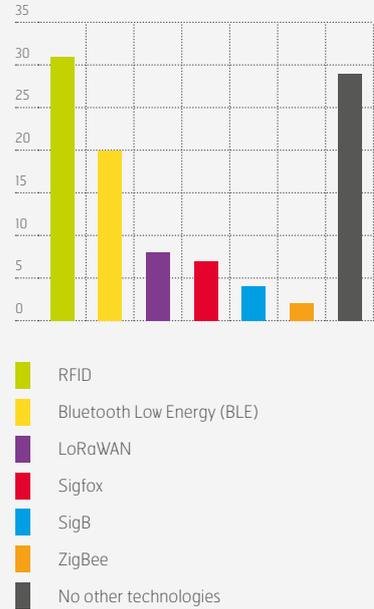
CONNECTIVITY AND IIOT TECHNOLOGIES

Robust, reliable connectivity is critical to the success of IIoT solutions. Without the constant transmission of data gathered by connected sensors for analysis in real-time, organisations will not gain full value from their IIoT deployments. Satellite networks are forming a core part of the connectivity mix that most organisations are adopting to transfer their IIoT data, alongside radio, cellular and fibre networks, providing complex, multi-national supply chains with reliable coverage to enable the constant transfer of data. To support their IIoT solutions, organisations are also investing in connectivity technologies such as RFID, Bluetooth Low Energy and LoRaWAN to enable seamless data collection and transfers from multiple data points.

DO YOU AGREE WITH THE FOLLOWING STATEMENT: SATELLITE CONNECTIVITY PROVIDES CRUCIAL SUPPORT TO YOUR IIOT COMMUNICATION NETWORKS? (%)



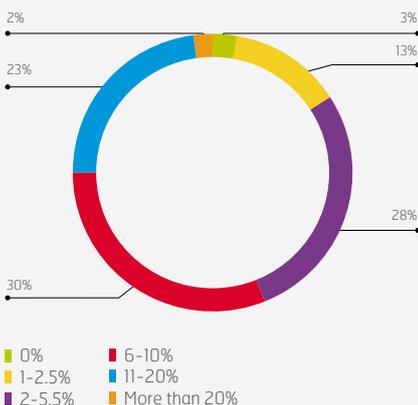
WHAT OTHER TECHNOLOGIES ARE YOU USING IN YOUR IIOT-BASED SOLUTIONS? (%)



INVESTMENT AND ROI

With the acceleration in IIoT deployment, businesses are investing more and more of their resources into the development of IIoT solutions. With just under 10 per cent of IT budgets earmarked for IIoT over the next three years, businesses are expecting significant returns on their investment with a 10 per cent reduction in costs and a five per cent lift in turnovers expected at the end of this period, and more by 2023. However, the varying levels of investment seen across the sector puts the potential for IIoT to revolutionise the global supply chain under threat. If one link in the chain does not have sufficient capacity to gather and transfer data, that can interrupt the flow of information and dramatically reduce the efficiency of the supply chain. Energy is set to lead the way in net investment with agriculture investing the least, while generally larger enterprises plan to invest a higher proportion of their IT budgets demonstrating their commitment to the technology.

WHAT PROPORTION OF YOUR ORGANISATION'S IT BUDGET DO YOU EXPECT TO SPEND ON IIOT-BASED SOLUTIONS OVER THE NEXT THREE YEARS? (%)



WHAT OPERATIONAL COST-SAVINGS WILL YOUR ORGANISATION MAKE FROM IIOT-BASED SOLUTIONS?



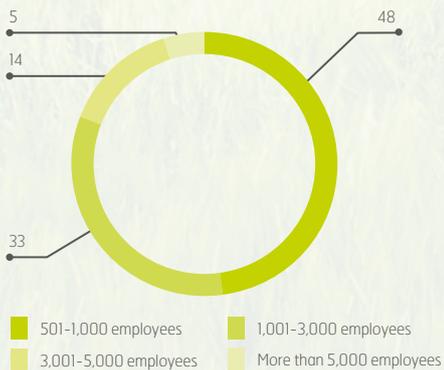
WHAT TURNOVER INCREASE WILL YOUR ORGANISATION MAKE FROM IIOT-BASED SOLUTIONS?



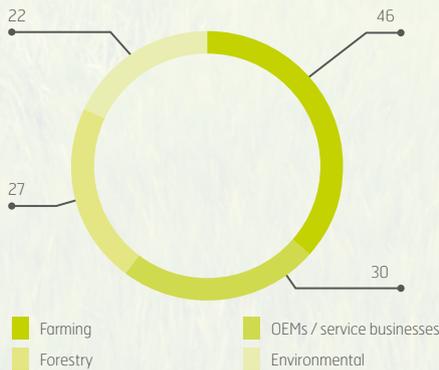


AGRICULTURE DEMOGRAPHICS

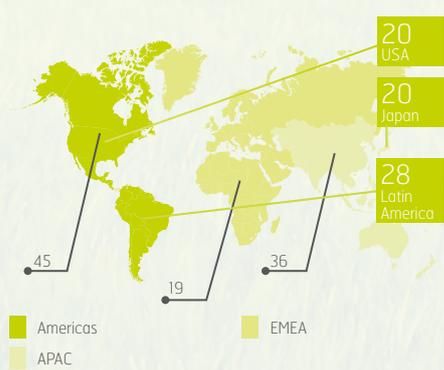
RESPONDENTS BY SIZE OF ORGANISATION (%)



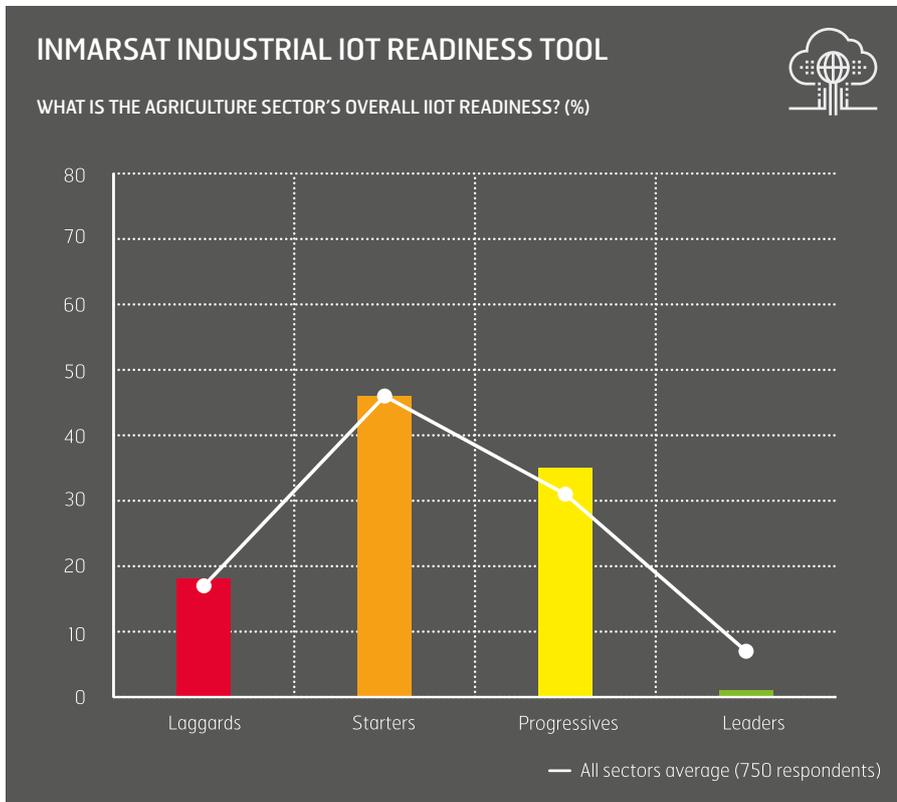
RESPONDENTS BY SUB-SECTOR (%)



RESPONDENTS BY REGION (%)



AGRICULTURE



The world population is expected to reach almost 10 billion by 2050¹, meaning that we will have over two billion extra mouths to feed. Agriculture must therefore improve its ability to deliver the organic products needed for food, clothing, medicine and a raft of other products, while simultaneously mitigating the effects of climate change.

Encouragingly, the sector is rising to the challenge and is starting to leverage new technologies, such as IIoT, to help it meet the challenges ahead. The overall IIoT readiness scores being reported in agriculture are broadly in line with those seen in the entire research sample. While it is notable that only a handful of respondents have yet earned a position in the leader category (all in the OEM sub-sector), the sector is laying the foundations of a smarter and more connected future.

However, the industry represents a broad number of different segments, from large-scale farming (both crop production and livestock) and forestry, to the OEM and service industries that furnish the sector with consultancy services, seeds and machinery, and organisations charged with protecting the delicate balance between humanity and nature. Each of these

groups have distinct reasons that are driving their use of IIoT and each face their own unique barriers to successful adoption, which we will unpack over the following pages.

Within the agriculture sector the enthusiasm for IIoT, and other next generation technologies, is undeniable, not least for their ability to protect often-slim margins by reducing operational costs (44 per cent), deploying resources like fertiliser and water more efficiently (38 per cent), and enabling businesses to become more sustainable (50 per cent). IIoT-based precision farming techniques, sometimes called variable farming, are much improved through IIoT. No two plots of land will be the same – soil types vary enormously, nutrient levels change and previous crop harvests alter the nature of the ground – meaning that IIoT can play a significant role in collecting data on the changing nature of the land. This information is hugely significant for farmers to understand the real time needs of their estates and increase crop yields.

Although it is still relatively early days, IIoT projects in the sector are already starting to deliver their intended results and respondents are reporting improvements in their operational sustainability,

productivity and asset utilisation, and it is IIoT data that sits at the heart of this transformation.

However, like every sector, skills and security challenges exist. Indeed, agriculture is an industry that appears to be struggling with security more than most, indicating that the sector is having a difficult time adapting to its new digital dependencies and vulnerabilities.

Connectivity is another challenge that must be resolved and the results indicate that many respondents, particularly those from Latin America, are struggling to access the connectivity they need to fully exploit IIoT. Given the remoteness of agricultural operations, connectivity is always going to be something to be navigated, though it is clear respondents that depend the most heavily on satellite are having the most success addressing the issue and reporting the most success from their IIoT initiatives.

IIoT an essential part of the future of the industry. However successful deployments sit on a foundation of knowledge about how to use data, courage and openness to new innovation, and for the sector to think and act more in-step with other agriculture and supply chain businesses and share insights smoothly between organisations. This will make the agricultural supply chain become more effective. The sector is reaching for these elements, but as our report shows, it does have further to go on its journey before it can realise transformative success in IIoT.

INMARSAT INDUSTRIAL IOT READINESS TOOL



Our tool allows us to benchmark sectors, organisations and industries against each other based on their IIoT readiness.

We asked our 750 respondents a series of questions, with points attached to their responses, scoring their IIoT development in six key areas:

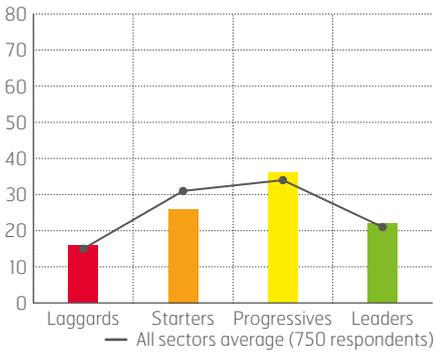
- Adoption
- Security
- Connectivity and IIoT technologies
- Skills
- Data
- Investment and ROI

Using the scores, we divided our respondents into categories indicating their IIoT maturity: laggard, starter, progressive and leader.

¹ www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

ADOPTION

HOW MATURE IS THE AGRICULTURE SECTOR IN RELATION TO IIOT ADOPTION?



Today over half of organisations in the agriculture sector have fully (22 per cent) or partially (31 per cent) deployed IIoT solutions – a figure that, on land, can only be beaten by organisations in the transport sector – and all respondents expect to have IIoT solutions in place by 2020. This uptake of IIoT places well over half of respondents in the progressive or leader categories in our IIoT adoption readiness tool.

Respondents from across the agriculture spectrum are clearly enthusiastic about the potential that IIoT holds for their organisations. 77 per cent of respondents agree or strongly agree that it will revolutionise the industry, while 82 per cent think that IIoT will be essential for their organisation to gain an edge on the competition.

As a sector that is coming under intense pressure to increase production and protect margins, it should come as little surprise that these factors are driving the adoption of IIoT in the sector. Half (50 per cent) reported that environmental monitoring (of soil and weather conditions) was a driver, 44 per cent identified the promise that IIoT holds for reducing operational costs, and 38 per cent sought to improve resource efficiency through the technology.

Smarter IIoT-enabled irrigation systems are just one area where all three of these drivers can be achieved. Just 20 per cent of agricultural land is irrigated today, accounting for 40 per cent of the food produced globally, and while the expansion

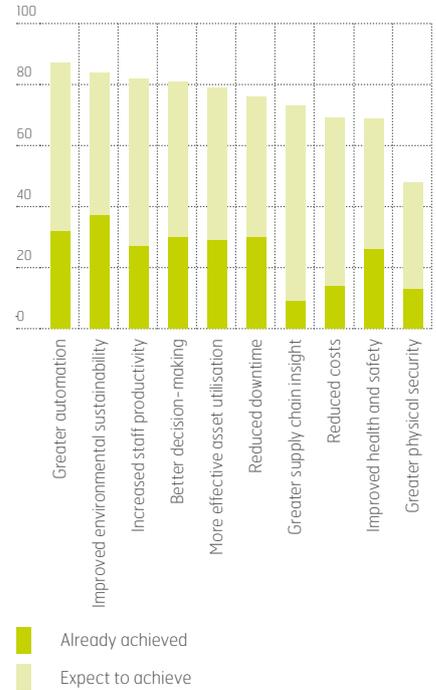
of irrigation systems would see yields increase considerably, current techniques represent a desperate waste of water. Adding an extra layer of intelligence to these solutions with IIoT sensors means that precious water reserves can be maximised, opening up the possibility for more farmers around the world to irrigate their crops and increase yields sustainably.

However, some interesting differences emerge when we break the sample down by respondent type. Those from forestry were most interested in the potential that IIoT holds for opening up new revenue generation opportunities (52 per cent). Farmers were concerned with using IIoT to reduce resource efficiency and to reduce costs (both 46 per cent). OEMs on the other hand, driven by need from other parts of the agricultural sector, are prioritising using IIoT to bolster physical security and health and safety (both 50 per cent).

Importantly, many respondents report that their IIoT projects are already starting to bear fruit and deliver the sort of changes that the sector needs to cope with the macroeconomic challenges it faces. 37 per cent report that IIoT has increased their environmental sustainability, 32 per cent have increased automation within their organisations, which in turn speeds up production and reduces the reliance on manual labour, and 30 per cent have achieved better decision making and less downtime as a consequence.

However, it's worth noting that respondents aren't yet reporting universal success rates in realising their objectives. Just 9 per cent state that they've achieved their objective of securing greater insight into their supply chains, while 64 per cent believe they will achieve this in the future. This is notable as the biggest disparity between what has been achieved so far and what agricultural respondents predict in the future. There is clearly momentum toward IIoT driving better supply chain insight in the agricultural sector, and with the right strategies and investment this prediction will revolutionise the industry.

HOW WOULD YOU SCORE YOUR ORGANISATION'S ACHIEVEMENT OF EXPECTED BENEFITS OF IIOT-BASED SOLUTIONS? (%)



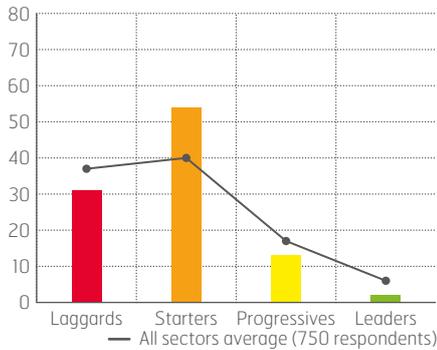
9%

have achieved greater insight into their supply chains to date, while 64 per cent believe this will happen in the future

IIoT projects are starting to bear fruit and deliver the sort of changes that the sector needs to cope with the macroeconomic challenges it faces

SKILLS

DOES THE AGRICULTURE SECTOR HAVE THE SKILLS IT NEEDS FOR IIOT? (%)



While skills are in short supply across all sectors and at all levels, they are most acute in the agriculture sector when it comes to keeping IIoT solutions up and running after deployment. Only 6 per cent stated that they had all the skills they needed in this area, with 92 per cent stating they would benefit from additional skills to augment those that they do have in this area. Evidently there is an opportunity for managed services companies to better support agricultural organisations with their IIoT deployments, after initial deployment, in order to deliver agreed productivity objectives.

Moreover, a lack of in-house skills emerged as the single biggest barrier to the adoption of IIoT solutions within agriculture, selected by 46 per cent of respondents, indicating that many are finding it difficult to adapt to an increasingly digital future.

The skills shortages being reported are particularly acute amongst OEMs, where over half (56 per cent) identified skills shortages as one of their biggest barriers to the development

of IIoT solutions within their organisation. This is not surprising considering their position at the sharp-end of the market developing IIoT-based solutions, and their greater understanding of its possibilities.

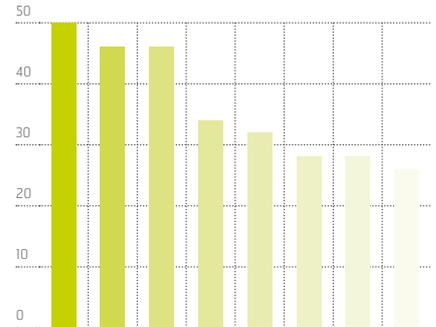
Looking at the specific skills needed, 50 per cent identified a shortfall in data science skills, making it harder for the industry to take meaning from the information they are collecting from their IIoT solutions. 46 per cent, meanwhile, believed that they lacked the necessary technical support and security skills for their IIoT initiatives.

These factors combined are putting a break on IIoT innovation within the sector. Furthermore, challenges in getting the right in-house skills means that it is likely costs will be higher in the development phase as organisations explore options to get their deployments right.

As the industry matures, and more off-the-shelf IIoT solutions become available (the current absence of which was identified by three in ten respondents as a barrier to IIoT adoption), the lack of in-house skills should become less of an issue. However, the sector must focus its efforts on upskilling and reskilling their existing workforce and technology education needs to be seen to be part of what it means to work in agriculture.

The future of agriculture depends on not only understanding how to produce organic materials, but also how technology sits at the centre of all aspects of the industry. The answer lies in greater collaboration in the sector and to work more closely with partners who can share their skills and experience to smooth out the process.

WHAT ADDITIONAL SPECIFIC SKILLS DO YOU THINK YOUR ORGANISATION NEEDS TO DELIVER IIOT-BASED SOLUTIONS? (%)



- Data science skills
- Technical support skills
- Security skills
- Database management skills
- Planning skills
- Management skills
- Customer service skills
- Decision-making skills

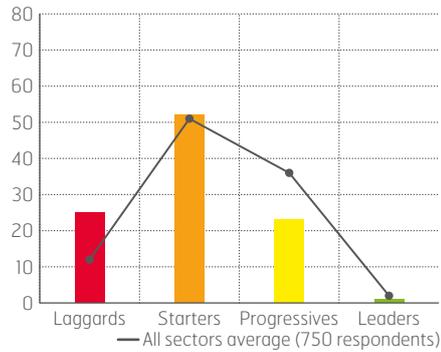
50%

lack the data analysis skills they require for IIoT

Skills shortages, particularly amongst OEMs, are putting a break on IIoT innovation within the agriculture sector

SECURITY

HOW MATURE IS THE AGRICULTURE SECTOR'S APPROACH TO IIOT SECURITY? (%)



Industry experts are coming to terms with the idea that, while the industry is not going to come under the same concerted attacks that finance houses are, there's a growing need to protect agricultural set-ups. But despite this recognition, security is still an area that much of the sector is struggling with, with the clear majority of respondents ranking in the laggard or starter categories when it comes to IIoT security.

By its nature, the agricultural sector has traditionally been well insulated from cyber-attacks, so the limited progress in this area is somewhat expected. However, as farms integrate evermore internet-enabled technologies into their operations that is rapidly changing. Such attacks could have devastating consequences, and a well-targeted hack of a smart irrigation system or harvesting machinery could well do irreparable damage to a supply chain or wreak havoc in the commodity market.

While it is encouraging that just 19 per cent stated that security was a barrier to adoption – significantly lower than the figure reported in some other sectors – six in ten respondents admitted that their processes to combat cyber-

security and protect against data mishandling could be improved. Moreover, 98 per cent said that they had IIoT security concerns of some sort.

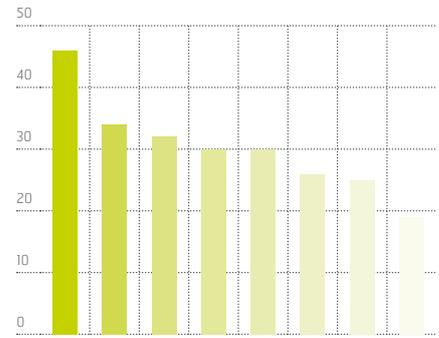
However, despite their recognition of the potential security risks, the steps agriculture respondents have taken to address these vulnerabilities indicates that they are not yet properly confronting the issue. While around half have instigated initiatives to train employees on IIoT (46 per cent), only around 34 per cent have moved to improve the security of physical assets such as sensor nodes and just 25 per cent have invested in new security technologies.

The low level of activity being reported to improve the security surrounding IIoT solutions may owe to the relatively limited involvement of Chief Information Security Officers (CISOs) in IIoT deployments in the sector. Almost four in ten (38 per cent) respondents state that their CISOs are not involved in IIoT deployments, but should be, and a further 18 per cent didn't see a need for their involvement at all. When we consider the skills shortages and challenges being reported with regard to security in all segments of the agriculture sector, this is surprising.

On a more positive note, the agriculture sector is actively looking to plug the gaps in its security capabilities and work with third party specialists to secure their IIoT initiatives. Just 13 per cent of agriculture respondents intend to manage the ongoing security of their IIoT solutions, with the majority expecting to enlist the help of security experts.

When we consider how quickly the threat landscape is evolving, and the security challenges being reported, agriculture's recognition that it can't solve the security issue on its own is encouraging; however, it has much to do to safeguard its future.

WHAT CHANGES TO SECURITY HAS YOUR ORGANISATION MADE, OR DOES IT INTEND TO MAKE, TO ADDRESS IIOT SECURITY CONCERNS? (%)



- Training employees on IIoT
- Securing physical assets such as sensor nodes
- Upgrading existing security technologies
- Partnering with a third party
- Hiring skilled staff
- Communicating to customers on the use of IIoT
- Investing in new security technologies
- Creation of an external IIoT security policy for suppliers and partners

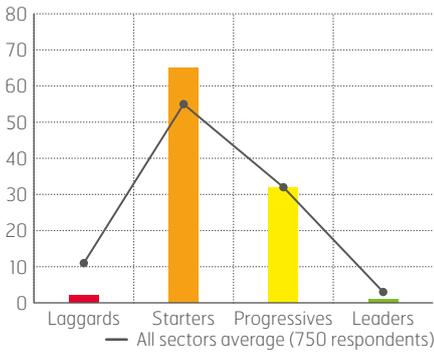
60%

stated that their approaches to cyber-security could be stronger

The agriculture sector is actively looking for support from third party specialists to secure their IIoT initiatives

DATA USAGE

HOW ADVANCED IS THE AGRICULTURE SECTOR'S APPROACH TO IIOT DATA? (%)



The agriculture sector is doing marginally better than others in the way that it harnesses IIoT data, but our research indicates it has some way to go before it can fully leverage it to maximise competitive advantage. While just 2 per cent of respondents registered in the laggard category, a further two-thirds came out as starters, suggesting that much of the data generated by IIoT solutions is left to go to waste, which is a missed opportunity.

As we touched on earlier, agricultural businesses are beginning to realise some benefits of IIoT within their organisation, but more sophisticated analysis and a view of their wider supply chain is still out of reach.

Respondents clearly recognised the potential that IIoT data holds for enabling them to transform their business and optimise their operations, and businesses are expecting to put the data that is available to them to a number of innovative uses. For example, 81 per cent of businesses involved in forestry hope to use this data to improve environmental sustainability, and 89 per cent in the farming sector expect to use the data to increase staff productivity.

Our research indicated a number of factors that may be hindering agricultural firms in their use of data. Security is of course one of the most pressing issues, with 36 per cent of agriculture businesses reporting that insecure data storage and transmission was one of the reasons they were not able to use their data as effectively as they would like.

38 per cent of respondents identified a lag between data being collected and it being available for analysis as the reason they were struggling to utilise their data, showing how critical it is for businesses to have robust connectivity channels in place to allow real-time monitoring. Equally important is the need for a well architected flow of data, with careful consideration needed regarding what data is processed at 'the edge', by the sensors, vs. the data that is sent to the cloud for aggregation into analytic dashboards. This is an area in which many agriculture respondents fall down.

Without these networks and skillsets in place, agricultural businesses cannot make best use of their data, to provide up-to-the-minute insights on what's going on in the field, in order to inform real-time decision-making. If further evidence was needed that agricultural businesses need to get better at sharing the data gathered by IIoT solutions, internally, of the 125 companies that we surveyed, just 9 per cent said the data was available to everyone within the organisation, with 41 per cent saying it was only available to certain departments involved in that IIoT deployment, making agriculture more siloed than any other industry we reviewed. For businesses to gain the full benefits of IIoT deployment, they must open up access to their data so that the potential for innovation is increased and staff can collaborate.

While the immediate priority will be to share data within organisations, a siloed approach to data will not benefit agricultural companies – particularly due to increased regulation, governmental involvement and the opportunity for tertiary businesses. In time, the manner in which data flows out of the agricultural organisation will become paramount as these third-parties begin to rely on this real-time information to gain insight into the global production and supply chain. Those agricultural businesses who begin to work with their digital partners in this way will benefit from the development of new revenue streams and symbiotic digital eco-systems that afford them significant competitor advantages.

A big issue regarding data sharing is about trust. Many farmers – of all sizes – are very concerned about who owns their data and how it is used. Players in the agricultural supply chain vary

WHAT CHALLENGES DOES YOUR ORGANISATION FACE IN USING DATA EFFECTIVELY AS POSSIBLE? (%)



- It is only available to the IT department and senior management
- It is only available to certain departments involved in the IIoT deployment
- It is available to anyone in the organisation, but access must be granted
- It is available to anyone in the organisation to access and use

enormously in scale. Retailers and distributors can be significantly larger than the farmers they work with and this has been previously used to squeeze sales margins. The idea of sharing valuable data up and down the supply chain therefore causes concern amongst some farmers who feel at greater commercial risk. In time however, those who do not share data reciprocally will find themselves disadvantaged.

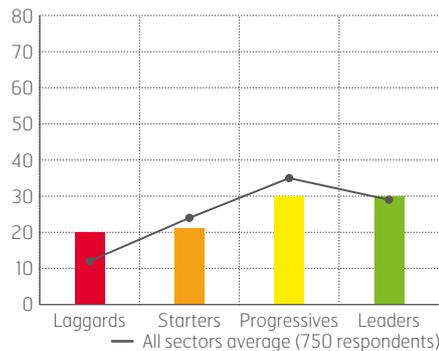
55%

restrict access to IIoT data within their organisation

The majority of agriculture companies expect the data from IIoT solutions to deliver improvements to staff productivity and sustainability

CONNECTIVITY AND IIOT TECHNOLOGIES

HOW WELL IS THE AGRICULTURE SECTOR ADAPTING TO THE CONNECTIVITY REQUIREMENTS OF IIOT? (%)



Overall, the agriculture sector showed a healthy level of connectivity to enable Industrial IoT, with some 60 per cent of respondents ranking in the progressive or leader categories. However, looking into the detail, especially the performance of communication networks, it can be seen that organisations that struggle with reliable connectivity are significantly behind the sector overall, with many having barely begun their journey into IIoT deployment.

When asked whether they ‘struggled with reliable connectivity when it comes to successful IIoT deployment at least some of the time’, 40 per cent of respondents agreed. Whereas overall, 51 per cent of agricultural respondents had fully deployed or were trialling the deployment of IIoT, this figure drops dramatically to just 4 per cent for those saying that they had connectivity issues. The difference is stark in a number of areas – 88 per cent of those that could be classed as ‘connectivity strugglers’ said that it was disrupting their ability to take advantage of the technology (compared to just 10 per cent of the overall sample).

On nearly every measurement, whether it is access to skills and expertise, forecasted cost savings and impact on turnover, or planned investment in digital transformation – those who struggle with connectivity are at a serious disadvantage and can be considered laggards in their IIoT maturity. Getting the right connectivity in place is fundamental to improving business performance and grasping any of the opportunities of the fourth industrial revolution.

Those that do not have the right connectivity in place will soon face a serious competitive challenge from any company with a solid communications network behind it.

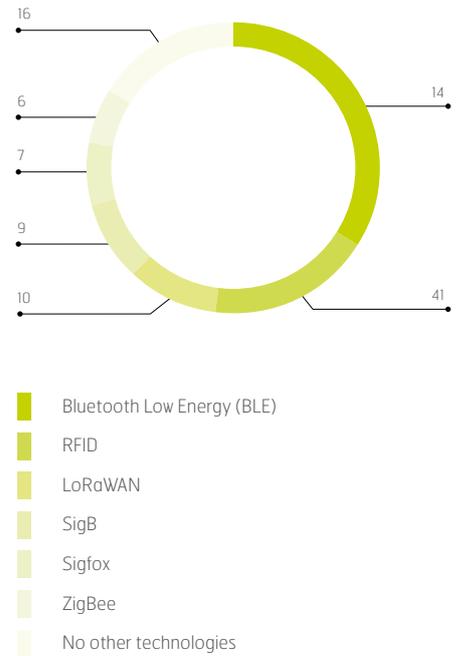
The research also investigated what types of communication network were proving most popular in the sector. The remoteness of certain parts of the agricultural industries lends itself to a greater use of satellite communication networks so it is not surprising that 72 per cent said that they used satellite to some extent, followed by cellular networks (61 per cent) and fibre (49 per cent). Perhaps the most significant finding was the divergence in satellite use being a determinate of whether they experienced connectivity difficulties. 82 per cent of respondents who do have reliable connectivity use satellite to some degree, but the proportion falls to 57 per cent who report connectivity struggles.

Moreover, Latin America stood out from other regions participating in this research on the connectivity issue. More than double (82 per cent) the respondents in Latin America reported struggling to some degree with connectivity, compared to the overall response (40 per cent), giving some indication of why just 4 per cent from the region have IIoT projects in the field. Again, like the rest of respondents who reported connectivity problems, Latin American organisations are behind their global competition when it comes to satellite deployment and on every measurement of IIoT deployment maturity.

It is clear that OEMs are placing their bets on satellite connectivity to help them overcome their connectivity gaps, and more so than the other subsectors that make up the agriculture industry. Almost all of OEMs (94 per cent) believe that satellite is essential for IIoT, primarily because these companies report valuing network coverage above all other attributes. When you consider how the research has shown significance of satellite to reliable connectivity this should not be surprising.

Over a third of respondents (34 per cent) are using Bluetooth Low Energy to support their IIoT deployments, making it the most commonly-used technology in the sector, followed by RFID (used by 18 per cent). However, a broad range of other IIoT protocols are being used. One in ten (10 per cent) are reliant on LoRaWAN, while 9 per cent report that they are using SigB.

WHAT TECHNOLOGIES ARE YOU USING IN YOUR IIOT-BASED SOLUTIONS DEPLOYMENTS? (%)



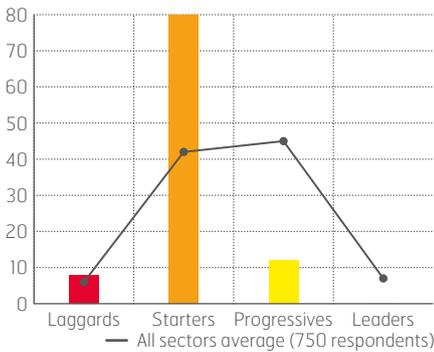
72%

will use satellite technology to support their IIoT projects

OEMs are placing their bets on satellite connectivity to help them overcome their connectivity gaps

INVESTMENT AND ROI

HOW WILL THE AGRICULTURE SECTOR INVEST IN IIOT? (%)



The level of investment in the agricultural sector is significantly lower than the levels seen in the other industries included in this report. With 80 per cent of agriculture businesses ranked as IIoT starters, the industry is clearly at the early stages of its IIoT investment cycle, and if it is to capture the full value of IIoT solutions it must ramp up its level of investment to ensure successful deployments.

However, the picture is more complicated than these figures would suggest and when viewing agriculture’s investments in IIoT to date, and those planned in future, as a percentage of overall IT budgets, the sector appears in a better light. Respondents invested 2 per cent of their IT budgets in IIoT over the last three years – a comparable figure to the overall sample – and their planned investment over the next three years surpasses that seen in other sectors. Agriculture respondents will devote 9 per cent (11 per cent in farming) of their IT budgets to IIoT through to 2021, which would indicate that the sector is investing heavily in the technology.

Despite this, the absolute figures reveal a different view. Agriculture businesses reported that they expect to spend on average close to \$1 million on IIoT solutions in the next three years, significantly below the average amount of over \$5 million that respondents across all

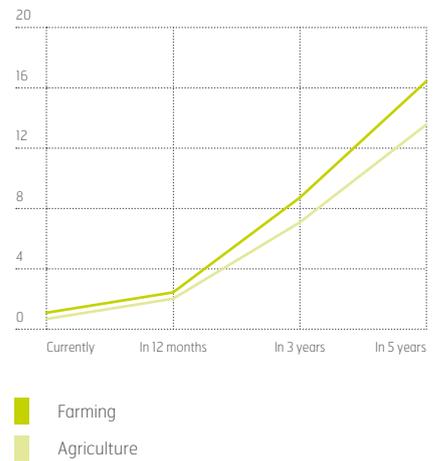
industries expected to invest over the same timeframe. The investment picture also shows significant variation across the different sub-sectors. Those businesses involved in farming and OEMs are showing bullish levels of investment, at well over \$1 million, while the forestry sector languishes behind on just over \$400,000.

These differences owe much to the size of organisations surveyed but also, more importantly, agriculture’s relatively low-tech starting point. It of course stands to reason that a farm would spend less on technology than, say, an oil company, though agriculture businesses should reassess the amount they spend on technology as they look to seek the benefits of a more digitally-enabled future.

While sensors can be deployed in fields or on livestock to monitor basic parameters such as soil moisture levels or animal welfare at relatively low cost and to good effect, heavier duty IIoT deployments hold the promise of more substantial rewards. Completely automating heavy machinery, like seed drills or crop harvesting machinery, for example, would reduce the sector’s reliance on manual labour, speed up the rate of production and serve to maximise crop yields. These next-level IIoT deployments come with a higher price tag, though the data indicates that a higher spend on IIoT technologies comes with a correspondingly high return on investment.

Large scale farmers’ enthusiasm for IIoT, and higher level of investment, is reflected in these organisations’ expectations for IIoT’s contribution to their turnover and costs. Over the next five years, farming businesses expect IIoT solutions to help grow their turnover by over 16 per cent, well above the agriculture average figure of 14 per cent. In addition, farmers expect IIoT solutions to help them save almost 20 per cent of their costs, ahead of the 18 per cent reported by agriculture respondents overall, reflecting IIoT’s potential to help businesses in the sector operate with much greater efficiency.

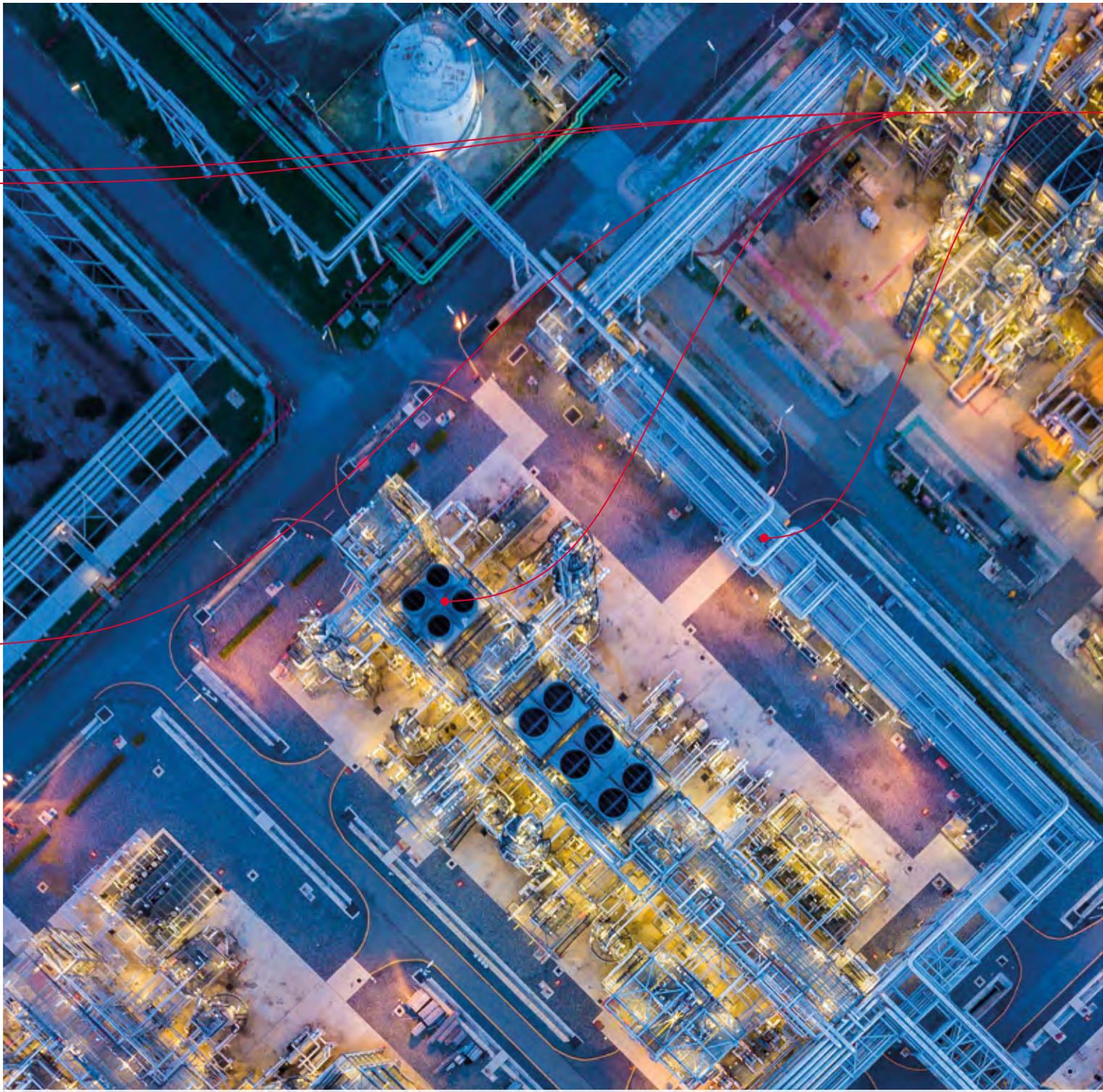
WHAT TURNOVER INCREASE IS YOUR ORGANISATION LIKELY TO ACHIEVE THROUGH ITS USE OF IIOT? (%)



9%

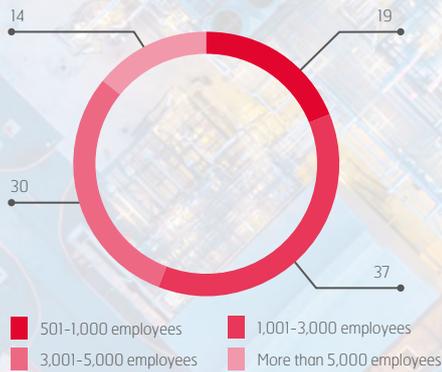
of IT budgets will be spent on IIoT over the next three years

Over the next five years, farming businesses expect IIoT solutions to help grow their turnover by over 16 per cent

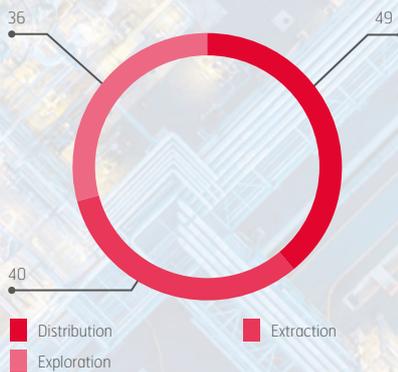


ENERGY DEMOGRAPHICS

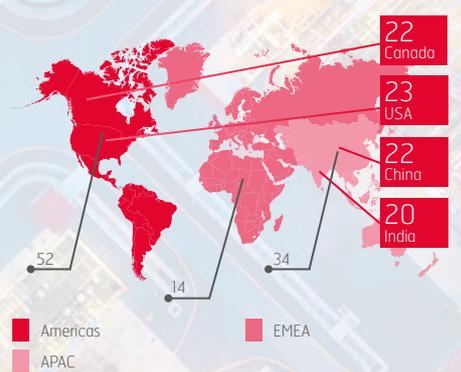
RESPONDENTS BY SIZE OF ORGANISATION (%)



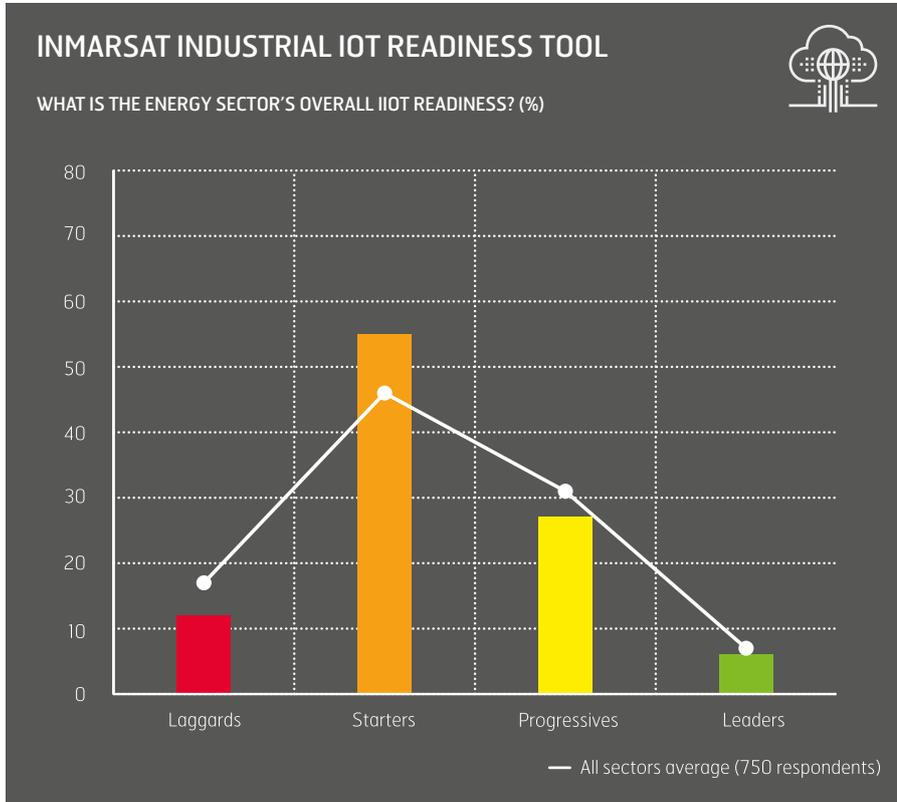
RESPONDENTS BY SUB-SECTOR (125)



RESPONDENTS BY REGION (%)



ENERGY



The energy industry is in an unprecedented state of transformation. Ever-increasing pressure from governments, consumers and activists to reduce non-renewable energy consumption and humanity's impact on the environment is putting revenues, profits and margins under severe strain. With renewable energy uptake accelerating and innovations like electric vehicles gaining mainstream attention, traditional oil and gas businesses face an uncertain future.

The sector undoubtedly has a great deal to gain by harnessing smart technologies such as IIoT, which promises to help it increase outputs and profitability. However, our research suggests that while pockets of the industry – chiefly the distribution end of the market – are progressing well towards IIoT, the majority of respondents are closer to the start of their journey.

In the exploration phase, IIoT can help accelerate and enhance seismic data acquisition and analysis to improve production performance, leading to the faster extraction of gas or oil. In the

extraction and drilling process, IIoT can enable real-time process monitoring, predictive maintenance and automation, reducing the number of staff needed on site to monitor production equipment.

Energy distributors build and operate vast networks of pipelines, from which they can gather datasets to monitor the integrity of pipes and deploy a rapid response if they detect a leak, through pressure monitoring sensors. IIoT sensors can also help to optimise supply and demand forecasting, as well as pipeline operations.

The energy exploration and extraction businesses that were surveyed in the report are still in the early stages of their IIoT adoption and deployment. While many are at the trial stage (33 and 43 per cent respectively), just 3 per cent of extraction and exploration businesses have fully deployed IIoT, as opposed to 14 per cent from those organisations focused on distribution, which should come as little surprise, given the growth of smart metering in the consumer end of the market.

Where IIoT has been implemented, energy companies are primarily seeing the benefits in areas such as improved health and safety, environmental sustainability and efficiency. While this is encouraging progress, the sector must focus on developing new streams of revenue and improving the profitability of production, if they are to gain the full benefits of IIoT.

A chronic lack of skills still pervades the industry, in part due to the cuts to staffing levels that were made during recent leaner years, which must be overcome if the energy sector is to make best use of IIoT.

Another key roadblock to successful IIoT deployments is security. While some energy businesses are rightly concerned by the threat of kidnappings or piracy attacks, which IIoT can play a role in deterring, the respondents clearly see the threat of IIoT networks exposing energy infrastructure to the malicious intent of cyber-criminals or hostile state actors.

From creating a more connected industry, to radically improving health, safety and sustainability, to developing new revenue generation opportunities that will enable energy businesses to ride the volatility of fluctuating production prices, the respondents to our survey clearly recognise that the potential for IIoT to radically transform the energy industry is immense.

INMARSAT INDUSTRIAL IOT READINESS TOOL



Our tool allows us to benchmark sectors, organisations and industries against each other based on their IIoT readiness.

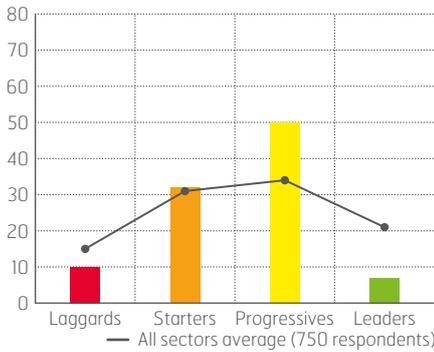
We asked our 750 respondents a series of questions, with points attached to their responses, scoring their IIoT development in six key areas:

- Adoption
- Security
- Connectivity and IIoT technologies
- Skills
- Data
- Investment and ROI

Using the scores, we divided our respondents into categories indicating their IIoT maturity: laggard, starter, progressive and leader.

ADOPTION

HOW MATURE IS THE ENERGY SECTOR IN RELATION TO IIOT ADOPTION? (%)



The energy sector is making solid progress in relation to IIoT adoption, with half of respondents ranking in the IIoT progressive category. Today, 44 per cent of energy companies have deployed IIoT solutions to some extent, and while 84 per cent of these are still in the trial phase, nine in ten expect to have fully deployed IIoT solutions by the end of 2019.

It is interesting to note, however, that distribution companies are somewhat further along their IIoT journey than those engaged in extraction and exploration. As the arm of an industry that is closest to the consumer, and has been developing smart meter and smart grid technologies for a number of years, this is to be expected. However it is clear that energy companies further upstream have some catching up to do in order to ensure the energy supply chain functions with complete transparency and efficiency.

Nine in ten energy companies believe that IIoT will be essential for them to gain a competitive advantage, and a similar proportion (89 per cent) believe that they will be left behind without IIoT, indicating the importance placed upon IIoT in the sector.

The ability of IIoT solutions to improve the health and safety of staff, monitor environmental changes and improve resource efficiency are key drivers of IIoT amongst energy companies, though some interesting differences emerge beneath the surface. Improving the security of sites, for example, was

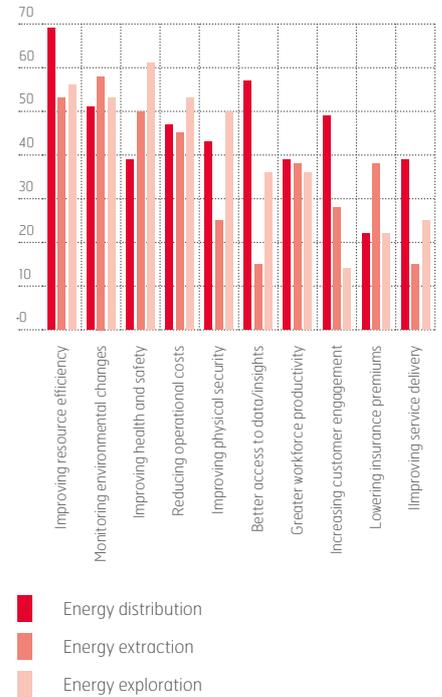
seen as critical for 50 per cent of energy exploration companies – whose remote and embryonic sites may lack the infrastructure of fully-established operations or be located in territories with political instability and conflict.

Driving deployment in the distribution sector is improving resource efficiency within the organisation (69 per cent) and gaining better access to insights and data (57 per cent). These two business activities are critical to the effective and profitable distribution of energy, enabling distributors to do more with less.

With energy extraction and exploration businesses prioritising monitoring health and safety (50 per cent and 61 per cent respectively), and environmental changes (58 per cent and 53 per cent), the focus for these businesses is clearly on the quick wins of IIoT deployment.

However, these projects are delivering results, with over a third (36 per cent) reporting that they have already realised improvements in health and safety, 34 per cent have improved the environmental sustainability of their operations, and while just 10 per cent of energy companies have successfully lowered their insurance premiums to date, a further 35 per cent expect to do so in future.

WHAT ARE THE MOST IMPORTANT DRIVERS FOR THE DEPLOYMENT OF IIOT-BASED SOLUTIONS IN YOUR ORGANISATION? (%)



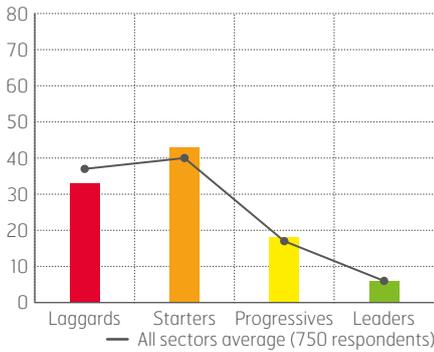
90%

believe that IIoT will be essential to gain a competitive advantage

Improving the health and safety of staff, monitoring environmental changes and improving resource efficiency are key drivers of IIoT

SKILLS

DOES THE ENERGY SECTOR HAVE THE SKILLS IT NEEDS FOR IIOT (%)



Like most other sectors examined in this report, the energy sector is lacking when it comes to the skills required to architect, deploy and manage IIoT-based solutions.

As is to be expected, this shortfall in skills is both inhibiting the rate of adoption, and limiting the success of IIoT initiatives once deployed. Around a third (34 per cent) of energy respondents identified a lack of skills as one of the biggest barriers they have encountered in the adoption of IIoT solutions, and 27 per cent stated that they lacked the skills to extract and use the data generated by their IIoT solutions, as efficiently as they would like.

Respondents in both distribution and extraction sectors identified skills shortages in all areas of IIoT deployment, with only around one in five stating that they have all of the skills they need to devise IIoT strategies and manage them once they are up and running.

However, some clear differences between these parties emerge when we examine the specific skills required. Over half (56 per cent) of distribution companies, for example, felt that they required additional data science skills to fully realise their IIoT initiatives, considerably higher than the 41 per cent of extraction respondents that thought the same.

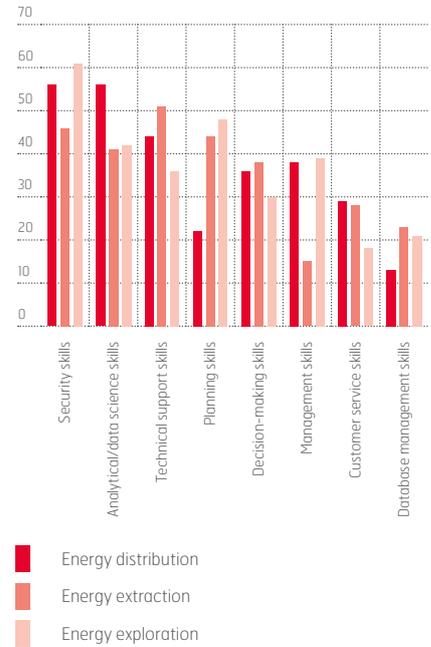
By automating historically mechanical processes, companies focused on the exploration and extraction of oil and gas stand to make considerable gains, enabling them to extract staff from potentially hazardous situations and speed up the rate of production. However, realising these benefits depends heavily on having access to advanced technical support skills to architect and manage these solutions – skills that are currently out of reach for many in the sector.

This decline in skills can be correlated with recent job losses suffered by energy producers, who in the past may have had teams of staff available to analyse data and ensure cyber-security compliance but now find themselves short-staffed and competing with other industries for data security expertise.

With limited internal resources to manage the challenges of IIoT deployment, it is no surprise to see energy businesses reaching out to a growing number of disruptive, tech-driven start-ups, who have established themselves as strategic partners with the niche skills capable of delivering IIoT solutions.

The vast majority of energy companies are using, or planning to use, partners to develop and manage their IIoT initiatives. Some 80 per cent of respondents stated that they will use partners to some extent to develop their IIoT initiatives, while 72 per cent will use partners to manage them. Without this assistance, they will struggle to get their IIoT projects off of the ground.

WHAT ADDITIONAL SPECIFIC SKILLS DO YOU THINK YOUR ORGANISATION NEEDS TO DELIVER IIOT-BASED SOLUTIONS? (%)



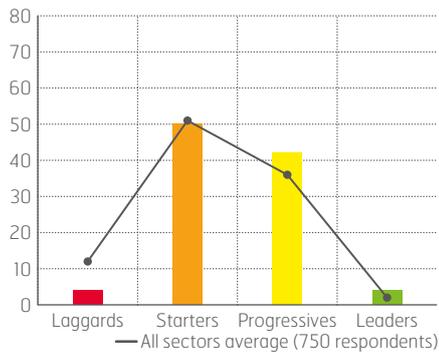
51%

of energy producers need to improve their technical support capabilities to successfully deliver IIoT

In their efforts to acquire new staff with skills in disciplines such as data analysis and cyber-security, energy companies face stiff competition from major technology companies

SECURITY

HOW MATURE IS THE ENERGY SECTOR'S APPROACH TO IIOT SECURITY? (%)



Respondents from the energy sector are more confident than most in their ability to fend off the security threats posed by their IIoT deployments, and the steps to increase the security of IIoT-based solutions place the sector just ahead of the IIoT security index.

This level of maturity, while encouraging, masks some serious challenges for the sector. The energy industry is one that has long been susceptible to cyber-attacks. It is a prime target for criminal elements, though while in the past this may have been for financial gain, the industry is increasingly under threat from terrorists and rogue states.

One of the most famous examples of an energy-related security breach occurred in December 2015, when hackers attacked the Ukrainian power grid leaving 230,000 citizens in the dark by compromising information systems of three energy distribution networks.

However, attacks on the sector are increasingly common. A report in March 2018 from the insurance and risk management group, Marsh (Could Energy Industry Dynamics Be Creating an Impending Cyber Storm?) revealed that about a quarter of respondents from the energy industry knew that their companies had been hit by a cyber-attack in the past year alone.

As a sector that has long been concerned about the implications of network vulnerabilities, IT managers within the energy industry should be well aware of the security pitfalls of IIoT and therefore be able to mitigate the risk.

Despite this, challenges persist and 99 per cent of respondents report facing security challenges of some sort. Around half cited the risk of external cyber-attacks (48 per cent) and the potential for IIoT data to be misused by employees (46 per cent) as a risk, while 42 per cent were concerned about the security of their networks.

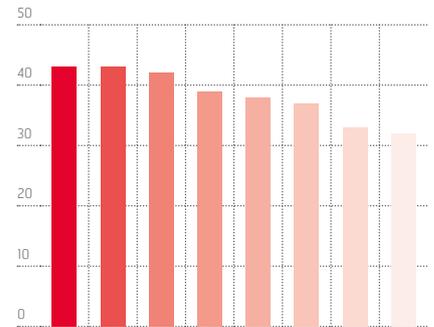
Given the historical levels of threats in the industry it would have been a fair assumption that the sector would be well placed to deal with its security challenges, though seven in ten (74 per cent) agreed or strongly agreed that they should be doing more to beef up their protection against cyber-attacks. While this anxiety about cyber-attacks is reported by all parts of the energy industry, energy extractors appear least prepared to deal with the challenge, with 85 per cent stating there was room for improvement.

However, energy companies, are taking remedial action to address their vulnerabilities. 75 per cent of energy respondents reported that they were working with partners to ensure the ongoing security of their IIoT initiatives to some extent, while 55 per cent of extraction companies stated that they would outsource the security of their IIoT solutions as much as possible (compared to just 31 per cent of distribution), in reflection of the deeper skills shortages they face.

Beyond this, looking at some of the specific actions taken to improve security, four in ten have upgraded their security technologies (43 per cent), and a similar proportion has invested training for employees and security policies.

There is good recognition among C-level execs about the potential vulnerabilities of IIoT: 17 per cent of energy respondents (and 29 per cent of distribution companies) say that CISOs (Chief Information Security Officers) are leading their IIoT projects, and they influence them in 38 per cent of cases – the highest reported level of CISO involvement of all the sectors in this report.

WHAT CHANGES TO SECURITY HAS YOUR ORGANISATION MADE, OR DOES IT INTEND TO MAKE, TO ADDRESS IIOT SECURITY CONCERNS? (%)



- Investing in new security technologies
- Creation of an internal IIoT security policy
- Training employees on IIoT
- Securing physical assets such as sensor nodes
- Communicating to customers on the use of IIoT
- Upgrading existing security technologies
- Hiring skilled staff
- Creation of an external IIoT security policy for suppliers and partners

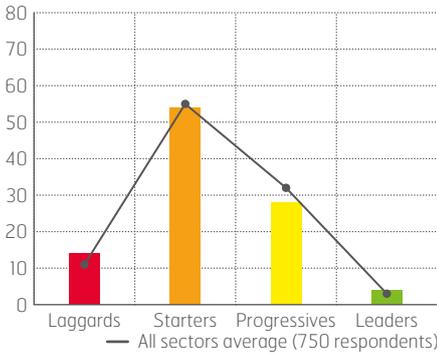
75%

are working with partners to ensure the ongoing security of their IIoT initiatives

Energy companies are taking more remedial action than other sectors to address security issues related to IIoT

DATA USAGE

HOW ADVANCED IS THE ENERGY SECTOR'S APPROACH TO IIOT DATA? (%)



The majority of energy respondents fall into either the laggard or starter categories when it comes to their approach to using IIoT data. While these results are broadly in line with the overall sample, it is clear that many in the sector haven't yet worked out how to use the data generated by their IIoT solutions to the best effect; though this improves toward the distribution end of the chain.

Over half of distribution companies expect to use the data generated by their IIoT solutions to monitor and improve productivity (57 per cent) and identify cost-saving opportunities (53 per cent). Somewhat understandably, extraction companies are chiefly concerned with the opportunity to use IIoT data to better monitor environmental changes (38 per cent) and to improve health and safety (43 per cent).

It is notable that 10 per cent of energy respondents – and 17 per cent of those from energy exploration – have no plans to use their data at all. With these companies not unlocking the value of the potential insights from their accumulated data, it isn't yet the new oil.

However, despite their intentions, it is clear that there are a number of barriers that stand in the way of energy companies' ability to use it effectively. Security is just one of the challenges that must be navigated – 33 per cent of energy respondents overall cited concerns about the security of the data they capture. Interestingly, fears about the misuse of data were the most pronounced in distribution companies, who are grappling with

how to best manage the vast customer data sets that grid management and smart metering systems are furnishing them with.

A lag between the data being collected and it being available is another pressing issue that needs to be addressed, with 40 per cent of energy companies overall and almost 49 per cent of distribution companies citing this as a challenge to being able to use their data effectively. As much of the data generated by IIoT is important for providing real-time insight, this inability to take data and make it actionable, say to redirect power in the grid, stands as a major barrier to the effectiveness of IIoT implementations in the sector.

The security challenges reported go some way to explain why access to IIoT-generated data is heavily restricted in the sector. Taking extraction companies as an example, just 3 per cent of respondents stated that data was readily available to anyone within the organisation to access and use, with 28 per cent reporting that it was strictly the preserve of the IT department and senior management.

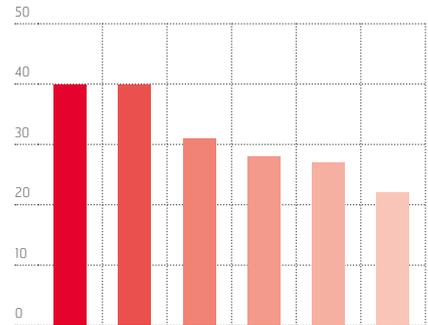
By their own admission, it is this restriction of access that is preventing many organisations from using their data as effectively as they could be, with 40 per cent identifying this as a barrier.

Respondents report that they have, on average over 2,000 IIoT sensors in the field, each of which will be a valuable source of real time business intelligence. However, while the sector has great ambitions for its IIoT data, until these challenges are resolved, their initiatives will struggle to meet their full potential.

33%

cited concerns about the security of the data they capture

WHAT CHALLENGES DOES YOUR ORGANISATION FACE IN USING DATA AS EFFECTIVELY AS POSSIBLE? (%)

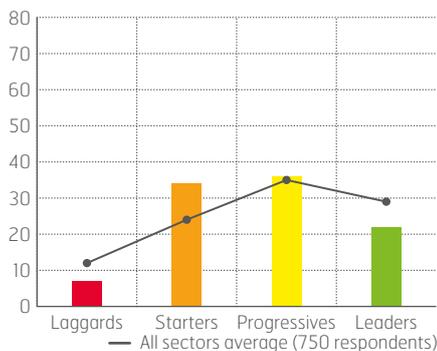


- Data is only available to certain departments involved in the IIoT deployment
- There is a lag between data collection and it being available
- Security/privacy concerns
- Data is stored in an unusable format
- We don't have the skills to extract/use data
- There is such a large volume of data we struggle to utilise it

10 per cent of energy respondents – and 17 per cent of those from energy exploration – have no plans to use their data at all. With these companies not unlocking the value of the potential insights from their accumulated data, it isn't yet the new oil

CONNECTIVITY AND IIOT TECHNOLOGIES

HOW WELL IS THE ENERGY SECTOR ADAPTING TO THE CONNECTIVITY REQUIREMENTS OF IIOT? (%)



Energy respondents are – generally speaking – able to secure the reliable connectivity they need to support their IIoT initiatives. Just a quarter of respondents identified connectivity as one of the biggest challenges facing their IIoT deployments and only around a third (32 per cent) thought that connectivity issues could hold them back – numbers that are significantly lower than those reported by other sectors.

However, looking deeper at the subsectors that we surveyed, we can see marked differences, with some achieving better connectivity levels than others. Distributors led the way here, a trend that can in some part be attributed to their in-built advantage in accessing the necessary connectivity for their IIoT deployments via grid systems and their distribution linking them to connected urban areas.

On the other hand, extraction and exploration companies struggled more with their connectivity levels, which no doubt factors into the relatively low levels of IIoT adoption in these segments of the market. 43 per cent of extraction businesses stated that connectivity was one of their biggest IIoT challenges – significantly higher than the 14 per cent of distribution companies that thought the same. Additionally, over half (51 per cent) of extraction respondents reported that they struggle to access reliable connections.

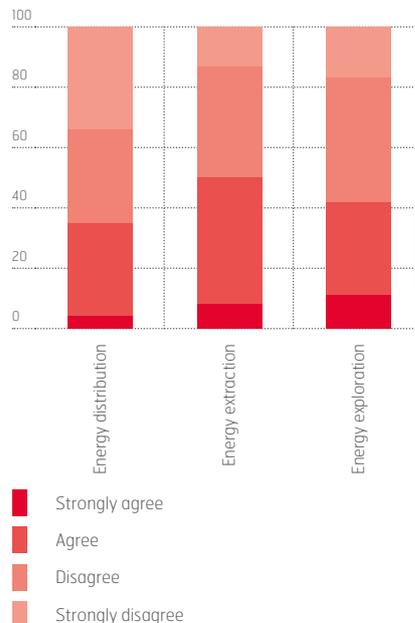
Satellite is playing a critical role in enabling energy extraction businesses to transmit IIoT data from remote locations. 70 per cent of these organisations stated that satellite was essential for delivering their IIoT-based solutions, while on average 38 per cent of IIoT data was transmitted via satellite within these organisations – considerably higher than satellite usage seen in the energy distribution market (where this figure sat at 25 per cent).

However, satellite is just one part of the connectivity mix, and most organisations will find themselves using satellite in conjunction with a range of cellular, fibre and radio networks to support their IIoT deployments. Fibre is playing a particularly significant role in the connectivity mix, with 57 per cent of respondents citing it as key to supporting their IIoT networks, with radio networks following close behind with 54 per cent, cellular on 49 per cent.

Connectivity is, however, just one part of the picture as the effectiveness of IIoT initiatives depends upon users' ability to take the data generated by sensors and action it to drive better business outcomes. This is where the new wave of wireless data collection technologies, which enable edge processing and real time data routing, come in to the frame and bring these solutions to life. It is notable then, that over a third (37 per cent) of energy companies are not using any such technologies at all.

Where they are being deployed, however, RFID came out as the most commonly-used in the sector, selected by 30 per cent of respondents to support their IIoT initiatives, followed by Bluetooth Low Energy (BLE) (20 per cent). LoRaWAN is particularly popular amongst the energy distributors we surveyed, with 16 per cent using the technology, compared to just 8 per cent of extraction companies.

DOES YOUR ORGANISATION STRUGGLE WITH RELIABLE CONNECTIVITY WITH ITS IIOT DEPLOYMENTS? (%)



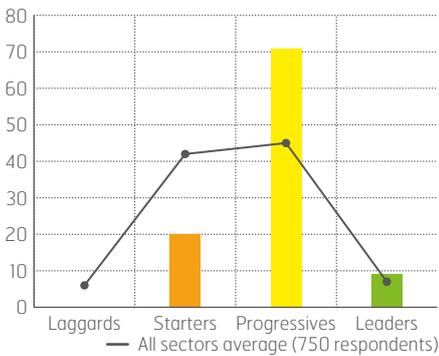
42%

of energy companies struggle to access reliable connections for their IIoT deployments

As IIoT deployment accelerates, extraction businesses will have an ever-increasing demand for reliable data transmission, and it is satellite connectivity that will meet this demand

INVESTMENT AND ROI

HOW WILL THE ENERGY SECTOR INVEST IN IIOT? (%)



The current and planned investment in IIoT-based solutions by energy respondents points to a higher level of maturity than witnessed in all of the sectors in this report, with 80 per cent of respondents falling into the IIoT progressive or IIoT leader category. Respondents expect to invest an average of \$4 million in IIoT initiatives over the next three years, amounting to a not insignificant 9 per cent of their overall IT budgets.

There are, however, clear differences in the planned spend on IIoT at a subsector level. Energy distributors expect to devote 12 per cent of their IT budgets to IIoT over the next three years, around double the amount of those involved in extraction and exploration (6 per cent respectively).

While smart grids will fundamentally change the way that energy is consumed, there is significant opportunity for IIoT further upstream at the point of production. This disparity in spend therefore suggests that those involved in extraction and exploration are limiting the scope of their transformations.

This plays out in the data when we look at how respondents expect IIoT technologies to impact their revenues. Distribution companies expect their investments in IIoT to deliver an additional 11 per cent to their turnover over the next five years; extraction companies by contrast expect to increase their revenues by 8 per cent during the same timeframe. While this is still a respectable figure, it does beg the question of what these companies could achieve by upping their investments in IIoT.

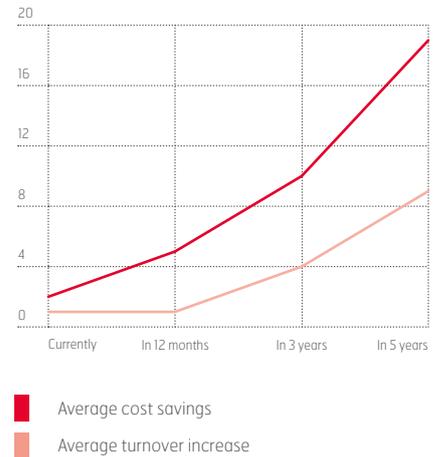
Cost savings are also high on the agenda, and energy respondents expect to shave around 19 per cent off of their operating costs from their use of IIoT within the next five years. Such a saving could be a boon for oil companies in particular, enabling them to streamline their operations and insulate themselves from the impact of commodity price shocks in the sector.

The high level of cost saving that the energy industry expects from its IIoT deployments reflects the key drivers influencing the development of IIoT solutions. Improving resource efficiency ranked as the highest-rated driver for IIoT deployments (60 per cent), with reducing costs in business operations (48 per cent) also motivating many energy businesses to develop and deploy IIoT.

While the potential for IIoT to improve the efficiency of operations and cut costs is well understood, energy businesses should also be investing in this potentially revolutionary technology to develop new streams of revenue. Energy businesses cannot go on operating as they have before, with the price of oil unlikely to reach the heady days of \$140 barrel, so new streams of revenue will be essential.

However, just 3 per cent and 6 per cent of energy extraction and exploration businesses are using IIoT to generate new revenue streams, while 27 per cent of distribution business are doing so. This perhaps explains the lower expectations in the upstream for turnover increase due to IIoT, while also reflecting an inability to analyse the data they have.

WHAT OPERATIONAL COST SAVINGS AND TURNOVER INCREASES IS YOUR ORGANISATION LIKELY TO ACHIEVE THROUGH ITS USE OF IIOT? (%)



11%

increase in turnover expected over the next five years due to IIoT

Upstream energy businesses should look beyond cost savings and follow the lead of their downstream counterparts, investing in IIoT to develop new streams of revenue

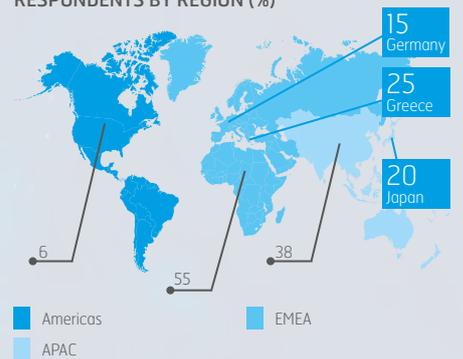


MARITIME DEMOGRAPHICS

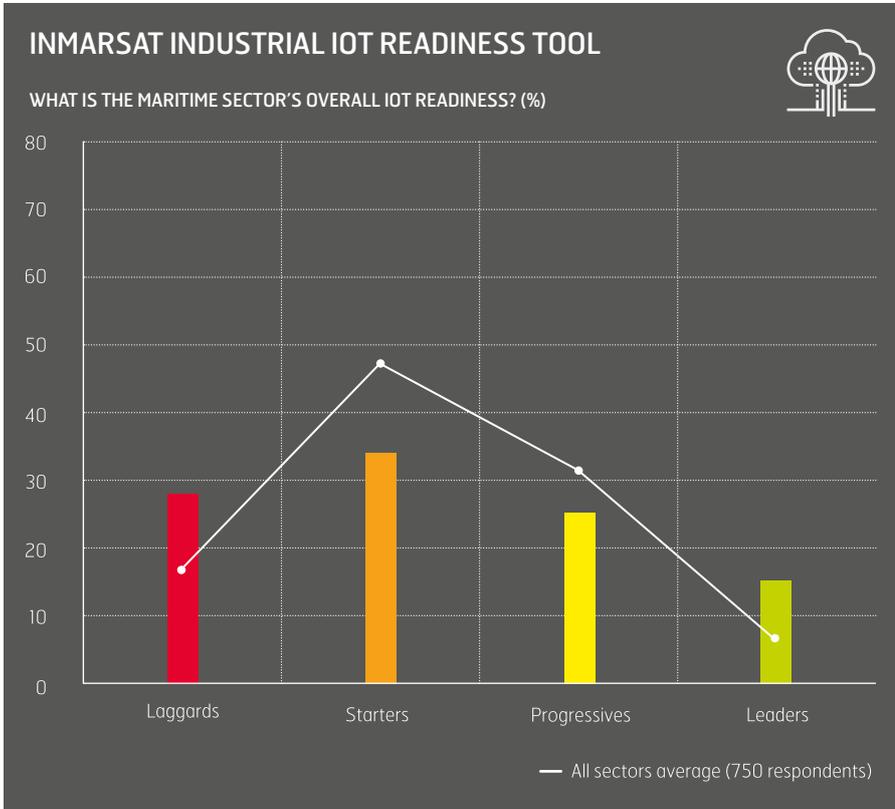
RESPONDENTS BY FLEET SIZE

Vessels	Total	Shipping	Fishing
1-10	40%	25%	79%
11-20	28%	33%	15%
21-30	16%	20%	6%
31-50	11%	15%	0%
51+	6%	8%	0%
Average fleet size	19	23	8
Base	125	92	33

RESPONDENTS BY REGION (%)



MARITIME



maritime world where the class societies enforcing safety standards are trialling drones to support ship inspections, where shipboard CCTV monitoring brings clear benefits for the safety and security of crew and cargoes alike, and where the digital platforms used for weather forecasting and distress alerts are joining IIoT.

Nevertheless, full-blooded maritime commitment to IIoT-based solutions will also be driven by the competitive edge established by the 'IIoT leaders', identified here as representing a larger than anticipated segment of respondents. While shipping has more than its fair share of IIoT 'laggards', a significant portion of respondents overall can be seen as recognising the digital opportunities offered to cut costs. As the data in our research indicates, key areas for IIoT-based solution deployment have been identified for the coming months and years. It is also clear, not only that some maritime companies are not responding to the increasing digitalisation, but that industry strategists and managers have plenty of work to do to prepare procedures, skillsets and security to take best advantage of the opportunities on offer.

With over 90 per cent of world trade carried by sea¹, shipping sentiment is continuously influenced by other stakeholders in the global supply chain, including regulators. Today, over-capacity in the container market, slower growth in demand for raw materials, soft tanker rates and idle offshore tonnage co-exist with market positives that include new northerly sea routes, the rise of liquefied natural gas and demand for cruise tourism.

Nevertheless, the consequences of the global financial crisis of 2008, the oil price slump from 2014 and tightening environmental regulations continue to frame the maritime narrative, with owners under pressure to cut costs and emissions but enhance safety.

In the following pages, we shall explore how IIoT-based solutions offer the maritime industry a straightforward way of 'getting its house in order' in response to rising environmental concerns, their use to enhance health and safety, and their potential to improve efficiency.

We will also address the challenges inhibiting adoption, including lack of in-house skills and industry knowledge, but also entrenched ambivalence towards new technologies.

Specific attention will be paid to 'gateway' IIoT-based solutions which simultaneously meet regulatory and cost efficiency requirements. For example, as further International Maritime Organization rules loom, limiting emissions from ships and ushering in an era of new more expensive fuels, IIoT-connected shipboard sensors provide a ready answer to monitor, report and verify fuel use. Today, 65 per cent of ship owners have or are trialling IIoT-based fuel consumption monitoring, with a further 9 per cent to do so within the next 12 months.

It is important not to overplay the 'compliance' card, given that around half of the maritime respondents in the current study say either they do not aim at or do not expect greater compliance as an outcome of adopting IIoT solutions. However, owners today inhabit a

INMARSAT INDUSTRIAL IOT READINESS TOOL



Our tool allows us to benchmark sectors, organisations and industries against each other based on their IIoT readiness.

We asked our 750 respondents a series of questions, with points attached to their responses, scoring their IIoT development in six key areas:

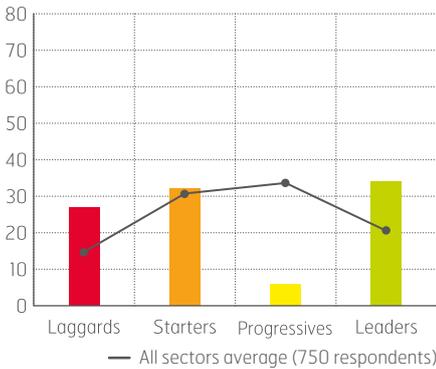
- Adoption
- Security
- Connectivity and IIoT technologies
- Skills
- Data
- Investment and ROI

Using the scores, we divided our respondents into categories indicating their IIoT maturity: laggard, starter, progressive and leader.

¹www.business.un.org/en/entities/13

ADOPTION

HOW MATURE IS THE MARITIME SECTOR IN RELATION TO IIOT ADOPTION? (%)



Shipping’s notorious ambivalence towards new technology is today characterised by a willingness by some to engage with predictive remote diagnostics, automated processes and blockchain, while others take regulatory compliance as their investment cue.

Thus, shipping’s ‘conservatism’ is belied by the significant group of maritime respondents identified as IIoT ‘leaders’ in our research. Some 34 per cent see themselves as having ‘fully deployed’ IIoT-based solutions, a proportion that puts maritime ahead of other industries such as agriculture, energy and mining.

At the same time, maritime also finds a home for the group which represents the largest rump of IIoT ‘laggards’ compared with the other sectors we interviewed, despite the fact that IIoT technologies hold much promise for the sector.

Driving the ‘leaders’ is the need for ships to be more cost efficient, cleaner and safer than ever before, with 56 per cent of maritime respondents using or trialling smart asset monitoring. For the moment, fishing lags marginally behind commercial shipping, but the disparity may be short-lived: 57 per cent of the 33 fishing organisations polled envisage uptake over the next 24 months.

Regulation is playing its part. In shipping, restrictions on emissions are driving owners to monitor fuel consumption using electronic

reporting: 47 per cent of respondents already use IIoT-based solutions to monitor fuel use rising to 100 per cent by 2023. In fishing, the regulatory requirement comes from the need for fishers to demonstrate that catches are from sustainable sources.

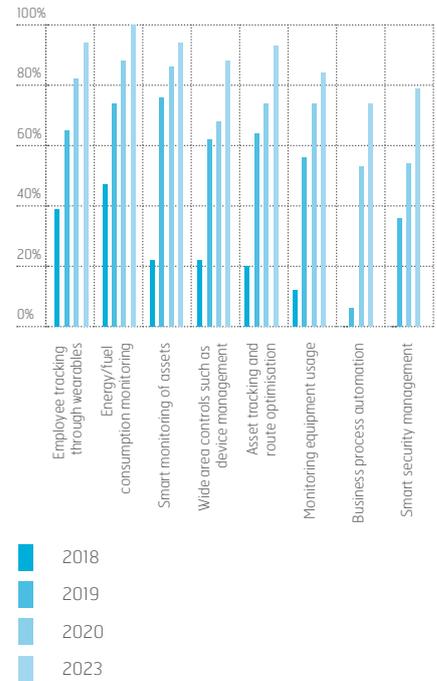
Safety is also a key factor in IIoT-based solution adoption. Cutting marine insurance premiums was cited by 70 per cent of respondents as one of the most important drivers for adoption, for example. Again, 45 per cent of shipping respondents (excluding fishing) use wearable technology for tracking, while 39 per cent intend to do so within two years.

Indeed, the 1.6 million seafarers working, resting and wanting to connect IIoT-based solutions from remote locations represent another variable peculiar to maritime: connectivity is a welfare issue within the Maritime Labour Convention and is also material to choosing an employer. Today, 25 per cent of the maritime industry obtains health and safety benefits through IoT solutions, while 56 per cent expect to do so in the future. Our research shows ‘health and safety’ as shipping’s second most commonly cited driver for adopting IIoT-based solutions.

However, the maritime sector’s decade-long fixation with cost is also of central importance. Some 51 per cent of respondents say the potential to generate new revenues does not figure in their thinking when considering IIoT solutions, while 75 per cent have or expect to realise cost savings. One technology identified is IIoT-based route optimisation, which 57 per cent of owners are operating or trialling, rising to 66 per cent excluding fishing. Respondents suggest that IIoT-based solutions will yield greater automation (40 per cent), achieve greater productivity (80 per cent) and improve decision-making (81 per cent).

Nevertheless, even in the case of costs, expectations appear divided: while 33 per cent of maritime respondents believe that IIoT solutions will bring 10-20 per cent savings within five years, 14 per cent believe that – even then – they will bring no savings at all.

IN WHAT AREAS WILL YOUR ORGANISATION ADOPT IIOT-BASED SOLUTIONS? (%)

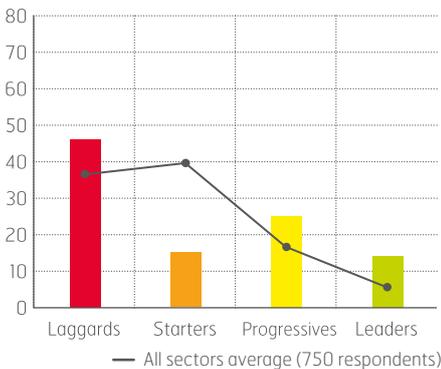


70%
say cutting insurance premiums is one of the most important adoption drivers

Restrictions on emissions are driving owners to monitor fuel consumption using electronic reporting

SKILLS

DOES THE MARITIME SECTOR HAVE THE SKILLS IT NEEDS FOR IIOT? (%)



A sector where individuals or small teams can have unusually strong decision-making power, which also acknowledges its own IIoT 'laggard' tendencies, is likely to benefit from not only enhancing, but importing and sharing new skills.

From the 1970s onwards, elements of the maritime sector have bemoaned skills erosion at sea, identifying a widening gap between advancing technology and the skillsets available to handle it. Nor have the efforts of regulators to harmonise technology standards been universally welcomed: the phase in of mandatory electronic chart data information systems is only one example of how well-meaning regulation 'freezes' technical progression before the full consequences for safety at sea have been established.

IIoT-based solutions can be deployed to improve safety, environmental performance and efficiency at sea, whether through capturing seafarer activities in real time, fuel use monitoring, or the analysis of shipboard data for diagnostics purposes. However, the most frequently cited shortcoming identified when it comes to delivering IIoT-based solutions (in 56 per cent of cases) relates to decision-making skills. Maritime also identifies itself as behind the curve when it comes to planning skills, where 42 per cent of respondents believe their organisations would benefit from additional skills against 37 per cent across all respondents surveyed.

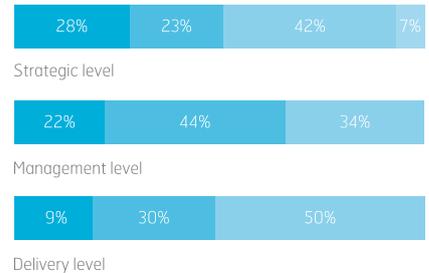
In all other areas, the maritime industry does not mark itself out as 'behind' comparable sectors in terms of the skills necessary to implement IIoT-based solutions. However, it should be noted that 53 per cent of respondents suggest additional security skills would be useful – a high number in absolute terms only diminished in relative terms by the extraordinary weight given to this indicator by mining respondents.

In maritime, individuals or small teams within an owner company can have unusually strong decision-making power when it comes to committing to IIoT-based solutions, but the maritime sector also self-selects itself for its IIoT 'laggard' tendencies: lack of in-house skills is its most frequently cited barrier to adoption. Respondents attribute a lack of skill in management (41 per cent), in strategy (42 per cent) and in implementation itself (50 per cent) as reasons why maritime organisations are not making the most of IIoT-based solutions.

The truth is that much of the technical expertise formerly held by owners has been outsourced to ship managers and equipment suppliers. A fuller picture when it comes to skills emerges after considering that marine equipment can contribute 70 per cent of the value of a new ship.

In reality, it has been suppliers – rather than owners – who have made much of the running on connectivity, big data analytics and application-triggered bandwidth to support remote equipment monitoring, diagnostics and preventive maintenance. In the current study, 68 per cent of maritime respondents said that they would use an external partner to facilitate 'some' or 'as much as possible' of their efforts to develop IIoT-based solutions.

TO WHAT EXTENT DOES YOUR ORGANISATION HAVE THE SKILLS TO MAKE THE MOST FROM IIOT-BASED SOLUTIONS? (%)



- We have all the skills we need
- We would benefit from additional skills at this level to augment those we have
- We are lacking the skills we need at this level
- I don't know

42%

believe their organisations would benefit from additional IIoT skills

Suppliers – rather than owners – are making the running on connectivity and big data analytics

SECURITY

HOW MATURE IS THE MARITIME SECTOR'S APPROACH TO IIOT SECURITY? (%)



Cyber-security has become a central concern for the maritime industry due to digitalisation and greater exploitation of IIoT increases the risk.

Shipping's vulnerability to cyber-crime was highlighted by the NotPetya virus in June 2017, whose impact is estimated to have cost one of the largest shipping groups in the world \$50 million. Its spread may explain why cyber-security fears in the current research focus on inward-facing matters such as data storage methods (55 per cent), poor network security (50 per cent) and potential mishandling/misuse of data (44 per cent), rather than targeted attacks (39 per cent).

In fact, some 87 per cent of maritime respondents either strongly agree or agree that their organisation's processes to protect against data mishandling could be improved. Whether justified or not, maritime also counts itself as one of the least exposed to external security challenges that might emanate from supplier or partner data regulation and compliance requirements (16 per cent of respondents) when measured against other sectors.

Cyber-security fears focus on inward-facing matters such as data storage

While the threat to cyber-security may not principally derive from targeted attacks, 72 per cent of maritime respondents nonetheless either agree or strongly agree that their organisation's processes to combat theft or malicious damage to hardware, software or the information on them could be stronger. Meanwhile, 53 per cent believe that more security skills would help deliver IIoT-based solutions.

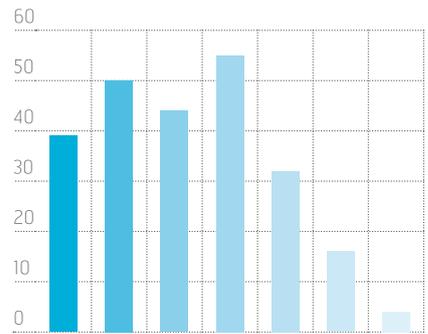
However, maritime is significantly behind the curve when it comes to addressing its own security skillsets: only 37 per cent of respondents report initiatives to improve security training, with only 25 per cent working on new IIoT security policies and just 18 per cent using skilled security staff.

One reason for relatively low activity to address security vulnerabilities in the maritime sector may be that 56 per cent of respondents say that the Chief Information Security Officer (CISO) is simply not involved with the organisation's IIoT initiatives. While 32 per cent of respondents answering in this way think that individual should be, a remarkable 24 per cent think that the CISO does not need to be involved in IIoT-based solution development at all!

Further analysis of data indicates that 77 per cent of maritime respondents are identifiable as 'laggards' or 'starters' when it comes to changes made or intended to address IIoT security concerns.

Meanwhile, the better informed maritime respondents appear to be putting their faith in IIoT-based smart security management: while no respondent reports having IIoT-based smart security management and only 2 per cent are trialling such an approach, 34 per cent say they will deploy within the next 12 months.

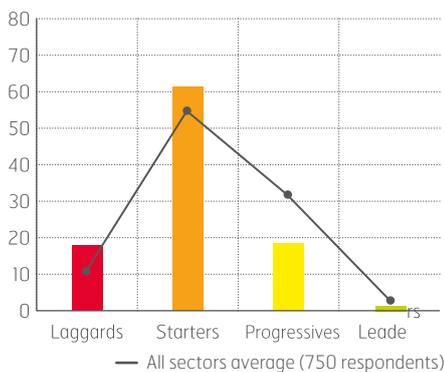
WHAT ARE THE BIGGEST SECURITY CHALLENGES ASSOCIATED WITH THE USE OF IIOT-BASED SOLUTIONS IN YOUR ORGANISATION? (%)



- Risk of external cyber-attack
- Poor network security
- Potential mishandling/misuse of data by employees
- Insecure storage of data collected
- Internal data regulation and compliance requirements
- Supplier/partner data regulation compliance requirements
- We have/will not face any security challenges

DATA USAGE

HOW ADVANCED IS THE MARITIME SECTOR'S APPROACH TO IIOT DATA? (%)



Befitting an industry where seafarers rely on safe ships and operations for their survival, maritime respondents most frequently cite the monitoring and improving of health and safety as their reason for collecting the data usable in IIoT-based solution.

However, the pressures being exerted by costs and environmental considerations are also fully apparent: where 43 per cent of respondents use or will use data for health and safety, cost saving opportunities and environmental monitoring (both 40 per cent) are close behind.

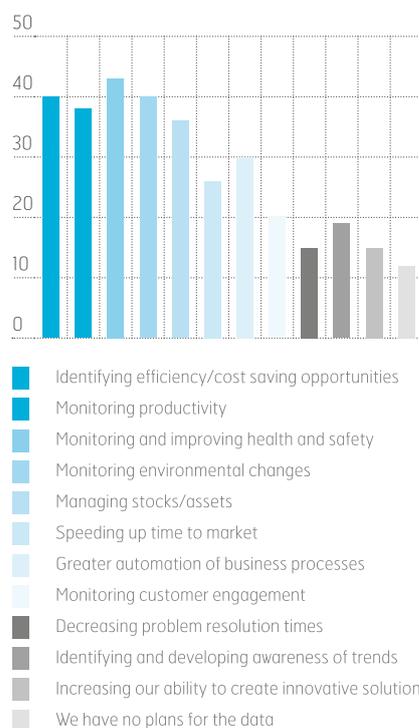
What research makes clear, and of particular significance for the current report, is that the maritime audience sees lack of timeliness in data availability as the most important single obstacle to successfully optimising IIoT-based solutions. Asked why their organisation was not able to make best use of data collected from IIoT-based solutions, 51 per cent of maritime respondents blamed the time lag between collection and availability for use. This was 11 per cent ahead of any other explanation.

The finding suggests that a greater maritime appetite for IIoT-based solutions will emerge if more data is delivered in real time, given that the maritime sector says it is also collecting data with the aim of boosting productivity (38 per cent) and better managing stocks/assets (36 per cent). It should certainly allow the startling 12 per cent of maritime respondents who say they are collecting data without any plans for it to consider better information use.

The fact that an above average 34 per cent of maritime respondents (29 per cent on average) identify themselves as lacking the skills to extract/use data and 10 per cent profess not to know who has access to data collected surely offers further impediments to widespread IIoT-based solution adoption. However, this lack of awareness does not appear to be related to a conscious lack of sharing. While 31 per cent of maritime respondents say IIoT-based data is only available to departments involved in IIoT deployment, a lower 21 per cent say that such data is restricted to senior management and IT departments.

Lack of timely data availability is frustrating success for IIoT-based solutions

HOW ARE YOU INTENDING TO USE THE DATA COLLECTED THROUGH YOUR ORGANISATION'S IIOT-BASED SOLUTIONS? (%)



43%
use or will use data to improve health and safety standards

CONNECTIVITY AND IIOT TECHNOLOGIES

HOW WELL IS THE MARITIME SECTOR ADAPTING TO THE CONNECTIVITY REQUIREMENTS OF IIOT? (%)



Given its global presence and the fact that ships are increasingly using satellite connectivity for operational efficiency, crew welfare and safety it is perhaps no surprise that the maritime sector does not strongly identify connectivity issues as impediments to IIoT-based solution uptake.

Only 20 per cent of maritime respondents cite connectivity as a barrier to adoption of IIoT-based solutions within their organisation – lower than any other sector. The finding is of significance because maritime is the sector most reliant on satellite connectivity for its IIoT-based solution adoption. No respondent at all disagreed with the proposition that satellite connectivity is ‘providing crucial support’ for their IIoT communications networks.

Some 69 per cent of maritime respondents say they rely on satellite connectivity to support their IIoT-based solutions, against 66 per cent using radio networks. Perhaps most remarkable – although not to the industry itself – is the maritime sector’s high usage of VSAT. 41 per cent of respondents use VSAT to support their IIoT-based solutions, against an average VSAT use across a range of industries of just 9 per cent. One caveat is the distinction between shipping and fishing, where VSAT is cited by 50 per cent of shipping respondents but only 15 per cent of fishers.

The pre-eminence of maritime satellite services overall is further demonstrated as respondents rank the networks supporting IIoT connectivity. Here, satellite networks are ‘number 1’ by some distance, claiming 51 per cent first ranking by respondents, with VSAT achieving 22 per cent and radio networks 21 per cent.

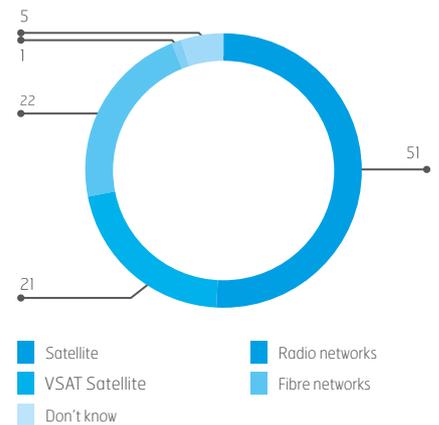
Network coverage, security and cost were the most frequently cited considerations determining connectivity choice for their IIoT-based solutions.

The dominance of established satellite networks in the maritime space, and the collection of vessel performance data also accounts for the low uptake of maturing technologies that support IIoT-based solutions. Some 50 per cent of maritime respondents (45 per cent in shipping and 64 per cent in fishing) do not use any other technology, while a further 16 per cent had no knowledge of any alternative technology used.

Technologies such as LoRaWAN, BlueTooth, Sigfox, SigB and ZigBee are currently making little impression, although RFID is playing a role, predominantly in asset tracking and port-side, with 16 per cent of maritime respondents using the solution, rising to 30 per cent among Japanese respondents.

51%
rank satellite connectivity as ‘number 1’ by usage

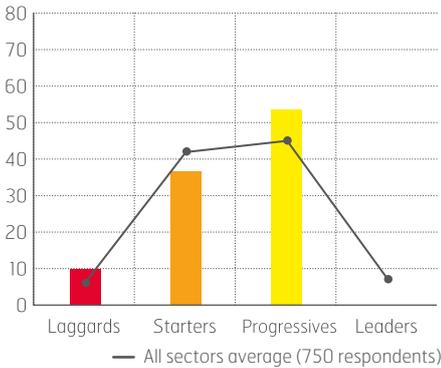
WHICH CONNECTIVITY TYPE IS MOST IMPORTANT TO YOUR IIOT DEPLOYMENTS? (%)



Maritime does not identify connectivity issues as impediments to IIoT uptake

INVESTMENT AND ROI

HOW WILL THE MARITIME SECTOR INVEST IN IIOT? (%)



Maritime businesses expect to invest considerable sums into IIoT over the next three years – generating an average figure per respondent organisation of \$2.5 million.

It is worth considering that budgets for IIoT-based solutions in the maritime sector go beyond pure IT spending, given that the IIoT and ship connectivity costs cut across the operations, safety and training budgets that often sustain adoption of new technologies.

If this is so, the maritime industry offers several or dispersed points of entry for IIoT-based solutions, over and above strategic decisions from senior managers.

Closer analysis of findings from the maritime sector nonetheless characterise the sector as featuring a larger proportion of IIoT 'laggards' (18 per cent) and 'starters' (61 per cent) than other industries, and a correspondingly smaller proportion of 'progressives' (19 per cent against 32 per cent overall).

14%

average cost savings predicted through IIoT-based solution use within five years

The planned spend on IIoT places it as the number one next generation technology that maritime companies expect to invest in over the coming period.

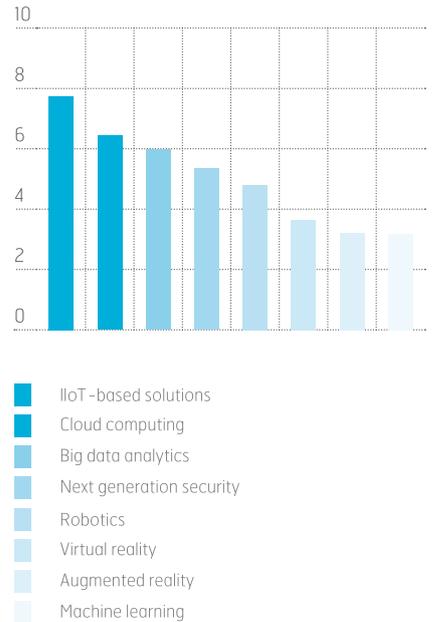
Respondents expect to spend more on IIoT than they will on cloud computing and big data analytics (each at 6 per cent) over the next three years, further indication of the sector's faith in IIoT.

However, there is some significant variation within the average spend on IIoT, with around a quarter of respondents (24 per cent) expecting to invest over \$3 million over the next three years, while 15 per cent say they will spend less than \$100,000 over the same period. Although size of operation will naturally dictate how much companies are able to – or need to – spend on the technology, this disparity once more demonstrates the variation in adoption attitudes within maritime businesses.

Plainly, not all maritime businesses have the same R&D budgets, and a high proportion of maritime respondents envisage making use of turnkey solutions in their forward-looking adoption projects. Some 64 per cent of respondents say that they are using or plan to use external parties to support some or as much as possible of their IIoT deployment strategies, while 48 per cent seek external help with management on an ongoing basis.

Maritime businesses see IIoT solutions as able to help them save money, but are less convinced of their ability to generate new revenues. While the cost savings are negligible today (2 per cent), this is expected to rise to 3 per cent within 12 months, to 7 per cent within three years, and then sharply to 14 per cent by the end of five years. Revenues generated by IIoT-based solutions are expected to increase less rapidly, reaching 7 per cent in five years, compared to 1 per cent today.

WHAT PROPORTION OF YOUR ORGANISATION'S IT BUDGET DO YOU EXPECT TO SPEND ON THE FOLLOWING DIGITAL TRANSFORMATION TECHNOLOGIES OVER THE NEXT THREE YEARS? (%)

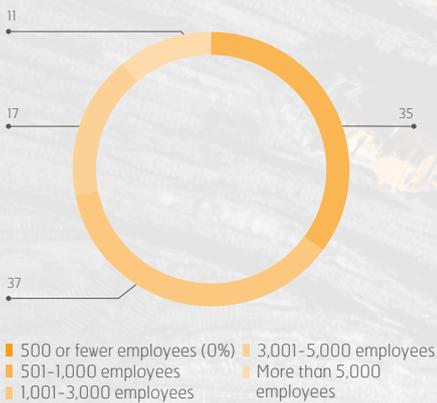


Respondents expect to spend more on IIoT than they will on cloud computing and big data analytics (each at 6 per cent) over the next three years, further indication of the sector's faith in IIoT

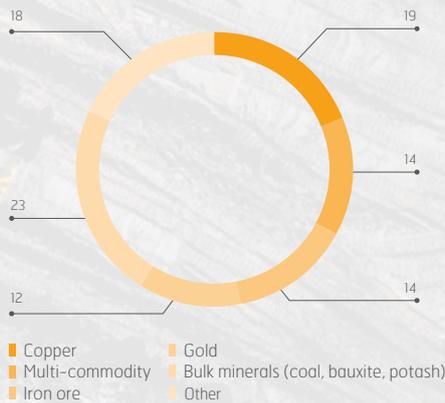


MINING DEMOGRAPHICS

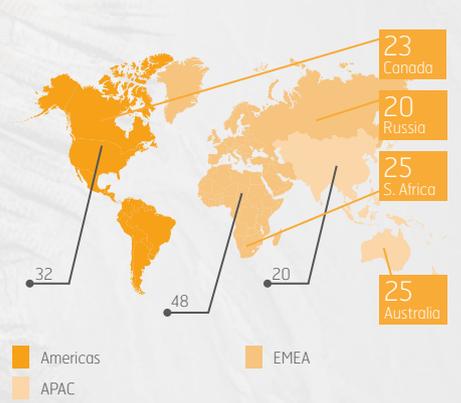
RESPONDENTS BY SIZE OF ORGANISATION (%)



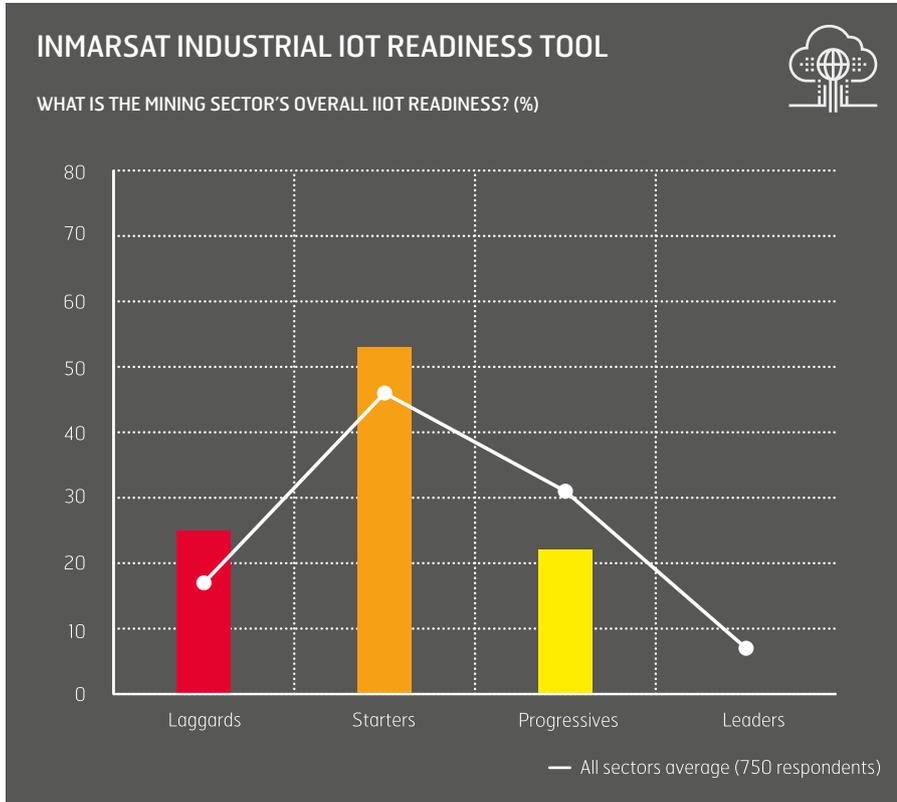
RESPONDENTS BY SUB-SECTOR (125)



RESPONDENTS BY REGION (%)



MINING



The mining data reveals the sector lags behind other industries examined in this report. Our IIoT readiness tool ranks the vast majority of respondents as either laggards or starters, with not a single respondent qualifying or the leader category overall. While this may seem surprising given some of the IIoT projects being developed by some of the major mining companies, our data found skills shortages and approaches to security and connectivity precluded our respondents from classification in this category.

Ultimately, with little value to add to the commodities they seek, success in mining depends upon companies' ability to extract raw materials more efficiently and more cheaply than their competitors can. However, as mineral reserves have depleted, mining companies have been led to evermore remote and difficult-to-access locations to establish their operations and the cost of extraction has increased. It is here that IIoT and other smart technologies can make a tangible difference, automating processes and upping the tempo of operations, making it critical to the future of the industry.

It was notable therefore that the top two drivers for adopting IIoT technologies were improving health and safety across the organisation (68 per cent) and improving the physical security of sites and assets (58 per cent), while the improvement of resource efficiency was third with 48 per cent.

The industry has been relatively slow to adopt of new technologies, preferring to stick to the well-trodden path of tried and tested techniques. And it may well be that wearables and site security are some of the most pressing areas to use IIoT. But, as the pressure on margins continues, and the need to extract raw materials in a way that doesn't cost the earth, harm the environment or endanger personnel, increases, it is becoming abundantly clear that radical new approaches are needed to transform operations.

Encouragingly, there are some very positive signs and most respondents expect to make significant progress over the next few years. Today, just 2 per cent of mining respondents have fully deployed any IIoT-based solutions; a figure that is set to climb to over half within a year.

There is near universal recognition among respondents in the promise that IIoT holds for

their organisations, and many view the technology as a way to become more profitable and to operate more sustainably and responsibly.

The level of investment set to be put into IIoT development in the coming years supports the idea that its usage will be accelerated. However, our readiness tool reveals that there are some clear leaders in the packs, with some mining companies' investment in and progress with IIoT remaining negligible, while others surge ahead. Naturally, companies with higher turnovers are investing more, while geographically those from North America – are rapidly steaming ahead. For mining companies in the likes of Australia, South Africa and Russia, that appear to be lagging behind, this should serve as a warning sign. Broken down by type, meanwhile, the data suggests that iron ore mines have taken an early lead on IIoT deployment to accelerate the rate of production, reflecting the increasingly pressurised steel market.

As the data in our research indicates, those organisations that are perfecting their IIoT strategies are already starting to reap the benefits and the mining sector is already showing some real promise. However, it is clear that many have some catching up to do.

INMARSAT INDUSTRIAL IOT READINESS TOOL



Our tool allows us to benchmark sectors, organisations and industries against each other based on their IIoT readiness.

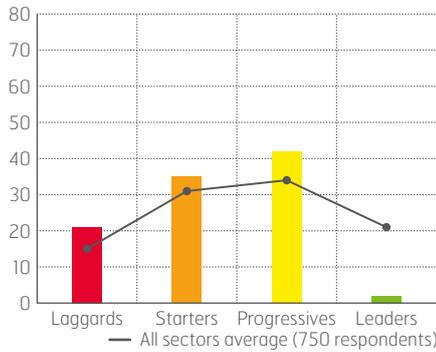
We asked our 750 respondents a series of questions, with points attached to their responses, scoring their IIoT development in six key areas:

- Adoption
- Security
- Connectivity and IIoT technologies
- Skills
- Data
- Investment and ROI

Using the scores, we divided our respondents into categories indicating their IIoT maturity: laggard, starter, progressive and leader.

ADOPTION

HOW MATURE IS THE MINING SECTOR IN RELATION TO IIOT ADOPTION? (%)



The mining industry is in the early stages of IIoT adoption with just 2 per cent of our respondents having fully deployed an IIoT solution. However, a further 29 per cent are trialling IIoT solutions, with the remaining 69 per cent planning to do so within the next two years, testament to the importance placed on the technology amongst R&D and innovation teams.

While mining organisations lag behind other industries connected in the global production and supply chain, there is evidence they are beginning to seriously consider the benefits that IIoT can bring to the bottom line. 84 per cent agreed that IIoT will revolutionise their organisation, and 79 per cent agreed that the technology is essential for their organisation to gain competitive advantage.

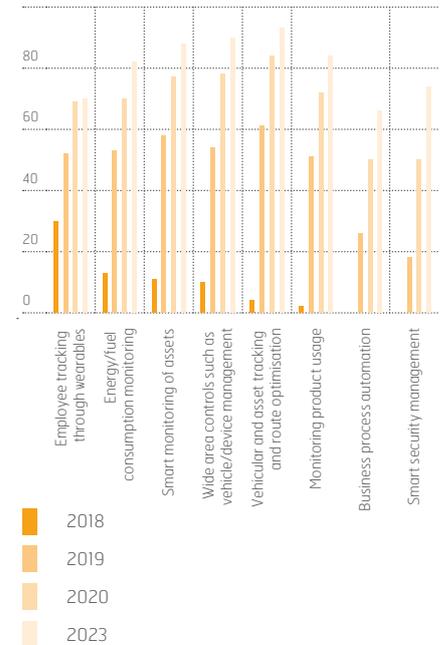
The priority forms of IIoT are focused on asset tracking and smart monitoring, and the greater use of wearables to track employees. The health and safety dangers in the mining sector makes IIoT an obvious choice to help make staff safer, and the complexity of mining operations – vehicles, engineering tools, and other devices needed for an effective site – makes getting detailed data to create efficiencies an early win for many.

It is also clear that 2019 is set to be a year where many trials in vehicular and asset tracking, among other areas, come to fruition.

In terms of the benefits achieved by those who have made or are trialling IIoT deployments, greater automation (41 per cent), improving health and safety (32 per cent) and improved environmental sustainability (28 per cent) rank highest. Overall, mining respondents have achieved less from their IIoT deployments than respondents in other industries, pointing to the challenges they face and the nascent state of IIoT within the industry. However, there are high hopes for IIoT in the future for a number of applications: greater physical security (67 per cent), better decision making (66 per cent) and increased staff productivity (64 per cent) the top three.

The mining industry faces a wide range of challenges as it adjusts to changing market conditions and seeks out new mineral deposits, and while these pose a threat to the sector's future prosperity, those companies that successfully harness digital technologies will be best placed to weather the storm.

IN WHAT AREAS WILL YOUR ORGANISATION ADOPT IIOT-BASED SOLUTIONS? (%)



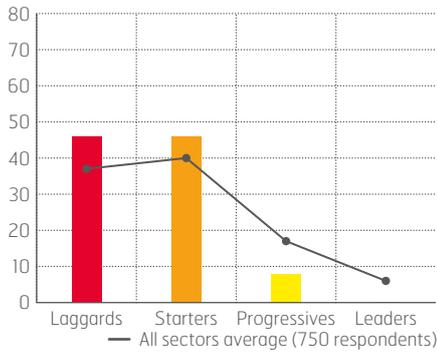
84%

agreed that IIoT will revolutionise their organisation

Mining businesses expect IIoT to deliver improvements in health and safety and environmental sustainability, as well as a raft of other benefits

SKILLS

DOES THE MINING SECTOR HAVE THE SKILLS IT NEEDS FOR IIOT? (%)



Skills shortages in mining have been more pronounced across the board in our 2018 research when compared to the other industries surveyed. Only 9 per cent stated that they have all the skills they need for a successful IIoT strategy, placing the majority of respondents in the IIoT laggard and IIoT starter categories in the maturity index. Unsurprisingly, 59 per cent of mining organisations stated that a lack of skills had caused a barrier to adoption of IIoT technologies.

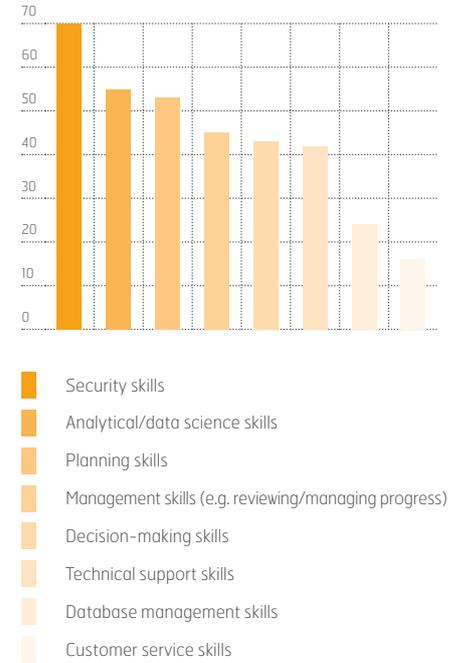
Skills shortages can be seen across all levels of seniority but become more pronounced at implementation levels – 38 per cent reported that they required more skills to devise IIoT strategies, considerably less than the number of respondents who stated that they lacked the skills needed for effective delivery and maintenance (66 per cent). While we can't entirely discount the potential bias of survey respondents (who were senior decision makers and therefore may consider themselves more skilled than they are in reality!) there is a clear pattern where those with both practical, hands-on experience of IIoT and the mining industry are in short supply.

Translating the theory of IIoT-enabled improvements into reality is clearly an area where improvements will need to be made.

The research attempted to understand which skills are most in need. The high level of concern about data security seen elsewhere in our mining data also came through when exploring skills shortages. (Data security was the skill in greatest demand) - 70 per cent said acquiring additional security skills was a top priority. The challenges to effectively interpret and use the data collected also came through with 55 per cent saying that they need more people with an understanding of analytics and data science.

The lack of skills sits at the root of most of the major issues acting as barriers in the mining industry today, and is something that will only gradually improve over the next few years as IIoT matures as a technology with it through upskilling and the introduction of talent from outside the industry. In the intervening time it will be even more important for mining companies to establish partnerships with IIoT service companies.

WHAT ADDITIONAL SPECIFIC SKILLS DO YOU THINK YOUR ORGANISATION NEEDS TO DELIVER IIOT-BASED SOLUTIONS? (%)



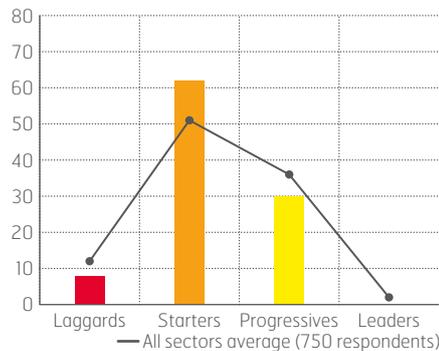
55%

need additional data science and analytical skills

A lack of available skills is proving to be a major inhibitor of IIoT adoption in the mining sector

SECURITY

HOW MATURE IS THE MINING SECTOR'S APPROACH TO IIOT SECURITY? (%)



To date the mining sector's attempts to tackle the security of their IIoT initiatives in line with the overall research sample, the majority of mining respondents have a considerable amount of work to do to address the security issue.

38 per cent stated that cyber-security posed a barrier to the development of IIoT in their organisations and, worryingly, 87 per cent and 84 per cent, respectively, agreed that processes to protect against cyber-attacks and data misuse could be improved.

Mining is a major strategically-important industry and a well-executed IIoT-related cyber-attack could have severe implications for not only the company directly involved but also the wider economy. As mining companies come to connect evermore parts of their operations to the internet, through IIoT, they open up new vulnerabilities and the risks of disruption from bad actors multiply.

Mining respondents are keenly aware of these threats, and 64 per cent cite concerns about the risk of external cyber-attacks in relation to their IIoT deployments. By comparison, only around half of respondents from other industries registered the same concerns, indicating the scale of the challenge confronting the mining sector.

Digging deeper, data storage challenges, misuse of data by employees, poor network security and the risk of external cyber-attack all caused a high level of distress amongst survey respondents.

Despite this recognition, the response from the sector to address IIoT-related security challenges has been somewhat muted, and has for the most part revolved around creating internal and external security policies for staff to follow (45 per cent). While this will help to address data misuse by employees, it will do little to protect mining companies from cyber-attacks, which is where much more attention is needed. While 40 per cent have upgraded existing technology, just one in five (22 per cent) respondents report having invested in new security technologies to protect their IIoT deployments, which trails other sectors' responses.

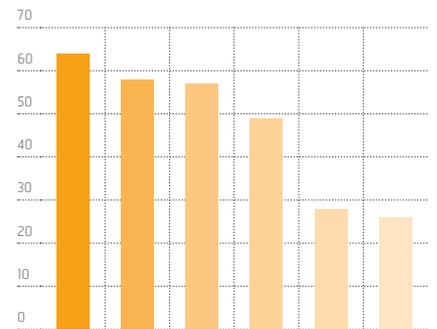
One reason for the relatively low level of activity to address security vulnerabilities in the mining sector may be that mining businesses do not have the right stakeholders involved in their IIoT initiatives. Over half (51 per cent) of respondents report that their organisation's Chief Information Security Officer (CISO) is not involved with their IIoT initiatives but should be, and a further 17 per cent report that they do not need to be involved.

The potential security vulnerabilities of IIoT are well documented, and it should be of some concern that there is not a total consensus that IT security specialists are fundamentally involved in IIoT projects. While this may change as the sector starts to invest in IIoT more heavily, this is an area to watch closely.

38%

stated that cyber-security concerns were a barrier to the development of IIoT solutions

WHAT ARE THE BIGGEST SECURITY CHALLENGES ASSOCIATED WITH THE USE OF IIOT-BASED SOLUTIONS WITHIN YOUR ORGANISATION? (%)

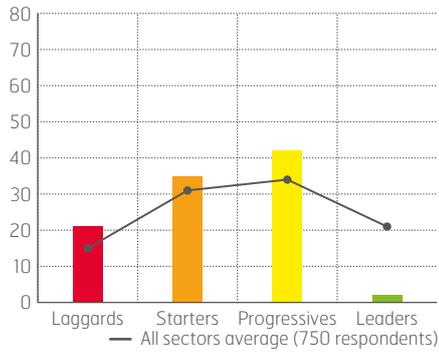


- Risk of external cyber attack
- Poor network security
- Potential mishandling/misuse of data by employees
- Insecure storage of data collected
- Internal data regulation and compliance requirements
- Supplier/partner data regulation compliance requirements

The response from the sector to address IIoT-related security challenges has been somewhat muted and needs to focus on new technologies that can fend off emerging and evolving cyber threats

DATA USAGE

HOW ADVANCED IS THE MINING SECTOR'S APPROACH TO IIOT DATA? (%)



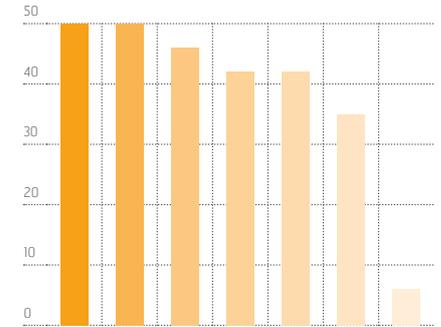
The mining sector has three clear priorities on how it wants to use data collected from IIoT infrastructure – to improve health and safety for employees (68 per cent), build better physical security of mines and the assets used onsite (58 per cent), and increase resource efficiency to reduce costs (48 per cent). However, respondents made it clear that there are some significant challenges in being able to use and share data to improve operations, which place the majority of respondents in the IIoT laggard or IIoT starter categories.

Only 23 per cent stated that data from IIoT was available to anyone (following security clearance) in the organisation to interrogate, and 34 per cent said that data was only for the IT department and senior management. This level of restriction has an impact on the pace of innovation.

As digital transformation has spread through organisations in recent years, innovation also needs to be dispersed if it is to be effective. While the involvement of senior management and IT departments are important, the best ideas for deployment do not come through a top-down hierarchy. More flexible approaches to innovation are needed in the mining sector where those working on the frontline can work hand in glove with specialists developing IIoT solutions. Historically, the mining sector has not been known for this level of flexibility in the way that it manages change. However, growing competitive challenges in the market are now forcing new cultural behaviour to more flexible approaches to innovation.

When asked what is holding back the sharing and use of data half said that they do not have the skills to extract and use data, 42 per cent said data was being stored in unusable formats, and 35 per cent said that there was just so much data that they were overwhelmed by the prospect of understanding and using it. So, as well as needing to be more flexible and open in how data is used and shared, IT leaders need to quickly improve their data analytics functionality to enable better use of the wealth of data that is being created.

WHAT CHALLENGES DOES YOUR ORGANISATION FACE IN USING DATA EFFECTIVELY AS POSSIBLE? (%)



- We don't have the skills to extract/use data
- Security/privacy concerns
- There is a lag between data collection and it being available
- Data is only available to certain departments involved in the IIoT deployment
- Data is stored in an unusable format
- There is such a large volume of data we struggle to utilise it
- We are able to use data as effectively as possible

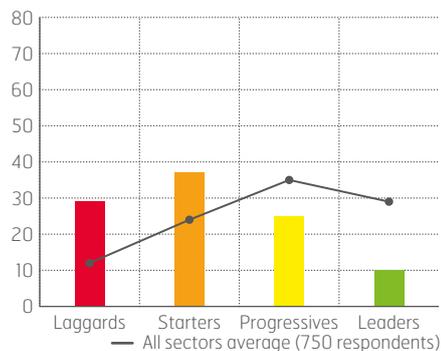
Businesses need to improve their data analytics functionality to enable better use of the wealth of data that is being created by their IIoT initiatives

68%

expect to use IIoT-generated data to improve health and safety

CONNECTIVITY AND IIOT TECHNOLOGIES

HOW WELL IS THE MINING SECTOR ADAPTING TO THE CONNECTIVITY REQUIREMENTS OF IIOT? (%)



The remoteness of many mines, combined with the challenge of multiple sites spread over great distances makes connectivity an especially pressing issue for the mining sector. Factor in a growing move toward automation, smart exploration and sample analysis and the need for reliable connectivity is more important than ever. However, 35 per cent of mining respondents cited connectivity issues as a barrier to IIoT adoption, a higher percentage than any other segment interviewed.

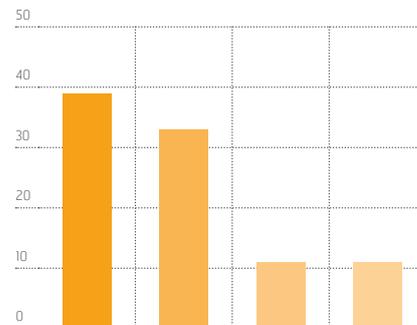
For control centre staff, connectivity issues may reduce visibility of data which will lead to a shut down in production, which could seriously impact upon a mine's profitability. A further 61 per cent agreed that connectivity issues could disrupt IIoT deployments and 66 per cent reported that they struggle with reliable connectivity at least some of the time.

Satellite evidently plays an important role in an industry challenged by connectivity issues in its journey toward digital transformation. 39 per cent viewed it as the most important connectivity method, and those that viewed it this way were more likely to be enjoying the benefits from their IIoT deployments.

Given satellite's potential to deliver connectivity to a remote site and mesh radio networks' ability to facilitate data transfer in areas where line of sight is obscured, such as an underground mine, it is no surprise that radio networks also rank highly in importance.

Increasingly, mining companies are using newer wireless data collection mechanisms: RFID was the most widely-used with 42 per cent using it, followed by LoRaWAN and SigFox with 10 per cent each. SigFox was more commonly used in Australia than LoRaWAN, while this was inverted as a trend amongst Canadian mining businesses. Only in Russia did RFID not rank as the top IIoT protocol, with respondents there instead citing Bluetooth Low Energy top.

WHICH CONNECTIVITY TYPE IS MOST IMPORTANT TO YOUR IIOT DEPLOYMENTS? (%)



- Satellite
- Radio networks
- Cellular networks
- Fibre networks

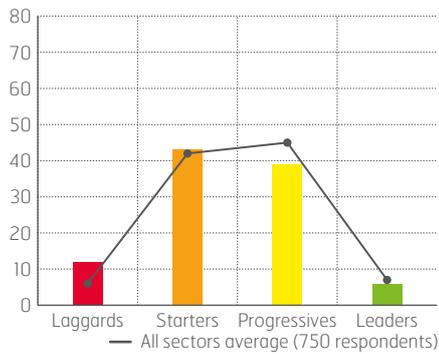
Of all the land-based sectors examined, mining emerged as the most reliant on satellite networks to support its IIoT initiatives

35%

of mining respondents cited connectivity issues as a barrier to IIoT adoption, a higher percentage than any other segment interviewed.

INVESTMENT AND ROI

HOW WILL THE MINING SECTOR INVEST IN IIOT? (%)



Mining businesses expect to invest considerable sums into IIoT over the next three years – with an average investment of approximately \$3 million. This equates to just under 8 per cent of mining companies’ overall IT budgets and represents around a six-fold increase from the amount spent on IIoT solutions since 2015.

This level of planned spend on IIoT places it as the number one next generation technology that mining companies expect to invest in over the coming period. Respondents expect to spend more on IIoT than they will on cloud computing, robotics and big data analytics (each at 7 per cent) over the next three years, coming as further indication of the sector’s faith in IIoT.

However, there is some significant variation within the average spend on IIoT, with around a third of respondents (32 per cent) expecting to invest less than \$500,000 over the next three years. Although the size of the operation will naturally dictate how much companies are able to – or need to – spend on the technology, this may indicate that some mining businesses are falling behind in the IIoT innovation stakes.

Plainly, not all mining businesses have the same R&D budgets, and the perceived high cost of IIoT solutions was identified as a barrier to the success of IIoT projects by 37 per cent of respondents.

A lack of turnkey, off-the-shelf solutions is also an issue for half of mining businesses, meaning that IIoT projects must be largely bespoke, driving up the costs of implementation. As the industry matures, and more off-the-shelf IIoT solutions come to market, these barriers should gradually start to subside. Increasingly, with fluctuating commodity markets driving organisational efficiencies, those companies who do not make the necessary investments will suffer.

However, when we consider the potential Return on Investment (RoI) of IIoT solutions in the mining sector, the implications for IIoT laggards become clear.

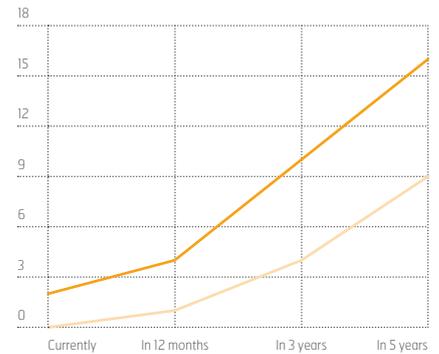
Mining businesses are generally confident in the ability of IIoT solutions to help them both save money and generate new sources of income. While the cost savings and turnover increases are negligible today, mining businesses expect their IIoT solutions to deliver an additional 9 per cent to their top lines and reduce their operating costs by 16 per cent within the next five years.

Respondents expect to realise increased levels of automation, more effective asset utilisation and lower insurance premiums as a result of their IIoT initiatives, all of which will contribute to their bottom lines and help to increase outputs.

Critically, those that are investing higher sums in IIoT are anticipating correspondingly high rewards. Multi-commodities respondents, who expect to invest 6 per cent of their IT budgets in IIoT over the next three years state that this should deliver an extra 6 per cent to their revenues by 2023. Iron ore companies, who will invest 9 per cent over the same time frame, expect to add 9 per cent to their topline.

Those mining businesses that are slow off the mark, and fail to invest sufficient amounts in IIoT technologies will therefore be placed at a distinct financial disadvantage.

WHAT OPERATIONAL COST SAVINGS AND TURNOVER INCREASES IS YOUR ORGANISATION LIKELY TO ACHIEVE THROUGH ITS USE OF IIOT? (%)



■ Average cost savings
■ Average turnover increase

16%

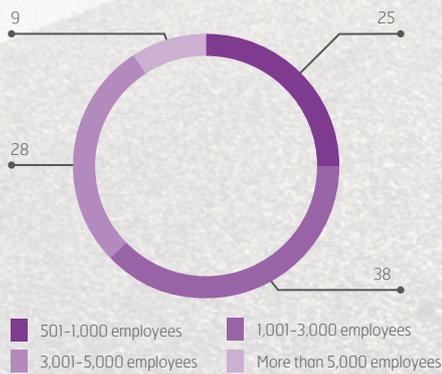
reduction in operating costs predicted through use of IIoT in five years

Those mining businesses that are slow off the mark, and fail to invest sufficient amounts in IIoT technologies, will increasingly find it difficult to compete

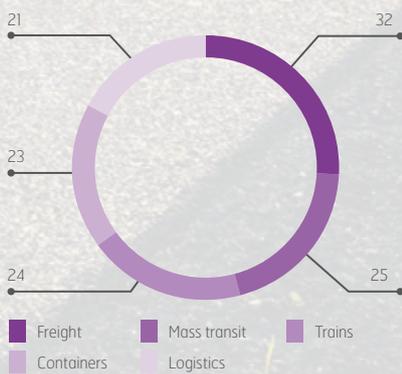


TRANSPORT DEMOGRAPHICS

RESPONDENTS BY SIZE OF ORGANISATION (%)



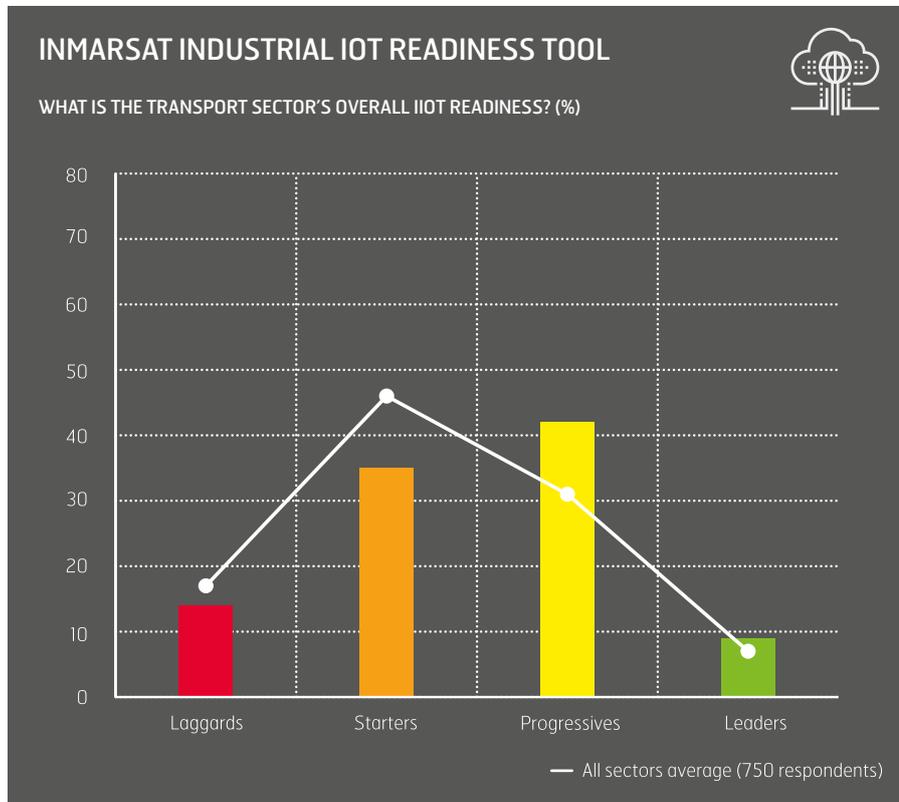
RESPONDENTS BY SUB-SECTOR (125)



RESPONDENTS BY REGION (%)



TRANSPORT



By 2050 the world's population is predicted to hit 9.8 billion¹. This increase in people will result in an explosion in the demand for goods and services. While the need for raw materials will put pressure on the producers in the agriculture and mining sectors, the movement of the components necessary for the manufacture and distribution of finished products will lead to unprecedented changes to global supply chains. Factor in the increased mobility of urbanising populations, with more people moving, and in greater distances than ever before, and it is clear that digitalisation will be the fundamental enabler to the transport industry.

One major concern for the transport industry as it carries more goods across greater distances is its growing impact on climate change; our research found that monitoring environmental parameters was the highest rated driver for IIoT deployments in the transport sector. In addition, as demand grows in developing economies for more goods to be transported along multi-modal logistics networks, and these countries further develop their own mass transit networks, the impact of the

transport sector on the environment will increase. While innovations, such as electric vehicles, will offset this somewhat, transport organisations must make radical changes to their operations to ensure that they operate with optimum efficiency.

IIoT will play a central role in these efforts. Emissions in the transport sector are exacerbated by faulty equipment, engine damage and poor route planning, but IIoT can address this. Smart telematics devices and diagnostic sensors can automatically gather vehicle data, including engine management, emission monitoring and driver behaviour to instantly notify fleet managers with damage alerts, faults or inefficient driving alerts. By proactively improving driving efficiencies, limiting engine wear-and-tear and increasing average miles-per-gallon (MPG), wastage can be minimised, and overall emissions can be further reduced. IIoT will also provide the building blocks for intelligent traffic systems and real-time route planning, enabling drivers to adapt to poor weather, road closures and traffic density to ensure all vehicles take the quickest and most efficient routes to reach their destinations.

The transport sector clearly recognises the value that IIoT, in conjunction with other technologies such as big data, automation and robotics, can bring in helping to move people and goods across the planet more sustainably. Sensors that can monitor shock detection, heat and moisture, as well as location and security tags, can provide logistics managers with an all-encompassing, granular view of how their cargo moves across their supply chains, enabling them to identify friction points and optimise the flow of global trade.

We surveyed the freight, logistics, mass transit, rail and container sectors, and while there is still some progress to be made before global supply chains resemble connected networks, there is good headway being made in IIoT adoption across the sector. With over half of respondents categorised as leaders or progressives in their readiness for IIoT, the sector is well ahead of its counterparts in other industries, using data and technology to move towards more digitally-oriented operations.

While it is encouraging that the transport sector is well ahead of its peers in other industries, this may present challenges when managing global supply chains. If a shipment of iron ore can't be tracked from the moment it is extracted in Western Australia to when it arrives in the form of steel pilings at a construction site in Guangzhou, then friction points and inefficiencies will remain in the supply chain, costs will continue to be higher than necessary and global trade will suffer.

INMARSAT INDUSTRIAL IOT READINESS TOOL



Our tool allows us to benchmark sectors, organisations and industries against each other based on their IIoT readiness.

We asked our 750 respondents a series of questions, with points attached to their responses, scoring their IIoT development in six key areas:

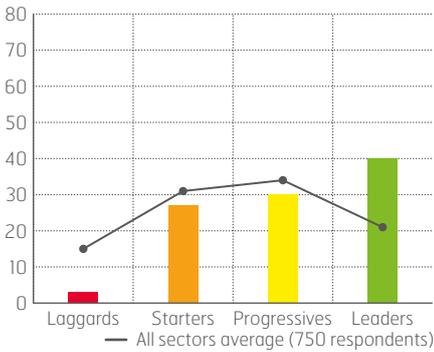
- Adoption
- Security
- Connectivity and IIoT technologies
- Skills
- Data
- Investment and ROI

Using the scores, we divided our respondents into categories indicating their IIoT maturity: laggard, starter, progressive and leader.

¹ www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

ADOPTION

HOW MATURE IS THE TRANSPORT SECTOR IN RELATION TO IIOT ADOPTION? (%)



The transport sector is racing ahead of other industries in its efforts to deploy IIoT solutions, with 40 per cent of respondents ranking as IIoT leaders, and a further 30 per cent as IIoT progressives. This high level of deployment may be a result of relatively straightforward IIoT applications in the transport sector, such as asset tracking or emissions monitoring sensors, but it certainly shows an industry well on its way to creating a connected, data-rich global supply chain and wider transport network.

As it stands, 40 per cent of transport businesses have fully deployed IIoT solutions, and 18 per cent are at the trial stage. Every transport and logistics company surveyed reported that they plan to deploy IIoT solutions within the next two years.

Within the transport industry we can see stark contrasts between different sub-sectors. The mass transit sector shows the most progress in IIoT adoption, with 64 per cent reporting full IIoT deployment, and all companies from the sub-sector expecting IIoT deployment to be completed within the next 12 months. However, businesses within both the freight and containers sub-sectors present a very different picture, with just 19 and 22 per cent respectively reporting full IIoT

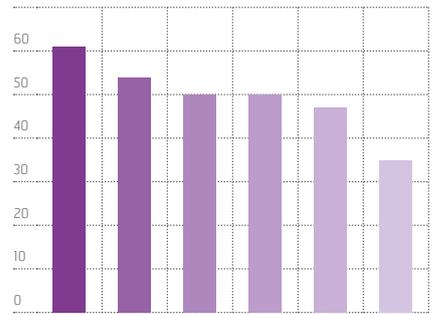
deployment, and a much slower rate of deployment predicted over the next two years.

Mass transit presents fertile ground for IIoT deployment, with controlled environments such as trackside infrastructure, as well as rolling stock, offering specific routing around which IIoT solutions can be built. Freight businesses, more susceptible to variable routes and conditions, appear to be struggling with IIoT deployment. The 'last mile' delivery sector in particular, where margins are relatively low, has thus far seen slow adoption of IIoT, however, when this takes off in volume it is expected to cause immense disruption to the sector.

However, despite these differences in adoption rates, there seem to be broadly similar objectives for deployment across the industry. Operating with greater efficiency is a key driver for the transport industry, with 61 per cent reporting that monitoring environmental changes - such as through the use of emissions sensors - was one of their primary motivations for IIoT adoption, and 54 per cent of businesses identifying a need to improve resource efficiency. Transport businesses are clearly having some success with this approach: 82 per cent of transport businesses reported that they are achieving, or expect to achieve, improved environmental sustainability, and 88 per cent reported reduced costs, surely due in large part to improving resource efficiency.

Tracking and monitoring assets as they move across the world will also enable transport businesses to streamline their operations, as well as ensuring that potentially valuable cargo arrives safely and in good condition at its end destination. Shock detection, heat and moisture sensors, and location and security tags can provide logistics managers with an all-encompassing, granular view of how their cargo moves across their supply chains, enabling them to identify friction points and optimise the flow of global trade.

WHAT ARE THE MOST IMPORTANT DRIVERS FOR THE DEPLOYMENT OF IIOT-BASED SOLUTIONS FOR YOUR ORGANISATION? (%)



- Monitoring environmental changes
- Improving resource efficiency of the organisation
- Improving health and safety across the organisation
- Improving the physical security of sites and assets
- Reducing costs in business operations
- Better access to data/insights

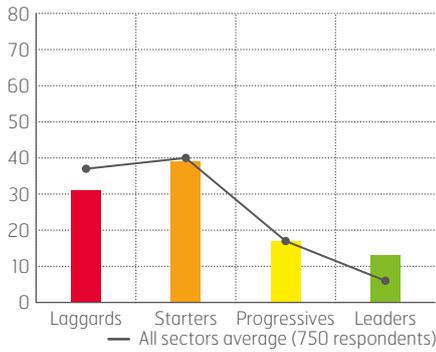
54%

reported that improving resource efficiency was a primary driver for IIoT adoption

Every transport and logistics company surveyed reported that they plan to deploy IIoT solutions within the next two years

SKILLS

DOES THE TRANSPORT SECTOR HAVE THE SKILLS IT NEEDS FOR IIOT? (%)



A lack of relevant skills within the transport sector has emerged as one of the key barriers to adoption of IIoT solutions. While the industry is ahead of its counterparts in energy, agriculture and mining, 70 per cent of respondents rank as either laggards or starters when it comes to the state of their IIoT skills base. This is one area in particular that will need to be addressed if transport businesses are to capture the full value of IIoT.

Reflecting the skills shortage that is seen across many industries, 34 per cent of transport businesses reported that lack of in-house skills was a barrier to IIoT adoption, just behind security implications. This concern around security was further highlighted when respondents were asked to identify the skills they most required to accelerate their IIoT deployment; 59 per cent reported that they required additional staff with

security expertise, the highest rated skillset. 46 per cent of respondents cited a lack of staff with experience in data science and analytics, suggesting that without the right staff in place, transport businesses will struggle to make best use of the vast reams of data collected by their IIoT deployments.

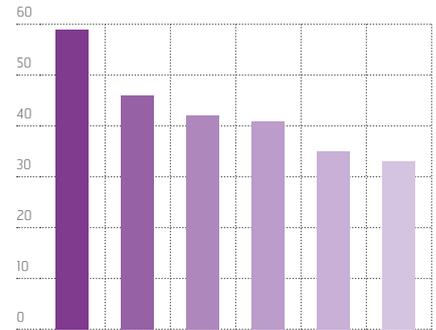
The skills shortages are particularly acute in certain sub-sectors of the transport industry. The mass transit sector faces a damaging lack of skills in data analytics, with nine in ten reporting a lack of staff skilled in this area, while 90 per cent of the containers industry requiring additional staff to provide technical support.

This skills shortage is also evident in the businesses' concerns around their IIoT deployments. Mass transit businesses cited a lack of skilled staff to extract and use the data as the top reason they weren't able to profit from their IIoT data. Similarly, with 90 per cent of the containers industry lacking sufficient technical support, it is no surprise to see that the sector shows the lowest rate of IIoT adoption.

59%

reported that they required additional staff with security expertise

WHAT ADDITIONAL SPECIFIC SKILLS DO YOU THINK YOUR ORGANISATION NEEDS TO DELIVER IIOT-BASED SOLUTIONS? (%)

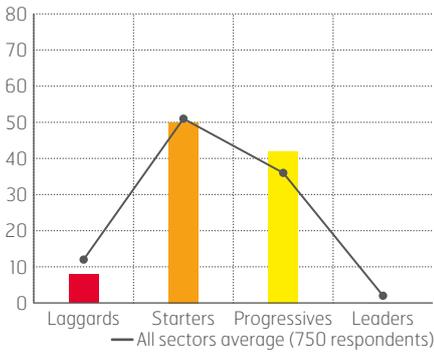


- Security skills
- Analytical/data science skills
- Planning skills
- Technical support skills
- Decision-making skills
- Management skills

Mass transit organisations are suffering from a damaging lack of skills in data analytics, with nine in ten reporting a lack of staff skilled in this area

SECURITY

HOW MATURE IS THE TRANSPORT SECTOR'S APPROACH TO IIOT SECURITY (%)



With increased deployment of connected sensors across multi-modal supply chains, the level of vulnerability of international transport businesses to cyber-security threats will increase, so the industry must take action now to ensure that vital infrastructure is not exposed to cyber-criminals and hostile state actors. The IIoT Safety and Security Protocol Report, published by the World Economic Forum, recommends a number of measures that businesses deploying IIoT networks should implement, including risk assessment models, enhanced end-to-end encryption and a rigorous, standardised software development lifecycle process.

With 50 per cent of transport businesses identified in our maturity model as starters, and 8 per cent as laggards, there is an immediate necessity for transport businesses to ramp up their cyber-security defences. Transport networks, whether on rail, road, sea or air, are vital for a successful, thriving economy and society. A successful cyber-attack on, for example, an autonomous rail network would be a major coup for cyber-criminals and have potentially devastating effects on safety and a country's economic activity.

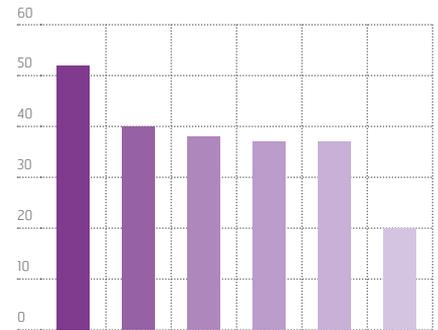
52 per cent of transport businesses identified external cyber-attacks as one of their biggest security challenges, reflecting the clear risk from malicious outside parties as we advance towards a more connected global supply chain. Other significant security challenges cited by transport businesses included poor network security (40 per cent) and insecure storage of data (37 per cent). Both of these fears align with the risk of external cyber-attacks, as poor network security and insecure data storage fundamentally weaken an IIoT solution and may allow those wishing to do harm access to sensitive data and infrastructure.

However, transport businesses demonstrate a strong understanding of their predicament. 64 per cent of transport businesses agreed that their processes to combat cyber-security threats could be stronger, and 66 per cent agreed that they could do more to protect against data mishandling.

Crucially the transport sector is not sitting idly by while its critical infrastructure comes under attack. While a lack of staff skilled in security, as identified above, may play a role in hampering the industry's efforts to bolster its defences, respondents to the Inmarsat survey identified a number of ways they are improving their security.

The mass transit and rail sector is leading the way in training its employees on IIoT, with 63 per cent reporting doing so to improve their security, as well as showing higher levels of investment in new security technologies (45 per cent). Businesses within the freight and logistics sector are focusing their efforts primarily on upskilling existing staff and hiring additional skilled staff, while those operating in the container sector have directed their attention to upgrading their existing security technology and finding external partners to help them further tighten their security defences. For all sub-sectors, a combination of these approaches will be necessary to ensure security risks are minimised.

IN YOUR OPINION, WHAT ARE THE BIGGEST SECURITY CHALLENGES ASSOCIATED WITH THE USE OF IIOT-BASED SOLUTIONS? (%)



- Risk of external cyber attack
- Poor network security
- Internal data regulation and compliance requirements
- Potential mishandling/misuse of data by employees
- Insecure storage of data collected
- Supplier/partner data regulation compliance requirements

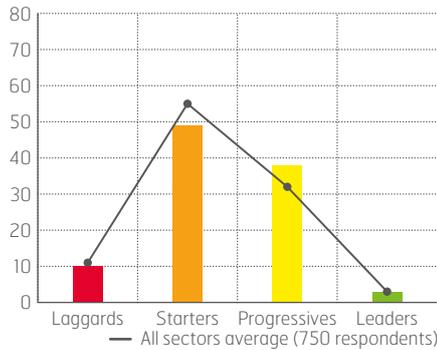
52%

identified external cyber-attacks as one of their biggest security challenges

A successful cyber-attack on an autonomous rail network would be a major coup for cyber-criminals and have devastating effects on a country's economic activity

DATA USAGE

HOW ADVANCED IS THE TRANSPORT SECTOR'S APPROACH TO IIOT DATA? (%)



With almost 60 per cent of transport businesses either identified as starters or laggards when it comes to using the data gathered by IIoT solutions, there are clearly many transport businesses still struggling to work out how to extract maximum value from their data. While data maturity in transport businesses is edging slightly ahead of their counterparts in other industries, the sector is tracking well ahead of others in deployment, suggesting a lack of strategy and insight into how best to use the data gathered by the IIoT solutions.

This may be about to change however as transport businesses clearly recognise the value that this data can bring and have identified a number of areas in which they aim to use this data, with efficiency and productivity at the forefront of their efforts. 56 per cent of mass transit and 63 per cent of rail companies identified that they would use their IIoT data to monitor productivity, the top-rated usage, while logistics businesses cited identifying cost saving and efficiency opportunities as their top priority. However, while transport businesses continue to have sub-optimal data-sharing processes and cyber-security hurdles to overcome, they will fail to create connected, multi-modal supply chains that ensure maximum productivity from their operations and staff.

61 per cent of respondents from the container industry reported focusing on managing stocks and assets as a key use for their data, understandable when IIoT offers so much potential for asset tracking and monitoring. This data is reflected in the rate at which the container sector is deploying IIoT to monitor its assets, with 66 per cent either already deploying or expecting to deploy within 12 months.

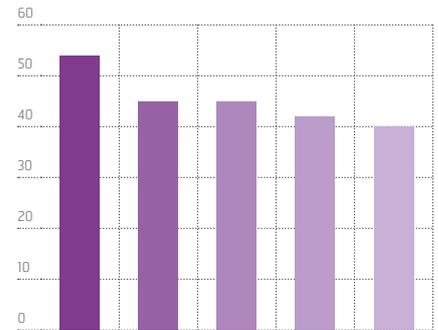
While it is clear that efficiency is the priority for many transport businesses, it is also encouraging to see that they recognise the positive benefits that IIoT could have for their staff, by improving health and safety, and reducing their impact on the environment. The mass transit and rail sectors are perhaps hoping to use IIoT to improve safety for passengers, with 64 and 54 per cent of respective respondents citing IIoT's potential for improving health and safety as key driver for deployment.

The transport industry needs to overcome a number of challenges before it can use its data to maximum effect. Security is still a major concern, with 41 per cent of respondents citing it as a reason why they are not able to use the data they collect as effectively as they should.

38 per cent reported that they face a lag between data collection and it being available, hindering an organisations' ability to make real-time decisions based on the data available to them. This lag is restricting the value that transport businesses can gain from their IIoT deployments, hindering them from making decisions in real-time from data gathered by connected sensors out in the field. In an industry which is so reliant on seeing where assets are this must be solved.

The issues caused by this lag are not helped by the restrictions that transport companies are placing on the visibility of data. Incredibly, in the mass transit sector just 2 per cent of businesses reported allowing anyone within their organisation to view it, hindering innovation and preventing colleagues from working together to establish creative applications for the vast swathes of IIoT data that they gather.

HOW ARE YOU INTENDING TO USE THE DATA COLLECTED THROUGH YOUR ORGANISATION'S IIOT-BASED SOLUTIONS? (%)



- Monitoring productivity
- Monitoring and improving health and safety
- Managing stocks/assets
- Identifying efficiency/cost saving opportunities
- Monitoring environmental changes

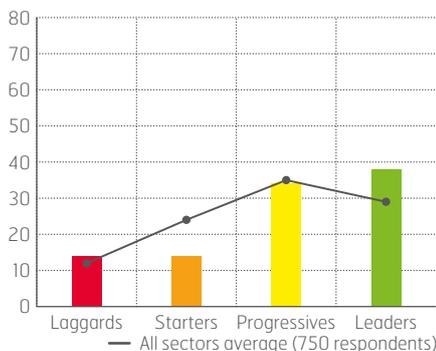
38%

reported that they face a lag between data collection and it being available

Effective data-sharing processes will be critical to the creation of connected, multi-modal supply chains, but cyber-security hurdles must be overcome before this is a reality

CONNECTIVITY AND IIOT TECHNOLOGIES

HOW WELL IS THE TRANSPORT SECTOR ADAPTING TO THE CONNECTIVITY REQUIREMENTS OF IIOT? (%)



Transport businesses are largely achieving the connectivity levels that they require, edging ahead of their counterparts in other industries with more IIoT leaders than any other sector. Much transport infrastructure is focused on urban areas, so this will be a contributory factor in why businesses in the sector are largely able to access the connectivity they require.

However, by their very nature, transport networks pass through remote regions and areas without consistent communications coverage at regular intervals. It is in these connectivity blackspots that a full view of critical data is most important, to ensure the safe passage of staff, passengers and cargo through potentially risky environments. Clearly a combination of connective technologies will be key to supporting the type of 'connectivity bubble' that will keep an asset continuously connected.

Transport businesses appear to recognise the challenges they face keeping their IIoT solutions in constant communication and are opting for a range of connectivity types to ensure reliable data transmission. Perhaps surprisingly, satellite communication networks emerged as the most common choice to support IIoT solutions amongst transport businesses, with 76 per cent using it. This was closely followed by cellular networks (75 per cent), fibre (64 per cent) and radio networks (36 per cent).

The rate of adoption of satellite networks among transport businesses was significantly higher than other sectors, reflecting the need within the transport industry to have truly global coverage to service global supply chains. Underlining this, 78 per cent of transport businesses agreed that satellite connectivity is crucial to supporting their IIoT communications networks, again slightly higher than other sectors, which came in at 69 per cent.

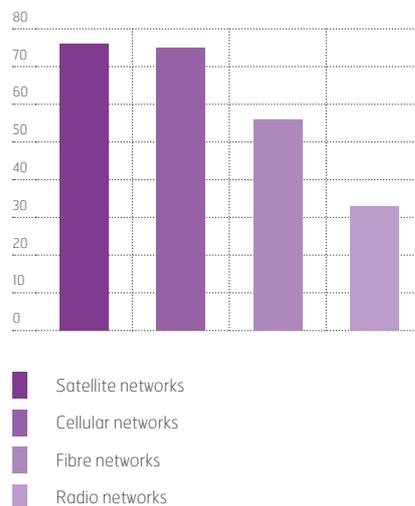
This is particularly pronounced within the logistics sub-sector, where 95 per cent of businesses agreed that satellite is crucial to their IIoT solutions. This perhaps should not come as a surprise, when supply chains are becoming increasingly global, delivering goods across vast distances where the need for constant, reliable connectivity is just as great.

To enhance their IIoT deployments, transport businesses are investing in a number of wireless data collection technologies. Radio frequency identification (RFID) emerged as the favourite, with 41 per cent utilising it in IIoT deployments.

The logistics industry is leading the way here: 62 per cent of respondents are using RFID to track vehicles and shipments of goods across global supply chains, much higher than any other technology. This is no surprise, given the capability of RFID tags to carry vital data, such as the contents of a container or identification of a vehicle. Integrating warehousing and vehicle RFID data into one process delivers further value. For example, the system will notify the driver if he has delivered too much or too little to the wrong location as he shuts the door getting into the truck. This value is reflected in the sector's adoption of IIoT solutions for asset and vehicle tracking, with 86 per cent of logistics businesses reporting that they have either already deployed these solutions or will deploy them within the next 12 months.

A global, stable and secure communications network, supported by satellite connectivity, will be fundamental for any transport business hoping to capitalise on the myriad opportunities of IIoT. Those that integrate satellite networks as part of their connectivity framework will be able to make significant operational improvements and offer a superior level of service, resulting in a better customer experience and increased profit margins.

WHAT TYPES OF COMMUNICATION NETWORKS DO YOU USE TO SUPPORT YOUR IIOT-BASED SOLUTIONS? (%)



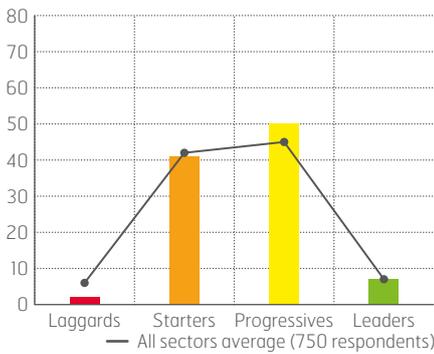
With increasingly global supply chains, 95% of logistics businesses agree that satellite is critical to maintain connectivity with their IIoT deployments

76%

of transport businesses are using satellite to support their IIoT initiatives

INVESTMENT AND ROI

HOW WILL THE TRANSPORT SECTOR INVEST IN IIOT? (%)



The transport industry tracks slightly ahead of other sectors when it comes to investing in IIoT. With 57 per cent of the industry identified as progressives or leaders, the transport sector is clearly stepping up its investment in IIoT, at a seemingly commensurate rate with the level seen across the other sectors examined in this report.

Transport businesses expect to invest an average of \$3.5 million in their IIoT development over the next three years, accounting for approximately 8 per cent of their total IT budget. Leading the field is the rail sector, expecting to spend 11 per cent of its total IT budget on IIoT development and deployment, with the logistics sector not far behind with an expected 9 per cent spend, above the industry average of 8 per cent.

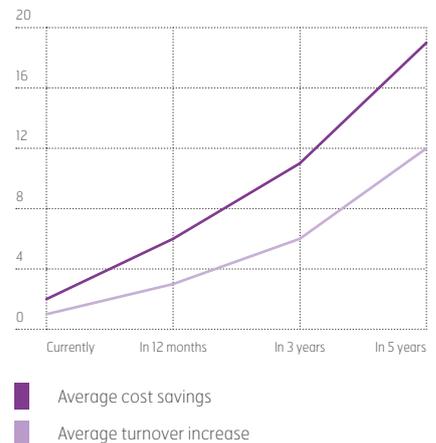
The complexity of operations in the rail and logistics sectors perhaps goes some way to explaining why businesses are investing heavily in IIoT monitoring to optimise their operations. In contrast to the container industry, which is prioritising asset tracking, the rail and logistics

sectors present a wider range of applications for IIoT deployment. With more staff put into potentially dangerous situations such as railway lines and ports, rail and logistics businesses can use IIoT to monitor and track staff health and safety. Monitoring vehicular energy consumption and environmental impact is also a key priority for rail and logistics firms' IIoT deployments, and we should expect to see high deployment rates (79 and 76 per cent have already deployed this to some extent) grow even further.

The wide range of use cases for IIoT in rail and logistics is further underlined in these sectors' expectations for how IIoT will help them to reduce their costs over the same three-year period. Businesses within the rail sector reported that they expected to save approximately 12 per cent of their costs, and logistics business 10 per cent. While these are relatively impressive figures, these sectors should step up its level of investment if it is to reap the full benefits of IIoT solutions.

The expected growth in turnover from the use of IIoT also shows the mass transit and rail sector to be leading the way in the transport industry. The sector expects to grow its turnover by 8 per cent by using IIoT, well above the industry average of 6 per cent, leaving sectors like freight and logistics (5 per cent) and containers (6 per cent) with much ground to make up.

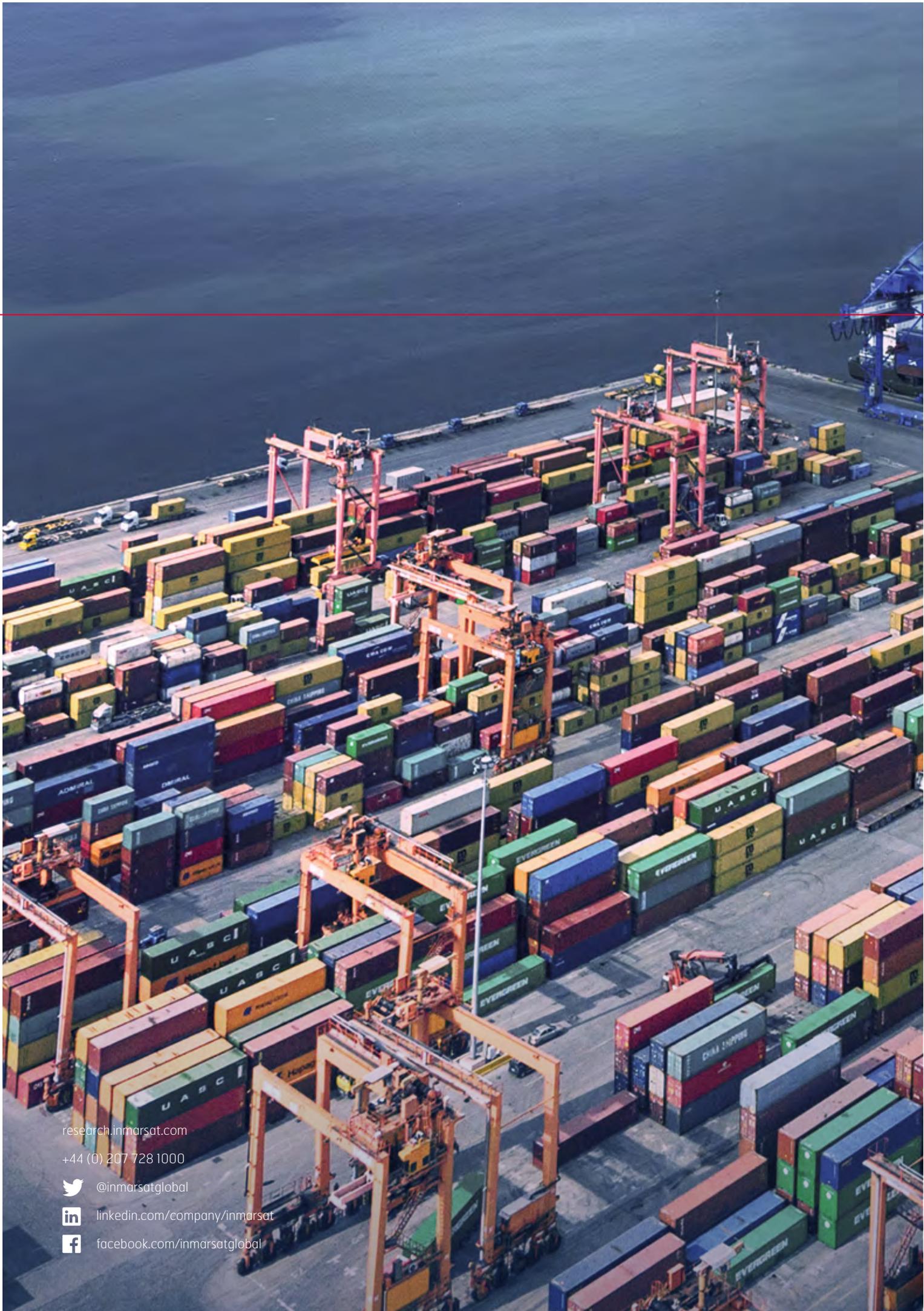
WHAT OPERATIONAL COST SAVINGS AND TURN-OVER INCREASES IS YOUR ORGANISATION LIKELY TO ACHIEVE THROUGH ITS USE OF IIOT (%)



8%

of IT budgets will be invested in IIoT over the next 3 years

Transport businesses expect to invest an average of \$3.5 million in their IIoT development over the next three years



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