



hypothesis

# IoT Signals

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## Background

The Internet of Things (IoT) is rapidly changing the world around us, transforming a huge range of physical objects through digital intelligence.

Beyond our ubiquitous smart personal devices, IoT is revolutionizing the way companies do business – helping them become faster, smarter, safer, and more efficient.

Microsoft continues to be an IoT innovator as IoT adoption rises steadily worldwide. The IoT Signals series was created to give a holistic view of the IoT ecosystem – providing insight into adoption rates as well as benefits, challenges, and emerging trends.

In 2019, Microsoft and Hypothesis embarked on an IoT Thought Leadership initiative, annually producing reports in the IoT Signals series. The goal of these reports is to better serve our partners and customers, help business leaders develop their own IoT strategies, and provide the most up-to-date research on IoT use across countries and industries.

Previous reports focused on three pieces of research – an initial round conducted in February 2019, which focused on IoT across industries, a follow-up in October 2019 that took a deeper look into four key industries (energy, manufacturing, healthcare, and retail), and a 2020 update of both the original and the follow-up.

In 2021, this current paper again builds off the success of the prior Signals papers, with new research uncovering fresh learnings and insights around the current and future state of IoT.

## Methodology

Microsoft commissioned Hypothesis Group, an insights, design, and strategy agency, to execute the IoT Signals research.

Two waves of the Signals research occurred in February 2019 and April/May 2020, when a 20-minute online survey was conducted with over 3,000 survey participants including business decision makers (BDMs), IT decision makers (ITDMs), and developers at enterprise companies from a range of industries across the US, UK, Germany, France, China, and Japan. In addition, nine in-depth interviews were conducted online in June 2020 among ITDMs from the US, UK, and Germany in a range of key industries.

In May 2021, a third wave was conducted across the same countries and new ones including: Spain, Italy, The Netherlands, Belgium, and Australia across a similar group of decision makers and developers. A similar survey was conducted with a five-minute deep dive into key industries (energy, manufacturing, smart places, & mobility). In addition to the online survey, 4 in-depth interviews were conducted online in April 2021 among ITDMs from the US in a range of key industries.

# Things To Know About IoT in 2021

01

## **IoT continues to drive organizations towards a more productive future**

Among the IoT decision-makers we spoke to from industries across the globe, 90% have adopted IoT (compared to 91% in 2020). IoT continues to be adopted for a range of uses leading to improved efficiency and productivity, and 66% plan to implement IoT more in the coming years. Those who use IoT for cloud security, supply chain management, and sustainability more strongly believe that IoT is critical to their organization's success, which could keep them on the cutting edge.

02

## **COVID-19 has accelerated IoT strategies and fueled business growth**

COVID-19 has resulted in many unexpected benefits for organizations and their IoT strategies, as 44% expect to increase their investment in IoT as a result of the pandemic (vs. 31% in 2020). Those intending to maintain or strengthen their investment tend to already be utilizing IoT for more varied use cases, and the pandemic has enticed many to use IoT to gain a competitive edge.

03

## **AI, Edge Computing, and Digital Twins are essential to advance IoT strategies**

The majority of organizations are implementing strategies for Artificial Intelligence, Edge Computing, and Digital Twins, and around 8-in-10 are working to integrate the technologies as part of their IoT solution. Despite the pervasiveness of these technologies, many projects are stuck in Trial/PoC due to a lack of infrastructure and the complexity of scaling and managing systems. Looking ahead, organizations will need specialized help as implementation level varies by industry on certain technologies (e.g., Smart Places is advanced in AI, Energy is advanced in Edge Computing, and Manufacturing is advanced in Digital Twins).

04

## **Although IoT projects are maturing, technological complexity persists**

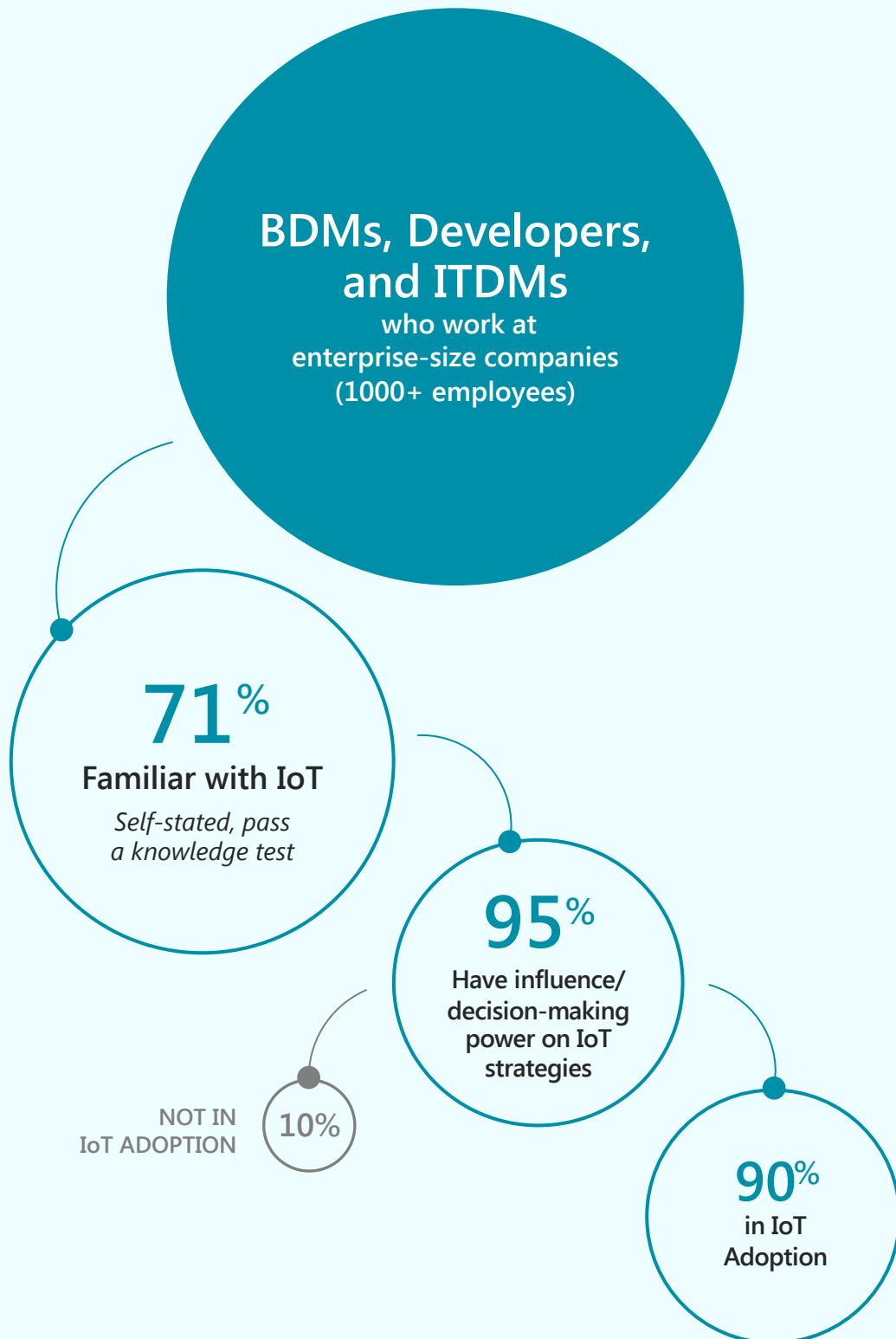
Business challenges are typically more surmountable than technical challenges (especially for those who outsource part of their IoT implementation). As IoT solutions are scaled and become more deeply embedded within organizations, navigating the technical complexity is even more difficult. Organizations seek more internal investment to acquire the technology and staff they need to manage complex data and emerging technologies.

05

## **Organizations are keeping a close eye on data security**

Securing IT infrastructure and assets is top of mind in 2021, and nearly a third are concerned about the security risk of IoT, with specific concern around ensuring data privacy and network-level security. To keep IoT projects secure, the primary focus is on preventing and detecting data breaches, though no single best practice is widely adopted. Those who outsource at least part of their IoT implementation tend to feel more secure overall.

## Who We Talked To



# State of IoT: Overall Research Learnings

## IoT: The Big Picture

This year, IoT continues to be widely adopted. 90% of organizations surveyed are IoT adopters, on par with 91% in 2020. ([See Exhibit 1](#)) Organizations also continue to place a high value on IoT: 90% consider the technology critical to overall success – the same percentage that placed high importance on IoT in 2020. In addition, satisfaction has grown since last year, with 96% saying they are very or somewhat satisfied with IoT in their organization, compared to 94% in 2020.

IoT projects can be categorized into four stages: learn, trial/proof of concept, purchase, and use. Of the 90% of organizations who identify as IoT adopters, 82% have at least one project in the use stage, similar to 83% last year. The percentages of projects in each phase also remain high. In 2021, 29% of IoT projects are in the Learn stage – the same percentage as in 2020. The percentage of projects in the Trial/PoC stage also stay the same – 25% in 2020 and 2021. Projects in the Purchase phase are up by 1%, going from 21% in 2020 to 22% in 2021. Projects in the Use phase stay at a steady 25% in 2020 and 2021. ([See Exhibit 2](#))

EXHIBIT 1

% IoT ADOPTERS

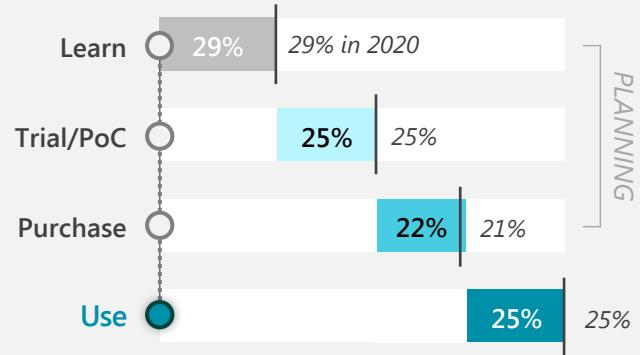


82% of total have at least one project that reached "use" stage  
(83% in 2020)

- 7% not using but have in past
- 2% not using, haven't in past

EXHIBIT 2

% IoT PROJECTS IN 4 STAGES



IoT is widely adopted globally, with Australia, Italy, and the US leading the way.

When it comes to percentage of projects in the use phase, the US leads the pack, with 27% as compared to countries like Spain (22%) and Australia (18%). The US is also ahead of the global game in terms of increasing IoT use as well: 78% of US organizations plan to use IoT more in the next two years. In contrast, only 53% of the German companies surveyed planned to increase use by 2023, and 51% of organizations in Japan. This may be because German and Japanese markets could be more cautious in their approach to the technology.

Time to use also varies across organizations. Italy is in the lead, taking an average of 10 months to reach a project's use phase. The US and Spain both take 11 months, while the Asia-Pacific region lags behind, with Japan taking 12 months, and China and Australia both taking 16. Projects in the Asia-Pacific region likely take longer because more education and knowledge about IoT is needed to get to use. Organizations in APAC are also more often challenged by not having the resources to implement and manage IoT solutions. ([See Exhibit 3](#))

### EXHIBIT 3

#### IoT ADOPTION AND VALUE BY COUNTRY

											
	Global	US	UK	FR	DE	SP	IT	BNLX	CH	JP	AUS
% IoT Adopters	90%	94%	91%	91%	88%	89%	95%	91%	85%	88%	96%
% Projects in Use phase	25%	27%	25%	23%	25%	22%	26%	25%	25%	23%	18%
Time to Use stage (months)	12	11	13	12	14	11	10	12	16	12	16
Plan to use IoT more in 2 years	66%	78%	69%	67%	53%	76%	69%	59%	65%	51%	56%

IoT adoption remains strong across industries. We surveyed decision-makers in a range of industries, with particular focus in the fields of manufacturing and energy (which we also surveyed in 2020) and added two industries of focus in 2021 – automotive/transportation/logistics (also known as mobility), and smart places. The latter industry focuses on how people occupy spaces, and includes physical infrastructure in areas such as government, real estate, and construction.

The overwhelming majority of companies we surveyed in all four fields identify as IoT adopters. The percentage of projects in the use stage is consistent across industries, with roughly a quarter of projects in this phase, and projects in all industries take a similar amount of time to get to this phase – around 13 months. Future dedication to IoT is also consistent across fields. Around two-thirds of companies in each field plan to use IoT more in the next two years.

While all four industries have similar levels of IoT adoption, the energy industry lags behind slightly. 85% of energy companies say they are IoT adopters, compared to the other three fields we surveyed, whose percentages of IoT adoption are in the 90s. Energy organizations have 22% of projects in use – the lowest percentage of the four industries. Finally, energy projects take an average of 15 months to get to the use phase – a full two months more than the manufacturing and smart places industries. ([See Exhibit 4](#))

#### EXHIBIT 4

##### IoT ADOPTION AND VALUE BY INDUSTRY

	Total	Manufacturing	Energy	Mobility	Smart Places
% IoT Adopters	90%	91%	85%	91%	94%
% Projects in Use phase	25%	26%	22%	23%	24%
Time to Use stage (months)	12	13	15	14	13
Plan to use IoT more in 2 years	66%	68%	61%	61%	69%

## Why Adopt IoT?

The top reasons that companies adopt IoT are consistent with last year's reasons: organizations use IoT to maintain quality, secure technology, and optimize resources. This year, several use cases are emerging that move the needle on how IoT is perceived to influence organizational success.

Organizations that adopt IoT for cloud security, supply chain management, and sustainability see IoT as even more critical. (See Exhibit 5) A decision maker in the energy industry explains how their organization uses IoT to gather valuable information about power quality and usage: "IoT gives us feedback on how the power quality is for the end customer. We can extend that innovation beyond adjusting the level of quality of power, but also to know how much electricity is generated, how much power is consumed at the household level, and how solar panels factor into the equation."

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### EXHIBIT 5

#### TOP REASONS FOR IoT ADOPTION



This icon highlights organizations that use IoT for these use cases and believe IoT is 12%+ more critical to organizational success.

One in three organizations use IoT for improving products and services for customers, and those that do benefit from a stronger bottom line. 50% of companies using IoT for this purpose report increased revenue, compared to 39% who don't utilize the technology in this way. Although these organizations enjoy increased earnings, they also face a slightly more complex business transformation. 30% of those who use IoT to improve products and services grapple with this complexity, compared to 27% of those who are not using IoT for this purpose. ([See Exhibit 6](#))

#### EXHIBIT 6

#### IMPROVING PRODUCTS/SERVICES FOR CUSTOMERS DEEP DIVE

	Use IoT to improve products and services for customers (i.e., sales enablement)	Using IoT, but NOT to improve products and services for customers (i.e., sales enablement)
% Projects in Use phase	26%	24%
Overall Satisfaction	97%	95%
Critical to success of company	93%	88%
Increases customer satisfaction	60%	45%
Increases revenue	50%	39%
Enables new types of customer offerings	50%	38%

In all five fields surveyed, organizations primarily use IoT for automation and efficiency, with a secondary focus on workplace and employee safety. Almost half of manufacturing companies cite industrial automation as a key use of IoT, with a similar number of power & utilities companies using IoT for smart grid automation. 40% of automotive/transportation/logistics organizations leverage IoT for manufacturing operations efficiency, while 47% of companies in the smart places field say IoT helps them with productivity enablement.

IoT is also used to enhance workplace safety across industries. A little more than one in three manufacturing organizations utilize the technology for plant safety. The energy industry also focuses its IoT use on workplace safety, with 37% of power & utilities organizations and 45% of oil & gas companies using IoT for this purpose. 42% of smart places businesses adopt IoT for building safety. In the mobility field, IoT is not only used for safety, but also for surveillance. ([See Exhibit 7](#))

One decision maker in the manufacturing industry explains how IoT facilitates both automation and safety. "We break IoT down into monitoring and control. For monitoring, this means tracking the temperature in food containers to make sure it's safe through the supply chain and ready when a bus load of kids comes in. For control, we can take information out and automatically take action to drive commands into pieces of equipment and respond to what's going on in the environment."

A smart places organization relies on IoT for crucial safety procedures. "We create fire safety systems, and to get any kind of information out of the system, a person had to be standing in front of it. We use IoT for condition-based decision-making, so the systems can instead act on what's happening in the environment and bring the business closer to the action so we can make faster decisions."

## EXHIBIT 7

### TOP REASONS FOR IoT ADOPTION BY INDUSTRY

Manufacturing		Power & Utilities		Oil & Gas		Mobility		Smart Places	
Quality and compliance	47%	Smart grid automation	44%	Workplace safety	45%	 Inventory tracking and warehousing	48%	Productivity enablement/workplace analytics	47%
Industrial automation	45%	Grid asset maintenance	43%	Employee safety	43%	 Manufacturing operations efficiency	40%	Building safety	42%
Production flow monitoring	43%	Remote infrastructure maintenance	40%	Remote infrastructure maintenance	39%	Surveillance and safety	34%	Predictive maintenance	41%
Production planning and scheduling	38%	Smart metering	37%	Emissions monitoring and reduction	35%	Remote commands	34%	Regulations and compliance mgmt	36%
Supply chain and logistics	38%	Workplace safety	37%	Asset and predictive maintenance	35%	Fleet management	32%	 Space mgmt and optimization	34%

Organizations are reaping the benefits of focusing their IoT use on safety and efficiency. Companies say that the top three advantages of IoT adoption are increased efficiency of operations (55%), improved safety conditions (51%), and increased employee productivity (50%). The least often cited benefits of IoT adoption include increased revenue, as well as the ability to create new revenue streams and customer offerings, but these are more indirect benefits, as it takes longer for organizations to realize them. ([See Exhibit 8](#))

## EXHIBIT 8

### BENEFITS OF IoT

Efficiency	Increases the efficiency of operations	55%
Safety	Improves safety conditions	51%
Efficiency	Allows employees to be more productive	50%
Unplanned Downtime	Allows for better optimization of tools/equipment	49%
Quality	Reduces chance for human error	49%
Quality	Increases customer satisfaction	48%
Yield	Increases production capacity	48%
Efficiency	Helps me be better informed and make better business decisions	47%
Quality	Increases my organization's competitive advantage	47%
Yield	Provides my business with cost savings	45%
Unplanned Downtime	Improves the traceability of goods	44%
Yield	Reduces business expenses	43%
Regulatory Compliance	Helps to ensure compliance	43%
Yield	Increases revenue	42%
Yield	Enables new types of customer offerings	41%
Yield	Enables new revenue streams	38%

## Measuring Success in IoT

The decision makers and developers we surveyed measure success in IoT slightly differently from 2020 to 2021. Last year, cost cutting was more important to organizations; this year, more than a third of companies say they gauge successful IoT implementation through the lenses of quality and cybersecurity. In particular, Smart Places organizations tend to view issues like a decrease in malware attacks as measures of success. (See Exhibit 9)

### EXHIBIT 9

#### MEASURES OF SUCCESS IN IoT

More common measures of success			Less common measures of success		
 Quality	40%		 More informed decision-making	27%	
 Security	37%		 Direct impact on increased revenue	23%	
 Production efficiency	35%		 Sustainability	21%	
 Reliability	34%		 % of projects deployed using IoT	17%	
 Cost efficiency	34%				

## Challenges of IoT Adoption

Several challenges continue to face IoT adopters in 2021. 30% of organizations are still implementing current solutions, preventing them from utilizing IoT more than they currently do. Businesses also struggle with the complexity of IoT implementation: almost a third of organizations want to work out existing challenges before adding or using more IoT solutions. In most markets, difficulty in implementing due to the technical complexity is a greater barrier than the business transformation needed. However, in Germany and Japan, where IoT adoption is lower, organizations see the business transformation as more of a challenge than the technical transformation.

While organizations use cybersecurity as a measure of successful IoT implementation, they also face challenges involving security issues created by adopting IoT: 29% feel that the risk isn't worth it. ([See Exhibit 10](#))

### EXHIBIT 10

#### CHALLENGES TO USING IoT MORE

<b>Still in Progress</b>	Still implementing our current solutions	30%
<b>Security</b>	Security risk isn't worth it	29%
<b>Complexity/Technical</b>	Want to work out existing/future challenges before adding/using IoT more	29%
<b>Complexity/Technical</b>	Too complex to implement because of technology demands	28%
<b>Complexity/Technical</b>	Too complex to implement because of business transformation needed	27%
<b>Lack of Budget/Staff</b>	Don't have human resources to implement & manage	26%
<b>Lack of Budget/Staff</b>	Don't have budget	26%
<b>Security</b>	Concerned about consumer privacy	26%
<b>Complexity/Technical</b>	Too long to implement	25%
<b>Compliance</b>	Too many compliance/regulatory challenges	25%
<b>Lack of Knowledge</b>	Lack technical knowledge	24%
<b>Lack of Knowledge</b>	Not enough training/guidance on how to deploy	23%
<b>Lack of Knowledge</b>	Don't know enough	22%
<b>Leadership/Team Challenges</b>	No buy-in from senior leadership	22%
<b>Security</b>	Unwilling to store data in public cloud	21%
<b>Haven't Found Right Solution</b>	No solution that meets our needs	20%

IoT adoption can challenge a company's business model and bring projects to a halt. A manufacturing decision maker says of business issues, "Many of our customers, who are other manufacturers, don't understand the value that IoT can bring from the onset. We invest time to help them identify what the value is, which would often change their business model. If this means increasing costs and getting more involved with the end customer, many of our customers will have to stop their Proof of Concept to re-evaluate."

For almost the same amount of companies, technological challenges prevent further IoT adoption.

**“** With IoT we ask ourselves what to do with the data, and how much data we should bring on-premise to our data center. That's when the cloud becomes much more attractive, because data is being generated constantly and we can't just keep buying more hard drives. But we need the right technical skills to operationalize projects at scale, including data engineers, data analysts, and data scientists.”

ITDM in Power & Utilities

The number of IoT projects that fail in the proof-of-concept phase has risen in the past year. Currently, 35% of IoT projects experience failure during Trial/PoC, up from 30% in 2020. The most often-cited reason for failure is the high cost of scaling, which 32% of organizations say has inhibited their IoT trials. 26% say they lack the necessary technology to bring a project to fruition, and 25% report that the projects did not have a clear business value or ROI. (See Exhibit 11)

#### EXHIBIT 11

#### REASONS FOR PoC FAILURE

Scaling	High cost of scaling	32%
Technology	Lack of necessary technology	26%
Business	Pilots demonstrate unclear business value/ROI	25%
Complexity	Too many platforms to test	24%
Complexity	Pilot takes too long to deploy	23%
Scaling	Lack of resources/knowledge to scale	23%
Business	Hard to justify business case w/o short-term impact	23%
Complexity	Too many use cases to prove out	23%
Business	Lack of leadership support and attention	21%
Business	No clear strategy	21%
Scaling	Lack of trust in scalability platforms	20%
Business	Didn't anticipate necessary business changes	19%
Vendors	Vendors not willing to subsidize pilots	16%

While business transformation is a top challenge to adopting IoT overall, it is less of a challenge at the PoC phase of a project. This is because organizations may not fully realize the extent of business transformation needed until they are further along. An automotive decision maker describes this issue: "IoT is terrible when it comes to scope creep. We considered designing a pet detection sensor based upon the temperature inside the vehicle and micro movements. We put the PoC together and created a huge AI database of two million dog images with 99.9% accuracy. Inevitably, somebody asked for more vision capabilities, and the programmers see it as a simple recoding exercise. But they don't realize I've got to go to a third party to see how much data bandwidth we have, which drives costs and could turn the whole business model upside down."

70% of organizations report that business challenges are the reason for a project's failure at the PoC stage. Businesses that struggle with scaling cost more often have trouble planning a long-term IoT strategy, especially because senior stakeholders are not fully bought in.

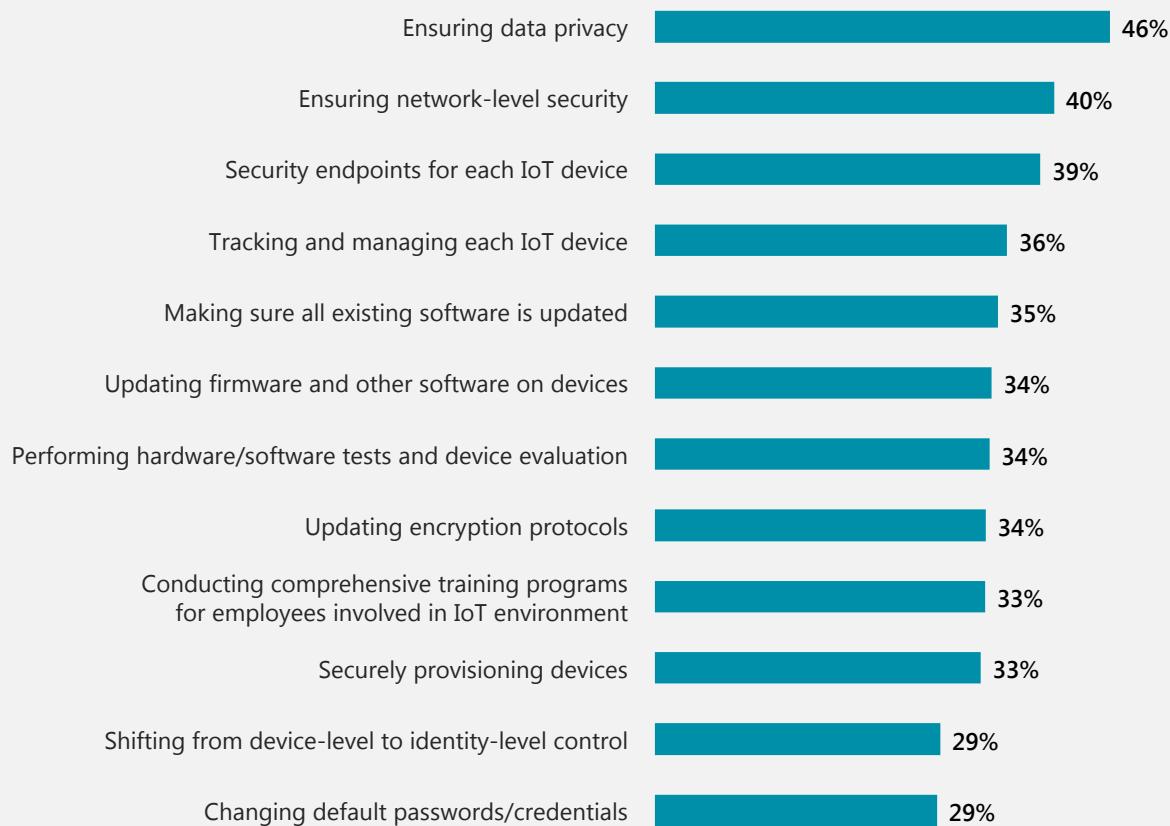
Organizations that grapple with the high cost of scaling IoT projects are particularly challenged by the complexities of integrating across layers (e.g., devices, edge connectivity, compatibility across applications), with 40% of adopters experiencing this issue. 37% of these adopters also have difficulty structuring data.



91% of organizations we surveyed have security concerns about implementing IoT. Adopters are especially concerned about how to handle security issues that arise during the early stages of a project. Nearly half of IoT adopters worry about ensuring data privacy, while 40% are concerned with network-level security, and 39% want to implement security endpoints for each IoT device. ([See Exhibit 12](#))

## EXHIBIT 12

### TYPES OF IoT SECURITY CONCERN



While security is a major consideration in terms of implementing IoT, organizations are not adopting a common best practice. While one of the top best practices involves designing security measures that assume breaches at every level of the project, less than half of adopters are using it. Companies are also analyzing dataflows for anomalies and to detect security breaches, but only 42% of them employ this as a best practice. ([See Exhibit 13](#))

For one decision maker in the smart places field, security is always a top-of-mind issue. "We are constantly thinking about data privacy and risk. What data are we going to store? How are we going to use that data? How do we make sure that if a breach occurs, it doesn't become national news on TV? It's a big challenge we try to stay ahead of."

#### EXHIBIT 13

#### BEST PRACTICES USED TO SECURE IoT PROJECTS

Designing security measures assuming breaches at every level of the IoT project	43%
Analyzing dataflows for anomalies and to detect breaches	42%
Defining trust boundaries between compartments of IoT projects	37%
Implementing least privileged access for both devices and cloud	37%
Common Vulnerabilities and Exposures monitoring for 3rd party dependencies	37%
Information sharing with other security organizations	34%
Penetration testing (including Red Team exercises)	32%
Static analysis of code (including Coverity and other tools)	30%
Threat modeling	28%
Fuzz testing	15%

## IoT Implementation Strategies

Two in three organizations outsource at least a part of IoT implementation – only 38% of decision makers and developers we surveyed say they build and implement solutions internally.

Those who choose to outsource IoT implementation reap greater benefits from the technology. More outsourcers see increased efficiency compared to those who don't outsource. Companies who outsource also report a reduced chance of human error and improved safety conditions. ([See Exhibit 14](#))

In addition, those who outsource IoT implementation have fewer business-related challenges. Almost a third of companies find it too complex to implement IoT in-house because of the business transformation that's needed to do so. Other in-house IoT implementers don't have buy-in from senior leadership. ([See Exhibit 15](#))

Companies who outsource IoT implementation prefer to collaborate closely with the organizations they work with, customizing the implementation process to their needs. "We like working with vendors that take a partnership approach where they have skin in the game as well," says a decision maker in the power & utilities industry. "IoT typically requires a long-term sales cycle, so many small vendors do not survive. They sell to so many different industries to remain successful but end up creating a horizontal product. When they try to make the same product work for different types of customers, they become profit-driven and lose focus on our needs."

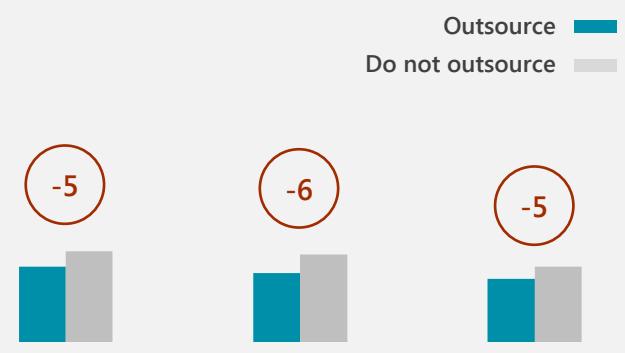
**EXHIBIT 14**

**BENEFITS OF IoT**



**EXHIBIT 15**

**CHALLENGES OF USING IoT MORE**



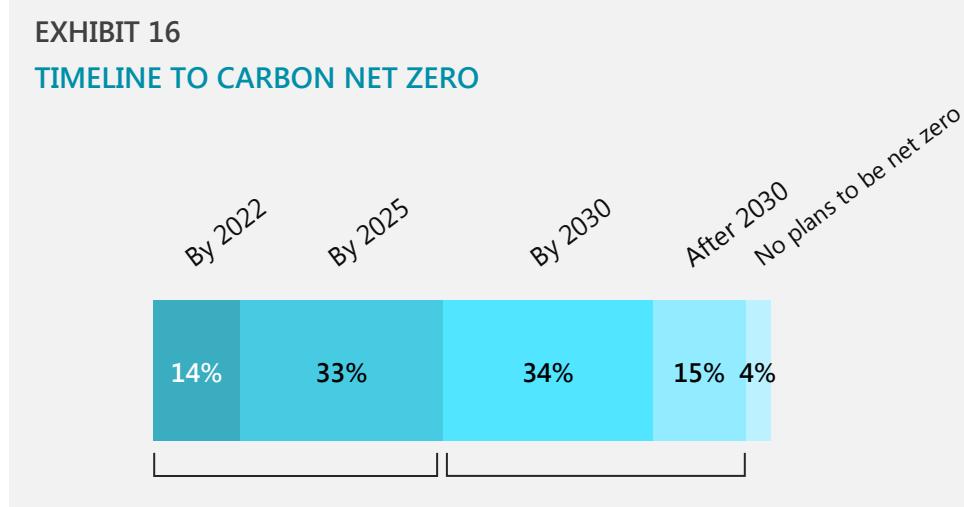
## Sustainability in IoT

34% of the organizations surveyed say they're prioritizing sustainability goals as part of their progress in the next year. Among adopters who focus on sustainability, half expect to reach carbon net zero by 2025, whereas the other half see it as a longer-term goal. ([See Exhibit 16](#))

Organizations who have near-term carbon net zero goals are more motivated by compliance than those with longer-term goals – 41% as opposed to 36%. It's also easier to implement sustainability now, which translates to extra motivation for companies focused on meeting zero-emission goals in the next few years: 37% of those organizations say it's a major impetus, compared to 29% of orgs with long-term goals.

Sustainability is often a side benefit of IoT adoption: when organizations adopt the technology for other reasons, such as to reduce costs or increase efficiency, they often find that they use fewer natural resources.

73% of adopters with near-term sustainability goals view IoT implementation as very important for progress toward sustainability goals, but only 43% are adopting it to achieve those goals – which aligns with sustainability as a side benefit of IoT adoption, rather than a main motivation.



## Impact of Covid-19 on IoT

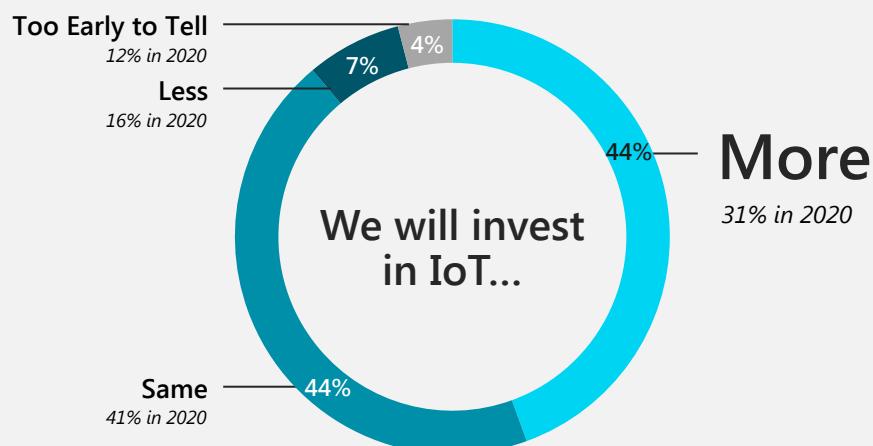
When it comes to investment in IoT, the COVID-19 pandemic in 2021 has accelerated organizations' investment even more than in 2020. In 2021, nearly half of organizations (44%) say they will invest in IoT more, compared to 31% in 2020. The US and China, whose GDP growth was least impacted during the pandemic among the markets we surveyed, are more likely to invest further in IoT due to COVID-19. ([See Exhibit 17](#))

Those who expect to invest the same or more in IoT because of COVID-19 are seeing more benefits already. More of these organizations are using IoT for use cases such as sales enablement and sustainability, and close to half cite increased revenue as a benefit of the technology. A majority of these companies are also incorporating more technology as a core or secondary component of IoT, with 81% using edge computing, and 82% utilizing digital twins.

COVID-19 has pushed some organizations to utilize IoT more as a way of staying ahead of the competition during an uncertain time. An automotive IoT adopter stated: "With COVID, everybody got on the fleet bandwagon for delivery and last mile logistics. Before that, it was all about rental cars and Uber and Lyft. But now all the rental car companies are on the brink of death at this point, as well as Lyft and Uber being a shadow of their former selves. Lyft always swore they would only deliver people, but now they're trying to deliver packages. They've had to do a radical business change, but fleet management assessment is mainstream now. COVID has accelerated our focus on last mile logistics, driver management, dispatch, and driver behavior to remain competitive."

EXHIBIT 17

COVID IMPACT ON IoT INVESTMENT



# Emerging Technologies Spotlight

## The State of Emerging Technologies

Research shows that the majority of IoT-adopting organizations are also using and exploring emerging technologies like artificial intelligence, edge computing, and digital twins. The majority of businesses using these technologies have integrated them into their IoT solutions and are finding that they enhance the ways IoT can be used.

However, organizations are finding that projects involving emerging technology can be hard to implement, due to barriers like the complexity of scaling and lack of infrastructure. About half of the decision-makers and developers we surveyed say that most of their emerging technology projects are in the trial/PoC stage. These barriers prevent companies from going further in their adoption of these technologies.

Different industries are also at different places when it comes to strategizing around emerging technologies. Of the industries we surveyed, smart places organizations are in the lead with regard to implementing AI, energy companies are ahead in edge computing, and manufacturing businesses implement digital twins technology more often. Mobility organizations are generally the slowest overall adopters of emerging technologies, but they tend to utilize AI much more often than edge computing or digital twins.

## Artificial Intelligence Deep Dive

Artificial intelligence is defined as the ability of a computer system to deal with ambiguity, by making predictions using previously gathered data, and learning from errors in those predictions in order to generate newer, more accurate predictions about how to behave in the future.

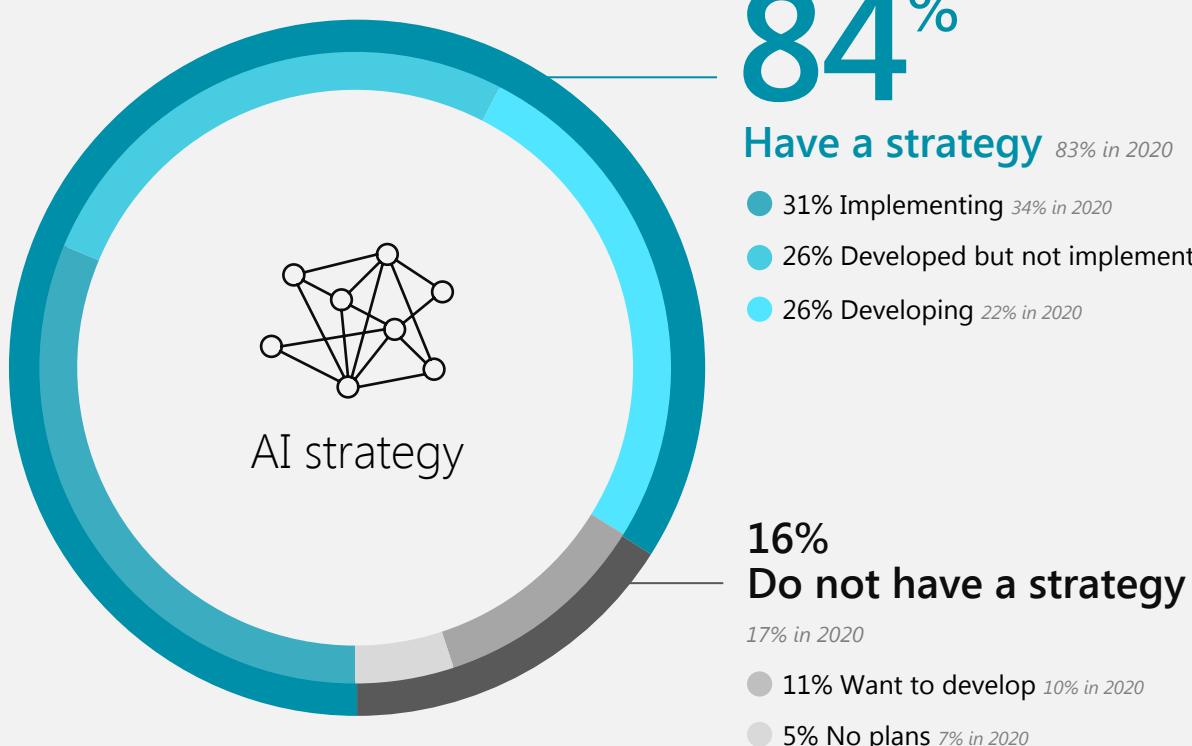
Since last year, knowledge of artificial intelligence has grown among IoT adopters: 64% of companies surveyed say they know it well, as opposed to 59% in 2020. 84% of IoT-adopting organizations report that they have an AI strategy in place. Of those organizations, one in three are currently implementing their strategy ([See Exhibit 18](#))

Businesses with AI strategies often struggle to bring projects to the use phase, with 46% saying most of their projects are stuck in the PoC stage.

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### EXHIBIT 18

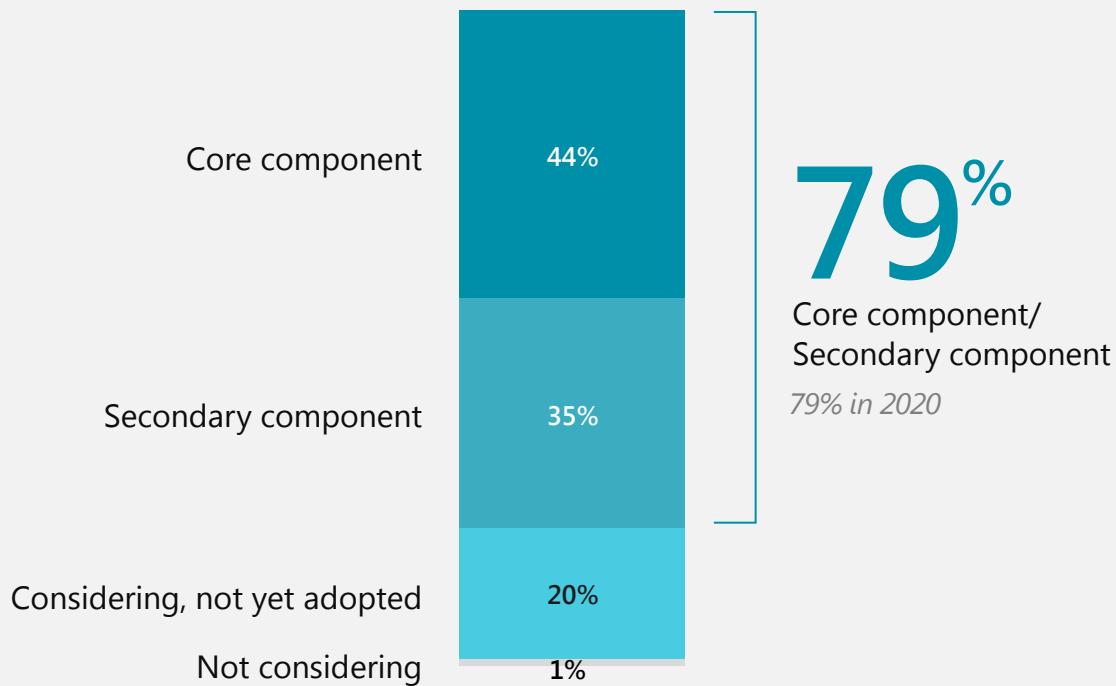
#### AI IMPLEMENTATION PROGRESS



Most businesses are successfully integrating AI with IoT – 79% report that AI is a core or secondary component of their IoT solutions. ([See Exhibit 19](#))

A decision maker in the power & utilities field explains how their organization integrates AI with IoT. "We deploy drones with sensors to capture the weather and take photos for regular inspections of thousands of miles of transmission lines. Our team then uses machine learning to sift through the data and detect specific patterns over which they can build and run AI models to generate insights. Having all the systems digitized rather than on paper has drastically improved the quality of our data and ability to make decisions."

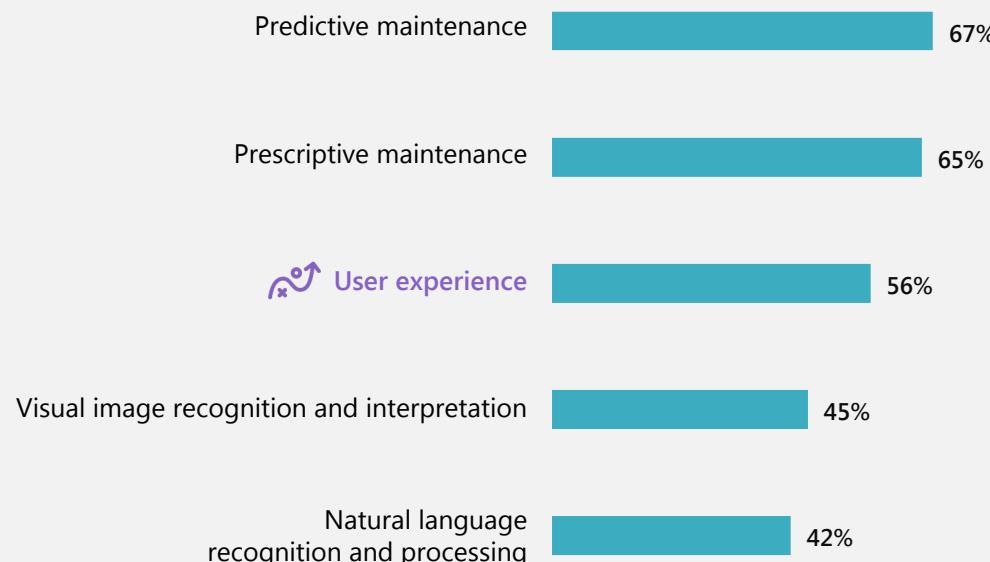
**EXHIBIT 19**  
**USE AND IMPACT OF AI IN IoT SOLUTION**



Organizations primarily adopt AI within IoT for maintenance – predictive maintenance is the top reason for AI and IoT integration, with two-thirds of companies saying they use the technologies for this purpose, while the number-two reason is prescriptive maintenance. 56% of organizations use AI and IoT to enhance user experience, and those who do more often report that it helps their companies achieve success. Close to half of organizations say they're utilizing AI within IoT to develop vision and speech applications. ([See Exhibit 20](#))

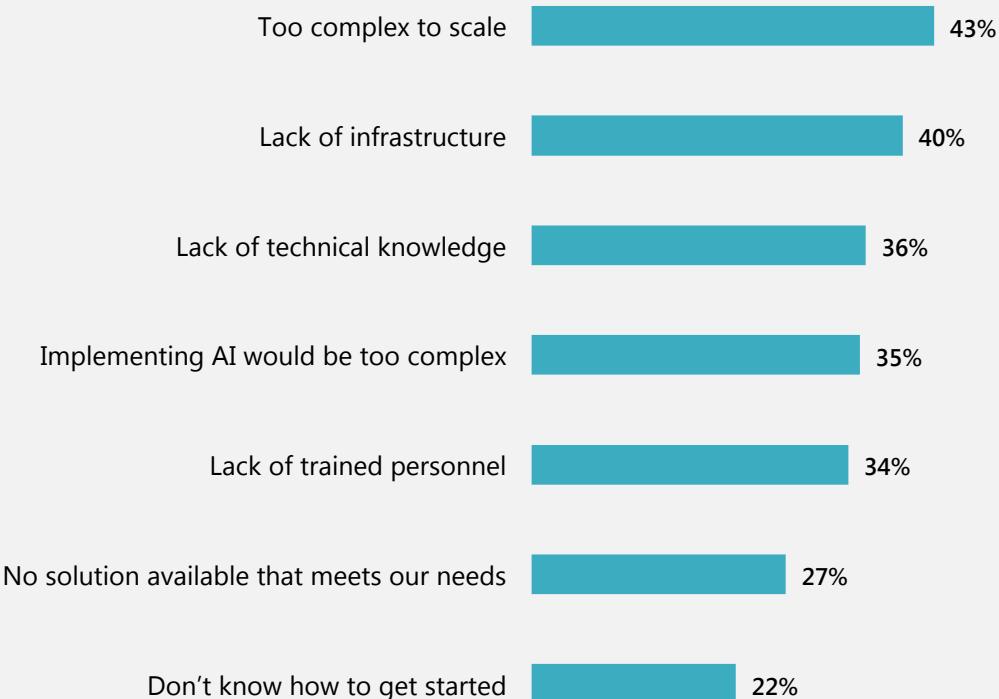
## EXHIBIT 20

### REASONS FOR AI IN IoT ADOPTION | Ranked Top 3 Most Important



This icon highlights organizations that use IoT for these use cases and believe IoT is 7%+ more critical to organizational success.

A significant amount of companies call attention to the complexity involved in AI implementation. Scaling issues are the main barrier to implementation – 43% cite them as a challenge – and lack of infrastructure comes in a close second, with 40% saying it's a barrier. ([See Exhibit 21](#))

**EXHIBIT 21****BARRIERS TO USING AI MORE WITHIN IoT | Ranked Top 3 Most Challenging**

Across industries, more than 80% of companies have an AI strategy in place. When it comes to implementing AI strategy, businesses in the mobility and smart places fields lead the charge, with 36% and 39% respectively saying they are actively employing the technology. However, smart places organizations lag behind other industries with regard to integrating AI into IoT: 75% of those we surveyed are doing so, compared to 83% in manufacturing, 89% in energy, and 85% for mobility organizations. ([See Exhibit 22](#))

## EXHIBIT 22

### AI ADOPTION AND VALUE

	Total	 Manufacturing	 Energy	 Mobility	 Smart Places
Have an AI strategy	84%	84%	90%	81%	88%
Implementation progress against AI strategy					
Implementing	31%	31%	26%	36%	39%
Developed	26%	23%	28%	25%	28%
Developing	26%	30%	36%	20%	21%
Use AI in IoT solution	79%	83%	89%	85%	75%

## Edge Computing Deep Dive

Edge computing enables artificial intelligence, cloud analytics, and business logic to be moved to edge devices. This ensures devices spend less time communicating with the cloud, react more quickly to local changes, and operate reliably even in extended offline periods.

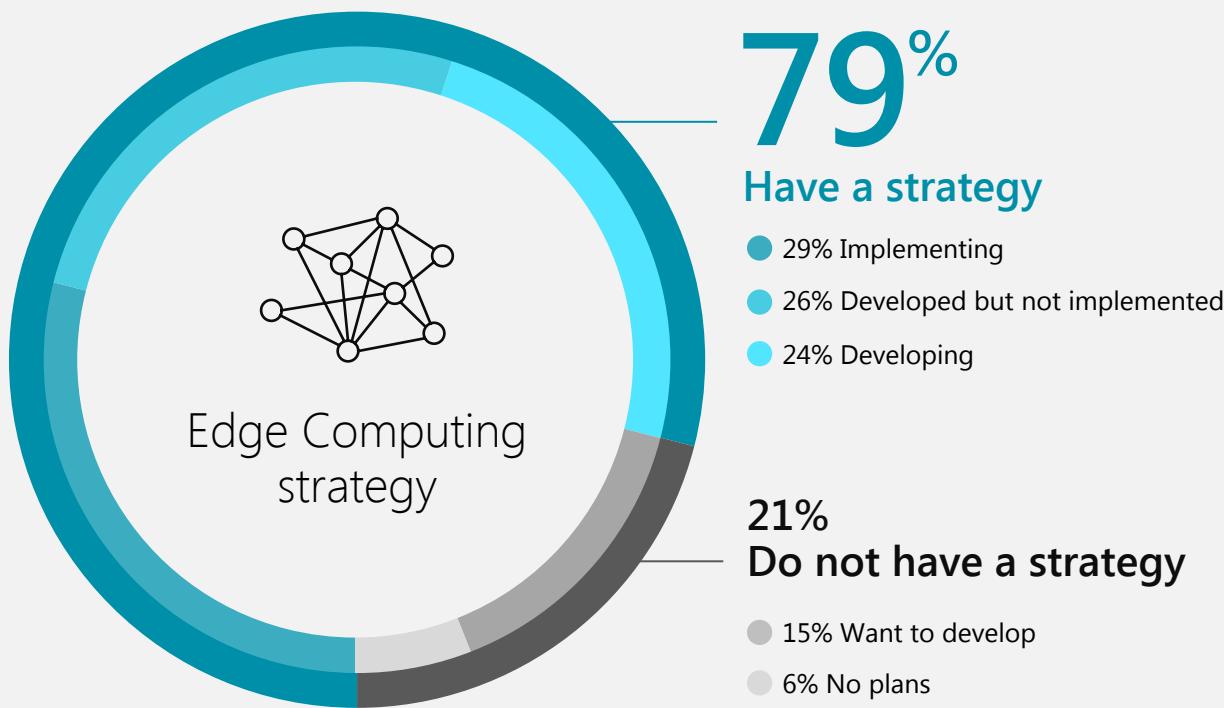
Knowledge of edge computing has grown in the past year. In 2021, 52% of survey participants say they know the technology well, compared to 42% in 2020.

Of the organizations that are familiar with edge computing, more than three quarters have a strategy in place for utilizing the technology, and 29% are implementing that strategy. ([See Exhibit 23](#))

Similar to AI, around half of organizations with an edge computing strategy report that most of their edge computing projects are stuck in the trial/PoC stage.

### EXHIBIT 23

#### EDGE COMPUTING IMPLEMENTATION PROGRESS

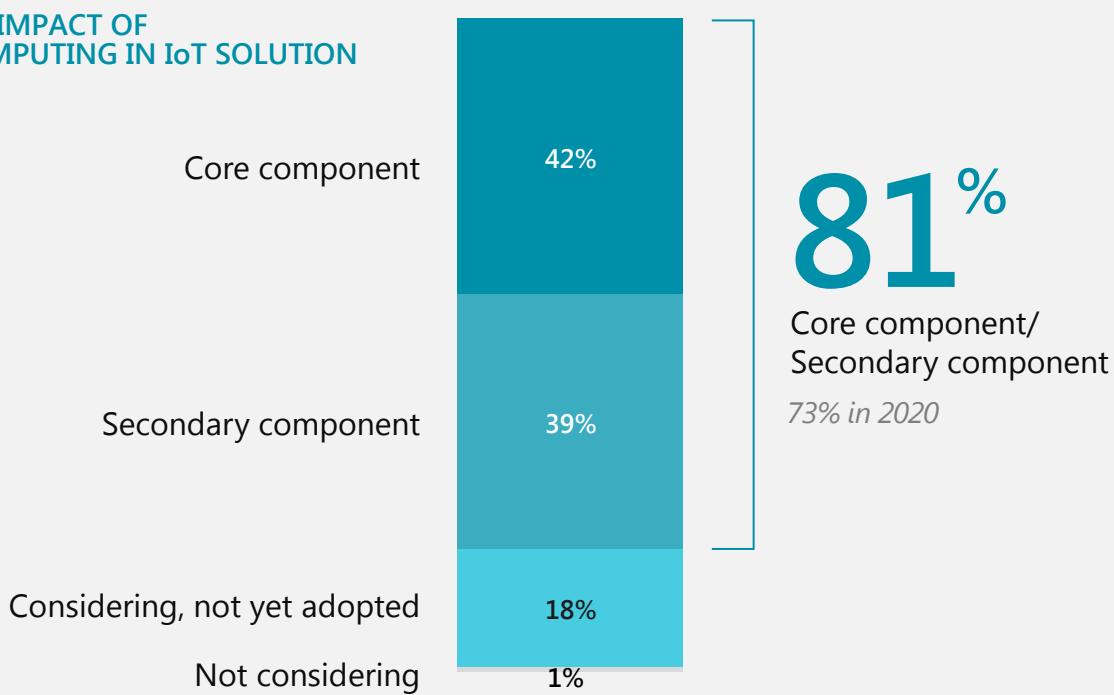


Organizations are increasingly using edge computing and IoT together: 81% of those who have an edge computing strategy are using the technology as a key element of their IoT solution, up from 73% in 2020. ([See Exhibit 24](#))

As organizations utilize edge computing more, they are refining their strategies to meet their needs. "There's a balance between the cost of the edge hardware versus how much computing power we really need," a manufacturing decision maker told us. "We started purchasing edge devices with a tremendous amount of compute power, but they were really expensive. The overall cost led us to parse it down to understand what's beneficial and what's not. We learned that the data transfer protocol that we use to pull data from legacy systems drives a significant cost and presents a significant security risk. We had to ask ourselves if the edge technology is really worth it."

#### EXHIBIT 24

##### USE AND IMPACT OF EDGE COMPUTING IN IoT SOLUTION



Security is a key reason why organizations integrate edge computing with IoT. Close to half of survey participants use the technologies for cloud security, while more than a third employ them for device and asset security. Those who integrate edge computing with IoT for these reasons more often believe that IoT is critical to their organization's success. Quality assurance is also an often-cited use, with 35% saying they use edge computing within IoT for this purpose. Less common uses for these two technologies include contact tracing (23%), personal comfort (17%), and space optimization (17%). [\(See Exhibit 25\)](#)

Organizations enjoy many benefits of using edge computing, and report that the technology helps them improve automation and productivity. For more than three quarters of companies surveyed, edge computing enables connectivity of old and new devices because of protocol translation. 72% say that utilizing edge computing improves privacy, with 72% also benefiting from improved operations.

## EXHIBIT 25

### REASONS FOR EDGE COMPUTING IN IoT ADOPTION | Ranked Top 5 Most Important



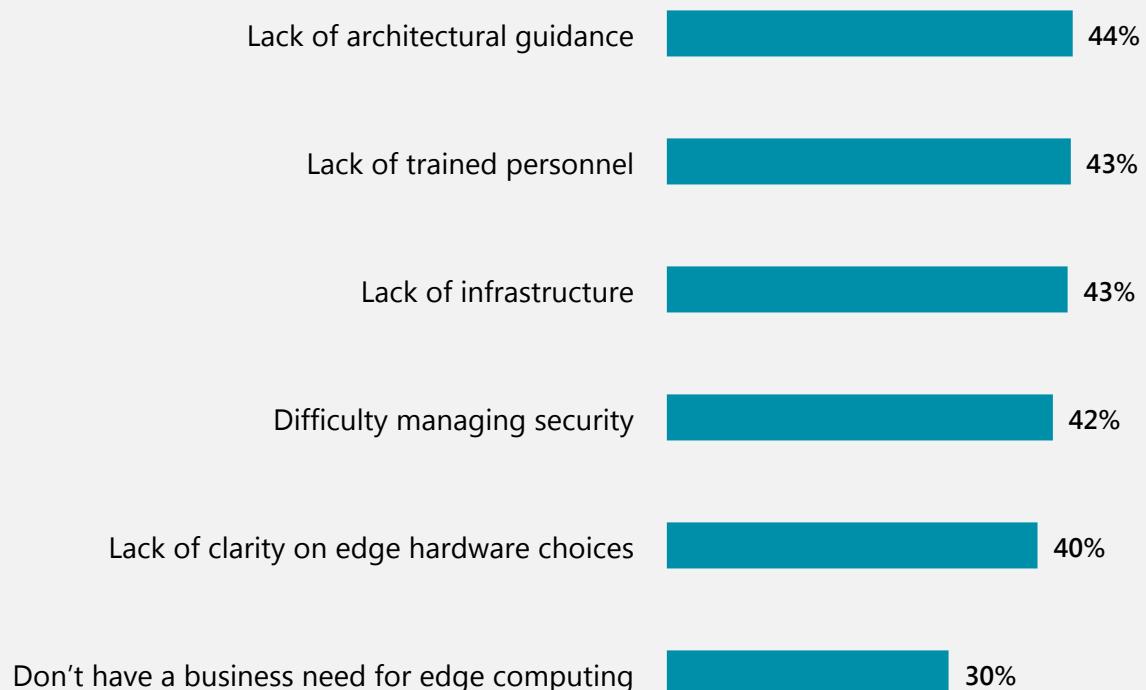
This icon highlights organizations that use IoT for these use cases and believe IoT is 7%+ more critical to organizational success.

Companies who want to further utilize edge computing with IoT face a wide array of challenges. Nearly 1 in 2 companies report a lack of architectural guidance. 43% say they don't have enough trained personnel, and another 43% don't have adequate infrastructure. Almost the same amount have difficulty managing security, and 40% aren't well enough informed about edge hardware choices. **(See Exhibit 26)**

The 42% of organizations with edge computing-related security concerns cite several specific challenges. Close to half say application security is a top concern, with similar numbers reporting that they're concerned about threat detection and perimeter security.

#### EXHIBIT 26

#### BARRIERS TO USING AI MORE WITHIN IoT | Ranked Top 3 Most Challenging



While 81% of the verticals we surveyed use edge computing as part of their IoT solution, manufacturing organizations lag behind other fields, with 77% combining the technologies, as compared to 88% in mobility, 85% in energy, and 83% in smart places. However, manufacturing companies are implementing edge computing strategies at a higher rate than almost all other verticals, with only energy scoring higher. ([See Exhibit 27](#))

#### EXHIBIT 27

#### EDGE COMPUTING ADOPTION AND VALUE

	Total	 Manufacturing	 Energy	 Mobility	 Smart Places
Have Edge Computing strategy	79%	83%	85%	85%	85%
Implementation progress against Edge Computing strategy	<div style="display: flex; justify-content: space-around;"> <div>Implementing</div> <div>Developed</div> <div>Developing</div> </div>	<div style="display: flex; justify-content: space-around;"> <span>29%</span> <span>26%</span> <span>24%</span> </div>	<div style="display: flex; justify-content: space-around;"> <span>37%</span> <span>28%</span> <span>18%</span> </div>	<div style="display: flex; justify-content: space-around;"> <span>38%</span> <span>25%</span> <span>23%</span> </div>	<div style="display: flex; justify-content: space-around;"> <span>18%</span> <span>30%</span> <span>37%</span> </div>
Use Edge Computing in IoT solution	81%	77%	85%	88%	83%

## Digital Twins Deep Dive

Digital twins is a digital replica of physical environments that allows modeling of relationships and interactions between things, places, business processes and people. It provides the ability to create reusable, highly scalable detailed digital models of comprehensive environments that fuse data across the physical and digital world to track both past and present events, simulate possibilities, and help predict future events for those environments.

Almost all the organizations surveyed are aware of digital twins, and that number has grown since last year: 39% say they know the technology well, compared to 33% in 2020.

Among those aware of digital twins, more than three in four have a strategy incorporating the technology, and a quarter are implementing their strategy.

(See Exhibit 28)

EXHIBIT 28

DIGITAL TWINS IMPLEMENTATION PROGRESS



77 %

**Have a strategy** 73% in 2020

24% Implementing 27% in 2020

29% Developed but not implemented 28% in 2020

24% Developing 18% in 2020

23%

**Do not have a strategy**

27% in 2020

14% Want to develop 12% in 2020

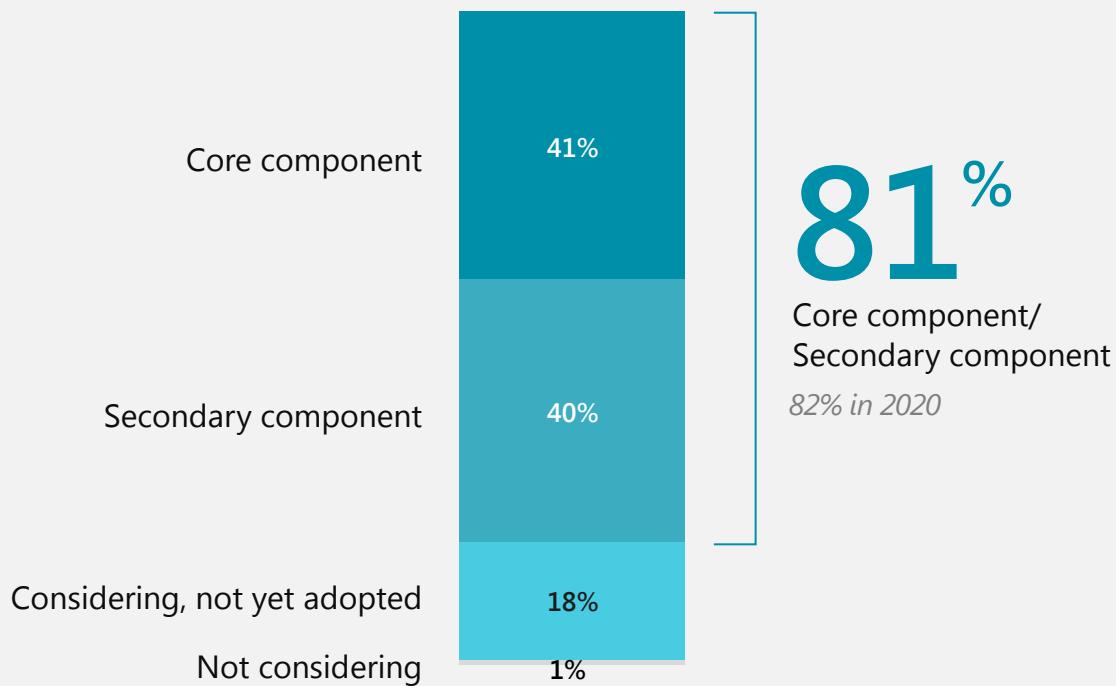
9% No plans 15% in 2020

As is the case with AI and edge computing, a significant number of organizations report that their digital twins projects are stuck in the trial phase: 51% say they are facing this challenge, compared to 23% in the learn stage, 12% in the purchase stage, and 13% who have reached the use phase.

81% of those with a digital twins strategy are incorporating it into their IoT solution, leaving only 18% of IoT adopters who are considering integrating digital twins but haven't yet done so, and 1% who are not considering integration. (See Exhibit 29)

#### EXHIBIT 29

#### USE AND IMPACT OF DIGITAL TWINS IN IoT SOLUTION

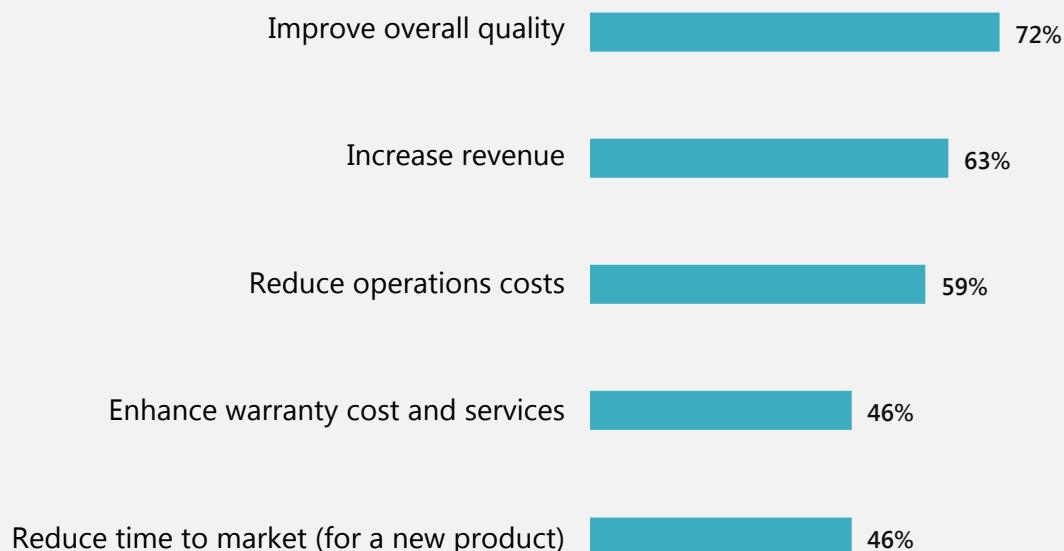


The benefits of digital twins projects include improved quality, which nearly three quarters of organizations report; increased revenue (63% of companies cite this as a benefit); and reduced operations costs (59%). ([See Exhibit 30](#))

A smart places ITDM describes how their organization utilizes digital twins to monitor building changes. "A new digital twin of the building is created each time someone wants to put up electrical contractor bidding, or create a permit, or test the fire protection system. Each of those digital twins fits into a puzzle that leads us to create the best replica that we possibly can. As a result, the final digital twin can guide the user to which part of the building changed in the past year. That's critical for us because not all of these systems are used daily, so we know where the fixes are needed."

#### EXHIBIT 30

#### BENEFITS TO USING DIGITAL TWINS WITHIN IoT | Ranked Top 3 Benefits Gained



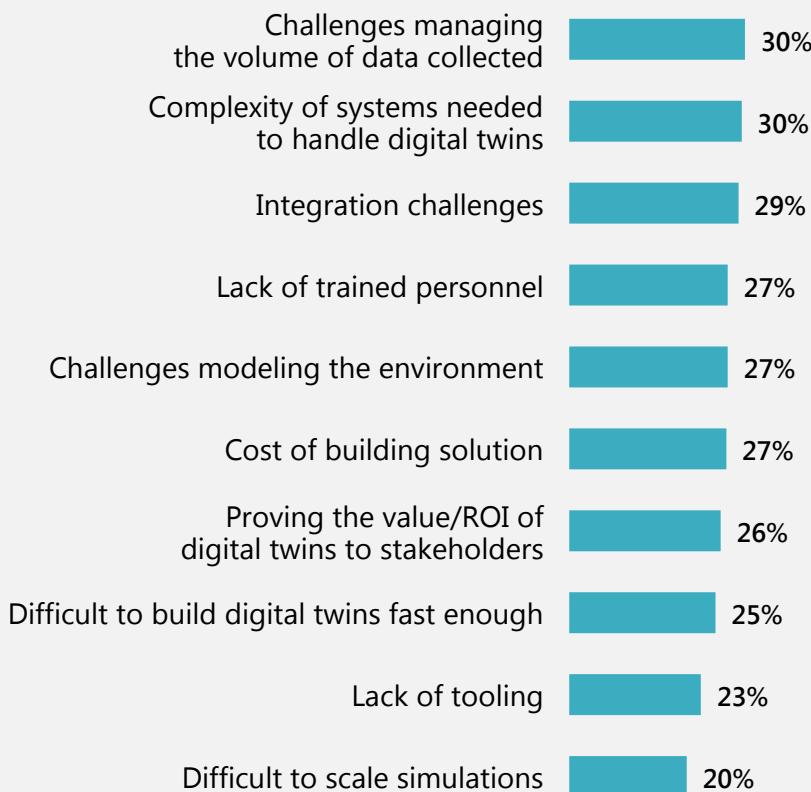
As with edge computing, in order to use digital twins more, organizations need help with an array of challenges. For adopters of digital twins technology, these challenges are specifically data- and people-related. Close to 1 in 3 organizations have trouble managing the volume of data collected, while the same number find that the systems needed to handle digital twins are very complex. 29% come up against integration challenges.

People-related challenges include a lack of trained personnel, as well as difficulty proving the value of the technology to stakeholders. ([See Exhibit 31](#))

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#### EXHIBIT 31

#### BARRIERS TO USING DIGITAL TWINS MORE WITHIN IoT | Ranked Top 3 Most Challenging



In contrast to their level of edge computing implementation, the manufacturing industry is ahead when it comes to digital twins: 31% are implementing against a digital twins strategy. The mobility field lags behind the others in key areas, with 77% using a digital twins solution as compared to 86% in manufacturing. In addition, only 15% of mobility organizations are implementing against a digital twins strategy. (See Exhibit 32)

### EXHIBIT 32

#### DIGITAL TWINS ADOPTION AND VALUE

	Total	 Manufacturing	 Energy	 Mobility	 Smart Places
Have a Digital Twins strategy	77%	79%	79%	76%	82%
Implementation progress against Digital Twins strategy	<div style="display: flex; justify-content: space-around;"> <div>Implementing</div> <div>Developed</div> <div>Developing</div> </div>	<div style="display: flex; justify-content: space-around;"> <span>24%</span> <span>31%</span> <span>26%</span> <span>15%</span> <span>27%</span> </div>	<div style="display: flex; justify-content: space-around;"> <span>29%</span> <span>25%</span> <span>29%</span> <span>39%</span> <span>35%</span> </div>	<div style="display: flex; justify-content: space-around;"> <span>24%</span> <span>23%</span> <span>24%</span> <span>23%</span> <span>20%</span> </div>	
Use Digital Twins in IoT solution	81%	86%	82%	77%	85%

# Industry Spotlights

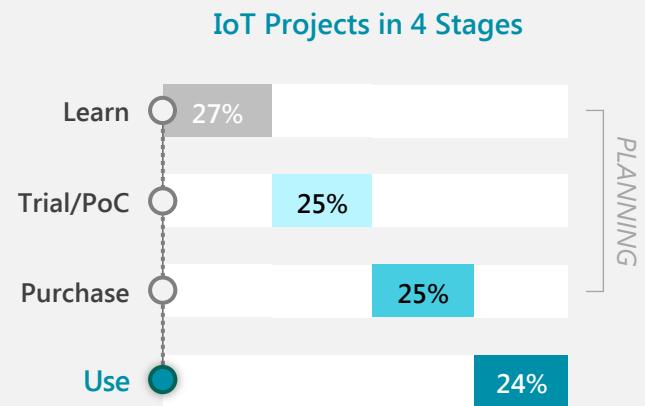
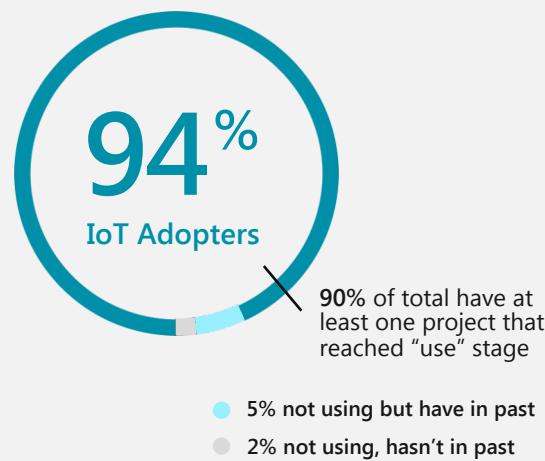


## Smart Places Deep Dive

94% of smart places organizations we surveyed are IoT adopters. They benefit from the technology in numerous ways, with top benefits including increased operational efficiency, improved safety, and better optimization of tools and equipment. (See Exhibit 33)

### EXHIBIT 33

#### SMART PLACES IoT SUMMARY



#### Top Benefits of IoT

**#1**

Increases the efficiency of operations

**#2**

Improves safety conditions

**#3**

Allows for better optimization of tools/equipment



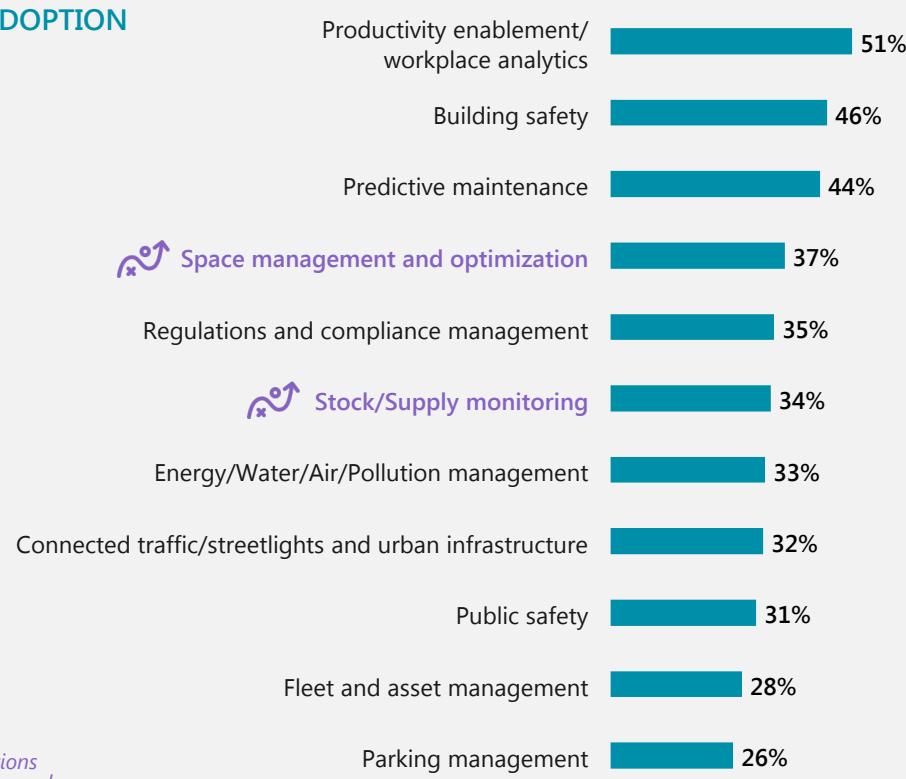
Likewise, top applications of IoT in smart places organizations also involve productivity and safety – over half of smart places businesses use IoT to enable productivity and workplace analytics, 46% use it for building safety, and 44% employ it in predictive maintenance. For smart places organizations, those who use IoT for space management and optimization, as well as stock and supply monitoring, more strongly believe that IoT is critical to their success.

(See Exhibit 34)

IoT opens up new use cases for smart places organizations that were not possible before. "We spent millions of dollars to try and save seconds in response time, but we waste minutes communicating with firefighters when transcribing from phone to phone and typing things up," a smart places decision maker explains. "IoT allows us to collapse that process and get data immediately, which makes it a much safer outcome."

#### EXHIBIT 34

#### REASONS FOR IoT ADOPTION



*This icon highlights organizations that use IoT for these use cases and believe IoT is 12%+ more critical to organizational success.*



Smart places organizations face many of the same barriers encountered by other industries when implementing IoT. 32% are still implementing their current solution, and 31% worry that the security risk of employing IoT isn't worth it. 30% feel that the level of business transformation needed makes it too complex to implement; the same percentage say that technology demands increase complexity too much.

Problems involving lack of knowledge are lesser barriers to implementation. A quarter of companies say they don't have enough training or guidance on how to deploy IoT. Around the same amount cite lack of technical knowledge or say they simply don't know enough about IoT to implement it. ([See Exhibit 35](#))

#### EXHIBIT 35

#### CHALLENGES TO USING IoT MORE

Still in Progress	Still implementing our current solutions	32%
Security	Security risk isn't worth it	31%
Complexity/Technical	Too complex to implement because of business transformation needed	30%
Complexity/Technical	Want to work out existing/future challenges before adding/using IoT more	30%
Complexity/Technical	Too complex to implement because of technology demands	30%
Security	Concerned about consumer privacy	29%
Complexity/Technical	Too long to implement	29%
Lack of Budget/Staff	Don't have human resources to implement & manage	26%
Lack of Budget/Staff	Don't have budget	26%
Leadership/Team Challenges	No buy-in from senior leadership	25%
Compliance	Too many compliance/regulatory challenges	25%
Lack of Knowledge	Not enough training/guidance on how to deploy	25%
Security	Unwilling to store data in public cloud	25%
Lack of Knowledge	Lack technical knowledge	24%
Lack of Knowledge	Don't know enough	23%
Haven't Found Right Solution	No solution that meets our needs	19%

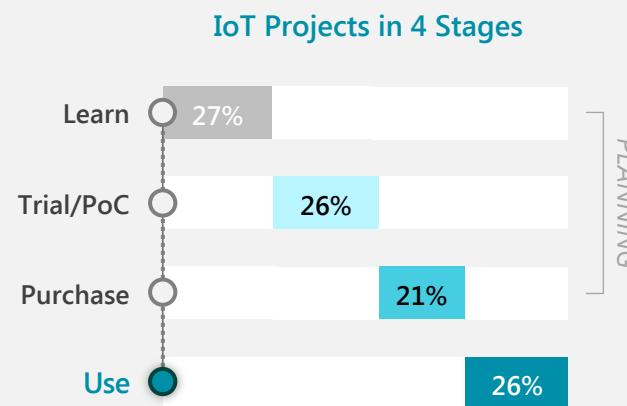
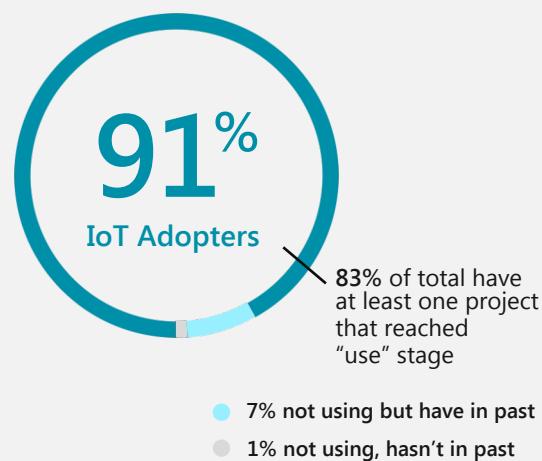


## Manufacturing Deep Dive

As in the smart places field, the majority of manufacturing organizations we surveyed are IoT adopters and the top benefit they're realizing is increased operational efficiency. Businesses also say IoT increases production capacity and reduces human error. (See Exhibit 36)

### EXHIBIT 36

#### MANUFACTURING IoT SUMMARY



#### Top Benefits of IoT

**#1**

Increases the efficiency of operations

**#2**

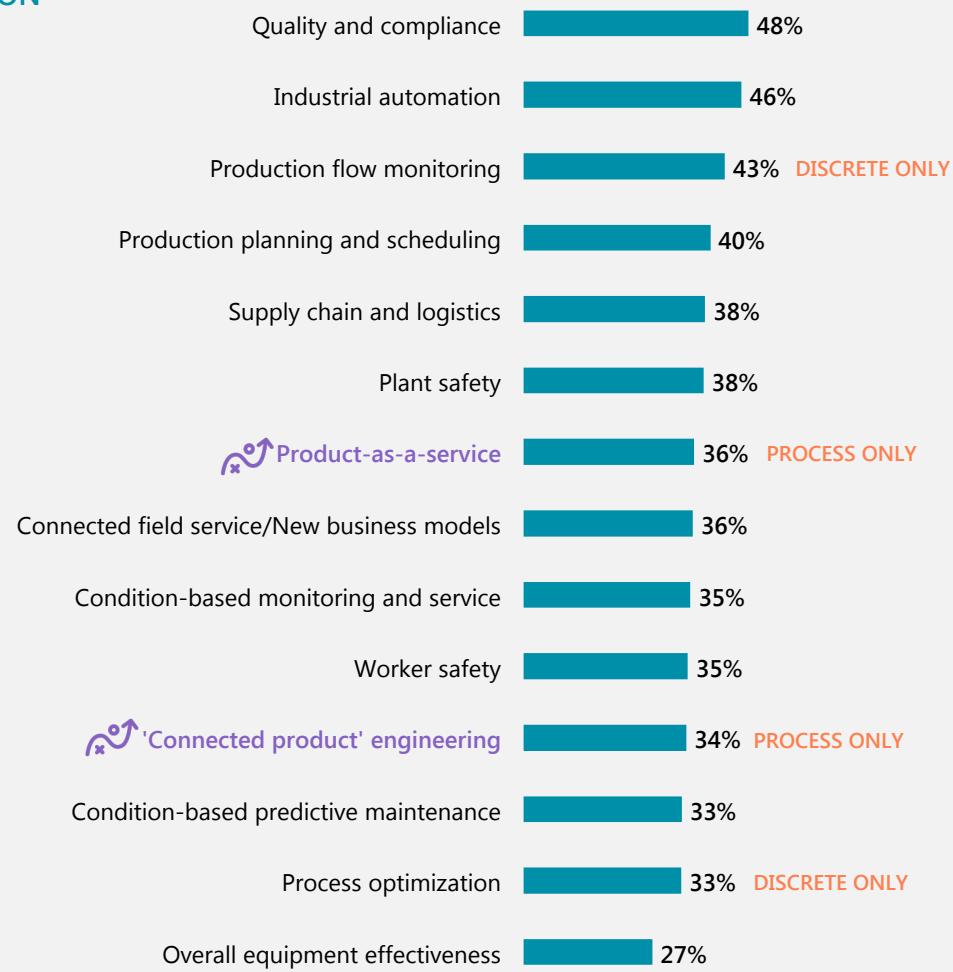
Increases production capacity

**#3**

Reduces chance for human error



The top application of IoT in the manufacturing field focuses more on quality and compliance, with 48% of organizations citing that as their main reason for adopting IoT. The second most common application is industrial automation. Manufacturing organizations who use IoT for product-as-a-service implementations and "connected product" engineering more strongly believe that the technology is key to their success. (See Exhibit 37)

**EXHIBIT 37****REASONS FOR IoT ADOPTION**

This icon highlights organizations that use IoT for these use cases and believe IoT is 11%+ more critical to organizational success.



Challenges to implementing IoT in the manufacturing industry are much the same as the ones that smart places companies face. 29% are still implementing their current solution; 27% say the technological demands prohibit implementation; and another 27% feel the security risk isn't worth it. For process manufacturing organizations, lack of human resources and lack of budget are stronger barriers than they are for discrete manufacturing organizations.

**(See Exhibit 38)**

Technological challenges abound for some manufacturing organizations. "There are so many technological limitations that constrain us, and no standards in place. We have to think about whether we can extract data from a legacy device, how we'll work with partners to extract the data, which mechanisms we'll use to transport the data. But this space moves so quickly – what we read about as the latest thing today will be different tomorrow. It's a battle to avoid "technology orphanage" as we make the purchase decision and gauge whether the technology will be relevant three years from now."

## EXHIBIT 38

### CHALLENGES TO USING IoT MORE

Still in Progress		
Complexity/Technical	Still implementing our current solutions	29%
Security	Too complex to implement because of technology demands	27%
Complexity/Technical	Security risk isn't worth it	27%
Lack of Budget/Staff	Want to work out challenges before adding/using IoT more	26%
Complexity/Technical	Don't have human resources to implement & manage	25%
Lack of Budget/Staff	Too complex to implement because of business transformation needed	24%
Lack of Knowledge	Don't have budget	23%
Security	Not enough training/guidance on how to deploy	22%
Compliance	Concerned about consumer privacy	22%
Lack of Knowledge	Too many compliance/regulatory challenges	21%
Complexity/Technical	Lack technical knowledge	21%
Lack of Knowledge	Too long to implement	20%
Leadership/Team Challenges	Don't know enough	20%
Security	No buy-in from senior leadership	19%
Haven't Found Right Solution	Unwilling to store data on public cloud	18%
	No solution that meets our needs	17%



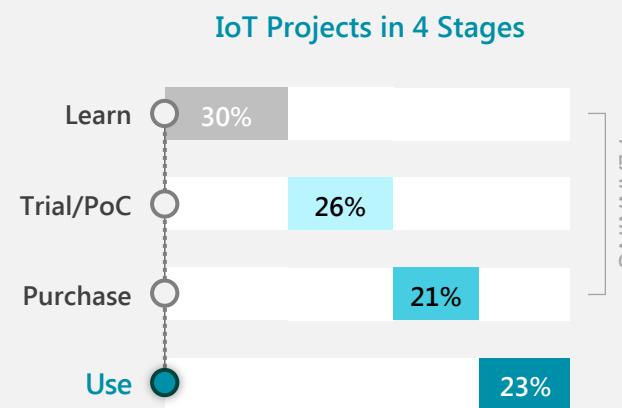
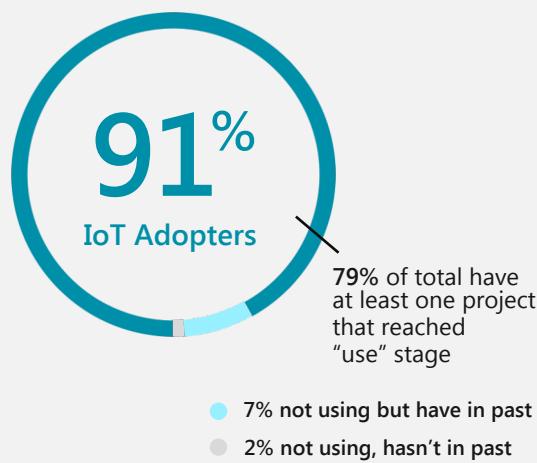
## Mobility Deep Dive

91% of the mobility organizations we surveyed are IoT adopters – a similar percentage to manufacturing and smart places. As is the case with those two industries, mobility orgs also say operational efficiency is the top benefit of using IoT. As with smart places companies, safety and production capacity are also top benefits in mobility. Employee productivity is another high-ranking benefit.

(See Exhibit 39)

### EXHIBIT 39

#### MOBILITY IoT SUMMARY



#### Top Benefits of IoT

#1

Increases the efficiency of operations

#2

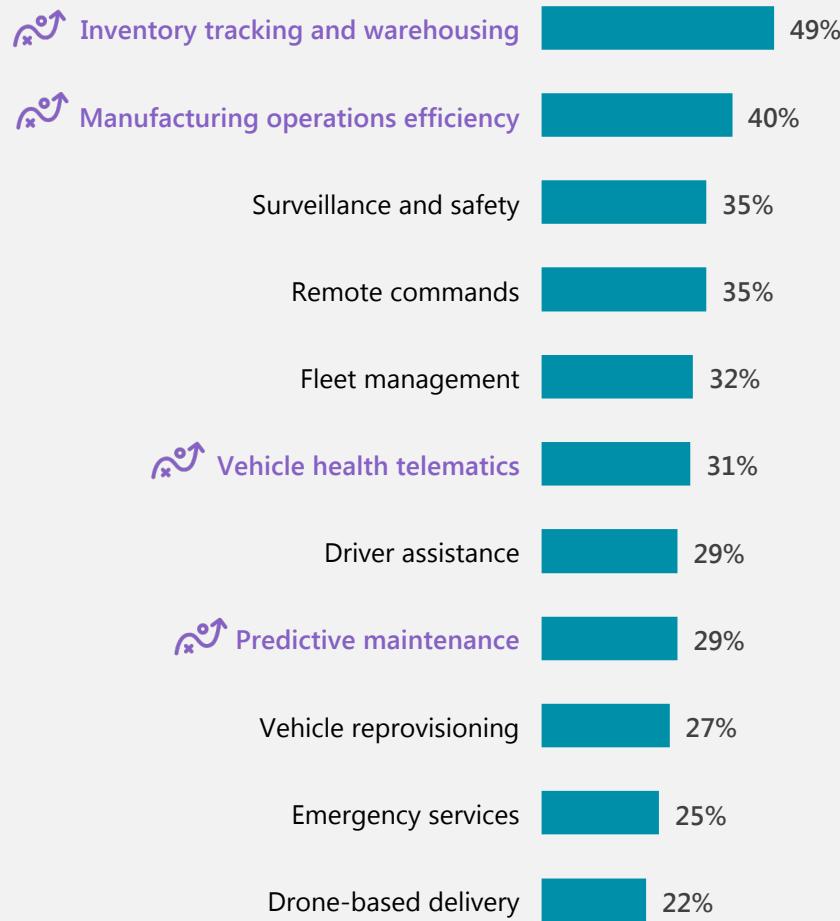
Allows employees to be more productive

#3

Improves safety conditions  
Increases production capacity



As well as being a top benefit, operational efficiency is also a primary reason that mobility organizations adopt IoT. These companies also adopt the technology to track inventory and manage warehousing. Those who use IoT for facilitating vehicle health telematics and for emergency services more often believe that the technology is critical to their organization's success. Automotive and transportation businesses more often use IoT for remote commands. Emerging use cases for IoT in mobility include vehicle reprovisioning and drone-based delivery. (See Exhibit 40)

**EXHIBIT 40****REASONS FOR IoT ADOPTION**

This icon highlights organizations that use IoT for these use cases and believe IoT is 12%+ more critical to organizational success.



Like smart places and manufacturing, one of the mobility industry's top barriers to IoT adoption is that they're still implementing current solutions. In addition, nearly one in three companies want to work out existing challenges before embarking on something new. As with smart places orgs, mobility companies grapple with technological complexity, but business complexity is less of a challenge. [\(See Exhibit 41\)](#)

For one automotive organization, the struggle to work out existing challenges has brought projects to an abrupt halt. "A lot of times, the PoCs change scope midway through, and they don't deliver on what the original production intent was. Even if a PoC delivers on everything asked of us, I've got somebody on my team who has been asleep at the wheel and doesn't understand it's a PoC, so they expect it to operate like a beta prototype. Then they'll just dismiss the whole thing, because they don't have a proper understanding of the context."

#### EXHIBIT 41

#### CHALLENGES TO USING IoT MORE

Complexity/Technical	Want to work out challenges before adding/using IoT more	30%
Complexity/Technical	Too complex to implement because of technology demands	29%
Still in Progress	Still implementing our current solutions	28%
Security	Security risk isn't worth it	27%
Complexity/Technical	Too complex to implement because of business transformation needed	27%
Lack of Budget/Staff	Don't have human resources to implement & manage	26%
Lack of Knowledge	Don't know enough	25%
Leadership/Team Challenges	No buy-in from senior leadership	25%
Lack of Knowledge	Lack technical knowledge	24%
Compliance	Too many compliance/regulatory challenges	24%
Lack of Budget/Staff	Don't have budget	24%
Haven't Found Right Solution	No solution that meets our needs	23%
Complexity/Technical	Too long to implement	21%
Security	Concerned about consumer privacy	20%
Lack of Knowledge	Not enough training/guidance on how to deploy	19%
Security	Unwilling to store data in public cloud	18%

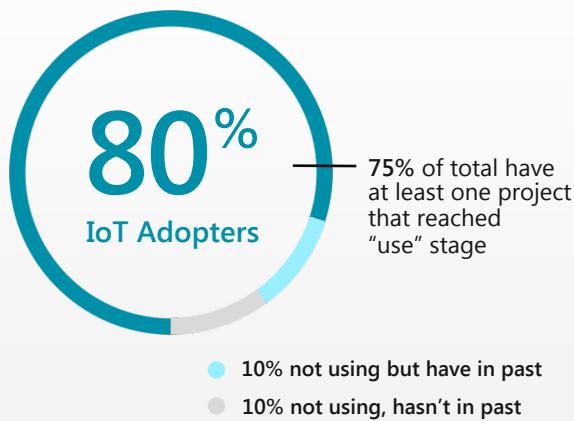
## Energy Deep Dive: Power & Utilities and Oil & Gas

80% of the power & utilities organizations we surveyed say they are IoT adopters. In contrast, a much higher number of oil & gas companies – 94% – are adopting IoT. (See Exhibit 42)

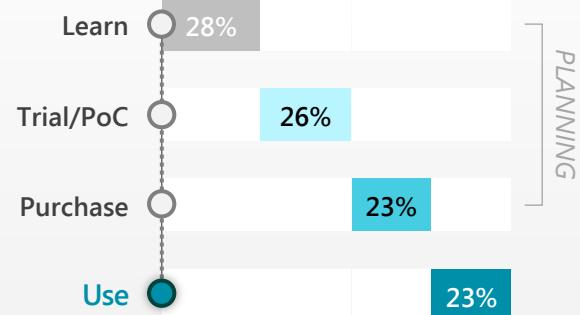
EXHIBIT 42

### IoT SUMMARY

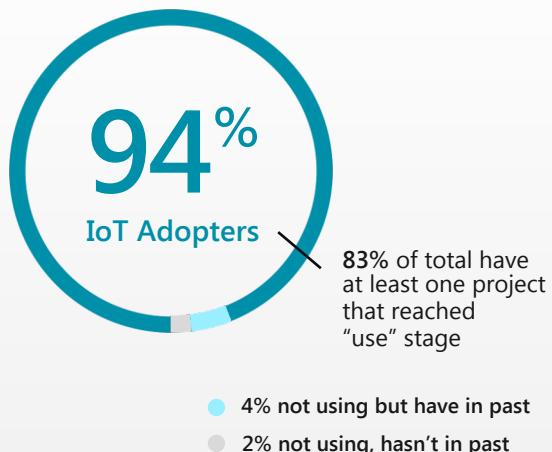
#### Power & Utilities



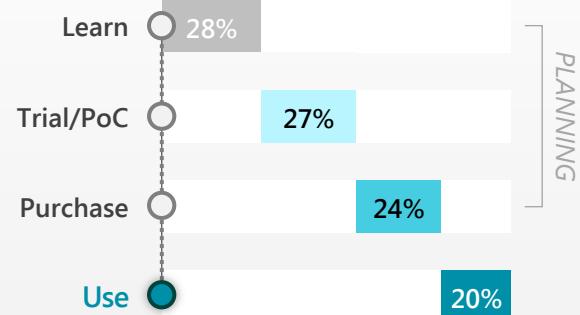
#### IoT Projects in 4 Stages



#### Oil & Gas



#### IoT Projects in 4 Stages





The top three benefits of IoT for power & utilities organizations are operations efficiency, production capacity, and employee productivity. Like power & utilities orgs, oil & gas orgs cite operations efficiency and production capacity as top benefits, but also say their use of IoT has increased customer satisfaction and improved business decision-making. ([See Exhibit 43](#))

#### EXHIBIT 43

##### TOP BENEFITS OF IoT



##### Power & Utilities

#1

Increases the efficiency  
of operations

#2

Increases production  
capacity

#3

Allows employees to be  
more productive



##### Oil & Gas

#1

Increases customer  
satisfaction

#2

Improves business  
decision-making

#3

Increases  
production capacity  
Increases the efficiency  
of operations



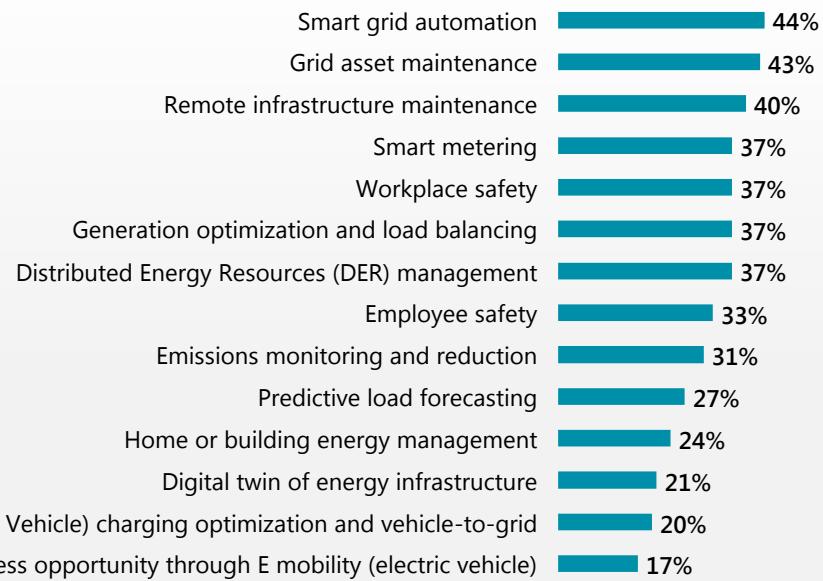
For power & utilities organizations, the most common reasons for IoT adoption are efficiency-oriented: 44% employ the technology for smart grid automation, and 43% use it for grid asset maintenance. For both the power & utilities field and the oil & gas industry, IoT is less often adopted for electric vehicle-related projects; however, increased attention from the US government means these use cases may be on the rise in the future.

Conversely, oil & gas companies tend to adopt IoT for safety-oriented use cases, with workplace safety and personal safety heading up the list of reasons for IoT adoption. ([See Exhibit 44](#))

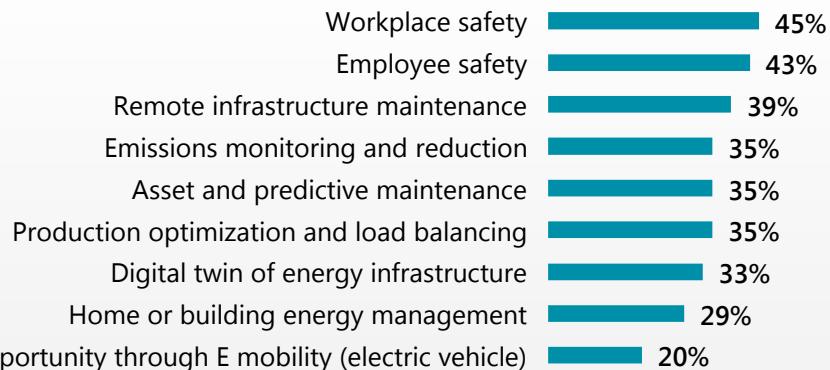
#### EXHIBIT 44

#### REASONS FOR IoT ADOPTION

##### Power & Utilities



##### Oil & Gas





In the power & utilities field, technological complexity is the main barrier to IoT adoption, with close to a third of companies citing it as a challenge. As with other industries, a significant percentage of power & utilities organizations say the security risk of IoT adoption isn't worth it. Lack of human resources is another top challenge.

An executive in the power & utilities industry describes the technological complexities that their company faces when adopting IoT. "IoT requires a lot of internal transformation. We need the big data skills. To build data pipelines, we need all new skill sets to operationalize IoT at scale, including engineers, analysts, and data scientists. At the pilot level, we can always hire a contractor, but they will acquire the skills and go away to the next gig. We need to sustain that knowledge internally, which has been a huge challenge."

As in power & utilities, complexity is a top barrier to IoT adoption in oil & gas, but for these organizations, this complexity more often comes from the level of business transformation needed to employ IoT. The top two challenges for the oil & gas field are knowledge-related: a third of businesses say they lack technical knowledge, while 31% say they simply don't know enough about IoT. **(See Exhibit 45)**

#### EXHIBIT 45

#### TOP CHALLENGES TO USING IoT MORE

 Power & Utilities	Complexity/Technical	Too complex to implement because of technology demands	30%
	Security	Security risk isn't worth it	29%
	Lack of Budget/Staff	Don't have human resources to implement & manage	29%

 Oil & Gas	Lack of Knowledge	Lack technical knowledge	33%
	Lack of Knowledge	Don't know enough	31%
	Complexity/Technical	Too complex to implement because of business transformation needed	29%

## Final Thoughts

IoT continues to be widely adopted across industries and around the globe, with adoption rates staying steady since 2020. Organizations in all the fields surveyed are adopting IoT for a broad range of reasons, including operations optimization, cloud and device/asset security, and quality assurance, and they are seeing improved efficiency and productivity. The vast majority of organizations say IoT is key to their continued success, and two in three say they'll implement the technology more in the years to come. In addition, COVID-19 has had an even stronger accelerating impact for organizations and their IoT strategies than last year, with more companies saying they'll maintain or increase their investment in IoT as a result of the pandemic.

Almost all organizations are implementing strategies for Artificial Intelligence, Edge Computing, and Digital Twins, and the majority are integrating these technologies into their IoT solution. To maximize the benefits of combining these technologies with IoT, companies will need to focus on building infrastructure and overcoming scaling issues.

Many organizations are outsourcing at least part of their IoT implementation, which helps them manage complex technical and business challenges. Those who outsource also feel more confident when it comes to security, which is top of mind in 2021. To keep IoT projects secure, organizations focus on ensuring data privacy – especially while working with vendors – and network-level security. Indeed, improved security is a top measure of success for IoT projects. Organizations that invest in IoT and overcome their challenges in implementing the technology are better able to capitalize on the benefits of IoT.

# Detailed Research Objectives & Audience Recruit

## THE OBJECTIVES OF THE RESEARCH INCLUDED

1. Understand the current state of IoT
2. Uncover benefits and challenges of adopting IoT
3. Analyze adoption and uses of IoT
4. Explore emerging technologies use within IoT, and dive into specific industry learnings

## TO MEET THE SCREENING CRITERIA, IoT PROFESSIONALS NEEDED TO BE:

A business decision maker, IT decision maker, or developer at their company

Employed full-time at an enterprise-level company (1,000 employees or more)

Ages 18-65

Familiar with IoT

Involved in decision making for IoT

## OF THE 3,000+ IoT PROFESSIONALS INTERVIEWED FOR THE RESEARCH WAVE BETWEEN APRIL AND MAY 2021

In the US, over 850 security decision makers were interviewed

In China, Japan, the UK, France, and Germany, over 350 security decision makers were interviewed

In Spain, Italy, Benelux (The Netherlands + Belgium), and Australia, over 150 security decision makers were interviewed in each country

In the Energy Deep Dive, 142 IoT Professionals were interviewed across all countries

In the Manufacturing Deep Dive, 596 IoT Professionals were interviewed across all countries

In the Smart Places Deep Dive, 266 IoT Professionals were interviewed across all countries

In the Mobility Deep Dive, 199 IoT Professionals were interviewed across all countries