

# The metaverse at work

A first look at how companies are navigating the industrial and enterprise metaverses

June 2023

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# Executive summary

The popular view of the metaverse is very futuristic, and many first think of purely digital environments focused on gaming, social networking, and commerce. Yet this picture is a remarkably small part of a greater whole, comprised of three distinct metaverses - consumer, enterprise and industrial - where the latter two are poised to progress more quickly in the near-term and provide tangible value, compared to the consumer metaverse, where much of the attention lays today.

This first-of-its-kind study focuses on the enterprise and industrial metaverses, and pushes beyond the theoretical to examine the state of play today. Conducted with individuals knowledgeable on the metaverse across six geographies and four industries, it presents a consistent global picture, and demonstrates how use cases are being practically planned and deployed differently across key verticals.

The research shows that the benefits realized by experienced early adopters generally exceed the expectations of those

in pre-deployment stages. It highlights the true challenges they've faced - often hinged on technical infrastructure - and that the partners they are employing to face these challenges are not necessarily the companies seen as driving the advancement of the metaverse.

This real-world approach proves that the industrial metaverse, particularly, is expected to deliver on and beyond expectations. These applications focus on enabling companies to do more with less and enhance the work employees are already doing. This report serves as a valuable guide for those beginning their journey with the metaverse and those looking to scale, by presenting the industrial and enterprise metaverses as they stand today, and the views of companies leading the charge.

## Key findings:

- ▶ Companies believe in the power of the metaverse - only 2% of respondents see the metaverse as a buzzword or fad.
- ▶ The industrial and enterprise metaverses are here, despite what some may think - 58% of companies who plan to enter the industrial and enterprise metaverses have already done so through at least a pilot program.
- ▶ The United States and United Kingdom are leading the way in actual experience - 65% of respondents in the US, 64% in the UK, and 63% in Brazil said they had a pilot or had fully deployed at least one industrial or enterprise metaverse use case; the average across Germany, Japan, and South Korea was 50%.
- ▶ The industrial metaverse is creating substantial business value - on average, 80% of experienced respondents believe that the industrial use cases tested will have a significant or even transformative impact on the way they do business.
- ▶ When asked to assess an array of use cases in the market today, respondents notably saw potential in all use cases, but viewed XR onboarding and soft-skills training as having the most potential impact among enterprise use cases and virtual R&D, prototyping and testing among industrial.
- ▶ The industrial and enterprise metaverses are exceeding expectations - companies having already deployed use cases report benefits more often than companies still in the planning phase expect. The most notable is cost reduction, with experienced companies citing a 15-percentage point increase in CAPEX reduction and a 6-percentage point increase in OPEX reduction.
- ▶ The enterprise and industrial metaverses require an extensive set of technical enablers, which many companies are not yet advanced in using - this gap in capabilities is most profound for cloud computing, AI, and network infrastructure and connectivity.
- ▶ Views on the companies leading the development of the metaverse and partners needed to deploy use cases are not always aligned - AI/ML providers and network infrastructure providers, for example, were not seen as driving development but considered key partners in deploying use cases.
- ▶ There are many risks and challenges companies face in entering the industrial and enterprise metaverses - from cybersecurity and data privacy concerns to challenges in finding people with the right expertise, proving ROI and driving adoption internally, companies face several barriers. Many companies are starting with quick wins to build confidence and knowledge to overcome these hurdles.

# About this study



## Respondents accessed through:

- Quantitative survey
- Qualitative interview
- Quantitative & qualitative

**The metaverse at work** is based on an online survey conducted by EY teams in collaboration with Nokia, of 860 business leaders in the US, Brazil, the UK, Germany, Japan, and South Korea across four key industries: automotive, industrial goods and manufacturing, transportation, supply chain and logistics, and power and utilities. To support our findings, we additionally conducted 22 in-depth interviews with topic area experts and industry leaders in metaverse across the four industries listed, plus interviews with leaders in public safety and defense. The research was conducted in March 2023. Respondents from automotive companies have been considered in the industrial goods & manufacturing industry if they sit within operations and production functions due to similarities in manufacturing between the two

industries, while respondents from all other functions within automotive are considered within the automotive industry.

The survey is designed to capture companies' current maturity and mid-term goals in adopting enterprise and industrial metaverse use cases. Our findings assess the key drivers, benefits, challenges and risks associated with deploying use cases in the metaverse, as well as the enablers and partnerships required to drive value.

Our research targets leaders (Director, VP or C-level) with moderate to extremely high levels of topic area knowledge reporting plans to develop capabilities in the metaverse, regardless of time to launch. Individuals failing to meet this criteria were excluded from the research.



# 1 What is the metaverse, and is it just hype?

Interest in the metaverse has skyrocketed in recent years, with amplified hype in the gaming, social and consumer spaces. Now the hype has begun to fade, and perhaps with that, deflating expectations about the value the metaverse will bring to society. But don't feel disillusioned - metaverse and metaverse technologies are here to stay. The market is re-adjusting and re-focusing on concrete use cases to pressure-test the contributions and real value the metaverse can bring.

This re-focusing has **solidified that the industrial and enterprise metaverses are here and offer real, lasting value** beyond the hype - by enabling companies to build upon their existing digitalization efforts and drive greater efficiencies, sustainability and safety improvements.

# 58%

of companies with future metaverse plans have already begun their metaverse journey and have deployed or piloted at least one metaverse use case in their organization.

## Consumer Metaverse

The consumer metaverse is centered around computer-generated environments where users can interact, purchase items, game, and have experiences like they would in the real world through digital only or digitally-augmented means.

## Enterprise Metaverse

The enterprise metaverse is driven by demand for better digital collaboration and communication tools. It will envelop the core productivity applications that make business function and allow for the next generation of virtual connections.

## Industrial Metaverse

The industrial metaverse is a physical-digital fusion and human augmentation for industrial applications; this includes digital representations of physical industrial environments, systems, processes, assets, and spaces that participants can control, monitor, and interact with.

Focus of this report



## Business leaders' views on the metaverse are optimistic, especially for those with hands-on experience

Given the metaverse is still a relatively new concept to most, there are questions about its true potential and long-term viability. However, many business leaders are optimistic about the applications and benefits the metaverse can offer.



Our kickstart in the metaverse was both driven by market trends and internal business demand.

VP of IT, Global Automotive Supplier

**Figure 1.1:** Which aligns most closely with your views on the metaverse?



\*All-encompassing view: The metaverse is a persistent and interconnected network of 3D virtual worlds that will eventually serve as the gateway to most online experiences and underpin much of the physical world.<sup>1</sup>

**Figure 1.2:** Experienced companies' views

1+ use cases deployed or piloted



**Figure 1.3:** Inexperienced companies' views

Companies planning to deploy use cases



Today, business leaders' views are becoming less dependent on market trends and based more on their first-hand experience with the metaverse. Most respondents indicated they see the potential for the metaverse to revolutionize digitalization or the internet as a whole, and this is especially true if their company has already deployed or piloted an industrial or enterprise metaverse use case.

For those inexperienced companies, who have interest in the metaverse but no tangible experience yet, over one-fifth of respondents still see the metaverse as an evolution of gaming and social networks. For those who have tested or

deployed use cases, that number shrinks to 7%, with 91% of respondents believing in the value of the metaverse outside of simply social and gaming applications.

This overwhelming majority of responses aligning to the all-encompassing and digital views is likely built on the promising, albeit early, results of industrial use case deployments and pilots. These industrial use cases span processes across a business's value chain, from design to production and delivery. Companies can create ongoing value in these areas in a way that has not yet been seen in the consumer metaverse.



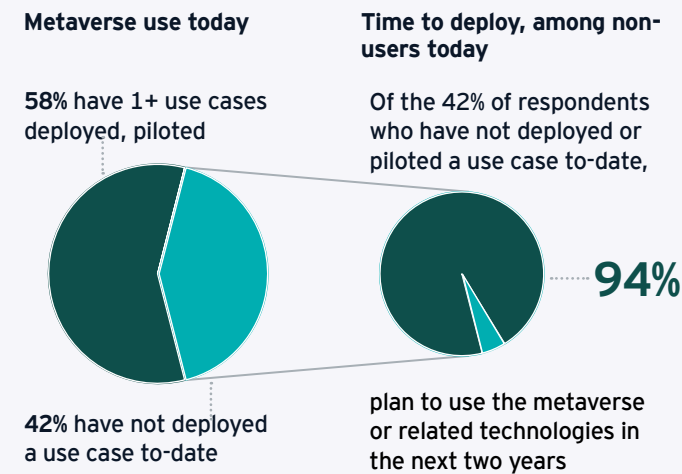


# 2 The state of the industrial and enterprise metaverses today

The industrial and enterprise metaverses are not simply a future-state vision garnering optimism from business leaders - they're here.

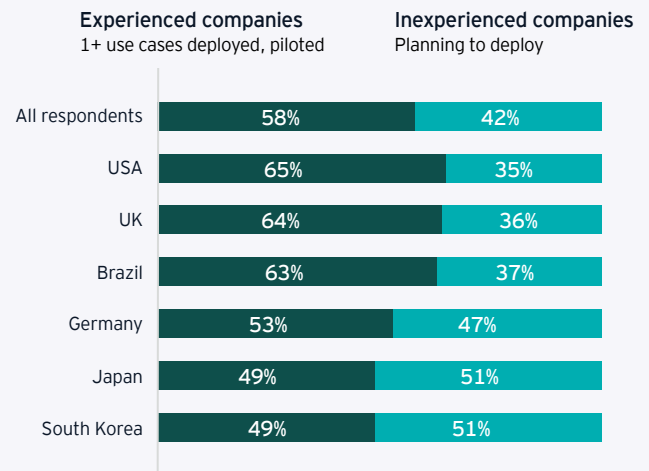
To many, the industrial and enterprise metaverses are not a bet, but rather a viable opportunity to drive value such as process efficiency and improved collaboration. Among companies interested in or considering using the metaverse, 58% are already piloting or deploying use cases. The US (65%), UK (64%), and Brazil (63%) are currently leading the way, where companies who have plans to enter the metaverse have deployed use cases at a higher rate than others across Europe (Germany 53%), and Asia-Pacific (Japan 49%, South Korea 49%) [Figure 2.1].

**Figure 2.2 :** Estimated time to use the metaverse, among respondents with no pilots or deployments to-date



Our survey polled business leaders with interest in using the metaverse. Within this population, 58% overall are experienced - having already deployed or piloted a metaverse use case today.

**Figure 2.1:** Hands-on metaverse experience today, across key geographies



For the 42% of inexperienced respondents, who have interest in using the metaverse but not yet to the pilot or deployment phase, the metaverse is still not a far-fetched concept. 94% of these respondents plan to pilot or deploy use cases leveraging metaverse technology in the next two years [Figure 2.2].

Like any other emerging technology, there is a learning curve with the metaverse - both for those beginning the journey and for those looking to expand and scale solutions. Many first movers are still learning what it means to build and interface with the next generation of the web or digitalization - this means defining the human and technical enablers for deploying use cases and developing the right partnerships.

Still, based on our research, companies that are taking the leap and experimenting with metaverse are recognizing tangible benefits out of the gate. These experienced companies serve as not only an important bellwether, but an example for those still planning or gathering internal support for future activities with the metaverse.

# 3 The metaverse and industry 4.0

## What does the metaverse bring to industry 4.0?

96%

of respondents agree that the metaverse brings additional innovative capabilities that will accelerate deployment, adoption, and monetization of industry 4.0 projects by mixing physical and virtual use cases.

This digital-physical fusion notably makes the increasingly complex data landscape companies are facing in industry 4.0 more human-centered and allows greater collaboration across ranks and skill levels.

**Metaverse is often a continuum of industry 4.0 capabilities, and many companies with advanced industry 4.0 solutions may be closer to employing the metaverse than perceived.**

By building upon industry 4.0 solutions and assets with the visualization and data interoperability that metaverse provides, companies can **make the insights and outputs more accessible and interpretable** to all employees for better planning, development, and execution. For example, companies can leverage VR headsets to allow for immersive 3D data visualization along the X, Y and now Z-axis, or third dimension, creating an improved understanding of data and the relationship between variables. **In other words, these elements which were once two-dimensional can now be interpreted intuitively through experience rather than analysis.**

## Example: improving and operationalizing predictive maintenance



### Industry 4.0 solution

Predictive maintenance is helping improve machine lifespans by pre-identifying maintenance needs and displaying in a maintenance dashboard.



### Adding in the metaverse

Predictive maintenance can become more actionable when visualized through a digital twin of an entire facility or of the machine itself.



### Longer-term opportunity

By adding facility planning capabilities to digital twins, companies can assess repair needs, plan factory rearrangement and simulate the optimal way to minimize downtime during repair windows.

## Industry 4.0

Industry 4.0 is the implementation of digital technologies to increase automation, predictive maintenance, self-optimization of process improvements and drive new level of efficiencies and responsiveness.

### Overlap example: Digital twin technology

## Industrial metaverse

Industrial metaverse adds the use of visualization tools, that allow new insights and data capabilities (i.e., interacting with a digital twin in an immersive environment).



“

Metaverse adds a different layer of interactivity and immersion. Industry gives the outputs of data simulation, but we can now watch and experience scenarios playing out.

Leading futurist in emerging technology









# 4 Industrial and enterprise metaverse use cases

We asked respondents to report anticipated business impact and actual deployment activity across a range of key enterprise and industrial metaverse use cases in the market today.

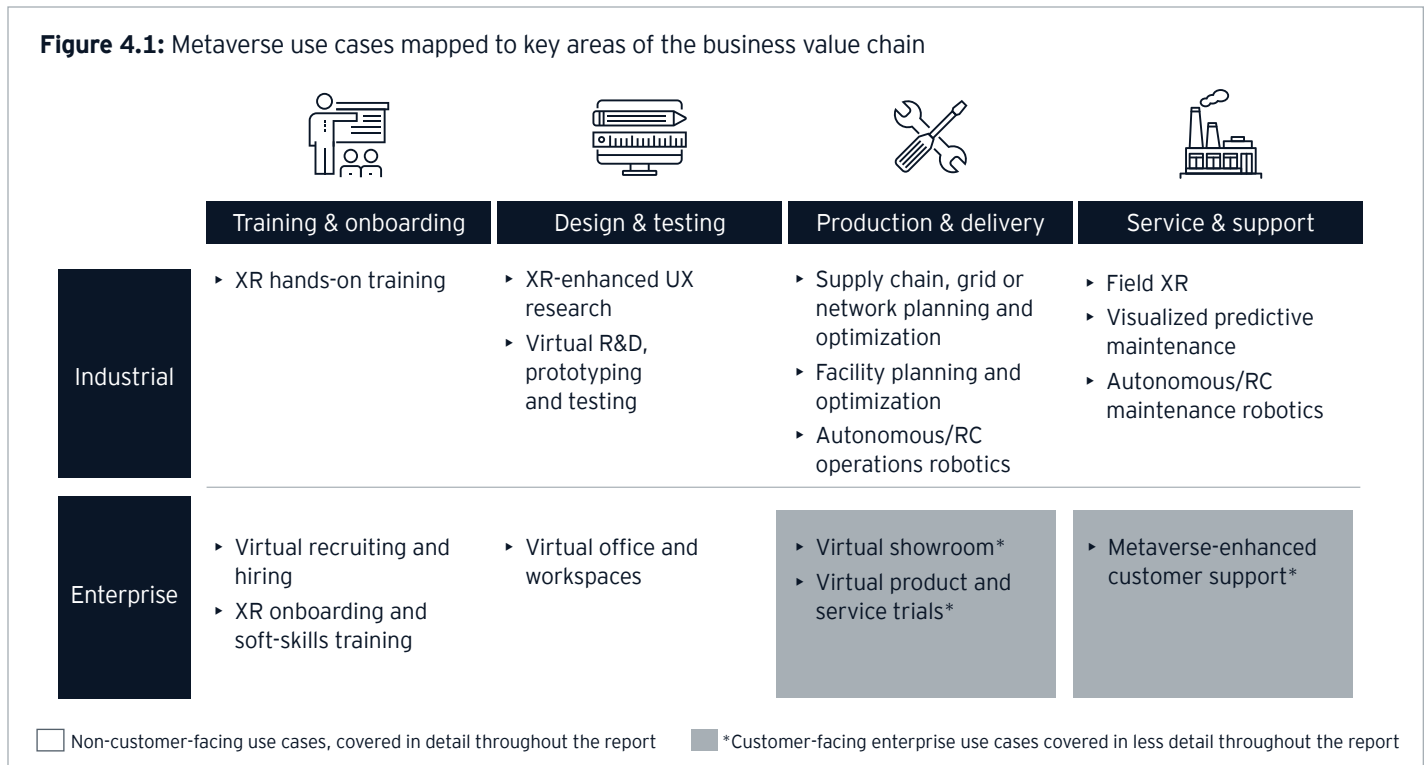
## What defines a use case in the industrial and enterprise metaverses?

Among today's most prevalent applications of the industrial and enterprise metaverse, some are novel solutions made possible by metaverse-enabling technologies like digital twins and extended reality (XR) headsets, while others are enhanced versions of technologies that have been around for decades. However, all the use cases share a few common characteristics:

- ▶ Use cases are either **purely virtual or combine virtual and physical elements**.
- ▶ Use cases **add enhanced visualization and contextualization** to traditional software and solutions.
- ▶ Use cases are defined as a **scenario or application of a metaverse technology**, not the technology itself (e.g., digital twin).

Although the full potential of the metaverse may still be unknown, industrial and enterprise use cases [Figure 4.1] are being deployed across the value chain to improve existing business processes by offering visualization, data interoperability, and interwoven digital-physical worlds.

**Figure 4.1:** Metaverse use cases mapped to key areas of the business value chain



See appendix for use case definitions.



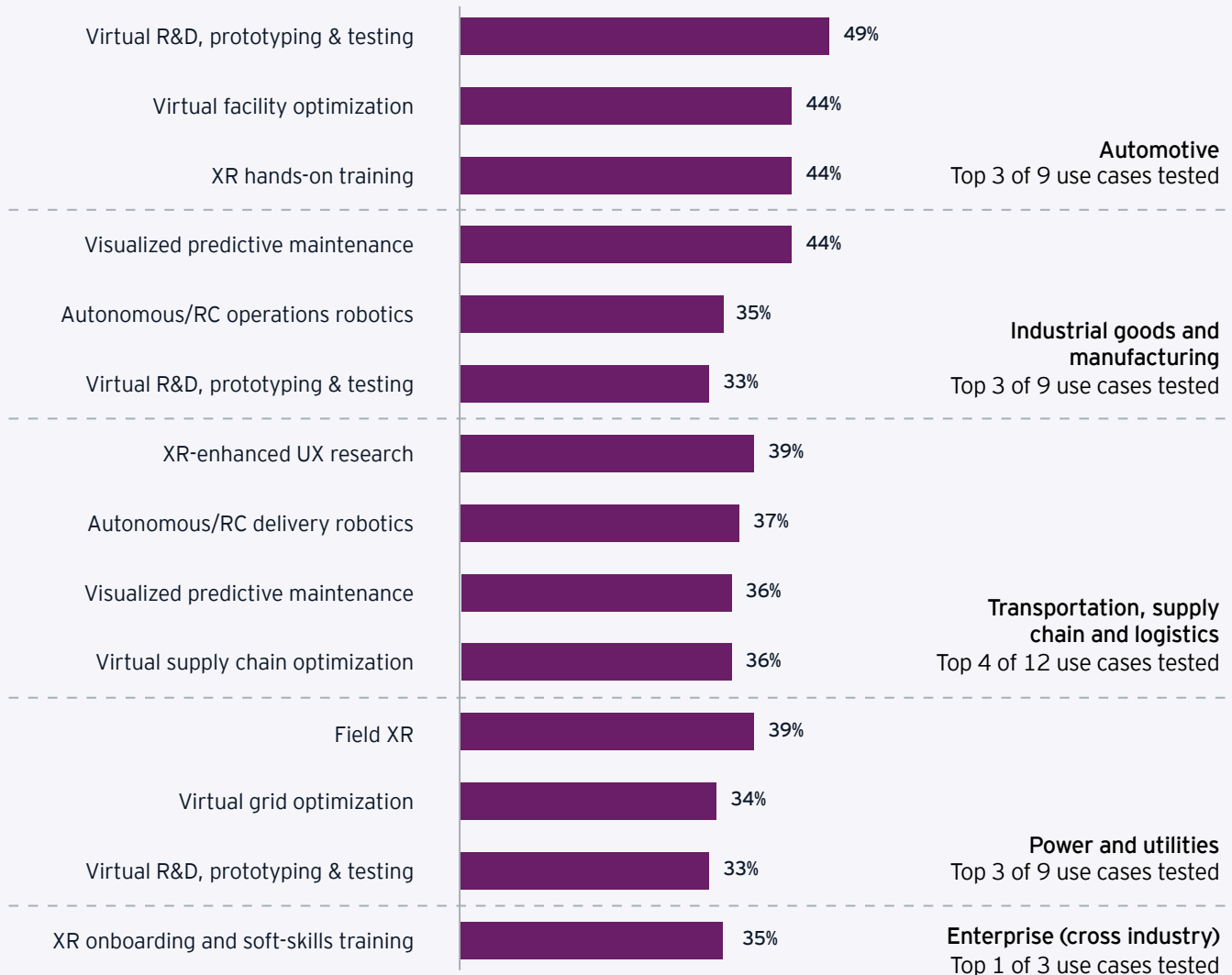
# Top use cases across industries

Each industry tested has different views on which industrial use cases they believe are most likely to deliver transformative value, based on their current operations today. Overall, automotive respondents are the most optimistic on the value that industrial metaverse use cases can bring to their business.

Across industries, some uses cases, like virtual R&D, rank highly in terms of potential transformative impact (3 of 4 industries), while others offer potential that is more attractive to certain industries. Field XR, for example, is seen as having more potential by power & utilities companies due to the ability to provide field technicians with better remote assistance in interacting with dangerous connected grid infrastructure. **Figure 4.2 shows the use cases respondents in each industry expect will have the biggest impact on the way their company operates in the future.**



**Figure 4.2:** Use cases most expected to deliver transformative value, by industry



For detailed definitions of each use case presented in the report, see Appendix [page 38]

## Transformative value does not always imply deployment

The extent to which these use cases are being planned and deployed does not always align to their expected impact. This can vary for a range of reasons, including the maturity of the enabling technologies, the complexity and scale of the use case, and the partners and technical infrastructure required to fully capture the value of the technology. What is clear, however, is that respondents across industries are aware of the large impact the metaverse can have throughout their company. The following pages look closer at the reported rates of deployment and benefits experienced from these use cases.

# Training and onboarding

To many, the core application of the metaverse and VR technology is training. For both the development of hard and soft skills, companies are exploring the ways the metaverse can create immersive experiences to onboard and upskill their workforce.

## XR hands-on training [Industrial]

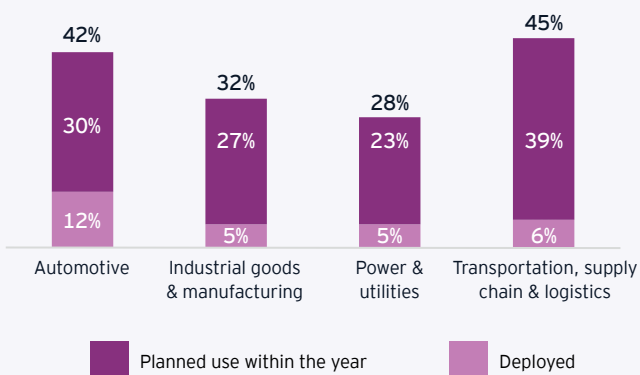
Extended reality (XR) allows for high-fidelity training experiences that replicate real-world scenarios without requiring the machinery, equipment, and risk necessary to performing the task in the real world.

Experienced respondents cite CAPEX reduction (65%), safety improvement (59%) and sustainability (47%) as key benefits of this use case. XR hands-on training programs drive these benefits in a few different ways. For example, these programs scale easily once developed and reduce or eliminate the need

for machine downtime and cycles committed to training. Further cost reduction and sustainability can also be achieved by eliminating the need for travel to training sites, all while reducing risk of injury and extending machine lifetimes.

Overall deployments (5% across industries) and planned deployments are slightly lower than deployments reported for other use cases (7% average across use cases); this is likely due to increased complexity in building the use case for a range of machines and product configurations.

**Figure 4.3:** Deployment of XR hands-on training by industry



**Figure 4.4:** Key benefits reported by companies currently using XR hands-on training







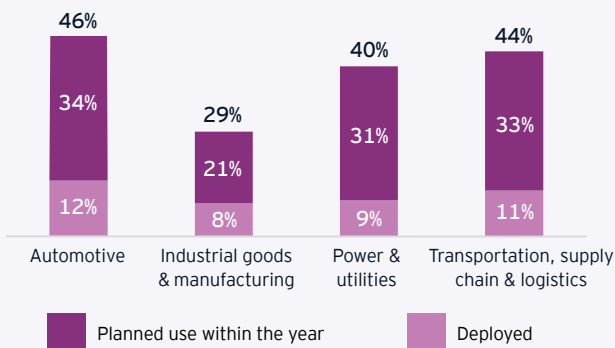
## XR onboarding and soft-skills training [Enterprise]

XR-based metaverse environments can also enhance onboarding processes and soft-skills training, with companies already testing a variety of programs around DE&I, customer service, and public speaking.

Across industries, 9% of respondents reported that they had already deployed the use case; this is likely due to respondents seeing strong benefits from this use case that touch both employees and customers - which they cite as new business models and offerings (63%), enhanced service and

CX (47%), staff retention and upskilling (47%). Fortune 500 companies like Volkswagen are making strides in the space, using VR to train employees in customer service practices and onboarding, in addition to hands-on training modules for production processes.<sup>2</sup>

**Figure 4.5:** Deployment of XR onboarding and soft-skills training by industry



**Figure 4.6:** Key benefits reported by companies currently using XR onboarding and soft-skills training



# Design and testing

The metaverse can enhance the product design and engineering process by creating more collaborative working environments and increasing the simulation and testing capabilities of existing technologies.



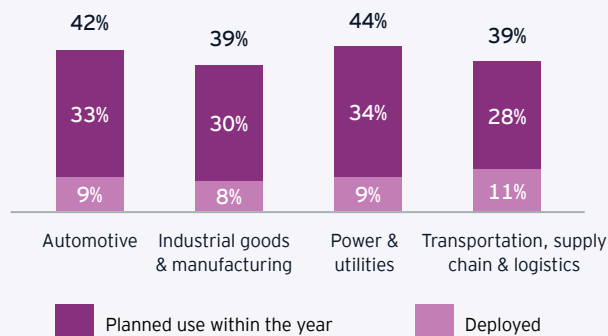
## Virtual R&D, prototyping and testing [Industrial]

Although many have been designing and testing products and machinery virtually for decades, enterprises are now looking to metaverse technologies to create higher-fidelity solutions with greater collaboration capability.

The appeal of this use case is clear, with high rates of deployments and planned deployments across all industries. **Overall, this use case ranks highest in terms of deployment out of all the industrial use cases tested.** Experienced companies report a range of benefits including process efficiency (63%) and safety improvement (59%) stemming from the ability to more effectively design and test products

than in past virtual environments, prior to real world production and use. Also noteworthy is the effect on staff retention and upskilling, with many interview participants saying metaverse technologies and a tech-forward reputation help them attract and retain top talent.

**Figure 4.7:** Deployment of virtual R&D, prototyping and testing by industry



**Figure 4.8:** Key benefits reported by companies currently using virtual R&D, prototyping and testing







## XR-enhanced UX research [Industrial]

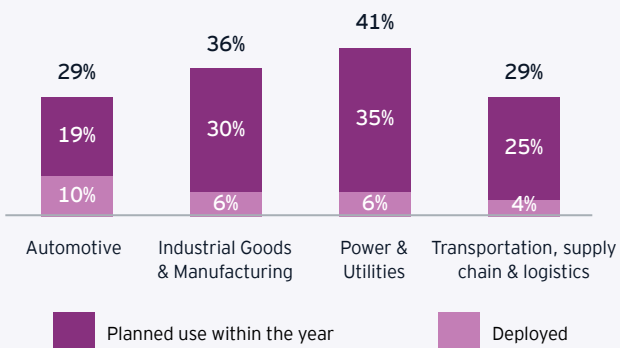
XR technology can also enhance and expedite user testing by using VR to test products prior to production or by using AR to overlay virtual elements on the real world in research.

Perhaps somewhat delayed by the current development of AR, still, 10% of automotive respondents reported deploying this use case within their company. Respondents from other industries express plans to test the technology at a higher rate than automotive (30% on average vs. 19% in automotive), which our interviews indicated may be lower as a result of challenges faced by early adopters in the industry. However, testing using VR is showing promise in certain cases. For

one automotive company interviewed, testing the driving experience in VR as a user with various physical attributes allowed them to limit the impact of glare for shorter drivers prior to production.

Overall, the top benefit reported by experienced companies is sustainability (61%): user testing in XR prior to production can limit waste and time lost compared to catching problems in physical testing or once products reach production. Additionally, the enhanced user testing and added process efficiency is benefitting the customer for almost half of companies currently using the technology.

**Figure 4.9:** Deployment of XR-enhanced UX research by industry



**Figure 4.10:** Key benefits reported by companies currently using XR-enhanced UX research



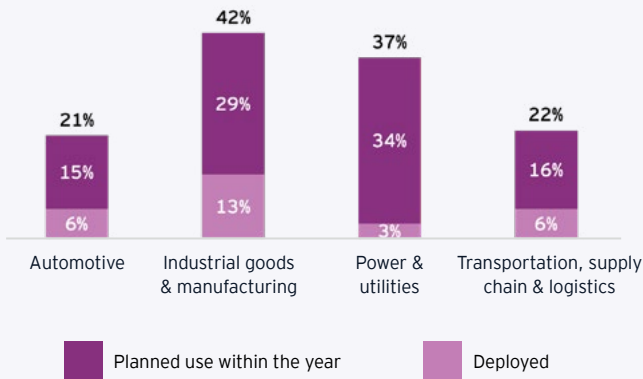
## Virtual office and workspaces [Enterprise]

The metaverse also offers the chance to create more collaborative and immersive workspaces, by both enhancing the abilities of a single employee through infinite workspaces (not bound by what fits on a screen or desk), or by creating a single, gated point of access for global teams.

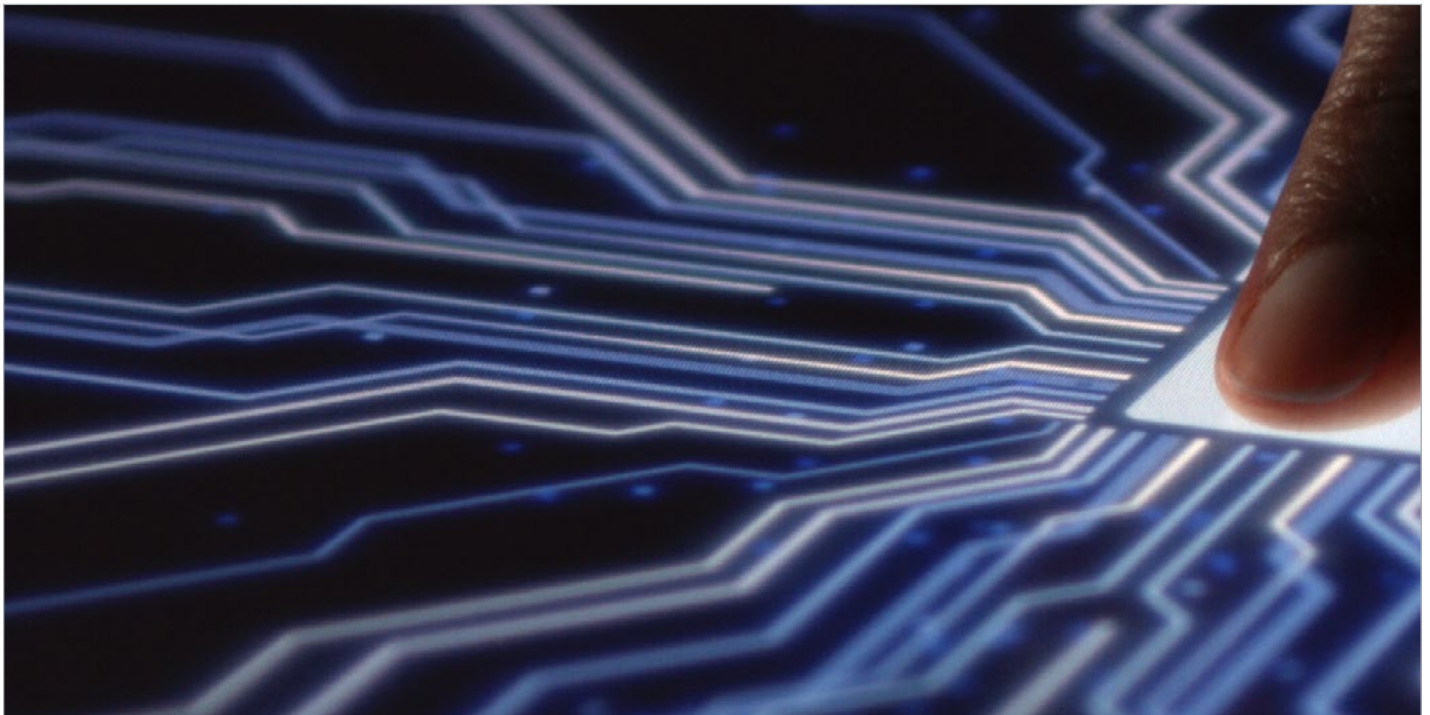
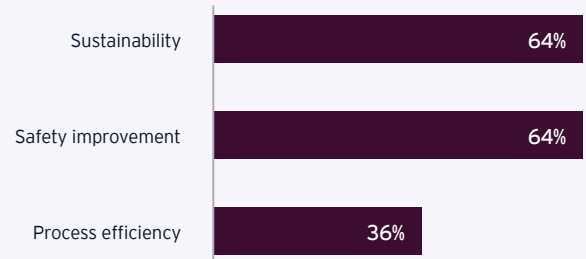
Many companies are still adjusting to hybrid working models that are based on technologies like Zoom and Slack, which may be the reason why metaverse-based virtual offices and workspaces is the least deployed of the three enterprise use cases tested in the survey. But those experienced

companies who have deployed virtual offices and workspaces as a use case are already seeing the benefits. Like other design and testing use cases, sustainability and process efficiency (both 64%) were among the top benefits reported as a result of the ability to better collaborate remotely. Improvements in safety are also key benefit, not only physically but also in terms of cyber safety; companies are limiting hacks by keeping data off hard drives and gating information in highly-secure metaverse environments.

**Figure 4.11:** Deployment of virtual office and workspaces by industry



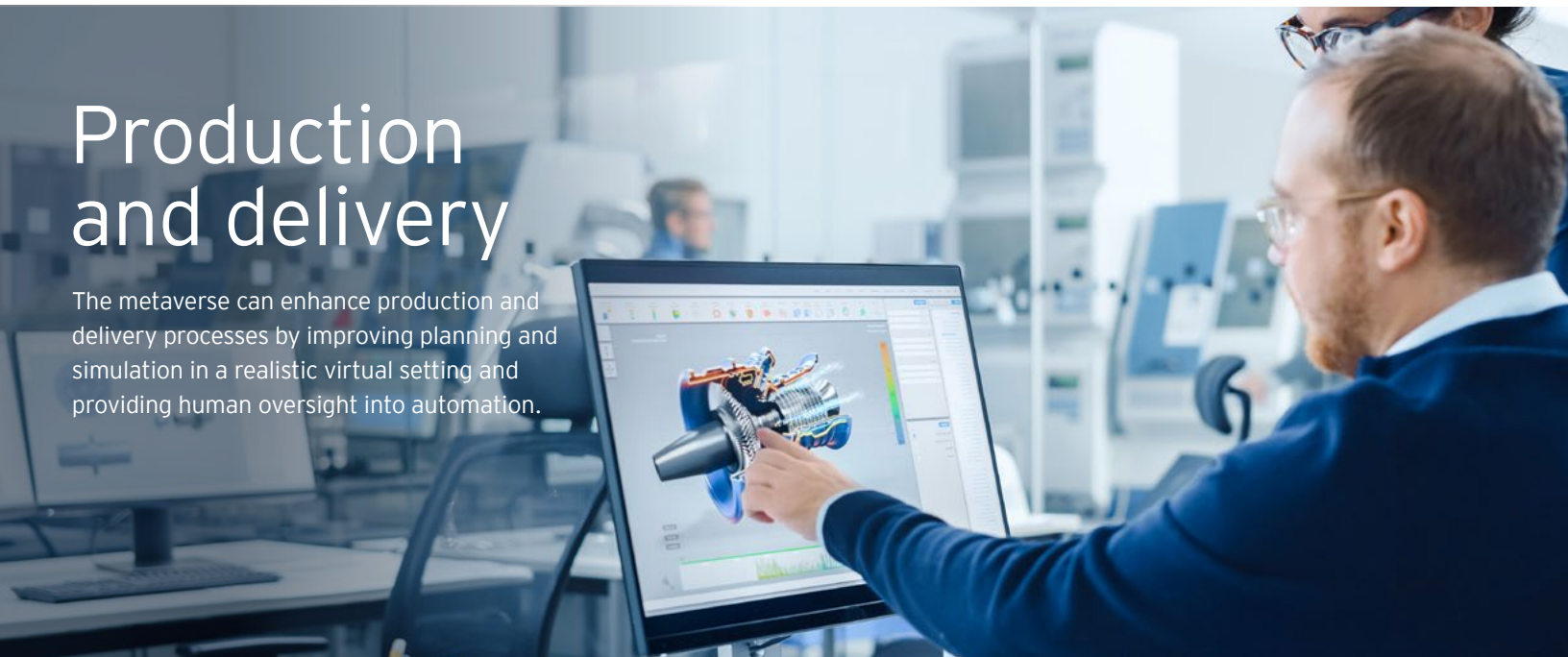
**Figure 4.12:** Key benefits reported by companies currently using virtual office and workspaces





# Production and delivery

The metaverse can enhance production and delivery processes by improving planning and simulation in a realistic virtual setting and providing human oversight into automation.



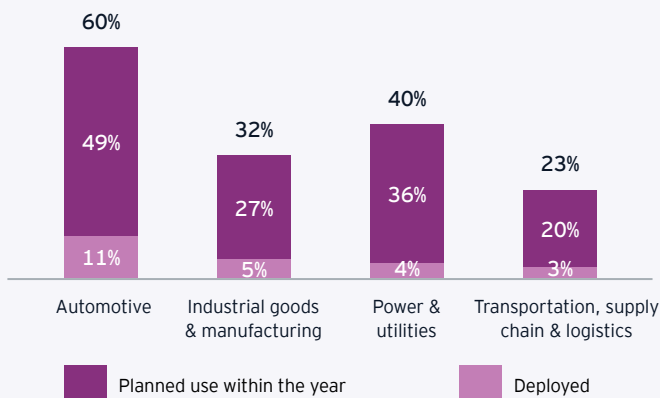
## Virtual facility optimization [Industrial]

Metaverse enabling technology, like the digital twin, offers the opportunity to overhaul the way companies plan and track their facilities and the processes within them. Virtual representations of facilities can also serve as a high-fidelity reporting dashboard for advanced data capture from Industry 4.0 solutions and monitor assets via smart sensors.

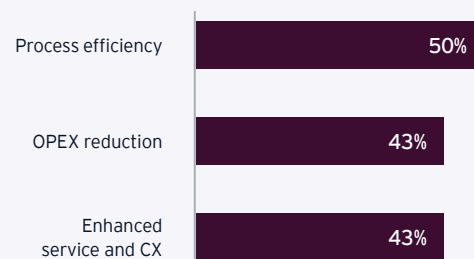
Automotive respondents are the most enthusiastic about this use case, deploying and planning at almost twice the rate reported by respondents in other industries. Automotive respondents in operational functions (considered within industrial goods and manufacturing vertical) also reported deployment at approximately twice the rate of other

subsectors in industrial goods and manufacturing. Because automotive companies engage in just-in-time manufacturing practices and have unique volume and complexity demands, there is greater need to reduce any potential downtime that comes from factory rearrangement. Optimizing facility layouts in virtual environments and tracking them in real-time allows manufacturers to simulate the optimal layout, prior to changing the physical space, driving more efficient processes and OPEX reduction. These solutions can also span the product lifecycle, for instance, allowing a customer to see a custom product they order in production or tour the factory.

**Figure 4.13:** Deployment of virtual facility optimization by industry



**Figure 4.14:** Key benefits reported by companies currently using virtual facility optimization



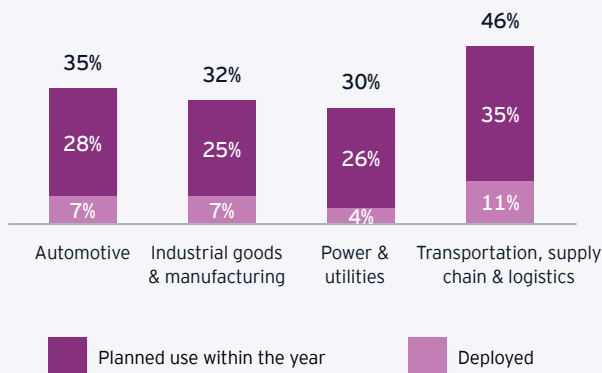
## Autonomous/remote-controlled (RC) operations robotics [Industrial]

By deploying, monitoring, and controlling operational robots in virtual environments, companies can streamline processes and create greater human oversight and intervention abilities (1 human can control multiple robots in a metaverse environment). Additionally, camera-mounted robots (e.g., drones or AGVs) can limit inspection risk, by providing remote specialists with a virtual view into a facility or machine.

Transportation, supply chain, and logistics companies reported deploying this use case at the highest rate, likely

as a result of the number of tasks able to be automated and augmented by metaverse controlled operations robots both inside a companies' walls and beyond. For companies that have already deployed this use case, key benefits include sustainability (74%), safety improvement, (53%) and time to market (53%). For example, Kroger, a US supermarket chain, is increasing safety and fulfilling orders more quickly in their Ohio "Hive", using over 1,000 robots to pack 20,000 online orders daily alongside just 400 human employees, using AI to optimize the layout and processes.<sup>3</sup>

**Figure 4.15:** Deployment of autonomous/RC operations robotics by industry



**Figure 4.16:** Key benefits reported by companies currently using autonomous/RC operations robotics

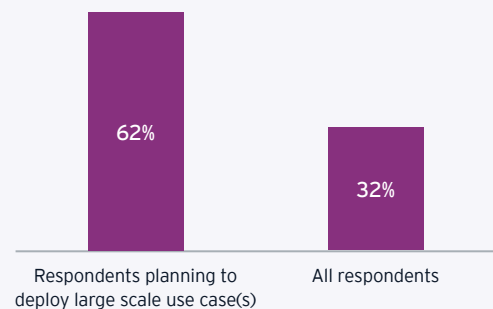


## Companies with previous success in using metaverse are more willing to tackle complex use cases

When looking at larger geo-spatial environments, metaverse technologies can revolutionize the way companies plan, track and adjust large-scale systems and processes such as supply chains, power grids, and transportation networks.

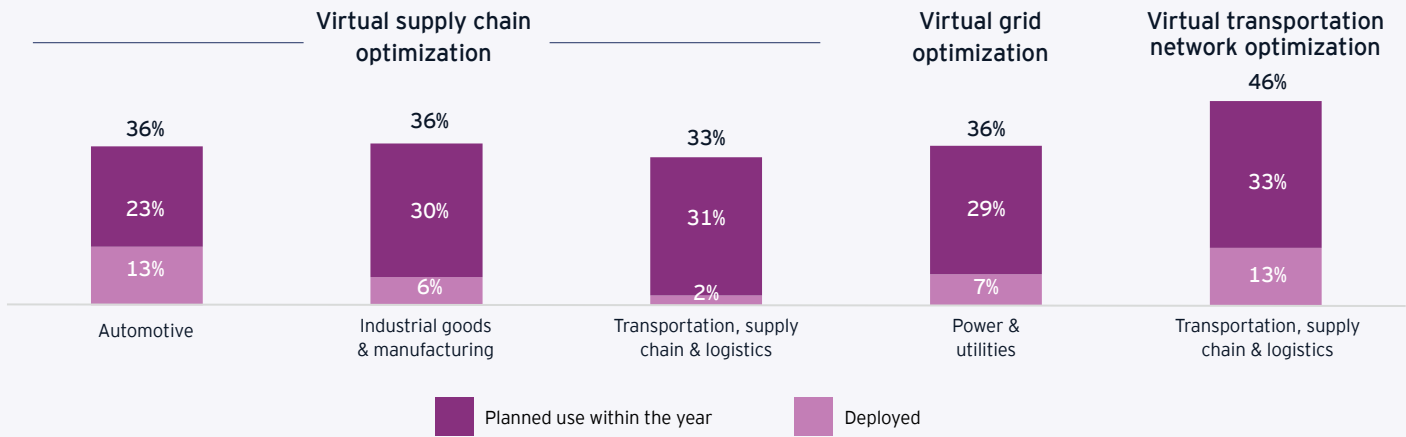
Those planning to use larger-scale metaverse use cases reported having previous experience at nearly twice the rate of other respondents in the survey.

**Figure 4.17:** Percentage of respondents with one or more previous metaverse deployments (not including pilots)





**Figure 4.18:** Deployment of large-scale metaverse use cases (virtual supply chain, grid, transportation network optimization) by industry



### Virtual supply chain optimization [Industrial]

Along the supply chain, the metaverse can serve as a point of connection for data from suppliers, production, and sales to help optimize forecasting and track the flow of goods. Automotive respondents reported deploying the technology at more than twice the rate of the next closest industry (industrial goods and manufacturing), as they work with a wide range of suppliers and dealers and can use the metaverse to connect sales data with production and supplier data, thus improving the accuracy of decision-making and efficiency of just-in-time manufacturing practices.

### Virtual grid optimization - power and utilities [Industrial]

The metaverse can also be used to better monitor and understand power grids. By creating digital representations of the assets within the grid and connecting usage data with the outputs of predictive maintenance models, companies can create an interconnected system that better supports operations and informs decision-makers. This can also be used in simulation to plan for consumption rates and in the face of severe weather events, plan reactions that will minimize the duration and size of blackouts.

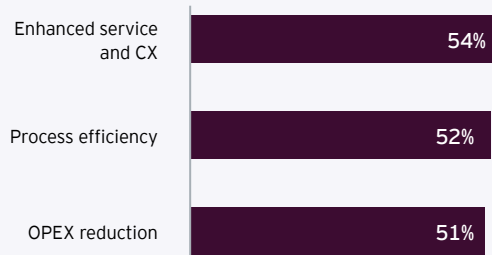
### Virtual transportation network optimization- transportation, supply chain, and logistics [Industrial]

Transportation companies are using industrial metaverse technologies like digital twins to plan the layout of fixed transportation networks like railways and highways to better design the initial layout, and to simulate events

and passenger flows prior to any actual development or construction. For active transportation networks, the metaverse can help in capacity planning the allocation of assets like trains on a rail network or emergency vehicles along highways to minimize energy use and increase safety.

**Key benefits** reported by companies using large-scale metaverse use cases include enhanced service and CX and process efficiency, both driven by enhanced consistency throughout supply chains, transportation networks, and grids. Additionally, OPEX reduction was cited by many due to limited fuel consumption and cost savings related to better initial planning and tracking of these systems.

**Figure 4.19:** Key benefits reported by companies currently using large scale metaverse use cases (virtual supply chain, grid, transportation network optimization )



# Service and repairs

XR and metaverse technology are also being used to enhance post-sale service and repairs and to improve internal processes around maintenance for machinery and equipment.



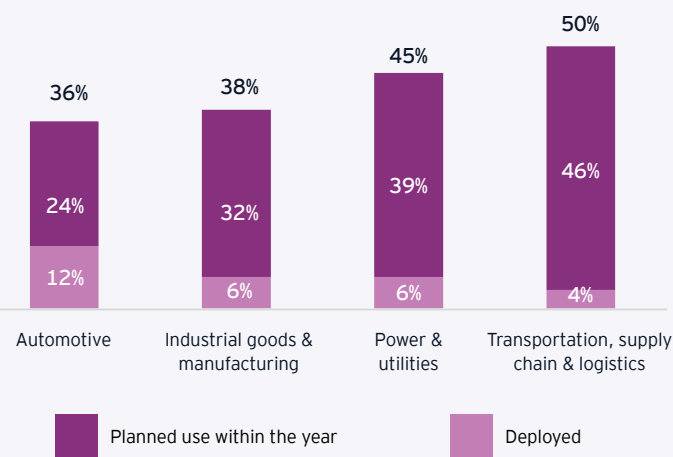
## Field XR [Industrial]

By using XR headsets or AR-enabled devices, companies can augment the capabilities and reach of technicians, maintenance workers, and other employees who can see equipment and infrastructure in entirely new ways and share these views with remote specialists when additional help is needed. This technology can also be extended to production and assembly, where AR can overlay manuals and guides onto the physical world.

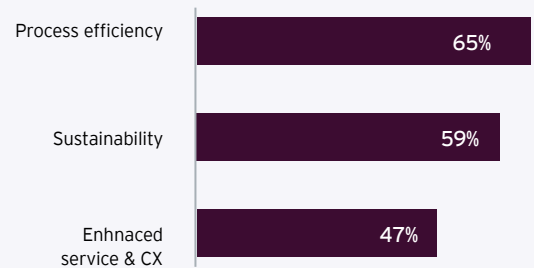
Like other AR-enabled use cases (e.g., XR-enhanced UX research), automotive is leading in deployments, reporting experience using the technology at over twice the rate seen in other industries (12% vs. 6%). However, they also have the lowest proportion of respondents planning to test the use case within the year, again showing their more realistic views on the current state of AR.

Benefits reported by companies currently using Field XR reflect the reduced time and increased efficiency of repairs, with process efficiency ranking highest. This use case also provides the benefit of enhanced service and CX especially when used in post-sale maintenance and repairs.

**Figure 4.20:** Deployment of field XR by industry



**Figure 4.21:** Key benefits reported by companies currently using field XR



Our headsets allow digital instructions to be viewed and executed completely hands-free. We also have a remote subject-matter expert for routine maintenance, inspections troubleshooting and live repairs. This allowed the workers to be more effective in a very safe environment.



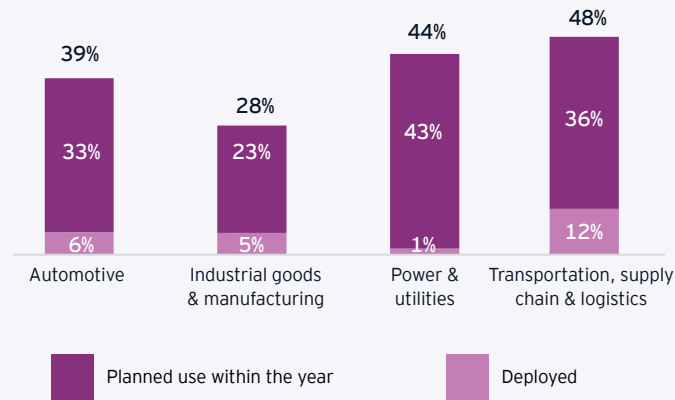
## Visualized predictive maintenance [Industrial]

Another opportunity to enhance maintenance for both internal and post-sale operations is through visualized predictive maintenance. By overlaying the output of sensor data on a digital twin, information can be made more actionable for technicians.

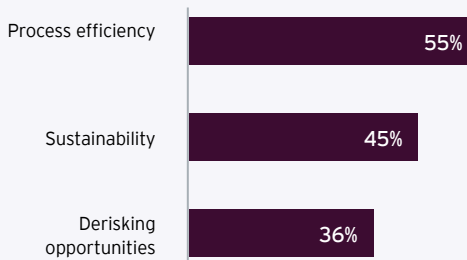
Transportation, supply chain and logistics companies are showing most interest in this use case with 12% of respondents having already deployed and additional 36% planning to use within the next year.

Key benefits experienced by companies that have deployed this use case include process efficiency (55%) and sustainability (45%) due to minimized machine downtime and extended machine lifetimes. Visualized predictive maintenance was also seen as the use case most benefitting companies in de-risking opportunities by ensuring a company's most important assets will not unexpectedly fail.

**Figure 4.22:** Deployment of visualized predictive maintenance by industry



**Figure 4.23:** Key benefits reported by companies currently using visualized predictive maintenance

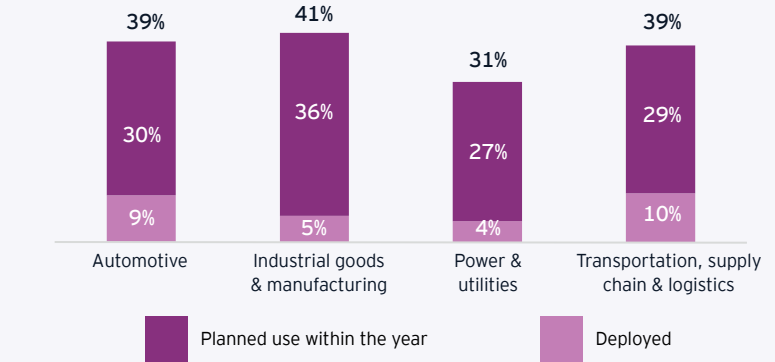


## Autonomous/remote-controlled (RC) maintenance robotics [Industrial]

Autonomous or remote-controlled robotics are also used in maintenance and repairs today. In most cases, the equipment is guided by a technician or specialist, to inspect and repair remote or hard to reach equipment, but fully-autonomous solutions are also in development.

Although there are limited reported deployments in the industrial goods and manufacturing (5%) and power and utilities (4%) segments, respondents from automotive and transportation, supply chain and logistics deployed this use case at double the rate seen in other industries, a result of the use case allowing for prompt maintenance interventions for vehicles on the move. Companies using maintenance robotics today report CAPEX reduction and sustainability benefits, as a result of extended machine lifetimes. Safety improvement is also a key benefit companies who have deployed the use case experience since they can reduce the need to put humans in higher-risk environments for certain repairs.

**Figure 4.24:** Deployment of autonomous/RC maintenance robotics



**Figure 4.25:** Key benefits reported by companies currently using autonomous/RC maintenance robotics



# Companies that have deployed industrial use cases are seeing more reported benefits than those still in the planning phase expect

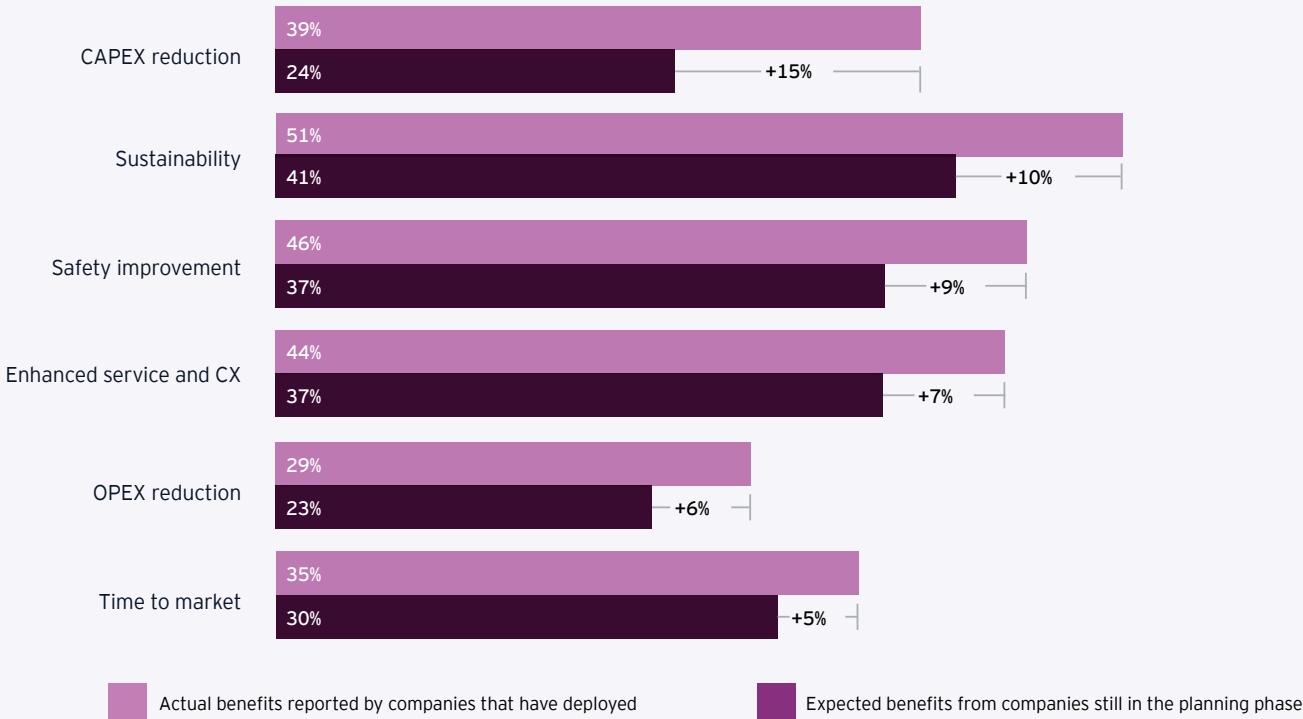
## Industrial use cases exceed expectations

On average, companies that have already deployed metaverse use cases report benefits 5% more often than companies still in the planning phase.

Across use cases, the most significant difference is cost reduction benefits, with a 15-percentage point increase in respondents citing CAPEX reduction and a 6-percentage point increase in OPEX reduction; according to companies who have already deployed industrial metaverse use cases, these use cases already impact the bottom line beyond the

expectations of even the most eager metaverse participants. Additionally, through the enhanced ability to track real-world items, collaborate, learn, and work virtually, the metaverse seems to exceed respondents' expectations in helping their companies reach their ESG goals, in serving and protecting their employees and customers, and in delivering high-quality products and services more quickly and efficiently than was previously possible [Figure 4.26].

**Figure 4.26:** Actual use case benefits reported by companies with deployments today compared to the benefits expected by companies still in the planning phase



## Differences are amplified further for specific use cases

In looking at specific use cases and the benefits perceived, the most notable difference is in XR hands-on training, where almost 65% of companies who have already deployed this use case, reported reduced capital expenditures. By contrast, just 22% of companies in the planning phase cite a reduction in

CAPEX as an expected benefit. Additionally, for the virtual facility optimization use case, 43% of companies who have already deployed this use case reported OPEX reductions, more than twice the rate expected by companies still exploring the use case.









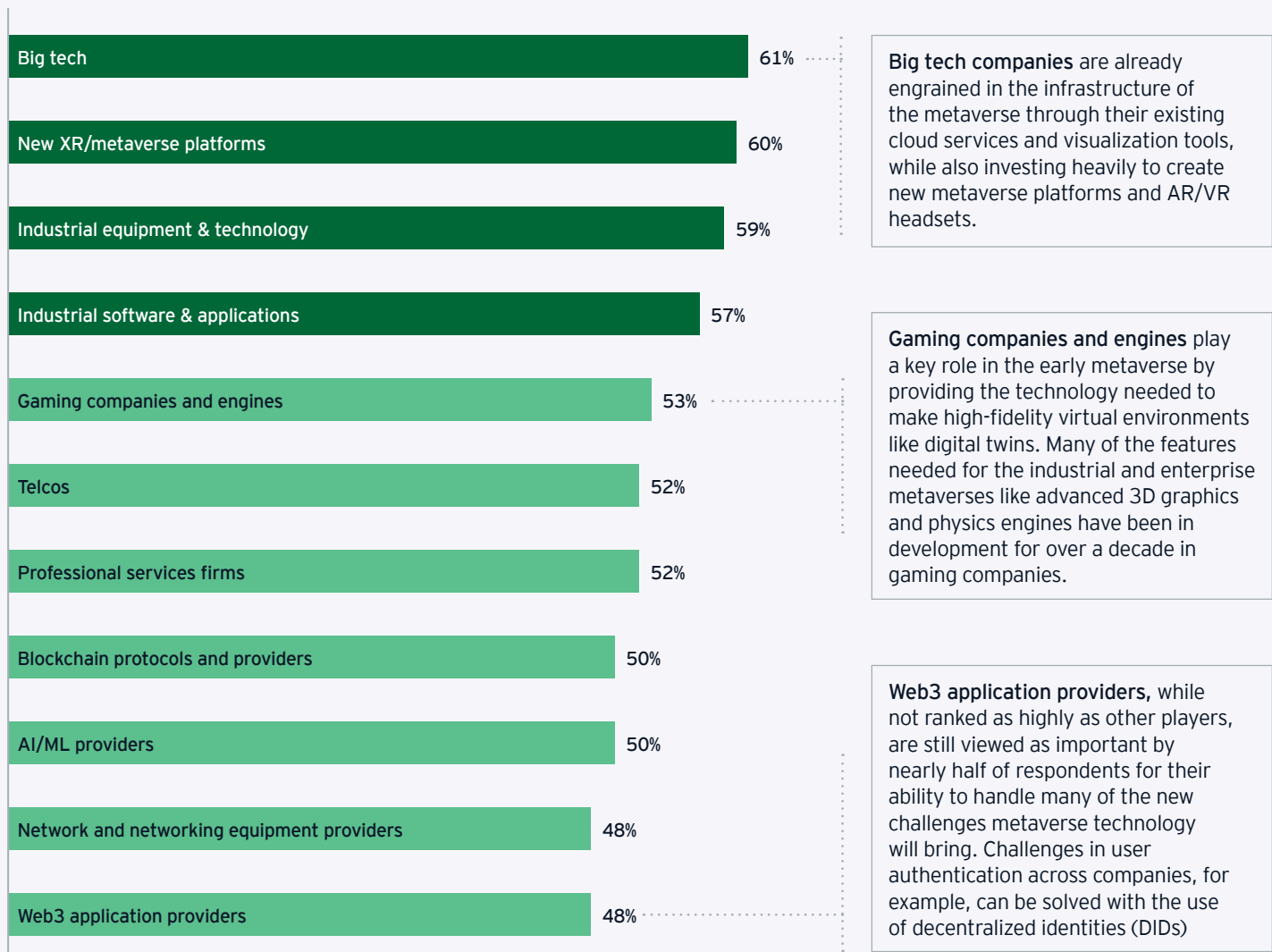
# 5 Key enablers and partners to deploying the metaverse

When it comes to the metaverse, there are players who stand out as having gone big and gone early to stake their claim on this evolving space. Not surprisingly, respondents in our survey rank these familiar faces like big tech, metaverse platform players and gaming companies as key in driving the metaverse forward - they create and control many of the inputs, pipelines, and mediums for experiencing the physical-

digital fusion of the industrial metaverse.

But industrial equipment and technology and industrial software and application players, also feature in the top five [Figure 5.1] - which makes sense as companies looking to deploy industrial and enterprise metaverse use cases look for guidance from players they know and trust.

**Figure 5.1:** Key players in driving the advancement of the metaverse, among all respondents



## Enabling technologies for the metaverse go beyond headsets: computing, AI and network are critical

While our respondents perceive that big tech companies and new metaverse platforms are primarily driving advancement in the metaverse today, enterprises understand they must look further when it comes to identifying providers of key technical enablers that allow metaverse use cases to succeed.

As seen in Figure 5.2, respondents overwhelmingly see the value of nearly all enablers, with only 7 percentage points separating the top ten.

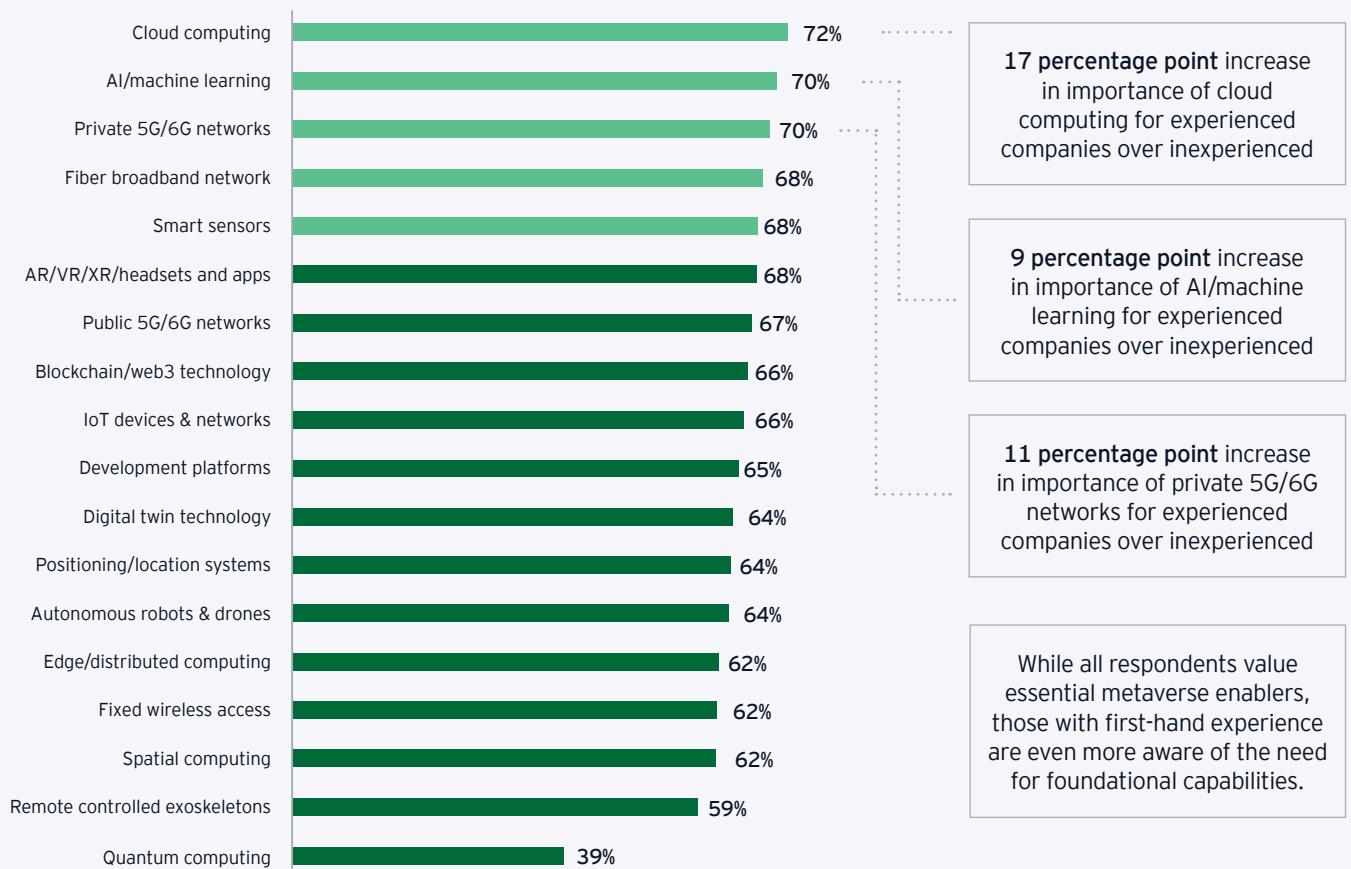
However, respondents do place greater importance on those enablers that are truly foundational to meeting

the demands of most enterprise and industrial use cases - such as cloud computing (72%), AI/ML (70%), and network connectivity (68-70%). Respondents appreciate the need for sufficient infrastructure and robust analytical capabilities when it comes to deploying metaverse use cases.

# 50%

of respondents say **technical infrastructure is a blocker preventing them** from deploying use cases.

**Figure 5.2:** Views on importance of technical enablers, among all respondents





“

We found that connectivity will be a huge challenge if we want to scale. We need strong bandwidth anywhere people access the metaverse solutions

VP of IT, Global Automotive Supplier

**Figure 5.3:** Industrial and enterprise metaverse foundational capabilities

Technical enablers that allow for enhanced collection, transmission, storage, and processing of data are foundational to launching metaverse use cases

**Cloud computing**

Enables the storage and processing of the large quantities of data inputs and outputs required to orchestrate metaverse use cases

**Network**

Cellular (public and private) networks and fiber allow for low-latency connectivity to get information to a person or asset at the right time, for a seamless experience

**AI/ML**

Indispensable for modeling digital twins and creating realistic environments and simulations and interpreting data/making predictions

**Industrial data collection**

Smart sensors, positioning/location systems and IoT enable the collection and exchange of data from industrial hardware in real-time, with strong connectivity as a prerequisite



At this stage, companies are relying on a range of partners to close capability gaps and deploy use cases

### Enterprises need further proficiency with key technical enablers

When deploying use cases, companies are not only focused on what blend of technical enablers is required, but also the level of advancement they must reach internally to successfully leverage the enablers. While companies appreciate the criticality of enablers such as cloud computing, AI/ML and network connectivity, there are self-reporting shortcomings in their ability to leverage them to support metaverse use cases [Figure 5.4].

### Gaps in expertise impacts the ability to scale

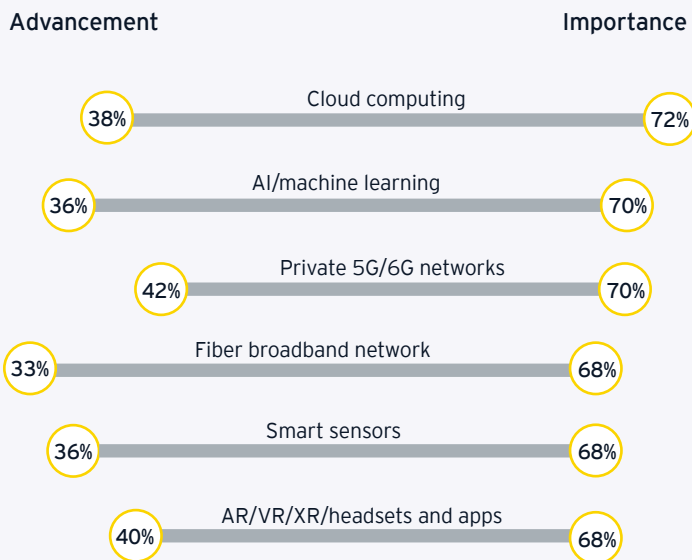
In research interviews, leaders highlighted a desire to scale metaverse use cases across sites. But most interviewed companies who had deployed use cases had not yet scaled across the organization or different sites. While technologies like sensors or connectivity may be adequate in some locations, other locations may be months, if not years behind in development. An IT executive in industrial manufacturing noted that metaverse may only be able to be rolled out across a few facilities until other sites can mature their core network and data collection capabilities.

“

We are a partner-led organization. We work with cloud vendors, gaming engines, digitalization software and AI library providers, consultants and more to execute.

VP of Sales, Metaverse Platform and Infrastructure Provider

**Figure 5.4:** Levels of importance of enablers and levels of advancement in leveraging enablers within your company, among all respondents



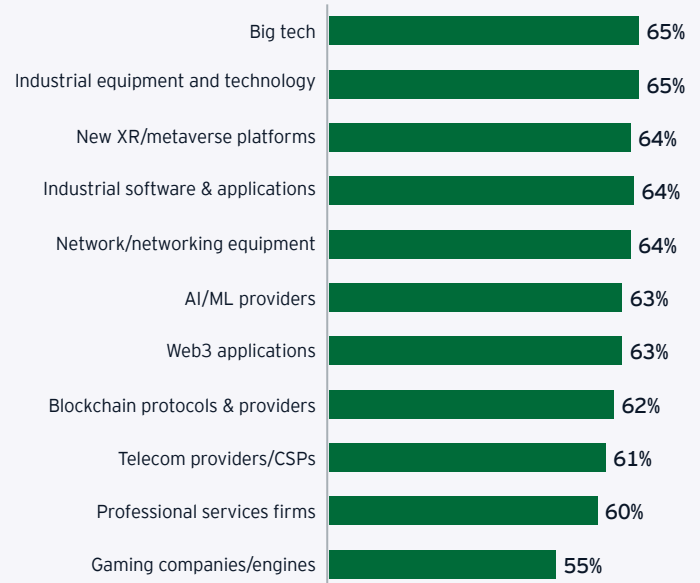


## Partnering becomes critical for success

For companies getting started in the metaverse and those looking to scale use cases, partnerships are critical to building and integrating technical enablers to launch use cases. In the current state, no one partner has proven able to provide the broad range of capabilities use cases require, leaving companies to devise a curated group of partners, each with highly specific functions, best-fit for their goals.

Approaching partners may present challenges, as many partners have yet to create an integrated go-to-market and delivery approach for metaverse solutions as they work with clients. While some alliances are forming, **most companies are left to piece together the partner puzzle themselves.**

**Figure 5.5:** Key partners in deploying industrial metaverse use cases, among all respondents



# Companies which are not perceived at the forefront of advancing the metaverse, become valuable deployment partners

When companies deploy industrial and enterprise use cases, they are reliant on a large set of partners to turn vision into reality. Interestingly, in some cases, these critical partners are not the same players respondents view at the forefront of metaverse advancement.

Figure 5.6 shows the difference between the top ranked deployment partners and the top ranked players advancing the metaverse. While the top four are the same, AI/ML (+3 ranks) and Network/networking equipment (+5 ranks) rank notably higher as important partners for launching industrial and enterprise metaverse use cases, compared to how they are viewed in terms of driving innovation in the metaverse overall. Perhaps not surprising, as networking and AI/ML are seen as key technical enablers for the deployment of industrial and enterprise use cases.

**AI/ML providers**

- ▶ Process raw data inputs collected from devices without human intervention
- ▶ Automate, predict, and visualize processes and insights gathered from connected devices, assets, and systems
- ▶ Provide generative capabilities to build customized, immersive environments and digital assets

**Network and networking equipment vendors**

Provide infrastructure and services to support the next generation of connectivity requirements (speed, bandwidth, latency) necessary to support metaverse use cases:

- ▶ Private 5G/6G networks
- ▶ Public 5G/6G networks
- ▶ Fiber broadband networks

Companies must look hard at their existing capabilities in relation to their metaverse ambitions. To support the industrial metaverse at scale, companies must invest and partner, where necessary, in order to support the transmission, processing and storage of data required to bring metaverse use cases to life.

**Figure 5.6:** Differences between key metaverse players, among all respondents

	<b>Ranked Most Important:</b> Partners to deploy use cases	<b>Ranked Most Important:</b> Driving advancement in the metaverse	<b>Difference</b>
<b>Big tech</b>	1st	1st	-
<b>Industrial equipment and technology</b>	2nd	3rd	▲ +1
<b>New XR/metaverse platforms</b>	3rd	2nd	▼ -1
<b>Industrial software and applications</b>	4th	4th	-
<b>Network/networking equipment providers</b>	5th	10th	▲ +5
<b>AI/ML providers</b>	6th	9th	▲ +3



“

I don't think our network is well equipped yet. We have a team that experiments on technologies, but they do not scale them... It's like saying, "How good are we at AI, ML, computer vision?" It's not like I have a team that's dedicated to these things. So, I think we're having some starting issues around how we organize around these areas.

C-Level, Digital Transformation, Apparel & Textiles  
Manufacturer

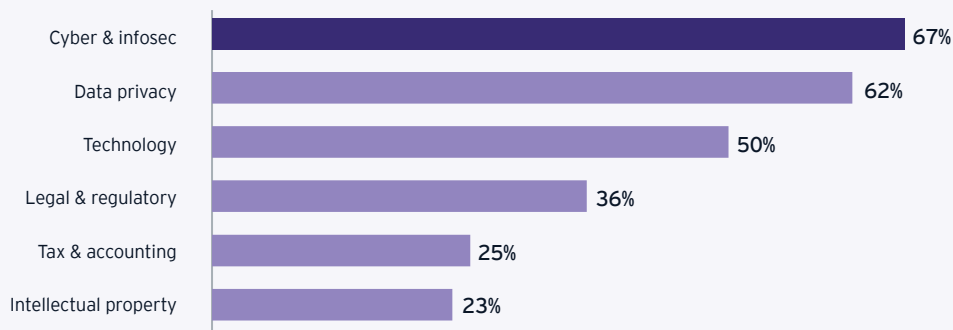




# 6 Risks and challenges within the metaverse

Companies recognize that, like any other new technology, implementing and scaling use cases in the metaverse poses certain risks.

**Figure 6.1:** Top risks in deploying metaverse use cases, among experienced companies



The primary concerns for metaverse use cases are cyber, information security and data privacy, with over 60% of respondents citing these as primary risks. Cyber and information security risks are paramount across a range of digital use cases but are amplified by the drastic increase in data, that industrial and enterprise metaverse use cases will produce. This was noted by multiple research interviewees, including one global automotive manufacturer, who highlighted additional risk when expanding metaverse use cases to involve outside parties, like suppliers. To help alleviate these concerns, companies would be prudent to first take necessary steps to assess and secure potential breach points, like sensitive databases or pipelines and network, before pursuing metaverse at scale.

Data privacy risks can prove especially complex, particularly as companies expand the scope and scale of use cases to reflect a more interwoven, data-driven virtual ecosystem, incorporating valuable, potentially sensitive, data assets. The protection of these assets, often regarded as the heartbeat of operations, should be highly considered in the use case development process.



**Security is #1. Everything must be secure by design.**

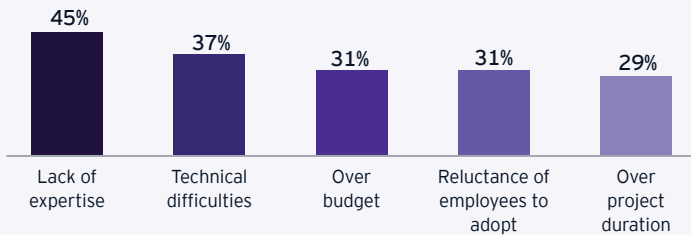
VP of Sales, Metaverse Platform and Infrastructure Provider

36% of respondents also acknowledge that the metaverse will come with its own set of legal and regulatory risks. One research interviewee in power and utilities noted that in many regulated markets in the US, companies need to prove the positive impact of metaverse use cases to regulatory bodies before making large investments. Quantifying ROI can be a challenge for some, which makes business, legal and regulatory justification more difficult. Today, companies must also prove metaverse solutions are not a surveillance mechanism for their employees.

## Start small and think big, in order to overcome an array of challenges

There is no defined playbook today for entering the metaverse, and companies are facing expected growing pains around people, process and technology.

**Figure 6.2:** Top challenges faced in deploying metaverse use cases, among experienced companies

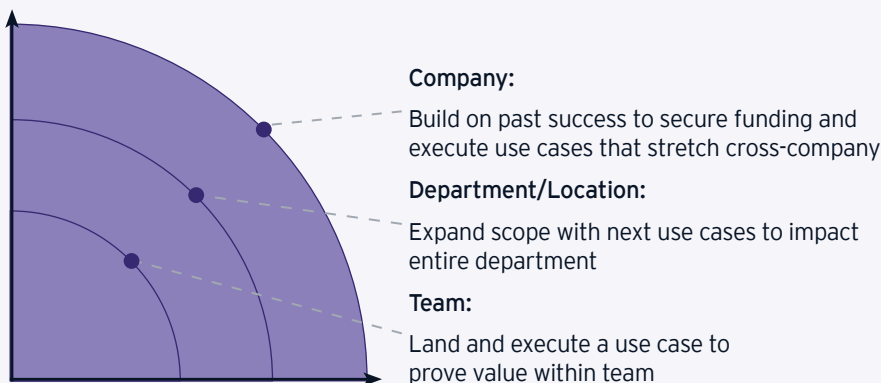


As shown in Figure 6.2, lack of expertise is cited as the top challenge companies face during the deployment process, with 45% of respondents indicating it as a struggle during deployment. For some, solving this challenge requires augmenting internal know-how through hiring or with external partners. For example, power and utilities companies in many geographies have leveraged professional services expertise for past digital deployments, and plan to do so for the metaverse as well. One leader interviewed in our research noted that utilities are “just trying to survive” and may require this additional support on innovative initiatives that go beyond day-to-day operations.

Technical difficulties is the second most common challenge in deployment, endured by 37% of experienced respondents. Some technical difficulties will naturally be overcome as key enablers are developed, gain additional capabilities, and become easier to use compared to their current state. On the other hand, some technical difficulties may take time to resolve. There are many organizations who are already in technical debt from working on improving legacy systems. One global automotive manufacturer interviewed in our research mentioned that their organization is still on the journey to embrace cloud technologies and leveraging AI, leaving metaverse “off the radar” until these initiatives are complete, despite interest. Choosing metaverse use cases that build upon industry 4.0 investments may allow companies to work in hand with their latest and greatest technology, to avoid legacy system roadblocks and reduce technical difficulty.

Companies also face challenges around both reluctance to adopt - with research interviewees citing the need for strong change management - and budget. Exceeding budget is not only a challenge for companies who have deployed metaverse use cases, but also similarly a concern for those planning to deploy, with 31% citing “lack of budget” as a primary challenge in pushing forward metaverse initiatives. In some cases, metaverse efforts may also be tabled while public markets reward more cost-conscious balance sheets (e.g., Disney abandoned its metaverse division in early 2023). To overcome budget constraints, some companies are deploying what one research interviewee coined a “land and expand model.” Starting with more budget-friendly use cases that provide clear, communicable value across an organization can serve as a stepping-stone to future success and warrant additional budget allocation for larger metaverse undertakings.

**Figure 6.3:** Land and expand for metaverse use cases



**59%**

of companies that have deployed metaverse use cases today have run into multiple challenges in deployment.

# 7 Taking the next step in the industrial and enterprise metaverses

While the consumer metaverse has received considerable attention over the past few years, especially in the media, the industrial and enterprise metaverses are proving tangible value beyond what some might deem a fad, and formidable growth is expected to continue. Today's successes in use case deployment will likely accelerate both interest and investment.

Companies are still learning what it takes to be a leader in value-creation with the metaverse and how to partner to achieve goals and scale. **It is important to explore and test applications, integrate lessons learned and quantify value early, as the industrial and enterprise metaverses are poised to become essential to driving competitive advantage in the future.**

## What's next? 3 points to follow when taking the next step in the metaverse

### To begin the journey:

1. **Begin laying the foundation of capabilities:** Map requirements to potential use cases and focus on assessing capability gaps for most crucial enablers
2. **Land and expand:** Start with a specific use case pilot or deployment as a proof point to generate buy in and learn from mistakes early
3. **Consider how you'll market your metaverse:** Using terms like "3D-virtualized environment" or "immersive experience" instead of metaverse may detach use cases from any circulating misconceptions or hype

### To build upon early wins:

1. **Re-evaluate what's needed to scale:** Consider any unanticipated enablers critical to take a pilot to deployment or scale a deployment across multiple sites and how current partners will support growth
2. **Expand the scope of use case(s):** Consider how a deployed use case might expand to integrate additional functionality, data points or sub-use cases
3. **Strive toward a metaverse ecosystem:** Consider how multiple deployed use cases might integrate to build an end-to-end approach





## Appendix: Use case definitions

Use case	Definition
<b>XR hands-on training</b>	Immersive technical training using XR technology to create realistic experiences and scenarios in a purely virtual or virtually enhanced physical environment, especially to enhance skills using different equipment and to practice safety procedures.
<b>Virtual R&amp;D, prototyping and testing</b>	Design or redesign of products, components, equipment and more in a virtual environment to enhance processes like prototyping, safety and performance testing, assessing production readiness, etc.
<b>XR-enhanced UX research</b>	Enhancing UX research using extended reality (XR) technology for eye tracking, overlaying virtual elements on the real world, user testing virtual prototypes (e.g., vehicles, machinery), etc. for end users, intermediaries, and/or company employees.
<b>Virtual facility optimization</b>	Designing, planning, simulating, and optimizing facilities (e.g., factories, warehouses, retail stores, etc.) in a virtual environment (e.g., digital twin) to enhance production and other processes without impacting live operations. Virtual tracking and data capture on factories, warehouses, and other facilities to see real-time performance and quickly flag problem areas.
<b>Virtual supply chain optimization</b>	Asset tracking (e.g., facilities, equipment, operational vehicles, devices etc.) and supply chain optimization in a virtual environment (e.g., digital twin) allowing for redesign and simulation without impacting live operations. Virtual tracking and data capture on actual supply chain to flag real-time problem areas and track the flow of goods.
<b>Autonomous/RC operations robotics</b>	Use of autonomous or remote-controlled robots which can be deployed, controlled and/or monitored virtually to assist in the operations like manufacturing, surveillance, rearranging assets in facilities, loading, storage and retrieval, packaging, and more.
<b>Autonomous/RC maintenance robotics</b>	Use of autonomous or remote-controlled robots which can be deployed, controlled and/or monitored virtually to perform maintenance in facilities, remote environments and more.
<b>Field XR</b>	Extended reality (XR) augmentation of workers, maintenance teams, inspectors, and technicians allowing the user to share views with a specialist or overlay virtual elements that may not otherwise be visible/accessible.
<b>Visualized predictive maintenance</b>	More accurate assessment of asset health (e.g., vehicles, or machinery) and flagging of problem areas on a virtual representation (e.g., digital twin) of the asset driven by enhanced data capture.
<b>Virtual grid optimization</b>	Tracking and arranging grid assets (e.g., facilities, operational vehicles, transmission lines, distribution lines, protection and controls systems, etc.) in virtual environments allowing for virtual redesign and process/production simulation without impacting operations. Virtual tracking and data capture on actual grid performance, inputs, outputs, and flagging of problem areas to minimize outages.
<b>Virtual transportation network optimization</b>	Planning transportation networks, asset placement (e.g., operational vehicles, rolling stock, maintenance crews, machinery), and passenger/freight flows virtually to allow for optimization and simulation of different potential threats and events.
<b>Virtual office and workspaces</b>	Use of immersive digital environments where employees can interact for enhanced networking and social experiences or use infinite workspaces, data interaction spaces, and spaces created to enhance collaboration and co-design.
<b>XR onboarding and soft-skills training</b>	Use of immersive digital environments in enterprise-level HR, onboarding and training processes for items like customer service training, general safety training, and company-wide programs on sustainability and diversity, equity and inclusion.
<b>Immersive recruiting and hiring experiences</b>	Use of immersive digital environments in the recruiting and hiring process to reach a broader, younger, and often more tech-forward work force and conduct technical interviews that previously would require on-site visits virtually.

# Endnotes

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