

# Introduction

It's clear advanced technologies like simulation, artificial intelligence (AI), high-performance computing (HPC), machine learning, and data analytics have already begun transforming the fabric of modern business operations. Whether your organization builds the world's most advanced supercomputers, conducts groundbreaking research, builds heavy equipment and machinery, constructs aircraft, delivers cutting-edge healthcare, or produces the latest consumer electronics, it's likely you've either heard of – or already use – these technologies in some form.

The next frontier, however, is one that complements and bolsters those existing technologies – digital twin technology. **Digital twin technology is the process of using data streams to create a digital representation of a real-world asset to improve collaboration, information access, and decision-making.** Data gleaned from digital twins gives organizations a world of new insight and can help teams work more efficiently to create better products, generate less waste, consume less energy, better assess risk, and so much more. In essence, digital twin technology opens doors and gives organizations around the world the opportunity to find their next big breakthrough.

Although it sounds new, digital twin technology has been around – in fact, NASA was one of the first organizations to employ rudimentary digital twins in the late 1960's. But contemporary digital twin technology, enabled by unprecedented connectivity, data, sensor, and Internet of Things (IoT) capabilities, has become an accurate, cost-effective solution that gives organizations more flexibility and power than ever before. That's why today, businesses of all sizes – from the smallest startups to international powerhouses – utilize digital twin.

But despite the skyrocketing adoption of digital twins, there are still huge gaps in our understanding of the landscape when we look at their adoption, including how digital twin technology is used, who's using it, who wants to use it, and where it's being used. For example, are companies in the Asia-Pacific (APAC) region more willing to adopt digital twin technology in the next 18 months than organizations in the United States? Are executives more knowledgeable about the technology than user-level employees, or vice versa? What do people want to learn more about regarding digital twins? How are organizations using digital twin technology to meet their sustainability goals – or are they using it at all? These are just a few of the questions we set out to answer.

By surveying more than 2,000 professionals around the world, we set out to paint a more complete picture of digital twin technology and its adoption. This report contains in-depth data that answers the most pressing questions surrounding digital twin technology and the organizations that utilize it. By reading this report, readers will have a better understanding of the business and environmental impacts of digital twin technology, and what lies ahead in the years to come.

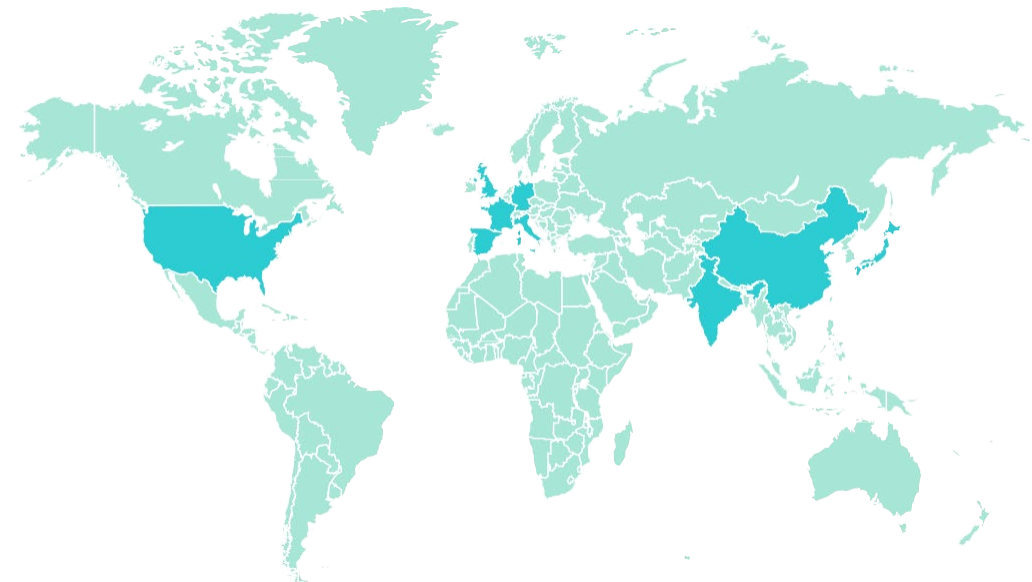
# Methodology

Altair commissioned an independent, international online survey of 2,007 professionals employed throughout many target industries who perform job functions related to data science, IoT and analytics, software engineering, research and development (R&D), engineering, information technology (IT) and information systems (IS), product development, and executive management. Target industries included:

- Aerospace
- Architecture, engineering, and construction (AEC)
- Automotive
- Banking, financial services, and insurance (BFSI)
- Consumer electronics
- Energy, oil, and gas
- Healthcare
- Heavy equipment
- Industrial equipment
- Manufacturing
- Technology and information technology (IT)

The sample group consists of respondents from ten countries employed by organizations with 100 employees or more. These countries include the following, where N denotes the number of respondents from each location:

- United States (N=200)
- China (N=200)
- France (N=200)
- India (N=206)
- Germany (N=200)
- United Kingdom (N=201)
- South Korea (N=200)
- Italy (N=200)
- Japan (N=200)
- Spain (N=200)



The sample's margin of error is +/- 2% with a confidence interval of 95%. Fieldwork was conducted in May 2022 by Atomik Research, an independent market research agency.

# Key Takeaways

Before diving into the report head-on, here are some of the key findings the data presented.



Of the 2,007 respondents surveyed, 69% (1,393) said their organization currently leverages digital twin technology, while 23% (460) said their organization did not. Of those who said their organization currently leverages digital twin technology (N=1,393), 23% of respondents said their organization began to invest in digital twin technology in the last six months or sooner; only 8% said their company began investing in digital twins three or more years ago.



Of those who said their organization isn't currently employing digital twin technology (N=460), the data indicates that a sizeable portion of respondents (58%) think their organization will adopt digital twin technology within the next one to two years or sooner. Additionally, 11% indicated they think their organization will adopt the technology within the next six months or sooner.

**23%** of organizations do not leverage digital twin technology.

92% of respondents that used digital twin technology (N=1,393) said it made their products and processes more sustainable. Overall (N=2,007) 85% of respondents said their organization either already does or is planning to use digital twin technology to meet their organization's sustainability goals.

In multiple respects, upper-level employees and user-level employees **understood, viewed, and used digital twin technology differently**, indicating a general disconnect of information between organizations' higher-ups and those who use the technology in their daily workflow (Section 4).

43% of respondents thought that digital twin solutions will make the need for physical testing obsolete within the next four years or sooner. Only 4% of respondents said that digital twins would never make the need for physical prototyping go away.

# Section 1: Understanding

The report’s first section seeks to understand users’ and organizations’ understanding of digital twin technology. Specifically, what companies think it is, what they associate with digital twin technology, and what more they’d like to know. With digital twin technology’s ascendancy now available to organizations of all sizes and not just the world’s largest, most well-funded organizations – would-be users have found it difficult to pin down exactly what digital twin technology is.

The question below aimed to reveal the extent of respondents’ knowledge. For this question, respondents could choose multiple answers:

- ▶ Which of the following statements best describes how you feel about digital twin technology?



**22%** of respondents found digital twin solutions to be “confusing,” or they had “no idea” what the technology is.

While 50% of respondents considered themselves “highly knowledgeable” about digital twin solutions, other respondents felt those solutions to be confusing or inconsistently defined, or they only had an inkling of what the technology is and what it could do. In all, 22% of respondents found digital twin solutions to be “confusing,” or they had “no idea” what the technology is. Additionally, 11% of respondents felt that the “definition of digital twins is inconsistent.” The findings suggest that more than half, or 54% of respondents, felt they either had limited knowledge about digital twin technology; they lacked a succinct, consistent definition of what the technology is; or they found understanding digital twin solutions to be confusing.

The next question asked respondents what they'd like to better understand regarding digital twin technology. Respondents could choose multiple answers:

► What would you like to better understand about digital twins?

The difference between data-driven digital twins and physics-driven digital twins



Use cases for product design



A straightforward, standardized definition that clearly explains the meaning of digital twins



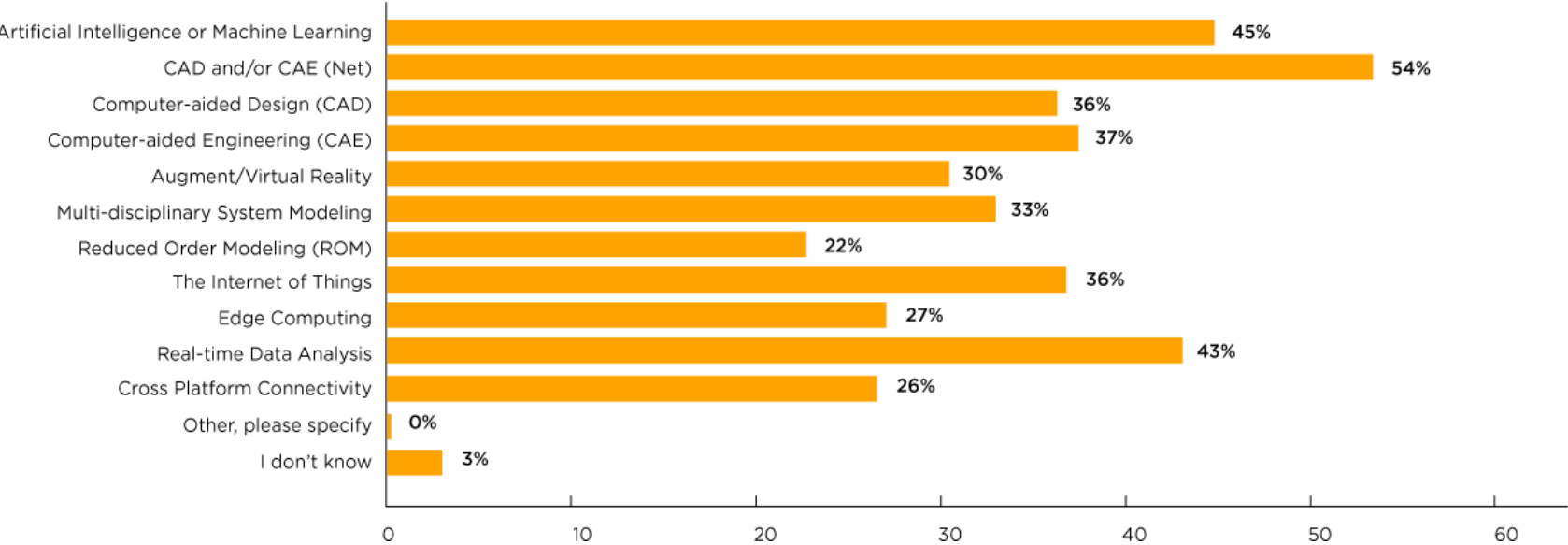
The data here indicates a keen interest in respondents wanting to learn more about digital twin technology. At least 45% of respondents wanted to better understand “use cases for improving processes and efficiency,” and 20% of respondents wanted to better understand “how digital twins converge with other solutions,” and “the most useful data to run accurate digital twin simulations.”

Also, 37% indicated they'd like to better understand (or obtain) a “straightforward, standardized definition” that clearly explains the meaning of digital twins.

The last question that pertains to the understanding of digital twin technology asked respondents to identify which technologies they associate with digital twin technology. Respondents could choose multiple answers:

► Which of the following technologies do you associate with digital twin capabilities?

Respondents associate many technologies with digital twins, but they primarily associate the technology with computer-aided engineering/design (CAE/CAD) and artificial intelligence (AI) and machine learning (ML). This indicates an understanding that digital twin – like other technologies – is a product of the convergence of many technologies and are associated with multiple different capabilities. Indeed, digital twin technology relies on many different technologies, including AI, machine learning, data analytics, IoT, and more, to produce virtual representations of real-world objects.



## Section 1 Key Takeaways

Most respondents (54%) indicated they had limited or no knowledge about digital twin technology, or they found understanding digital twin solutions to be confusing.

There’s widespread demand for more knowledge about digital twin technology and its applications, including 37% who wanted to see a concise, standardized definition of the technology.

Respondents associated a myriad of technologies with digital twin technology, including CAD/CAE, AI, machine learning, and real-time data analysis.

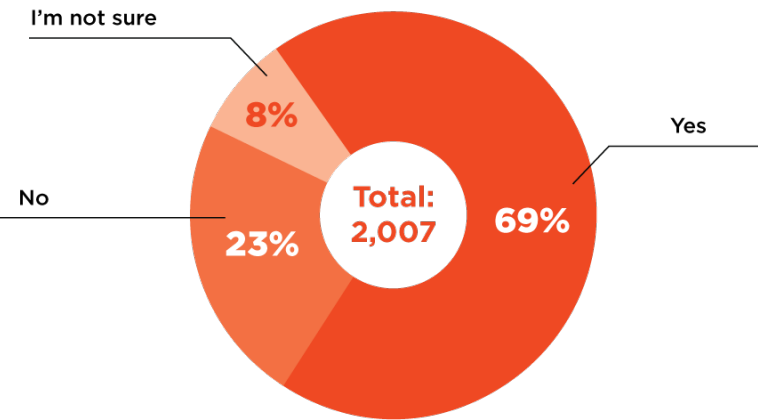


# Section 2: Adoption

This section examines respondents' views of digital twin technology adoption.

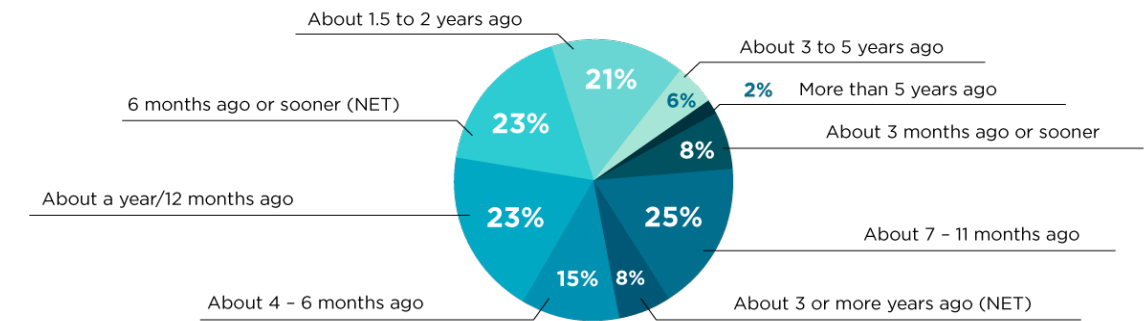
Overall, adoption is high and growing. Of the 2,007 respondents surveyed, 69% (1,393) said their organization currently leverages digital twin technology, while 23% (460) said their organization did not. Only 8% (154) said they weren't sure.

► Does your organization leverage digital twin technology (as defined previously)?



Of those who said their organization currently leverages digital twin technology (N=1,393), 23% of respondents said their organization began to invest in digital twin technology in the last six months or sooner. In addition, 25% said their organization began to invest in digital twin between seven and eleven months ago, while 23% said investment began about a year ago. Only 8% said their company began investing in digital twins three or more years ago.

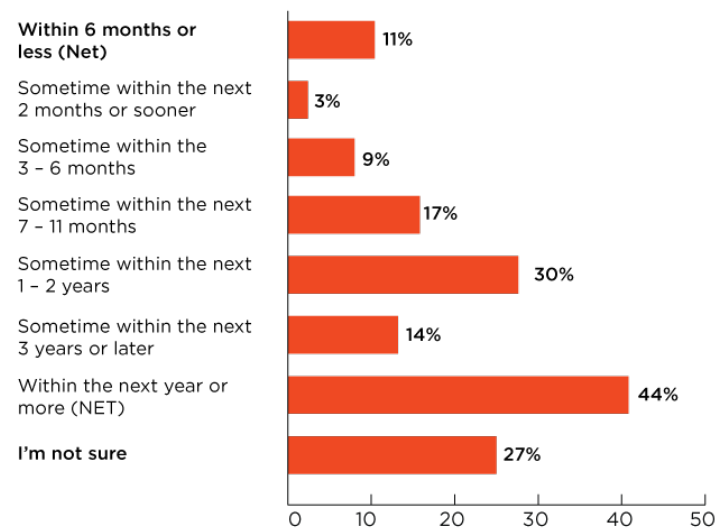
► When did your organization begin to invest in digital twin solutions?



This shows how recent and quick the adoption of digital twin technology has been. Even accounting for the fact that respondents could choose more than one answer, the data suggests that **71%** of respondents' organizations (N=1,393) began investing in digital twin technology in the past year.

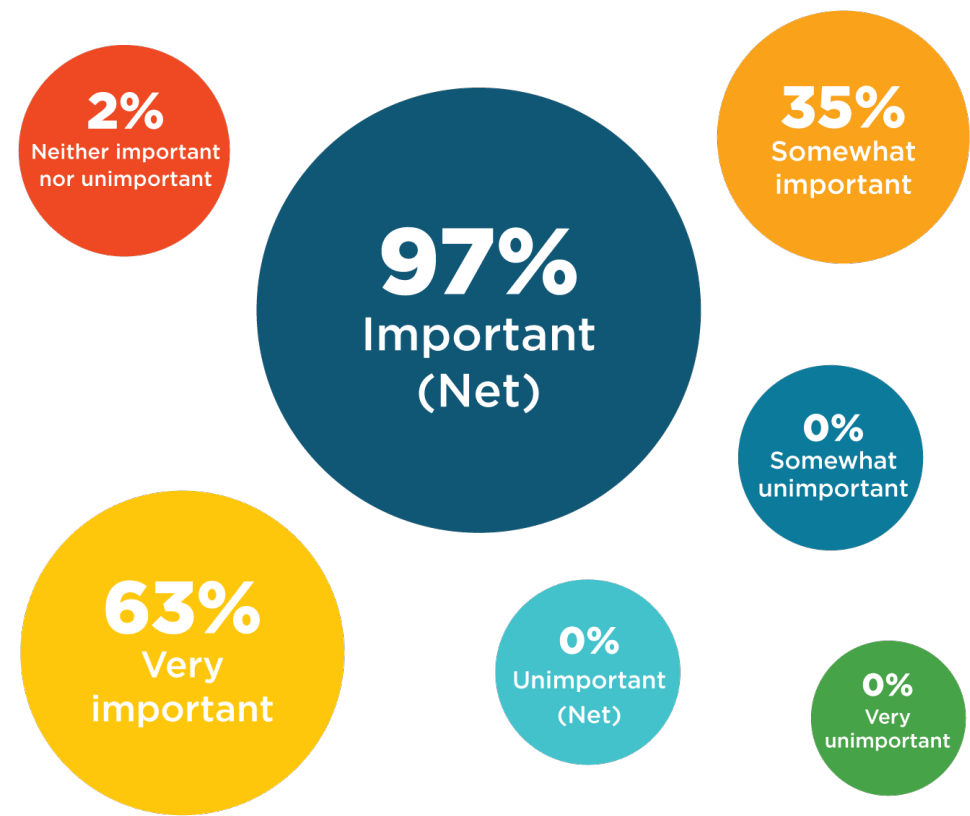
Of respondents who said their organization isn't currently employing digital twin technology (N=460), the data indicates that a sizeable portion (58%) think their organization will adopt digital twin technology within the next one to two years or sooner. Additionally, 11% indicated they think their organization will adopt the technology within the next six months or sooner; 27% indicated they weren't sure.

► When do you expect your organization to adopt digital twin technology?



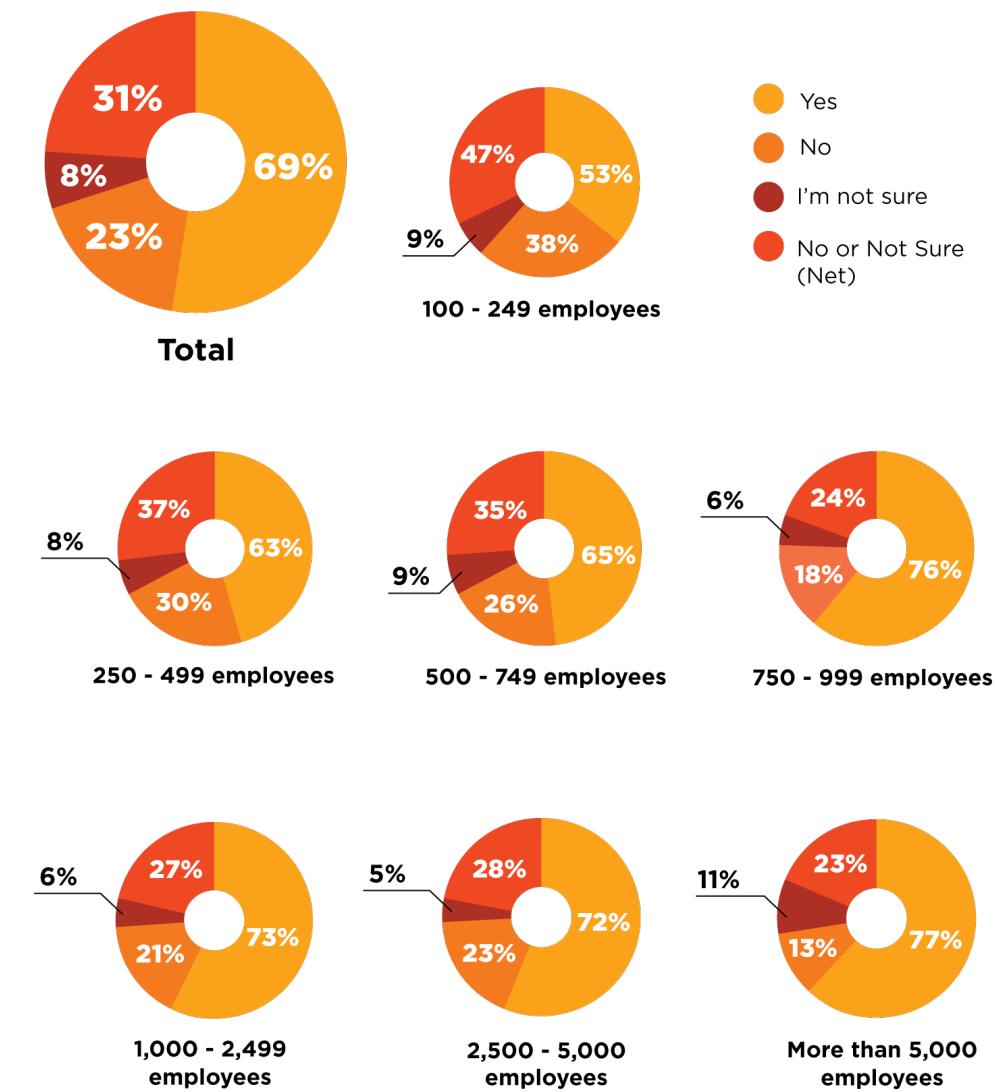
Additionally, of the respondents who said their organization leveraged digital twin technology (N=1,393), 97% said it was important to their organization; 63% said it was "very important," while 35% said it was "somewhat important."

► How important are digital twin solutions to your organization?



However, there are some nuances to the adoption of digital twin technology, especially among organizations of different sizes. Our data shows that, on average, larger organizations were more likely to leverage digital twin. For example, 77% of respondents who belonged to an organization with more than 5,000 employees said their company leveraged the technology, compared to just 53% of respondents who belonged to an organization that employed 100-249 people.

► Does your organization leverage digital twin technology (as defined previously)?



The data also showed that respondents from larger organizations that employed digital twin technology were more likely to say it was “very important” to their organization. Whereas 51% of respondents from organizations with 100-249 employees said digital twin was “very important,” 62% of respondents from organizations with 5,000 or more people said the same.

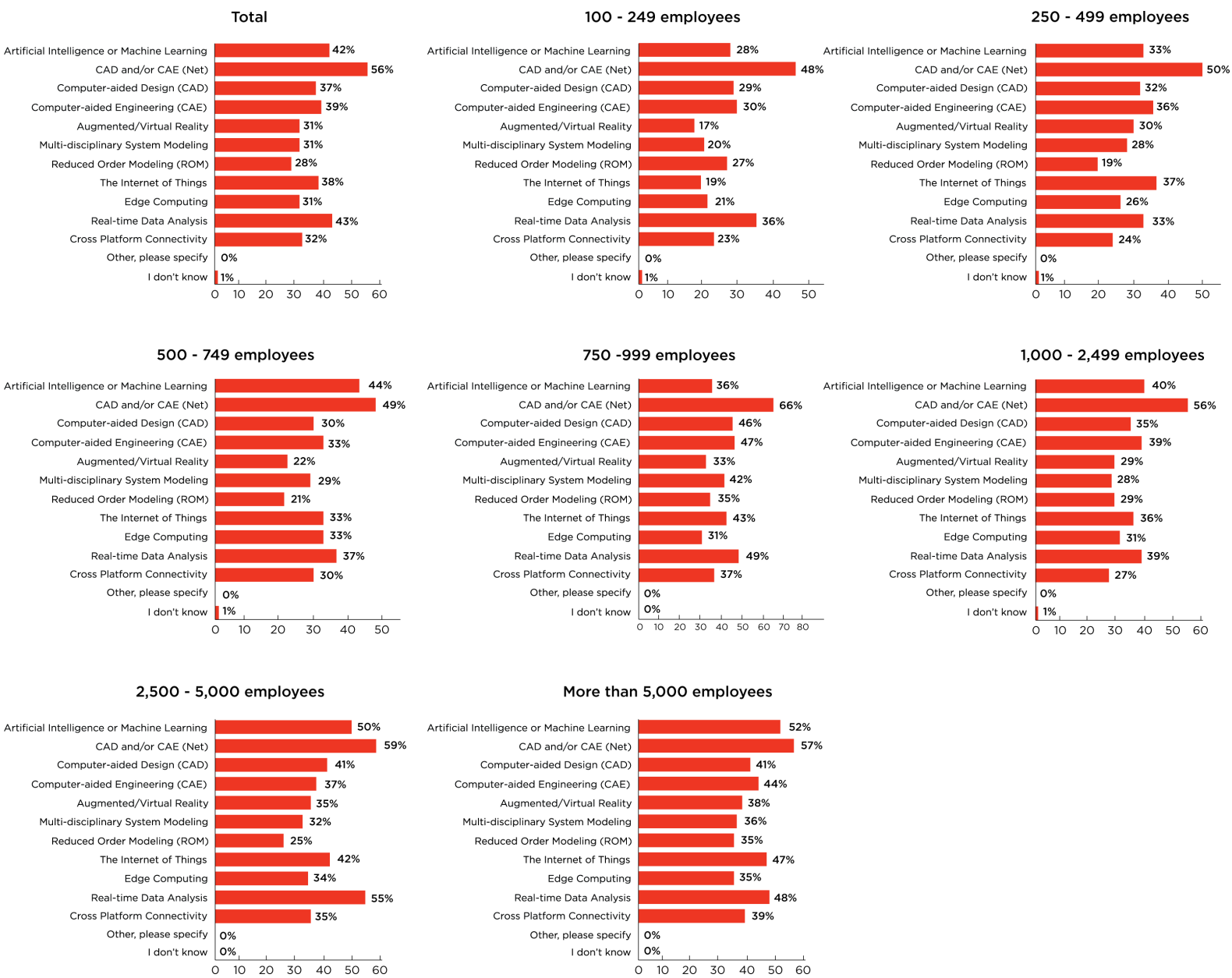
As high as 73% of respondents from organizations with 750 to 5,000 employees said that digital twin technology was “very important” to their organization.

► How important are digital twin solutions to your organization?



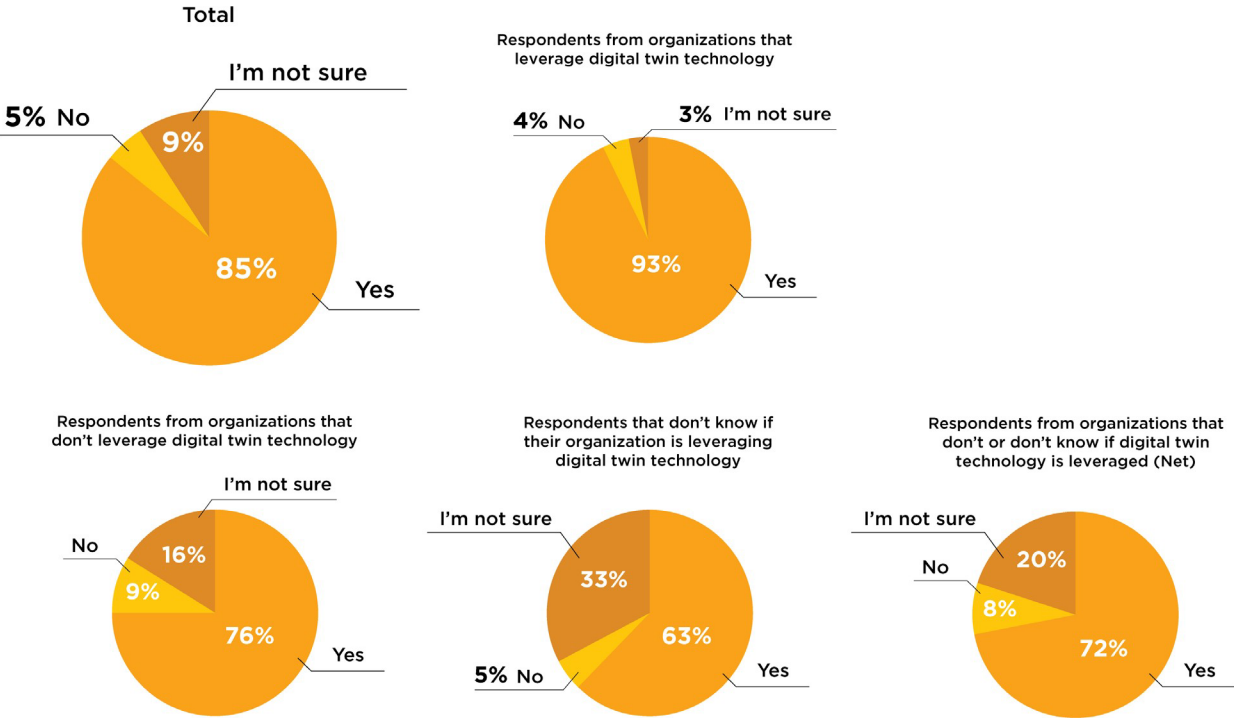
This may indicate that medium-sized organizations find digital twin technology more important to their core operations than very small or very large organizations. The data also indicates that larger organizations are more likely to employ additional advanced technology alongside digital twin.

► Which of the following technologies do you implement along with digital twin solutions to improve the process or outcomes?



Respondents from organizations that don't already leverage digital twin technology were less likely to say their leadership would invest in the technology if they better understood its benefits.

- Do you believe your leadership would be more likely to invest in digital twin solutions if they better understood the benefits of digital twins?



These results indicate that respondents at organizations that haven't already invested in digital twin technology may be less likely to invest in it at all, even if they were to have a solid understanding of the technology and its benefits. That said, **76%** of respondents at companies that don't currently employ digital twin technology still said they think their leadership would be more likely to invest in digital twin if they better understood the technology's benefits.

## Section 2 Key Takeaways

69% of respondents surveyed said their organization currently leverages digital twin technology, compared to the 23% that said their organization does not.

Of those at organizations that currently utilize digital twin technology, 71% said their organization began investing in the technology within the past year.

44% of respondents at organizations that don't leverage digital twin technology expect their organization to adopt it within the next three years; 11% said it would happen within the next six months.

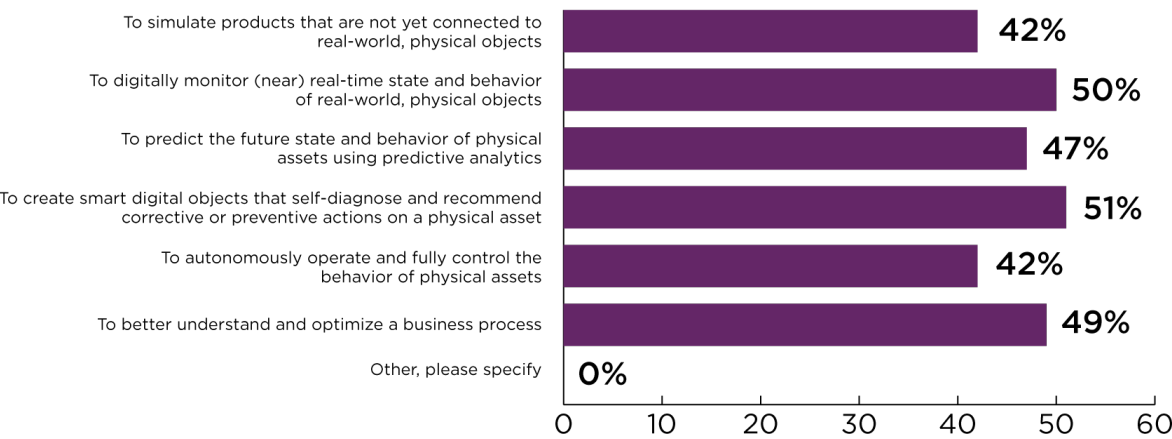
Respondents at larger organizations were more likely to leverage digital twin, more likely than smaller organizations to say it was “very important” to their organization, and more likely to utilize other advanced technologies like CAD/CAE, AI, edge computing, and IoT alongside digital twins than smaller organizations.

# Section 3: Usage and Rationale

This section explores how organizations use digital twin technology – it examines what functions they use it for, how they utilize it for sustainability, how it has improved their processes, how it has affected their costs, and more.

As the graph below displays, organizations that leverage digital twin technology use it for many different purposes. For this question, respondents could select multiple answers.

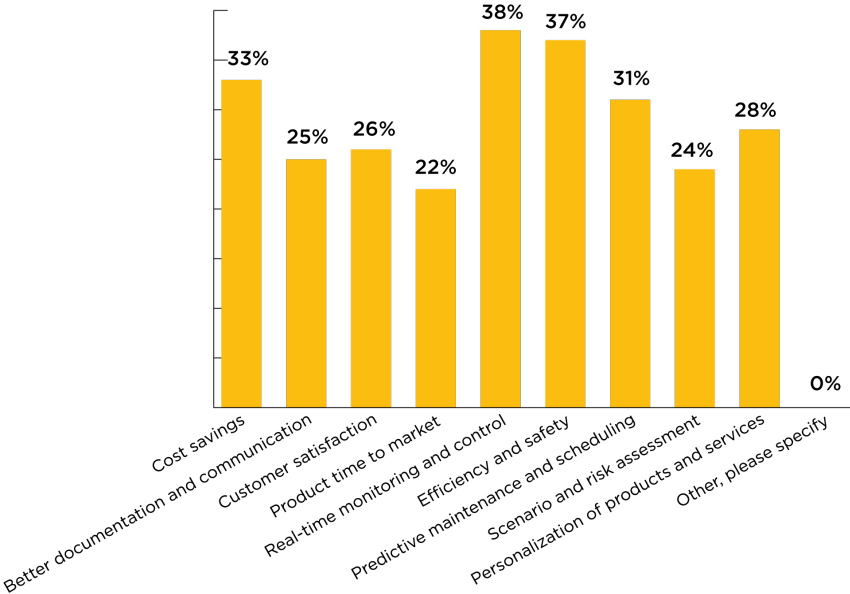
► How does your organization use digital twin technology?





The following graph shows what aspects respondents said digital twin technology had affected the most. For this question, respondents could choose more than one answer.

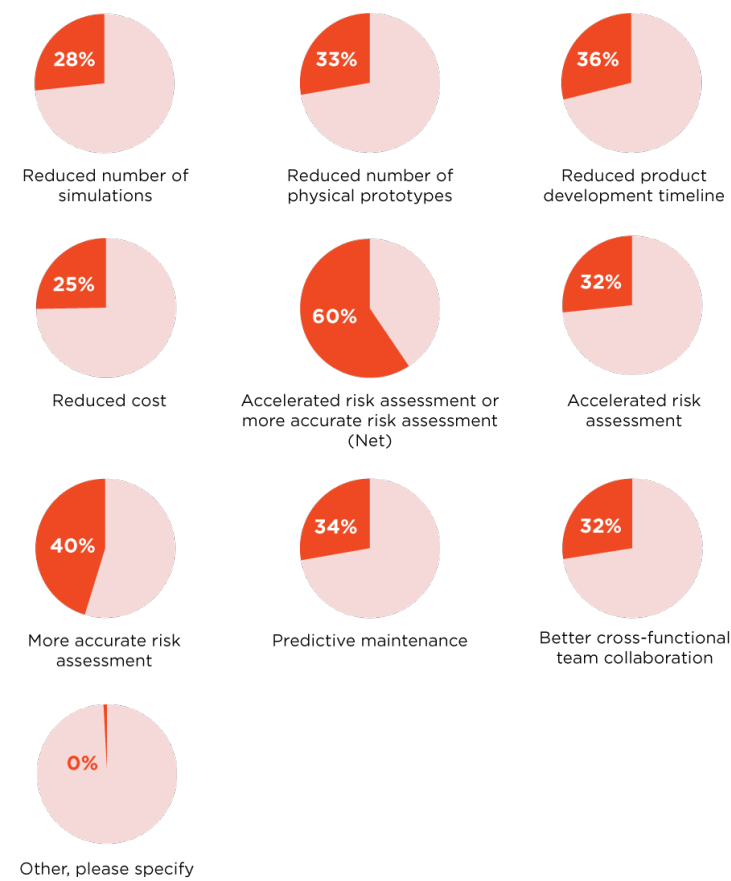
► At your organization, which of the following have digital twins had the greatest positive impact on?



According to respondents who work at organizations that use digital twin technology (N=1,393), the most common impacts from the technology have been real-time monitoring and control (**38%**), efficiency and safety (**37%**), and cost savings (**33%**).

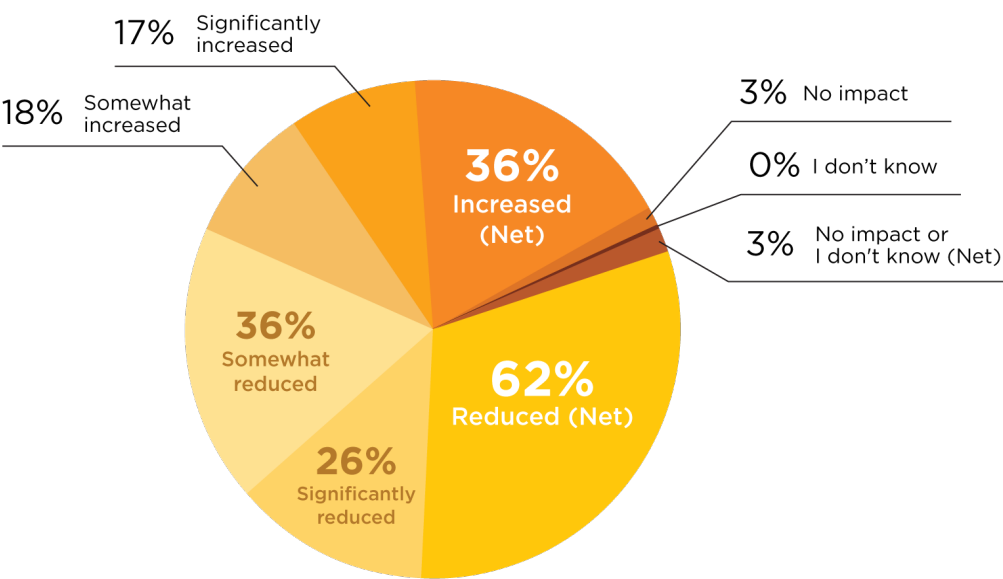
Respondents also indicated that enabling faster, more efficient, and more accurate risk assessments was digital twins' most significant benefits. For this question, respondents could select multiple answers.

► What does your organization believe to be the most significant benefit(s) of using digital twin technology in product development?



Interestingly, when asked how digital twin technology had impacted their costs, some said that it had increased their organization's warranty and maintenance costs.

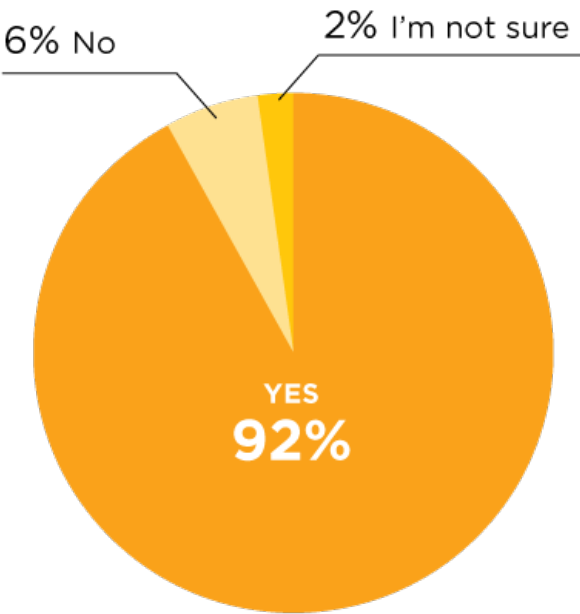
- ▶ Please fill in the blank with the response that best applies to you: Using digital twin technology has \_\_\_\_\_ maintenance and warranty costs at my organization.



While a clear majority (62%; N=1,393) said that digital twin technology had reduced these costs, many also said it had increased them (36%; N=1,393). This result may reflect the cost of the initial investment in digital twin technology, since earlier data showed that many organizations have only recently adopted digital twin technology, and respondents may not have yet experienced the accumulated cost savings over time.

One of the most definitive findings from this survey was that **92%** of respondents that used digital twin technology (N=1,393) said it made their products and processes more sustainable.

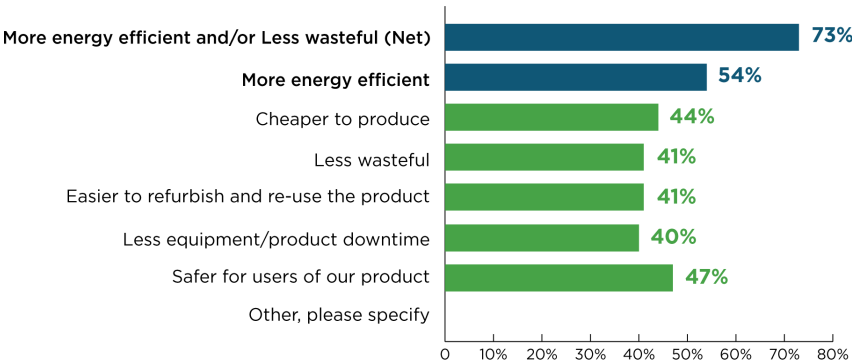
- ▶ Has digital twin technology helped your organization create more sustainable products or processes?



It's important to note that respondents were not asked to verify or prove how the technology made their operations more sustainable. "Sustainability" has many connotations in different industries and geographical regions, but it's nonetheless noteworthy for this data to be so overwhelmingly weighted in "yes" responses.

Following the previous data, respondents were asked to provide an idea of how digital twin technology has improved their products and processes. For this question, respondents could select multiple answers.

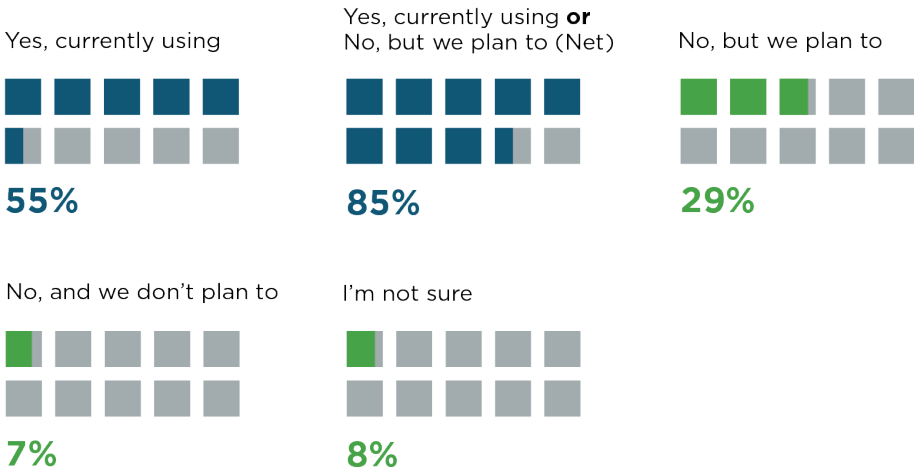
► Thinking of your organization's products or processes that are more sustainable thanks to digital twin technology, how have your organization's products or processes become more sustainable?



Taken together, 73% of respondents who indicate that digital twin technology helped their organization create more sustainable products or processes (N=1,275), said that digital twin technology made their products and processes less wasteful or more energy efficient. Additionally, 41% said the technology made it easier to refurbish or reuse products.

Lastly – and this question was asked to all respondents, not just those who currently utilize digital twin technology – 55% of respondents said they were already using the technology to meet their organizations' sustainability goals. Another 29% said their organizations planned to use the technology to achieve sustainability goals.

► Is your organization using digital twin technology to reach its overall sustainability goals?



In total, **85%** of respondents said their organization either already does, or is planning to use digital twin technology to meet their organization's sustainability goals.

## Section 3 Key Takeaways:

Organizations use digital twin technology for a range of functions and reasons, including to simulate products that are not yet connected to real-world, physical objects, digitally monitor (near) real-time state and behavior of real-world, physical objects, create smart digital objects that self-diagnose and recommend corrective or preventive actions on a physical asset, and more.

Respondents said the main benefits of digital twin technology include making products and processes less wasteful and more energy efficient, giving teams the power to implement real-time monitoring and control systems, improving efficiency and safety, and reducing costs.

92% of respondents whose organizations use digital twin technology indicated that it had made their products and processes more sustainable, and 85% of all respondents said that their organization either already does, or is planning to implement digital twin technology to meet their sustainability goals.

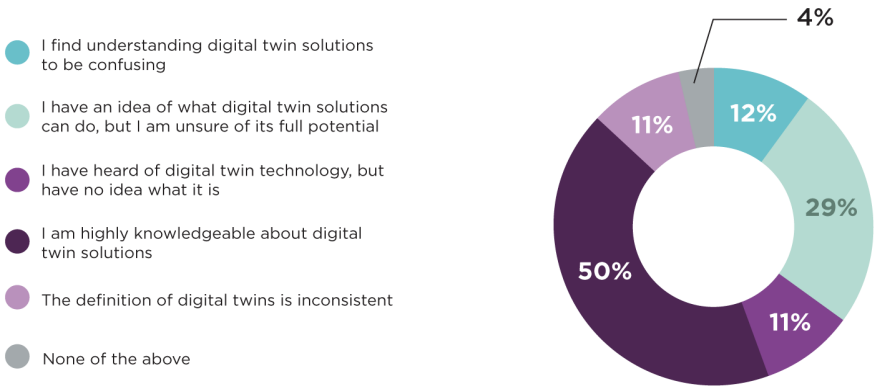
# Section 4: Geographic/ Organizational Role Comparison

This study not only analyzed respondents based on the size of the organization they work for, but also based on the countries and geographic locations they are in and what role they occupy in their organization. The data revealed these latter factors yielded some interesting, insightful responses to help deepen our understanding of digital twin technology, how it's used, how it's perceived, how different users within organizations feel about it, and more.

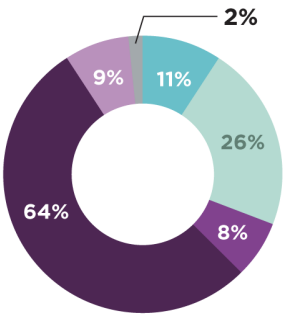
The first aspect worth diving into is the split between organizational upper management (such as CEOs, CTOs, CPOs, presidents, vice presidents, etc.) and user-level employees (such as managers, directors, engineers, designers, data scientists, etc.). The data consistently shows disconnects between these groups of employees.

To lead off, it's worth reiterating the survey data shows respondents felt leadership would be more likely to invest in digital twin technology if they knew more about it. It's interesting then to consider the split between upper-management and user-level respondents regarding their respective understanding of digital twin technology.

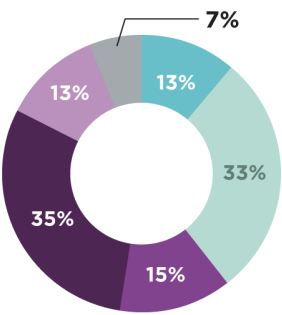
Which of the following statements best describes how you feel about digital twin technology?



Total



Upper-Management: President/Owners, C-Suites, VPs and Directors



Non-Upper Management: Managers and Non-Management

While 64% of upper-management respondents (N=1,007) said that they were "highly knowledgeable" about digital twin technology, just 35% of user-level respondents (N=1,000) said they were "highly knowledgeable" about the technology.

This gap is striking. Additionally, user-level respondents were more likely to say they found digital twin technology confusing, that the technology was inconsistently defined, and that they only had some knowledge of the technology. This data could mean a lot of things, such as:

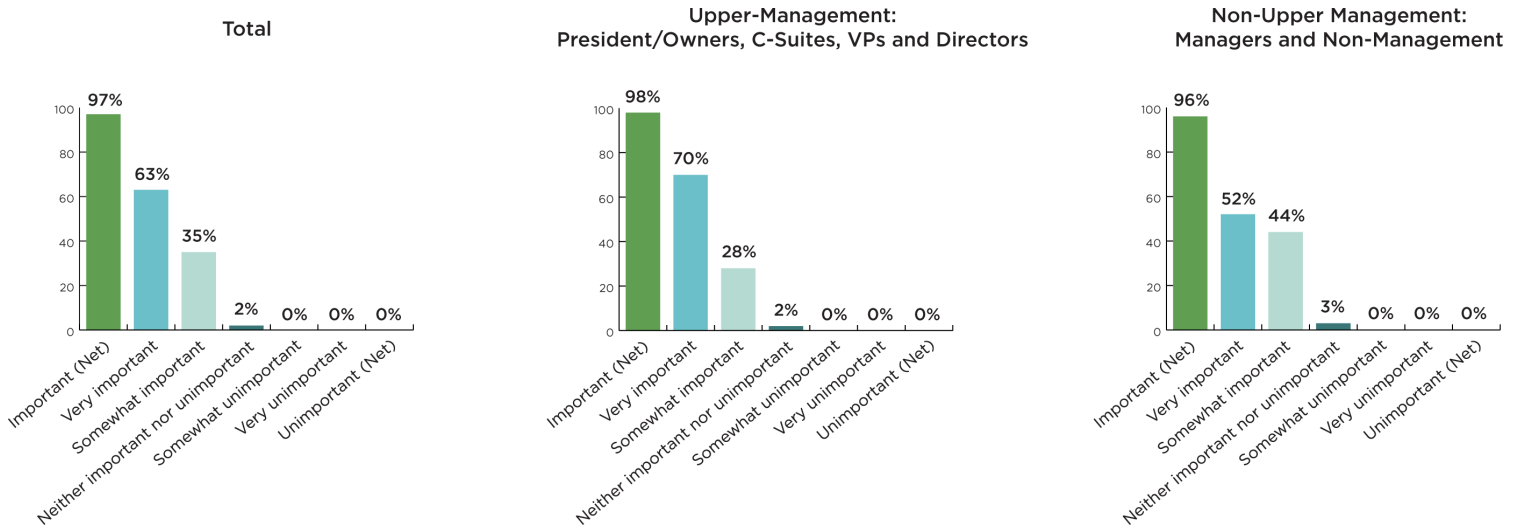
- Upper-management employees are more knowledgeable about the technology and its business impact than user-level employees.
- Upper-management employees are simply more confident about their knowledge than user-level employees.
- Upper-management and user-level employees are operating with different definitions/ conceptualizations about what digital twin technology is and what it does.

Regardless, it's evident there is a disconnect between upper-management and user-level employees when it comes to understanding digital twins.

Building more on the topic of this disconnect, we asked the two groups how important digital twin technology is to their organizations. Here again, we find a wide gap in responses between the groups.

► How important are digital twin solutions to your organization?

Overall, upper management employees were far more likely to call digital twin solutions “very important” to their organization than user-level employees. While 70% of upper-management employees said that digital twin solutions were “very important” to their organization, only 52% of user-level employees said the same. The two groups said the technology was important at the same overall rate, but the split between “very” and “somewhat” is the interesting find.



## Section 4 Key Takeaways

There’s a significant disconnect between upper management and user-level employees regarding what digital twin technology is, how their organizations use it, and its benefits.

64% of upper-management respondents said that they were “highly knowledgeable” about digital twin technology, but just 35% of user-level respondents said the same.

70% of upper-management employees said that digital twin solutions were “very important” to their organization, only 52% of user-level employees said the same.

While 66% of user-level employees said that digital twin technology had reduced maintenance and warranty costs, just 58% of upper-management employees said the same. And 29% of user-level employees said that the technology had increased these costs, compared to 40% of upper-management employees.

While 68% of upper-management employees said their organizations were using digital twin technology to meet their sustainability goals, just 43% of user-level employees said the same. In total, 92% of upper-management answered either “Yes” or “We plan to,” while just 77% of user-level employees said the same.

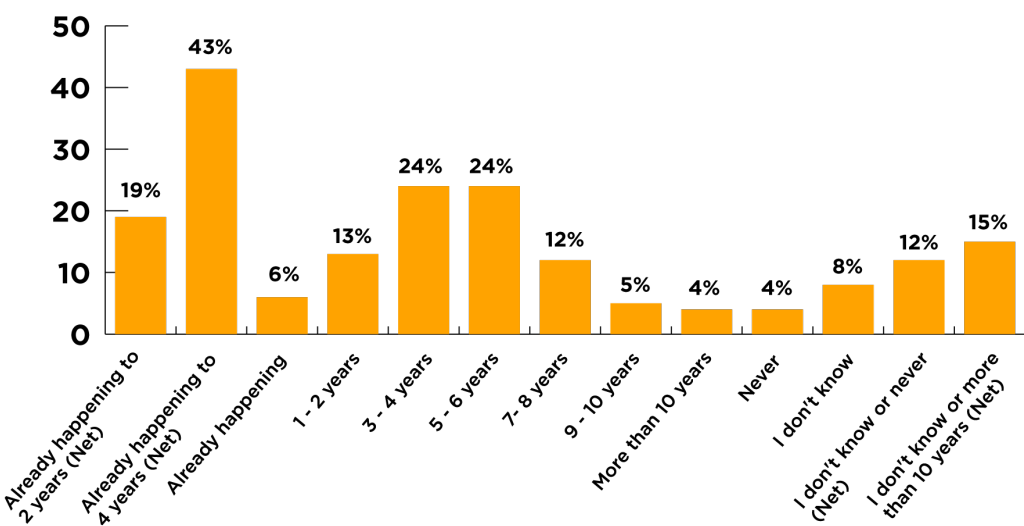
Respondents from China and India were more likely to say their organizations are using digital twin to meet their sustainability goals and more likely to want their leadership to know more about digital twin technology.

Respondents from the APAC region were the most likely to say their organizations were already leveraging digital twins at 78%; EMEA respondents were the least likely at 61%. APAC respondents were also more likely than other geographical regions to utilize other advanced technology alongside digital twin technology.

# Section 5: Business Impact and Future Impact

This final section examines how respondents said digital twin technology had impacted organizations and industries, and it also examines how respondents viewed the impact of digital twin technology in the coming years.

► When do you expect digital twin solutions to make the need for physical prototypes obsolete?



Another finding regarding business impact concerns how digital twin technology has impacted individual sectors. For example, the respondents' answers varied when asked if digital twin had reduced or increased maintenance and warranty costs.

Lastly, despite the variance in maintenance and warranty cost savings, there was broad consensus from all industries that digital twin technology helped respondents make their organization's products and processes more sustainable. In fact, 92% of respondents said digital twin had made their organization more sustainable.



## Section 5 Key Takeaways

43% of respondents felt that digital twin technology would make the need for physical testing obsolete within the next four years or sooner.

Respondents from the consumer electronics, AEC, and industrial equipment sectors were the most likely to say their organizations lowered their maintenance and warranty costs by using digital twin technology.

# Conclusions

**So, what did we learn?** Above all else, the data from this study suggests we are seeing just the tip of the iceberg with digital twin technology, and its story is still unfolding. The data shows digital twin technology has both arrived and is growing fast – around the world and in every industry.

First, we learned that companies around the world are adopting digital twin at astonishing rates. In companies that don't already invest in the technology, many are looking to do so in a matter of months. Additionally, a sizeable portion of companies that already invest in the technology said their organization invested in it just within the last year.

We also learned that internal education around digital twin technology is lacking, as suggested by the data comparing upper-management respondents with user-level respondents. Alignment between organizations' leadership and those who use the technology in their daily workflow is crucial, and without it, companies may struggle to maximize their investment. Additionally, the data suggested people around the world could benefit from a more standardized conceptualization and definition of digital twin technology, broadly speaking. Internal and external alignment isn't possible if people are operating with different definitions of digital twin, or if they don't have a solid grasp of how digital twin technology works within software and industries.

The data also suggested that warranty and maintenance savings stemming from digital twin technology doesn't always present itself immediately. The data suggests that companies may see losses in the short term, even though long-term savings from more efficient, more streamlined products and processes are assured. In this sense, digital twin technology is a lasting, long-term investment and companies should treat it as such – or risk being left behind.

Also, the data suggested that tech-curious regions and countries – particularly India and China – tend to adopt digital twin technology earlier and are generally more eager to do so if they haven't already; respondents from those countries were also the most curious about learning more about both digital twin and related technologies.

Lastly, we learned that companies view digital twins as a key technology that will help them reach their sustainability goals. Companies already using the technology indicated it helps them make products less wasteful and easier to refurbish and recycle, and a vast majority of respondents indicated they plan to adopt digital twin technology to meet their organizations' sustainability objectives. We can conclude that digital twin technology will be a critical part of future design and production, and that early adopters will have a head start on bringing better products to market, faster than the competition.