

Analytics Practice

## IoT comes of age

McKinsey research shows that adoption of IoT technologies has increased exponentially the past five years—but successful implementation still eludes some. Here's how to get it right.



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**In this episode** of *The McKinsey Podcast*, McKinsey partners Michael Chui and Mark Collins share their thoughts with Roberta Fusaro on the findings of McKinsey's latest Internet of Things report, including how to successfully integrate IoT, the situations in which the most value is being created, and what companies continue to get wrong.

After, it's expected a piece of space debris hit the moon on March 4, 2022. Hear about the implications of all the other pieces of space junk in orbit from McKinsey associate partner Chris Daehnck and podcast managing producer Laurel Moglen. The following transcript has been edited for clarity.

*The McKinsey Podcast* is cohosted by Roberta Fusaro and Lucia Rahilly.

## Defining the Internet of Things

**Roberta Fusaro:** How do you define the Internet of Things?

**Michael Chui:** The Internet of Things, or IoT, is when you embed digital technologies into the physical world. For example, we're seeing digital technologies embedded in cars and in buildings. You connect those physical objects through digital network connections back to computers, and that simply is it. That's the Internet of Things.

**Roberta Fusaro:** Mark, compared with McKinsey's previous research on the technology, what were some of the most surprising findings from the new IoT research? What were the areas where you found great uptake or where the use cases were more prevalent than in others?

**Mark Collins:** Looking at the settings or physical locations where IoT is deployed, of 99 individual cases, we found five represented 52 percent of the value in 2020. So a really big concentration in terms of where value is created.

The second thing that I found surprising is the massive growth of the connected home. Rewind the clock back five years ago, and the average American house had one connected device in it. We

fast forward five years, and homes have over five connected devices on average.

This shift has been born in part out of real innovation in technology with smart speakers, as well as us being caught in our homes for the last two years because of COVID-19. We're investing in the area around us, both to improve and make our lives easier.

**Roberta Fusaro:** You talked about how five areas accounted for more than half of the value that's being generated. What are the other four areas where you're seeing value created?

**Mark Collins:** Consumer applications is one of the fastest-growing areas, but it's not the largest as we think about it overall. And so when we look at the largest overall, what stood out to us were use cases related to human health in hospital, acute-care, and residential-care settings.

Also, we saw growth in operations and optimizations. So, how can we really drive greater efficiency, greater efficacy? And that was across the settings of factories, cities, and work sites. We also saw a real excitement around human productivity in the retail setting to really enhance what the experience can be for shoppers while also enabling companies to optimize both their revenue growth and their cost price.

**Michael Chui:** One of the remarkable things we've seen is that companies are deriving value from using these technologies. Whether it's in the factory, in healthcare, or in the automotive industry, we're seeing more and more cases where real value is growing and being created.

## Getting the integration of IoT right

**Roberta Fusaro:** Are there examples of companies that are truly getting the integration of IoT right?

**Michael Chui:** The World Economic Forum has identified a set of factories around the world that they describe as lighthouses. They are lighthouses in the sense that they are truly being forward-thinking in terms of the application of IoT within their factories.

For instance, they've deployed condition-based or predictive maintenance: rather than waiting for a tool in a factory to go down and bring down an entire assembly line, they're continuously monitoring the performance of that tool so as to avoid unplanned downtime.

So that lowers cost in terms of the maintenance itself, but more importantly, you don't lose the output of that entire line, which can be millions of dollars per day. And this is true in the chemicals industry as well.

**Roberta Fusaro:** I'm curious about one aspect of the consumer applications: It feels to me like one of the larger impediments to greater adoption is this privacy issue. How did that factor into the results of the research? And how can companies help resolve that tension?

**Michael Chui:** Privacy is absolutely a factor as we think about consumer preferences. And it's one which has increasingly become top of mind as we've seen very public incidents over the last few years.

Some companies make their value proposition based on privacy as they go forward. But what we also see is a tension for users because they want the convenience that many of these IoT devices can bring. They're seeking to balance these trade-offs between privacy, ease of use, reliability, ease of installation, et cetera.

## The impact of IoT on cities

**Roberta Fusaro:** What impact have you seen IoT have on cities?

**Michael Chui:** Cities are near and dear to my heart as a former municipal CIO [chief information officer]. One of the challenges that we've seen in a number of large cities around the world is the amount of traffic congestion in the center of cities.

A number of different cities have applied congestion pricing. They are tracking when vehicles are in the center of the city and charging for the times when congestion is highest. That doesn't necessarily make the driver happy, but we have seen material changes in traffic patterns within those cities that have invested in congestion pricing. You can think about a city being like a dynamic, living organism, and IoT can help it adjust.

**Mark Collins:** Taking the example of the living organism, we're seeing a real trend toward environmental, social, and governance [ESG] and sustainability right now. As someone who lived through the days of orange skies in San Francisco as a result of the fires a few years ago, I think we're seeing real focus now on things like air quality monitoring and water quality monitoring.

We're seeing cities intervene by deploying sensors to detect these things. We're also seeing democratization of that with private individuals

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—Michael Chui

paying for sensors that tell them the levels of air pollution in their region. These sensors allow governments to think about their response to pollution. And that can feed into decisions, such as what factories are going to be opened, where they're going to be opened, and what their hours are.

## What companies get wrong about IoT

**Roberta Fusaro:** So those are areas that show high promise and high activity. What are companies still getting wrong about IoT?

**Mark Collins:** I think one of the big findings when we looked back, relative to the research of five years ago, was that now largely we can say the technology is actually good enough. We've had huge maturation in things like network connectivity, battery power, computer advanced analytics, et cetera. What we saw happen all too often was IoT being treated as a technology project, often run by the CIO or by a small business unit or factory plant all by themselves.

And so the technology has changed, but the actual way of work has not. When we look at some of the lighthouse factories that Michael referenced earlier from the World Economic Forum, we see that they treat the integration of IoT as a holistic operating model transformation.

When they look at how systems and processes are going to change on the factory floor, for example, they think about how they may need to motivate individuals working within that system differently. And then to support that, they think about what are the KPIs and reporting that you need to be looking at on a forward basis. And we find when you bring these operating-model factors together with some of the fantastic technology that you have today, you really can produce some pretty magical results.

**Michael Chui:** As a former CIO, I feel the technology leadership is still important, though. We just need to make sure we have business leadership, too.

**Roberta Fusaro:** That's a good point, Michael. How should technology and business leadership be working differently to enable IoT initiatives?

**Michael Chui:** This is an old story. In any business application of technology, you need business leaders to partner closely with the technology leaders. To ensure smooth integration of IoT—because the technology has advanced a lot, you really need that coleadership.

At the end of the day, you need the business leader also to be able to say what's being targeted, for example, "We're going to target unplanned downtime. We're going to target inventory management cost. We're going to target our employees' safety." Whatever it is. That's the business result you're going for. Hopefully, the technology people are learning about that at the same time that the business people are learning about technology.

**Mark Collins:** To build off that, one of the themes that we heard in our client service is that the integration of IoT is often easier in greenfield settings. It's easy to build in the technology and the business icons from the start, or if you're a new IoT company being set up from scratch. Where we see this being a challenge is when you're trying to integrate it into legacy or brand field environments.

And that's not just the case of where you have a factory that's 50 years old that suddenly needs to be connected to the internet for the first time, but it's also in terms of companies that have traditionally sold unconnected products. How do they now move to a world which is much more software-driven, where they want to sell connected products going forward? In these situations, the connection between business leaders and technology leaders can have stunning results.

## The role of talent in the adoption of IoT

**Roberta Fusaro:** What role does talent play in the way that IoT is being adopted? Or is it holding the technology back?

**Mark Collins:** We see talent playing an absolutely critical role. And it's not just in terms of core academic disciplines, where there's a huge need for talent such as data engineers, data scientists, computer scientists, et cetera, who underpin all of the operations of analytics and IoT.

We also see it in terms of ways of working. We see companies doing really well when they're taking a design thinking methodology and working backward from their customers' needs all the way through to how they deliver it.

As we thought about the implications for governments or regulators, one of the key reflections that we had is how do governments and regulators think about turbocharging the talent that is needed to unlock this potential going forward. And that's going to require a whole raft of interventions all the way from primary and secondary and tertiary education through to thinking about skill development.

**Michael Chui:** Folks who know how to implement IoT and capture value from it in a business are in high demand. It is one of the bases of competition. And because IoT is not exclusive to the technology industry, you see automotive companies vying for the same talent as the tech industry.

## **Avoid a fragmented approach to IoT**

**Roberta Fusaro:** What's a typical example of some things that companies get wrong when they try to use IoT or implement IoT into their corporate strategies?

**Mark Collins:** What we sometimes see with large multinational companies that have global footprints is that there isn't a clear owner of IoT within the organization. And that leads to fragmented and decentralized decision making when it comes to IoT.

I remember an example: I was speaking with a colleague about a company that had multiple factories across the globe. And almost every factory had a bespoke application, a bespoke vendor for providing one single discrete use case.

Each of them worked well in terms of their individual silos, but when it came to looking across the company as a whole, it was next to impossible to get an aggregate view across the entirety of the company. It meant as you thought about scaling those solutions, you were structurally limited and almost had to go back to the start and reengineer.

I see a real theme around who owns the IoT agenda, particularly from multinational companies, and how being thoughtful about the short term and the long term, at a global and a local level, will allow you to capture value.

We've seen lots of examples where people buy a new piece of technology and it's used for the first week and then sits idle. And it's through uniting the business side and the technology side and changing the day-to-day ways of working that you get to real change for companies.

The classic example that Michael and I often talk about are the repairers, who, until recently, were the heroes of the hour when they fixed the repair. In the future, the hero of the hour will be the person who makes sure the repair is never needed in the first place. And so, you need to think totally differently about the KPIs, the incentives, and the performance management of people on a very practical level.

**Michael Chui:** Another thing that companies get wrong is they don't ensure that the machines they buy are connected to each other. A lot of companies that sell connected equipment to factories say that they'll do predictive maintenance, but unless all of the machines talk to each other, you're often going to underoptimize the performance of the whole factory.

When we did the analysis, well over 50 percent of the value that IoT can unlock requires interoperability. Unless the factory manager or the procurement manager specifies that connectivity and interoperability occurs, you'll have IoT devices that don't talk to each other.

## **Business ecosystems are critical**

**Roberta Fusaro:** What role do business ecosystems play in the changes you've seen? Is there more collaboration? Are these ecosystems bigger or better?

**Mark Collins:** I think ecosystems are absolutely critical as we think about the landscape going forward. And to give a very tangible example of this: One company I work with wants to deploy sensors within their production environment, and they

want to make sure that those sensors are secure. Making sure those sensors are secure requires having security designed in from the start. How is the network on which those chipsets communicate information secured? In the servers where that data is stored, how do we ensure that they are secure as well? And so, no single vendor can secure an entire IoT value chain. Rather, we need people who work together to integrate almost each layer of the stack to bring this together.

We have seen the emergence of platforms that are at scale that everyone can integrate with. We have not seen that emerge in IoT as of yet. And the emergence of that through an ecosystem play or through some other play is an unlock that we would be excited about.

## Applying IoT to supply chain and public-health issues

**Roberta Fusaro:** If we do this research again in another two to five years, what are some trends that you could imagine developing?

**Michael Chui:** We need our factories to be better performing. Look at all the supply chain issues that we've had. It has been, in some cases, a setting that ended up being slower growing than we thought back in 2015. At the same time, it actually is the largest potential source of value.

I'm not saying IoT can solve all of the problems, but if you have better visibility in your supply chain, if you have the ability to ramp up and down in volumes in your manufacturing, we can have a much more resilient and productive economy.

Hopefully, we will be able to manage the next pandemic, which I hope is a long way away, by better understanding how public health is doing and how we are all individually doing. Hopefully, our homes will become more energy efficient.

**Mark Collins:** We wrote this report in the middle of a pandemic. In many cases, the world is different now than when we started writing this report 18 months ago.

One CEO referred to there being a decade of progress in digital transformation in under ten months. And so, I think about how many of my clients are now achieving things at a speed that they would never have thought possible in equivalent time frames before. I also see the ambition levels increasing as they think about what they want to do, how they want to link the physical and digital worlds together and make concerted investments in things like digital twins and other technologies that not only would enable them to be better prepared for the future but also enable them to capture value and serve their customers better.

## It's time to go all in

**Roberta Fusaro:** What is one key takeaway you would offer business leaders to accelerate their adoption of IoT?

**Michael Chui:** I'd say, bring all of the innovation that you have in digital to the physical world using IoT. It turns out that to transform your business, you actually have to do a lot of things. It doesn't come down to one thing. That's what we've discovered. And so you really have to bring the whole playbook if you're actually going to transform using IoT.

**Mark Collins:** For me, it would be about thinking about how to start to sell and deliver outcomes versus technology.

**Roberta Fusaro:** In the research, you say, "Don't dip your toe in the water." What does that look like if you're an executive and you're maybe a little bit hesitant?

**Mark Collins:** Doing more things together means that you force change. And so, in the research that we've done every year, we've seen that those companies that deploy more use cases together in parallel consistently capture more value per individual use case. And that's because you force the rethink around your operating model, processes, incentives, and reporting. And it really serves as an unlock for the company.

**Roberta Fusaro:** What does it look like to deploy multiple use cases?

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**Mark Collins:** Multiple use cases may be occurring, but they may be occurring from different perspectives on different systems in different areas. And that’s why I think it’s so important to think about who is the IoT champion within your company. Who is the person that’s going to take on this mantle and lead forward? Because just by the act of appointing someone as the lead, you automatically enable greater coordination and greater visibility, which, as we’ve seen in our research, gives you a multiplier in terms of the outcomes you get.

### **IoT and the metaverse**

**Roberta Fusaro:** What role could IoT play in fostering the metaverse or challenging the metaverse?

**Michael Chui:** First, I want to recognize that there are a number of different opinions on what the metaverse is. So it’s hard to come up with a definitive answer that matches everyone’s definition. We tend to exclude user interface devices as part of the IoT, but nevertheless, those things are, from a very practical standpoint, metaverse related.

**Mark Collins:** Think about how you can create almost near-perfect replicas of things like telecom networks or electricity networks or

factory floors, where you can trial and test and get real-time feedback.

Sensors and IoT devices within these environments will provide the information to enable those digital twins to run in real time and give you the ability to think about how you can optimize. And these deliver benefits not just in terms of cost opportunity savings optimization but also in terms of situations such as telecom networks in the face of mass weather events when cell towers are falling over.

**Michael Chui:** If you have a digital twin of a factory and you can go into the factory and simulate what the operators might be able to do, you can start to train and you can start to optimize all those sorts of things.

### **What IoT can do for construction and healthcare**

**Roberta Fusaro:** Before we sign off, is there anything that you wanted to touch on that we’ve missed?

**Michael Chui:** One of the other settings that I’m excited about in which these technologies could be deployed is worksites. Productivity in construction has actually declined slightly over several years.

We badly need to do things such as building more housing. The hope is that IoT and other practices can improve the productivity of things like construction. That would be incredibly beneficial, not only to our economy but also for people.

**Mark Collins:** Michael, with you taking the efficiency angle, let me take the efficacy angle for a second. We spoke earlier about the impact of COVID-19 on the deployment of IoT. One area that has foundationally changed forever is the provision of healthcare.

The pandemic has reset how we interact with our healthcare providers. We're now in a world where the default is, "I'll engage with my primary care over unified communications (UC) or over my phone through videoconferencing. No longer am I going into a clinic or waiting room."

If you think about what IoT is enabling off the back of that, it's the ability to do diagnostic tests that were previously only possible in acute-care settings. Now, suddenly, I can do these with a wearable on my wrist and be done in 30 seconds. If I think about the potential for that not just to improve wellness but also for patients with acute and chronic diseases, it can make a real difference in terms of both quality of life and also detecting potential disease or deterioration earlier—helping to prolong life as well as expanding its quality.

## Segment Two: Look out for space junk

**Laurel Moglen:** At the time of this recording, a piece of space debris is expected to hit Earth's moon—if it hasn't already. That piece is not alone. Chris Daehnick, a McKinsey associate partner in the Aerospace & Defense Practice, says many thousands more are in orbit.

**Chris Daehnick:** The US Space Force tracks about 27,000 pieces of debris.

**Laurel Moglen:** That's 27,000 pieces of debris that are traceable. Chris says those pieces are—

**Chris Daehnick:** Roughly the size of a softball.

**Laurel Moglen:** What about the number of pieces that are not traceable?

**Chris Daehnick:** Several hundred thousand pieces, or at least a large multiple of the 27,000, are untraceable.

**Laurel Moglen:** What exactly are those thousands of pieces of junk?

**Chris Daehnick:** Space junk starts with pieces of rockets or old satellites that have outlived their usefulness. Everything from things that have fallen off the *International Space Station*, or the Space Shuttle in the past, or other spacecraft. In a few cases where someone has intentionally destroyed a satellite with an antisatellite weapon, that creates a huge amount of additional junk. You have things like paint flecks. There's even an astronaut's glove floating around out there.

**Laurel Moglen:** A paint fleck here on Earth is pretty innocent, but in space, it's a projectile that packs a punch.

**Chris Daehnick:** Somewhat notoriously, one of the space shuttles got a chip in one of its windows. It was a noticeable defect in the window when it came back to Earth. But didn't cause any greater damage.

**Laurel Moglen:** But greater damage is a possibility if space pollution increases?

**Chris Daehnick:** There is the potential over the long run that if you have enough pieces of junk in orbit and they begin to collide with each other, you could have almost a chain reaction. This was first theorized by a NASA scientist. It was called the Kessler Syndrome. We haven't quite reached that critical level yet.

**Laurel Moglen:** To avoid getting to that critical level, Chris says there are a few things we can do.

**Chris Daehnick:** Don't create debris intentionally. Improve the mechanisms for removing satellites once they're no longer active and have requirements that enhance the ability to get things out of orbit when they're a problem—when they're dead, literally.



**Laurel Moglen:** A couple of entities are taking an interest in the issue.

**Chris Daehnick:** The United Nations has taken this on. NASA has proposed some standards. I think it's safe to say there's interest from any space-faring nation. This is a common problem. The question, perhaps, is more about who is willing to take any sort of action.

**Laurel Moglen:** For now, that action depends mostly on the willingness of companies and individual nations.

**Chris Daehnick:** About all I can say is that we still don't have any agreement on that because now you're getting into sovereign rights and what a country is willing to limit for itself.

**Laurel Moglen:** Looking forward, it's expected there will be increased activity in space—from launching new communication constellations, greater human exploration, and space tourism. This heightens the chances of collisions.

**Chris Daehnick:** It's not going to be enough in the future to just hope that nothing bad happens. We are going to have to take a more active role in limiting debris.

**Laurel Moglen:** And, what about that piece of debris hitting Earth's moon? Chris says the moon will be okay. But it will spread a bunch of space debris around the surface and create a small impact crater.

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