The Economist Intelligence Unit

THE INTERNET OF THINGS BUSINESS INDEX 2017

Transformation in motion

Sponsored by arm IBM

Contents

About this report

The Internet of Things Business Index 2017: Transformation in motion is an Economist Intelligence Unit report, sponsored by ARM and IBM. It is intended to gauge the current and future use of the Internet of Things (IoT) by the global business community.

The report draws on two main sources for its research and findings:

- In September 2016 The Economist Intelligence Unit (EIU) surveyed 825 senior business leaders, 412 of whom are C-level executives or board members. Respondents were drawn from around the world, with 30% based in Europe, 30% in North America, 30% in Asia-Pacific and the remaining 10% in Latin America, the Middle East and Africa. A total of ten industries are represented in the study. Around 9% of respondents come from each of the following industries: financial services; manufacturing; healthcare, pharmaceuticals and biotechnology; IT and technology; energy and natural resources; construction and real estate; automotive; infrastructure; and outsourced facilities management. The sample is evenly split between large firms with an annual revenue of more than US$500m and small and mid-sized firms. Some of the results from this survey have been used to create the Internet of Things business index featured in this report.

- Alongside the survey, The EIU conducted a series of in-depth interviews with the following senior executives and experts (listed alphabetically by organisation):
  - Thomas Lesser, head of R&D, Big Ass Solutions
  - Paul DeLong, CEO, car2go
  - Martin Gaarn Thomsen, chief operating officer, ISS
  - Juha Pankakoski, chief information officer and chief digital officer, Konecranes
  - Jeroen Tas, CEO, connected care and health informatics, Philips Gordon Hui, vice president of strategy, Smart Design
  - Christian Renaud, analyst, The 451 Group

The report was written by Jessica Twentyman and edited by Pete Swabey. The EIU would like to thank all interviewees and survey respondents for their time and insight. ■

Executive summary
The IoT: Transformation in motion

The Internet of Things (IoT) is a key driver of the digital transformation that will enable businesses to reinvent products, services, internal operations and business models. As a result, the majority of executives surveyed by The Economist Intelligence Unit (EIU) for this report believe that following an IoT technology path is crucial to their long-term success.

Many respondents say that the IoT has already had a marked impact on their business model, allowing them to generate greater revenue and sparking a new innovation wave within their organisation. One-fifth have already seen a major impact on their industry, and a further 30% believe they will see significant impacts in the near future.

But while there is immense positivity across almost all sectors, many executives feel that the IoT has not progressed quite as fast as they had expected three years ago. So far, fewer than one in ten companies surveyed have achieved "extensive" implementation of the IoT for both external and internal operations.

These are some of the findings of the *Internet of Things Business Index 2017*. The purpose of the index, conducted by The EIU and sponsored by ARM and IBM, is to measure periodically the adoption of IoT technologies and services by businesses throughout the world and across all relevant industries. The inaugural study was conducted in 2013 and provides the baseline for this update, which tracks the business uptake of the IoT over the following three years to the end of 2016, giving a firm indication of how businesses are progressing with their plans.

Companies worldwide are eagerly pursuing the cost reductions, efficiency gains and new insights promised by a world of connected devices that are able to convey data on their usage and environment and can receive instructions remotely, the index reveals.

But even as underlying technologies and high-level business models have matured, companies are discovering that there are considerable organisational challenges to be addressed before the IoT will become a mass-market tool, such as the need to understand how companies must adapt their internal structures, as well as their go-to-market strategies. That will include how they work with suppliers.

Other key findings from the research include the following:

Many companies are seeing payback from their early IoT efforts. One in four (25%) survey respondents report that their organisation's use of the IoT has "sparked a new wave of innovation thanks to data that give us better insights". Almost as many (22%) say it has "unlocked new revenue opportunities from existing products and services", while 15% say it has lowered costs. For one in five respondents (20%) the IoT has changed existing business models or strategies, and 16% say it has enabled them to push into new markets and industries.

Executives believe in the IoT's potential, but progress has not happened as fast as expected. When asked about the impact of

the IoT on business in general, one in five respondents (21%) believe that it has already had a major impact, and a further 32% believe that while it has had a limited impact on business so far, it will have a major impact in the future. However, almost six out of ten (56%) agree "somewhat" or "strongly" that their progress with the IoT has not happened as fast as they had expected.

The main obstacles to IoT implementation are practical. In 2013 the main challenges to IoT adoption cited by executives related to understanding and perception. Today, they are more concerned with practical matters, with 29% of respondents suggesting that the high cost of required investment in IoT infrastructure is seen as a challenge. Concerns about security and privacy appear in second place, cited by 26% of executives.

Executives continue to put measures in place to get the IoT used more extensively in their businesses. Thirty-five percent say they are learning from the experience of early adopters, while the same proportion say they are seeking advice from third-party experts and consultants. One-third (33%) say they have already taken steps to train existing staff to work with the IoT, while 27% are conducting or sponsoring research to establish market size and demand.

There is still great optimism about the rewards ahead, and a firm belief that the IoT holds the key to digital transformation for many firms. More than half (55%) expect IoT technologies to help them make internal cost savings and/or generate external revenue in the next three years. Meanwhile, 47% agree that the IoT will be one of the most important parts of their organisation's digital transformation strategy. As one executive puts it: "The IoT has been a challenge in some respects, [but] there's potentially a huge upside here for us." ■

1 The Internet of Things Business Index

The Internet of Things is changing the way companies create and capture customer value, as a number of high-profile examples illustrate. The lighting division of electronics company Philips and the energy services company Cofely, for instance, now provide "light as a service" to Schiphol, Europe's fourth-busiest airport. The airport pays only for the light it uses, while Philips remains the owner of all fixtures and installations, taking joint responsibility with Cofely for the performance of the system and ultimately its reuse and recycling at end of life.

However, according to Gordon Hui, vice president of strategy at Smart Design, a New York-based design and innovation consultancy, many companies have yet to identify how the IoT can transform their particular value chains.

Back in 2014 Mr Hui wrote an article for the *Harvard Business Review*, in which he laid out the scale of the challenge. "As the Internet of Things spreads, the implications for business model innovation are huge. Filling out well-known frameworks and streamlining established business models won't be enough. To take advantage of new, cloud-based opportunities, today's companies will need to fundamentally rethink their orthodoxies around value creation and value capture."

Two years on, most companies have yet to address this challenge. "Despite substantial hype and investment in the IoT over the past few years, many companies have struggled to make the IoT a reality," Mr Hui says.

This helps to explain why the *Internet of Things Business Index 2017*, which aims to gauge the average level of IoT implementation across industries and geographies, finds that the companies surveyed had expected their IoT models to have advanced more over the last three years than they actually did. Almost six out of ten (57%) respondents agree "somewhat" or "strongly" with the statement: "Our progress with the IoT has not happened as fast as we expected".

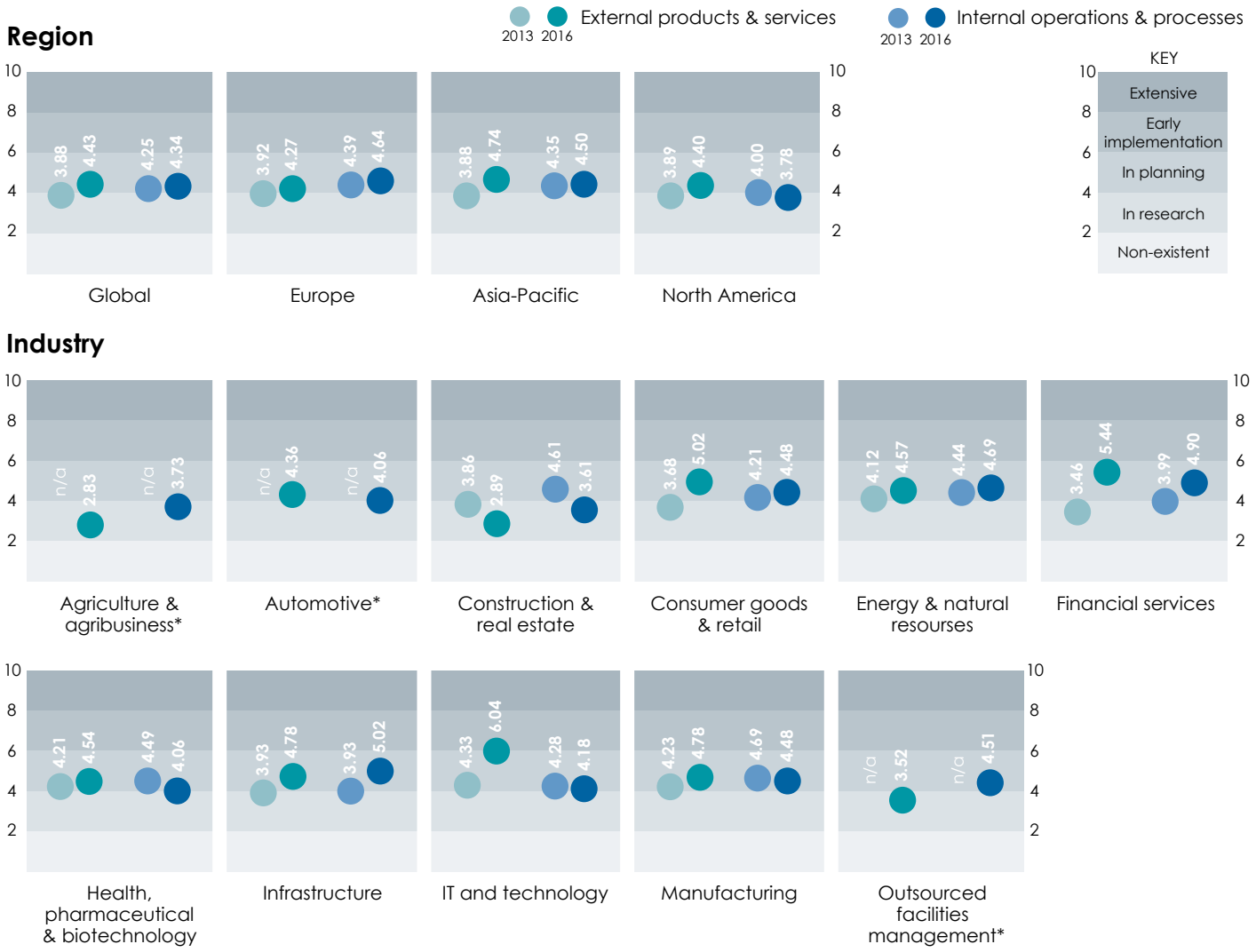
Back in 2013 the index found that businesses worldwide were, on average, still in the research stage (at point 4 on a scale of 1 to 10) and were slightly more likely to be using the IoT for internal operations and processes than in external products or services. Fast-forward to 2016, and the signs are that while some companies have moved beyond research, most have not progressed further than research and planning.

The overall score of 4.43 for using the IoT in external products and services, for example, shows that deployment here has progressed to a certain extent compared with 2013, when it stood at 3.88.

When it comes to using the IoT to monitor and measure internal operations, however, the survey suggests only limited progress, from 4.25 in 2013 to 4.34 in 2016.

A closer look at the regional breakdowns, meanwhile, provides greater insight into the trends underlying the overall index numbers. North America, Europe and Asia-Pacific have all made some progress on external products and services. The biggest surprise from the 2016 study is that the North American index for internal IoT adoption has slipped from 4.00 in 2013 to 3.78 in 2016. This may reflect the steep drop in oil prices since 2014 that have reduced

The Internet of Things Business Index



*Industries added to the index in 2016 Source: The Economist Intelligence Unit, 2016

the need for energy efficiency drives: just 1% of North American respondents identify "energy management" as one of the areas where the IoT brought about the greatest positive change so far, compared with 16% who expected this to be the case back in 2013.

Meanwhile, Asia-Pacific has made only limited progress, with a score rising fractionally from 4.35 to 4.53. European businesses, by contrast, are faring better, with a regional score on internal operations rising from 4.39 to 4.64.

So which industry sectors are forging ahead with their use of the IoT, and which are lagging behind? Compared with 2013, the industries that have made the most progress in using IoT technologies in their external products and services are IT and technology (with a score rising from 4.33 to 6.04), financial services (from 3.46 to 5.44), and consumer goods and retail (from 3.68 to 5.02).

Construction and real estate, by contrast, has slipped from 3.86 in 2013 to 2.89 in 2016. But this does not mean that the development of IoT functionality in the sector has stalled. Instead, an article accompanying this report, which focuses on the sector, reveals that this

reflects the fact that construction and real estate is being driven more by companies which manage properties than by those which build them. The outsourced facilities management sector, measured for the first time in 2016, achieves an external IoT index score of 3.21. Companies in that sector see in the IoT an opportunity to provide new value to commercial clients, for example, by helping them optimise office design for maximum employee productivity.

When it comes to using the IoT to measure and manage internal operations, the infrastructure sector, which includes transport, logistics and telecommunications, fares best with a score of 5.02, compared with 3.92 in 2013. Next comes financial services (4.9), followed by energy and natural resources (4.69) and outsourced facilities management (4.51). Once again, construction and real estate appears to be trailing the pack, with its score slumping to 3.61 from 4.61 in 2013. This is a sign, perhaps, that the use of the IoT to measure and monitor the progress of construction projects on building sites has yet to take off.

Practical concerns

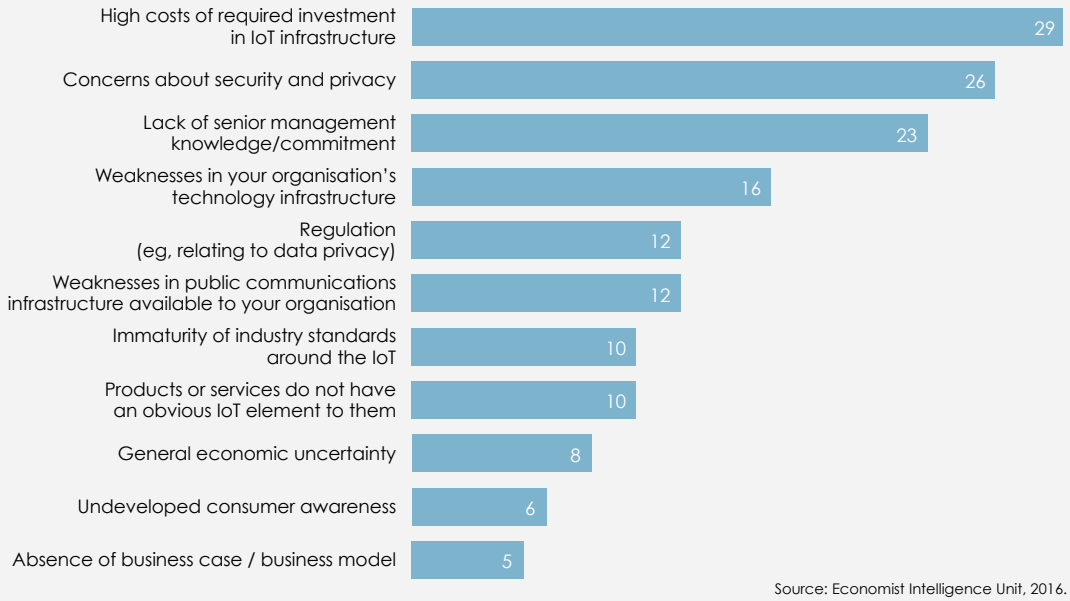
So what is holding businesses back? The survey reveals that companies' main concerns are practical ones. Top of the list of obstacles is what respondents see as the high cost of required investment in IoT infrastructure, cited by 29% of respondents, followed by concerns about security and privacy, cited by 26%.

Back in 2013, by contrast, concerns focused more on people issues, with 26% of respondents saying their employees lacked IoT skills and knowledge, and 23% saying senior managers lacked knowledge of, and commitment to, the required technologies. In this year's survey, lack of senior management knowledge and commitment slips to third place.

Security worries will almost certainly have been exacerbated by several cyberattacks in the US in late October 2016 that caused major issues for users of Internet services, including

The challenges to IoT adoption

What are the chief obstacles currently to your organisation using the IoT?
Select up to two.
(% respondents)



Source: Economist Intelligence Unit, 2016.

Twitter and Spotify.

The source of the distributed denial of service (DDoS) attacks, targeted at Internet infrastructure company Dyn, has been traced back to infected IoT devices, including Internet-connected baby monitors. Once these are compromised by malware, they come together to form a "botnet army", driving malicious traffic at a given target that overwhelms their targets, making them inaccessible to legitimate users.

While DDoS attacks are nothing new, they have in the past used large networks of malware-compromised personal computers to launch their attacks. However, a new breed of malware has emerged that enables attackers to expand their scale by using connected IoT devices instead. Already, the source code for one example of this kind of malware, Mirai, has been published on the Internet.

"IoT security has been bubbling up in our data and our client conversations as a major concern for some time now, and these attacks will make it an even bigger priority," says Christian Renaud, an analyst with The 451 Group, which provides IT research and advisory services in the US and internationally.

Mr Renaud believes that incidents such as the Dyn breach may prompt governments to mandate IoT security standards, which could in turn slow adoption. ■

2 IoT impact and responses

High-profile companies have succeeded in harnessing the transformative impact of the IoT on their business model. Danish facilities management firm ISS, for example, uses sensors embedded in the buildings it manages to analyse occupant behaviour and facilities usage. Based on this analysis, it is able to provide new advisory services to its clients (see accompanying article). ISS's IoT strategy is the single largest investment in technology that the company has made in its 115-year history.

German carmaker Daimler, meanwhile, sees the IoT as the beginning of a revolution in car ownership and use. Its car2go service, which uses IoT functionality to monitor and manage cars remotely, allows customers to use shared cars only when they need them. This represents a radical departure for the company: Daimler now sees itself as "a mobility company, not a car company", says car2go CEO Paul DeLong.

Just over one in five respondents to the IoT Business Index survey report that the IoT has had a "major" impact on their industry. On a regional basis, those based in North America are more likely to characterise it in this way than their counterparts in any other region. By industry, respondents from the IT and technology, financial services and manufacturing sectors are most likely to say the impact has already been major.

One-quarter of respondents say their organisation's use of the IoT has "sparked a new wave of innovation thanks to data that give us better insights". Almost as many (22%) say it has "unlocked new revenue opportunities from existing products and services", while 15% say it has lowered costs.

For just over one in five respondents (21%) the IoT has changed existing business models or strategies, and 16% say it has allowed them to enter new markets or industries.

More respondents believe, however, that the real impact of the IoT on their industry is yet to come: 32% of respondents report that while the IoT has had a limited impact so far, they believe it will have a major impact in the future.

So what measures are they taking to prepare for and capitalise on this opportunity? In our survey, 35% of respondents say that they are learning from the experiences of early movers, and the same proportion are seeking advice from third-party experts and consultants and are training existing staff to work with the IoT. In other words, measures taken so far have tended to involve the preparatory work required in order to get knowledge and skills up to speed.

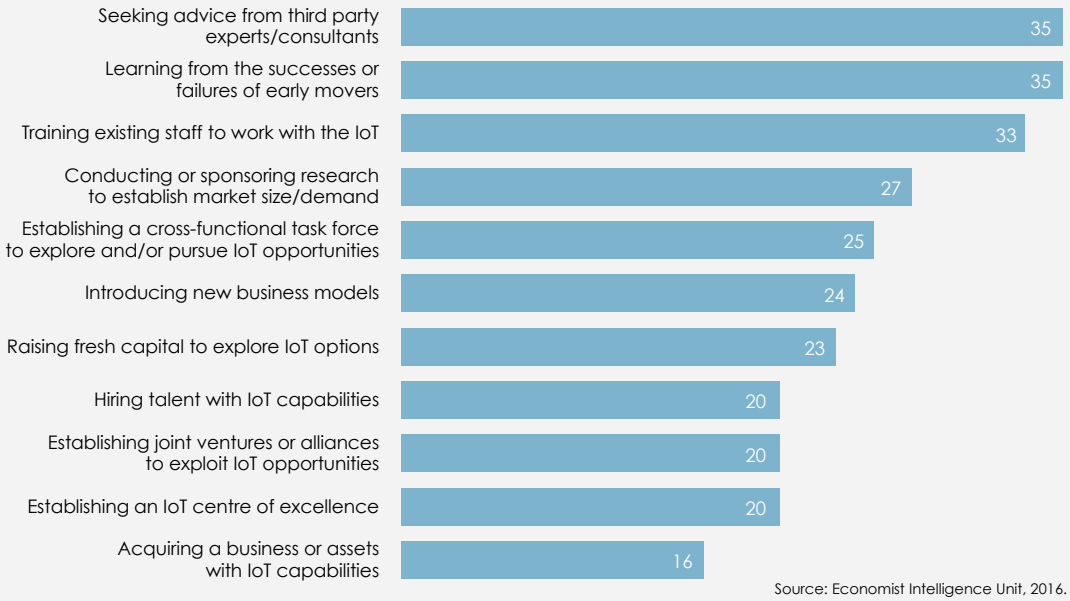
More practical measures come lower down on the list in 2016: conducting/sponsoring research to establish market size/demand (cited by 27% of respondents); establishing a cross-functional task force to explore and/or pursue IoT opportunities (25%); and introducing new business models (24%).

Fewer still have raised fresh capital to explore IoT options; established joint ventures or alliances with other companies to exploit IoT opportunities; hired IoT-specific talent; or acquired a business (or business assets) with IoT capabilities.

For many organisations, however, taking such steps will be not just desirable but essential. As Jeroen Tas, CEO of connected

Making the IoT happen

What measures has your organisation taken to use the IoT more extensively in the business?
(% adopted)



Source: Economist Intelligence Unit, 2016.

care and health informatics at Dutch electronics giant Philips, puts it: "We need to start joining the dots at last."

In other words, he explains, medical equipment manufactured by Philips may be just one element of a wider picture of "connected care networks" that link patients, carers, family doctors and hospital clinicians. These networks may also include equipment and systems from other manufacturers, including patient-worn devices for monitoring conditions such as epilepsy and diabetes, electronic medical record systems and cloud-based platforms where huge volumes of patient data can be stored and analysed. That means the company's IoT strategy is participating in emerging ecosystems of patients, customers, partners and suppliers.

"For us at Philips, IoT goes far beyond manufacturing connected devices," Mr Tas notes. "It's more about interoperability within ecosystems, where different organisations work seamlessly together. In future, we will definitely see far more of these ecosystems, but I think it's fair to say that not every organisation with an IoT strategy is ready to create and participate in them yet."

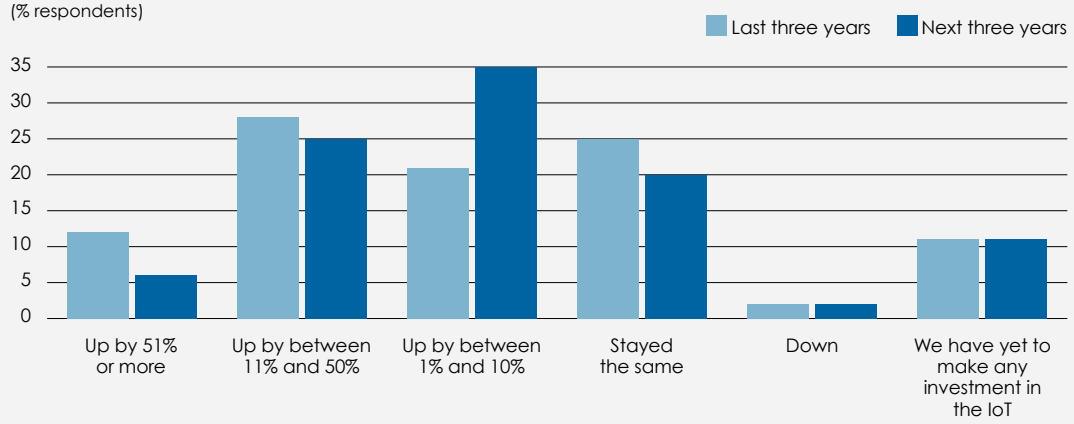
In 2016 just one in ten respondents identify the immaturity of connectivity standards around the IoT as an obstacle to adoption, down from 19% in 2013.

However, keeping pace with the proliferation of standards is still a strategic imperative for companies such as Big Ass Solutions. The US manufacturer of residential fans and lighting systems, which claims to have an "almost obsessive drive to innovate and improve", has brought products to market that integrate with smart home thermostats from manufacturers such as Nest and ecobee.

"We do our best to participate in as many of the industry standards organisations as we can," says Thomas Lesser, head of R&D at Big Ass Solutions. "We work very closely with the Thread Group on smart homes standards, for example. What I try to keep front of mind is that consumers today don't care much about standards—they just want these things to

IoT investments

How has your organisation's investment in the IoT changed over the last three years and how do you expect it to change in the next three years?
(% respondents)



Source: Economist Intelligence Unit, 2016.

work. But moving forward, they'll increasingly expect integration with other devices in their smart home set-ups, and so we have to maximise our ability to integrate with other manufacturers' products as much as possible."

The survey suggests that although investment in the IoT will be growing more slowly over the next three years, it will be more broad-based than in the previous three-year period. When asked about their IoT investments over the past three years, the most frequently cited response is a rise between 11% and 50%, but looking forward over the next three years, respondents expect a rise between 1% and 10%. That's perhaps unsurprising, given that many were starting from zero back in 2013 and are now looking to leverage the investments of the past three years.

On an industry basis, the sectors that saw the biggest rises in investment (up by 50% or more) are financial services, IT and technology, and energy and natural resources. Over the next three years, rises of 50%-plus are most often forecast by respondents from the financial services and IT and technology sectors, followed by manufacturing. ■

3 Looking ahead

The IoT Business Index reveals significant enthusiasm for the future of the Internet of Things. More than half (55%) of executive surveyed expect IoT technologies to help them make internal cost savings and/or generate external revenue in the next three years.

This is in spite of the fact that their IoT investments so far have not been quite as predicted. For example, in the 2013 survey 30% of respondents said they expected the IoT to create new revenue opportunities by 2016. Today, only 22% say that this has come to pass.

This suggests that, while companies' experience of the IoT has not been as anticipated, this has not dimmed their enthusiasm so much as given them a better understanding of what is required to make the IoT a success.

Big Ass Solutions is a case in point. "While the IoT has been a challenge in some respects, we're alive to the fact that there's potentially a huge upside here for us in terms of using the diagnostic and preventative maintenance data generated by smart fans and smart lighting to create new customer service and support strategies," says Mr Lesser.

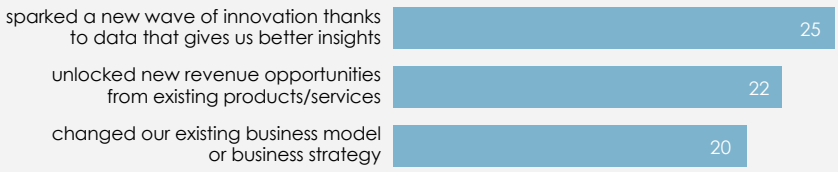
"Right now, I'd say we'll have to implement new layers of employee education and technical support deployment to take advantage of this, but over the long term we'll definitely be able to scale up this aspect of our business."

Success factors

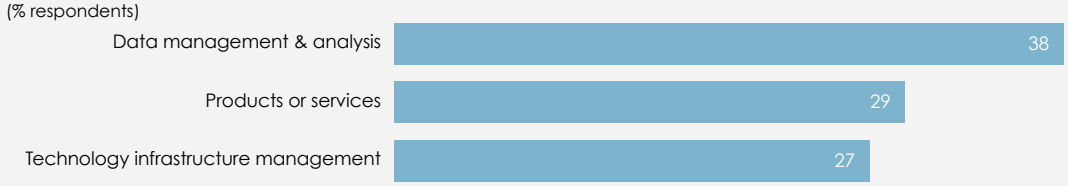
Executives see the technical capabilities that underpin the IoT as the most critical success factors for IoT strategies. When asked which organisational capabilities are considered to be most important to IoT success, 45% say technology innovation and 32% say data

Positive outcomes

In which, if any, of the following areas has your organisation's use of the IoT had the greatest impact? The IoT has…
(% respondents)



Which parts of your business have seen the greatest positive change from the IoT so far?
(% respondents)



Source: Economist Intelligence Unit, 2016.

analytics, while 25% cite business model innovation as a success factor. That emphasis on technology innovation and data analytics broadly holds true across the survey base, regardless of the IoT adoption phase that respondents are in.

One way in which the IoT may challenge firms' existing data analytics capabilities is the format of data produced by sensors. As Jim Hare, research director at Gartner, said at an event hosted by the analyst firm earlier this year: "The staple inputs for IoT analytics are streams of sensor data from machines, medical devices, environmental sensors and other physical entities. The challenge is going to be how to manage and store those data."

Data specialists are far more accustomed to working with structured data drawn from operational systems that fit neatly into the strict format of rows and columns offered by a relational database. According to Mr Hare, IoT data demand that they develop expertise in managing and storing data in event-stream processing platforms and time-series databases and become adept at using more specialised analytical algorithms.

The prospect of digital disruption, meanwhile, clearly weighs heavily on respondents' minds. More than half (52%) agree "somewhat" or "strongly" that the IoT "will most likely favour new digital-native entrants to our markets". In line with this, 46% agree "somewhat" or "strongly" that the IoT is "one of the most important parts of my organisation's digital transformation strategy".

That is certainly how Juha Pankakoski, chief information officer and chief digital officer at Konecranes, sees it. The Finnish company manufactures cranes and heavy lifting equipment for use in ports, factories and warehouses. Many of these products now bristle with sensors, says Mr Pankakoski—over 11,000 sensors in total. These provide both customers and Konecranes with data that give real-time visibility into the operational status of their equipment and how it is being used.

"In a sense, the IoT is bringing this equipment to life, because embedded intelligence allows a crane to sense its own condition and report back on it," explains Mr Pankakoski. That, in turn, enables Konecranes to build out digital services that support these assets and the companies that use them.

For example, a mechanical problem with a particular piece of machinery can be quickly detected and a Konecranes field engineer sent to service it, so that the customer does not suffer unnecessary downtime, he explains. Over time, much of this intelligence will feed directly into how Konecranes designs and develops future products, too.

"So the IoT is at the very heart of our digital transformation strategy," says Mr Pankakoski. "It's how we intend to stand out from the competition, because our customers are clearly very interested in how technology can help them use our equipment safely and productively, so they get the most from their investments." ■

Conclusion
Building a platform for progress

While this research suggests that many organisations have been forced into a "reality check" when it comes to their IoT ambitions, the overall message is a positive one. Businesses are laying the groundwork for the IoT, and while many have encountered challenges in doing so, the extensive research and planning they are engaged in points to an IoT built on firmer foundations than naive aspiration. Examples such as ISS and Daimler, which have successfully adapted their business models and organisational cultures to harness the opportunities of the IoT, offer concrete evidence that this transformation is not only possible but worth undertaking.

Many areas of the business have changed, or are changing, as a result of companies' early efforts—and for the positive, respondents say. Data management and analysis is where the greatest proportion (38%) have seen progress, followed by products and services (29%) and technology infrastructure management (27%). Employee productivity, customer service and support and supply chain management/ logistics have all seen positive changes, too.

That creates a powerful bargaining position, and while respondents acknowledge that senior leadership support and engagement is an essential success factor in getting the go-ahead for further work, one-half (50%) agree that their IoT initiatives now have this backing.

While many could see the transformational impact of smartphones when they first emerged, it took some years before that impact was well understood, and even longer before companies knew how to harness it. Now, though, few executives would question whether or not they have made a lasting impact on their business.

As the IoT business index 2016 reveals, most companies are (perhaps to their frustration) still in the early phases of their IoT journey. But with this level of executive backing and planning investment, the IoT promises to be in a very different—and more advanced—state in three years' time. ■

Appendix 1: Index methodology

The Internet of Things business index is based on an online survey conducted by The Economist Intelligence Unit in September 2016. (See Appendix 2 for survey details.)

The index scores are generated from the responses to two questions in the survey:

- To what extent is your organisation using, or planning to use, the IoT in its products or services (eg, embedding sensors in products, developing services utilising data generated by IoT technology)?
- To what extent is your organisation using, or planning to use, the IoT in its internal operations (eg, to reduce energy consumption, monitor status of plant and equipment)?

The response options to each question are: non-existent; in research; in planning; early implementation; and extensive. Each response option is assigned a score ranging from 1 (non-existent) to 5 (extensive). The responses to the questions are fed into a model which converts the scores—for the entire sample and for each regional and industry sub-sample—to a 1-10 scale, where:

1-2 = non-existent (or virtually non-existent)

3-4 = in research

5-6 = in planning

7-8 = early implementation

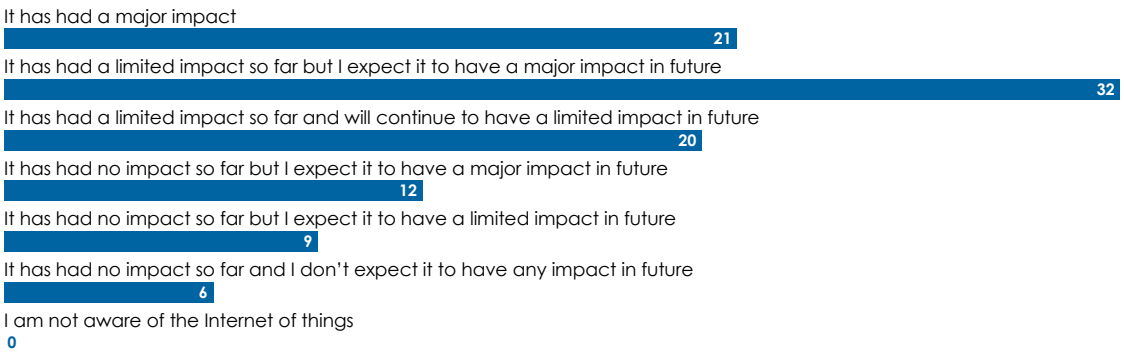
9-10 = extensive

Scores lying between these levels (for example, 2.5) indicate that businesses in the relevant sample or sub-sample are transitioning from one stage to another. ■

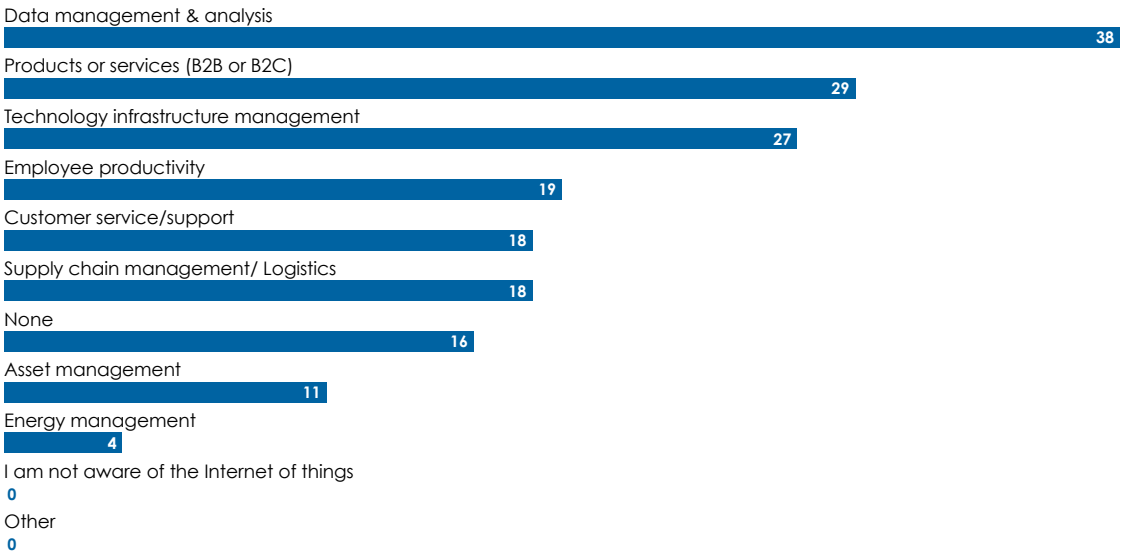
Appendix 2: Survey results

Percentages may not add to 100% owing to rounding or the ability of respondents to choose multiple responses.

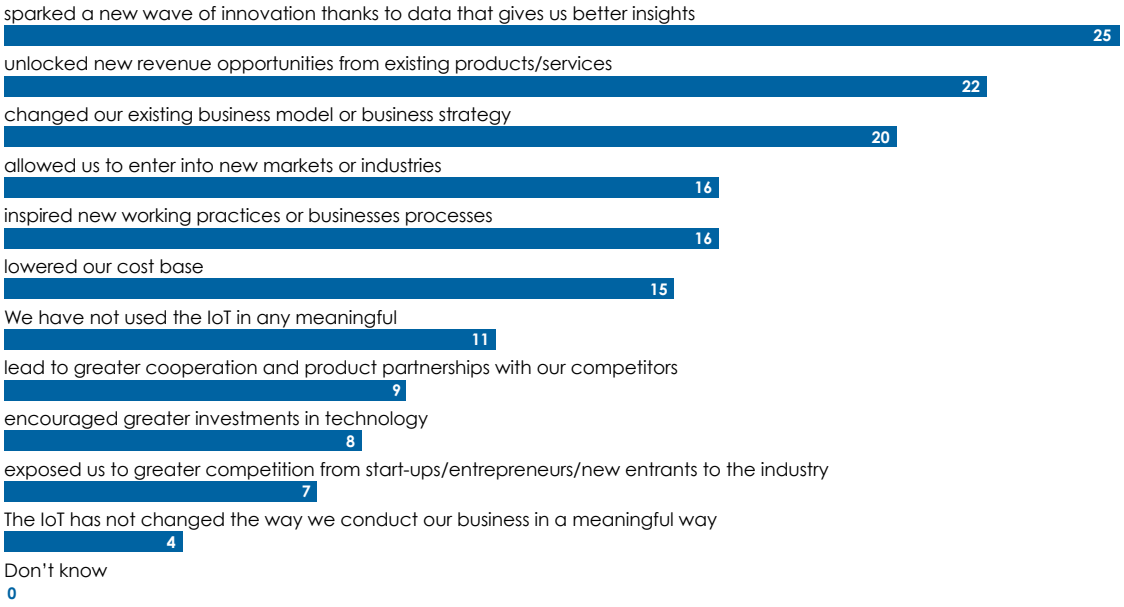
Which of the following statements best describes the impact IoT has had on business in general so far?
Select one of the following statements, which best characterises your view.
(% respondents)



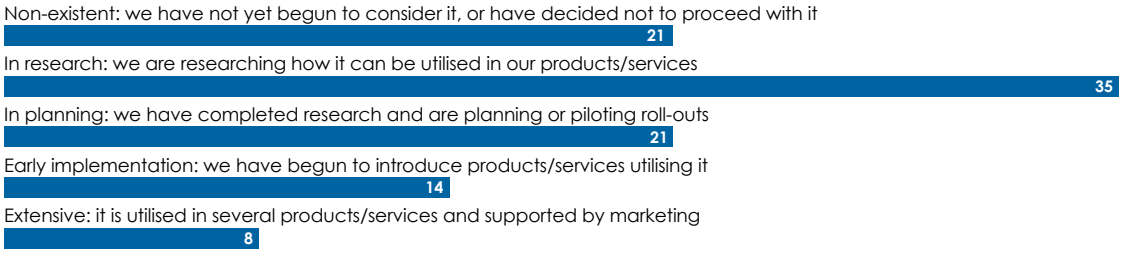
Which parts of your business have seen the greatest positive change from the IoT so far?
(% respondents)



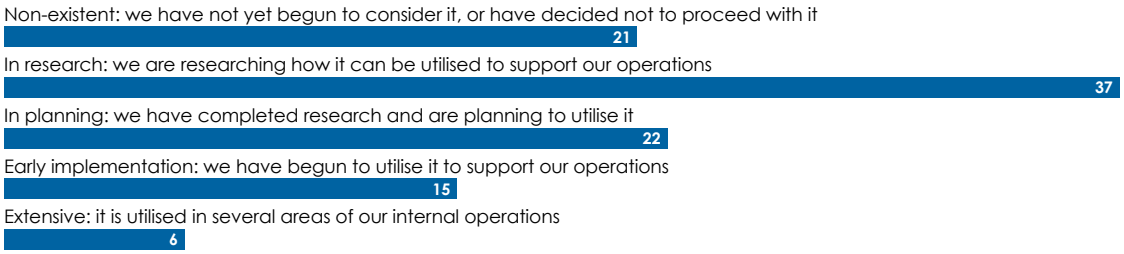
In which, if any, of the following areas has your organisation's use of the IoT had the greatest impact? The IoT has…
Select up to two.
(% respondents)



To what extent is your organisation currently using, or planning to use, the IoT in its products or services (eg, embedding sensors in products, developing services utilising data generated by IoT technology)?
(% respondents)

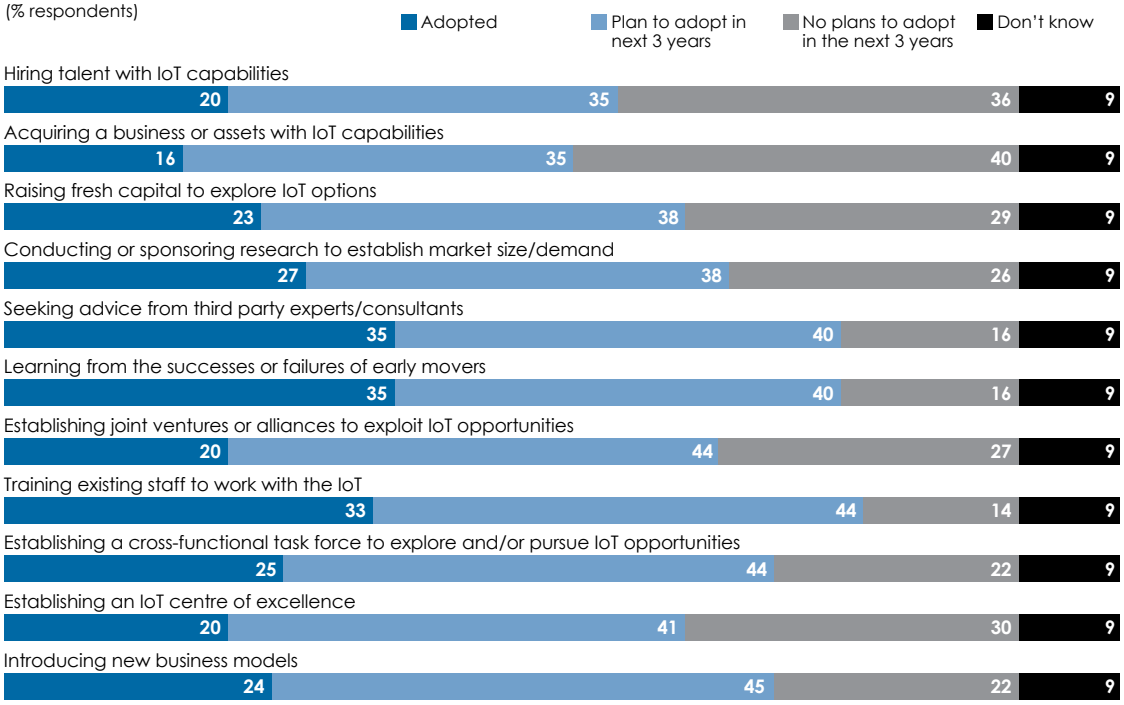


To what extent is your organisation currently using, or planning to use, the IoT in its internal operations (eg, to reduce energy consumption, monitor status of plant and equipment)?
(% respondents)



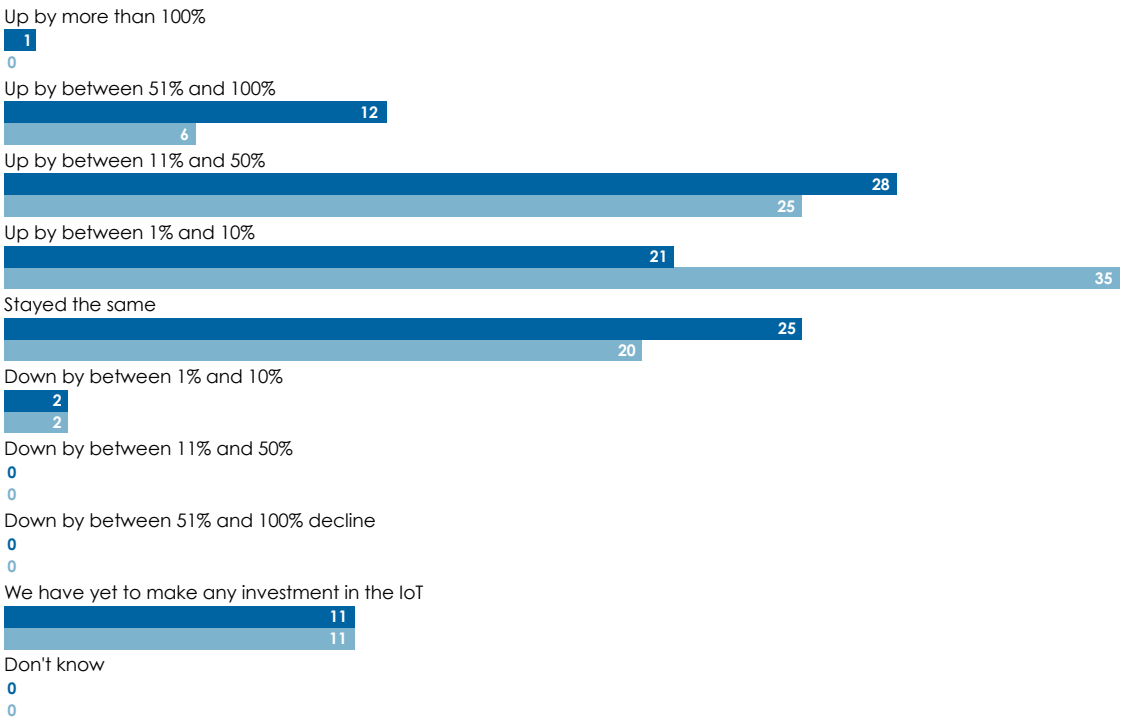
What measures has your organisation taken to use the IoT more extensively in the business (either in products/services or internal operations)? And which have you not yet adopted?

Please select one answer option for each measure.
(% respondents)

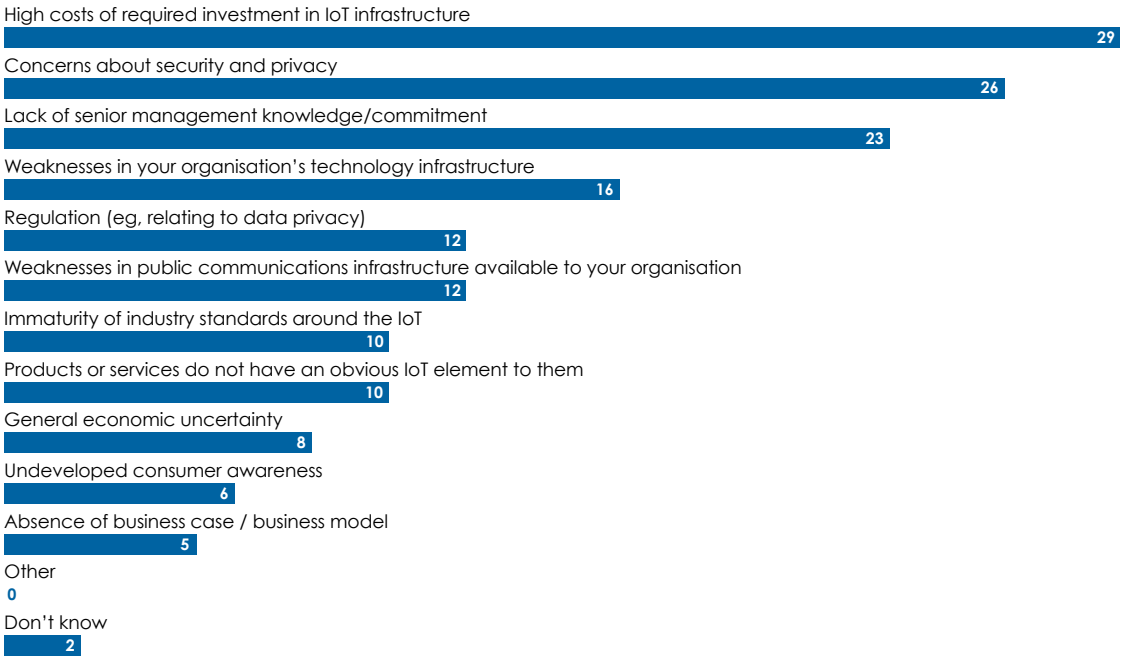


How has your organisation's investment in the IoT changed over the last three years? And how do you expect it to change in the next three years?

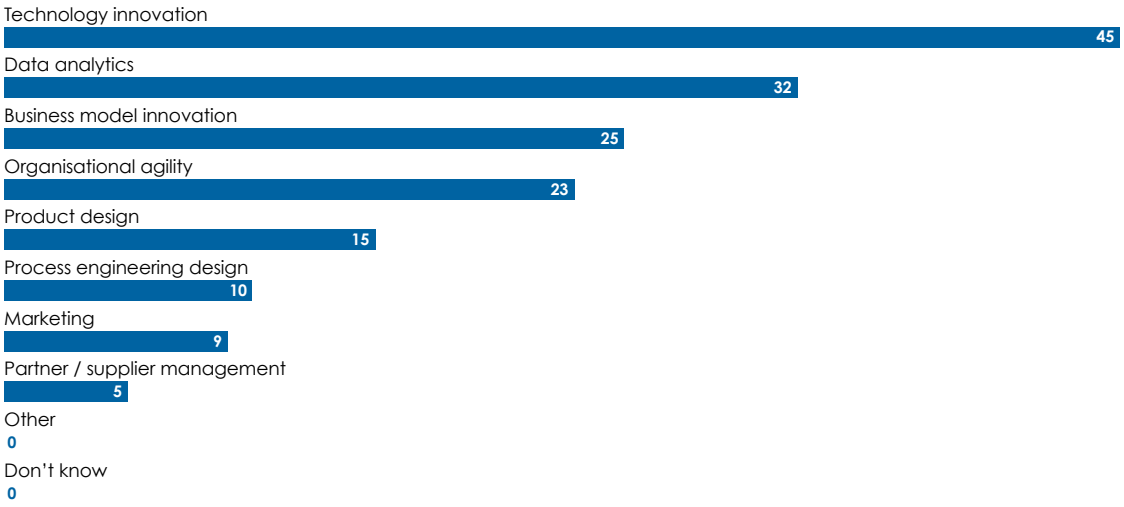
Last 3 years **Next 3 years**
(% respondents)



What are the chief obstacles currently to your organisation using the IoT?
Select up to two.
(% respondents)

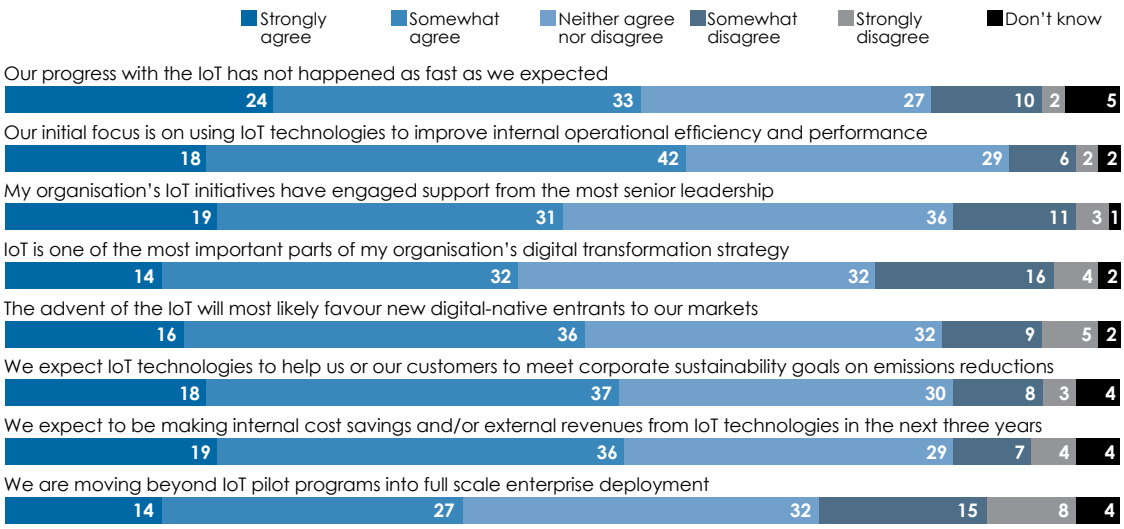


Which of the following organisational capabilities do you consider to be most important for success in the IoT?
Select up to two.
(% respondents)



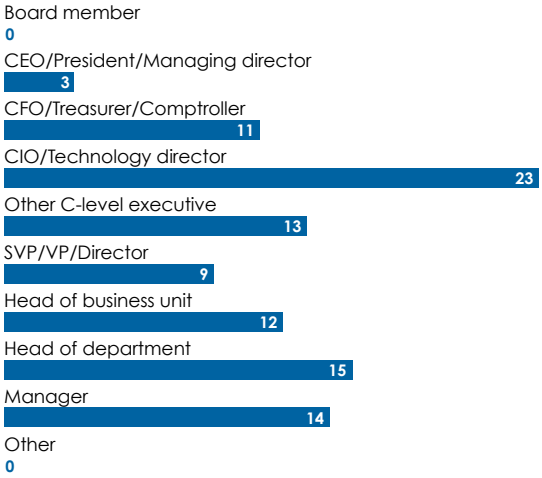
To what extent do you agree or disagree with the following?

(% respondents)



Which of the following best describes your title?

(% respondents)

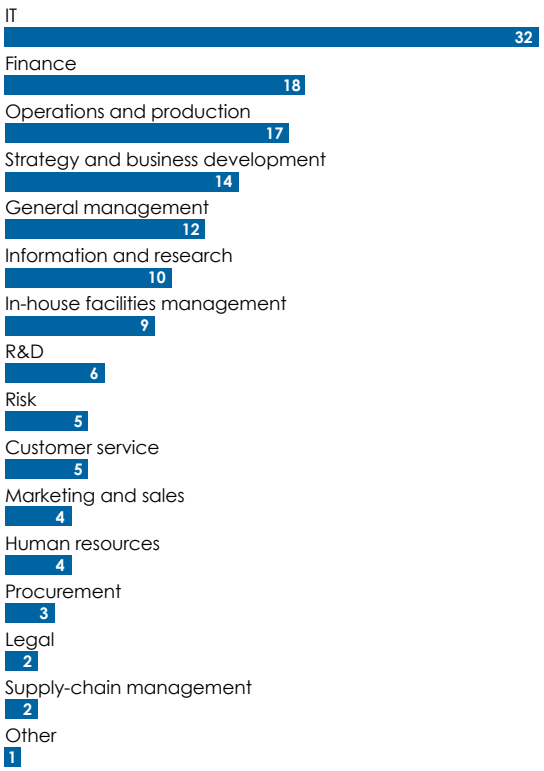


Where are you personally located?

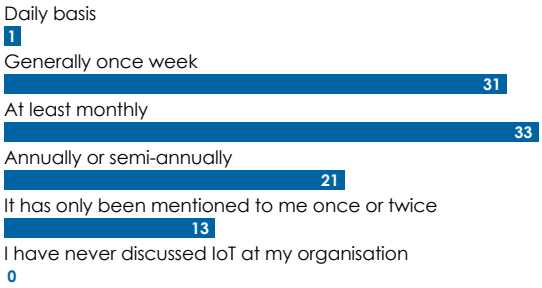
(% respondents)

What are your main functional roles?

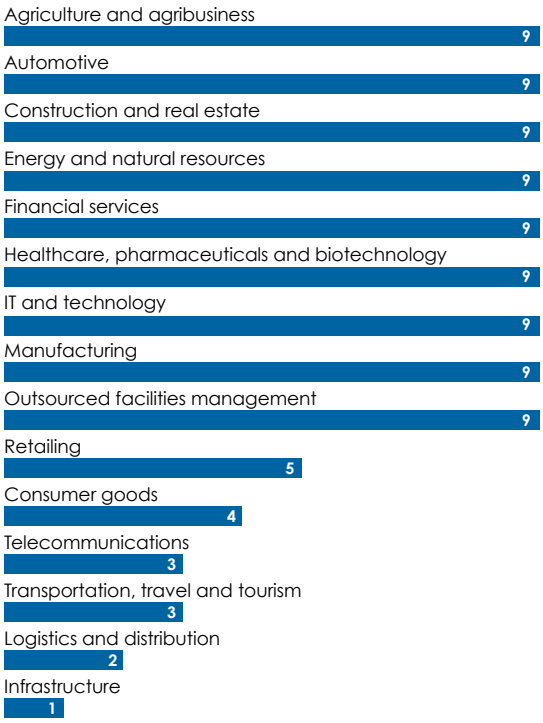
Select all that apply.
(% respondents)



Roughly how often are you involved in a formal conversation or structured meeting about the IoT at your organisation?
(% respondents)



What is the primary industry your organisation is in?
(% respondents)



Whilst every effort has been taken to verify the accuracy of this information, neither The Economist Intelligence Unit Ltd. nor the sponsor of this report can accept any responsibility or liability for reliance by any person on this report or any of the information, opinions or conclusions set out in the report.

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