RELIABILITY AND HARDWARE DESIGN

A Survey of System Architects and Design Engineers

NOVEMBER 2023

molex

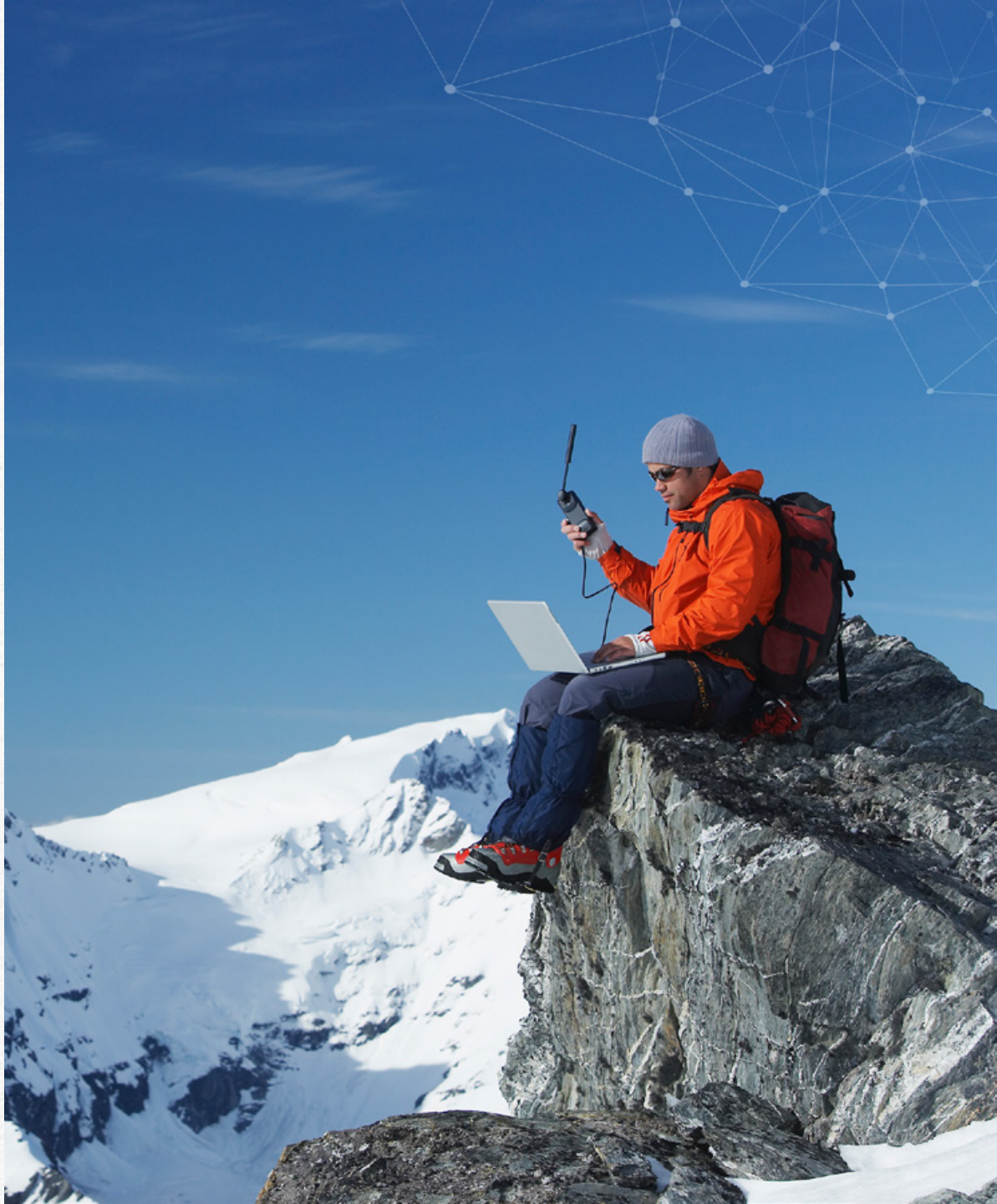
INTRODUCTION

What is reliability? The answer to this seemingly simple question can be the differentiator between a successful product launch and a failed brand reputation. Boiled down to its simplest form, reliability is a measure of consistency to expectation over the lifecycle of a product. In practice, however, the definition of reliability is much more fluid. Consistency, expectation and product lifecycle vary widely across industries and applications — and even within the same types of systems and devices. So, what does reliability really mean?

This report — compiled from data collected in the Molex Reliability and Hardware Design Survey of system architects, engineers and engineering managers working in several key industries — reveals a world of conflicting expectations, compromises, uncertainty and optimism when it comes to reliability. Today's engineers are forced to balance growing expectations for reliability with diminishing time for testing. Cost and manufacturability are colliding with performance characteristics and time to market. And products are growing more complex while a knowledge gap is emerging as the workforce ages, leaving critical roles open to younger, less experienced resources.

But the results also demonstrate excitement for the future. Digital technologies like artificial intelligence (AI), simulations and advanced analytics are expected to positively impact reliability. Can these technologies help offset the loss of highly experienced employees?

This report explores the current state of reliability, the challenges design engineers face in designing for reliability and the compelling innovations on the horizon.



METHODOLOGY AND PARTICIPANTS

Research Goal

Understand the significance of hardware device reliability in a new era of increasingly demanding applications across both signal and power.

Methodology

A variety of system architects, engineers and engineering managers were invited to participate in an online survey. They were asked a series of questions related to building reliable solutions. The questions covered three main themes: the **current state** of reliability, **challenges** delivering reliability and the impact of **innovation** on reliability.

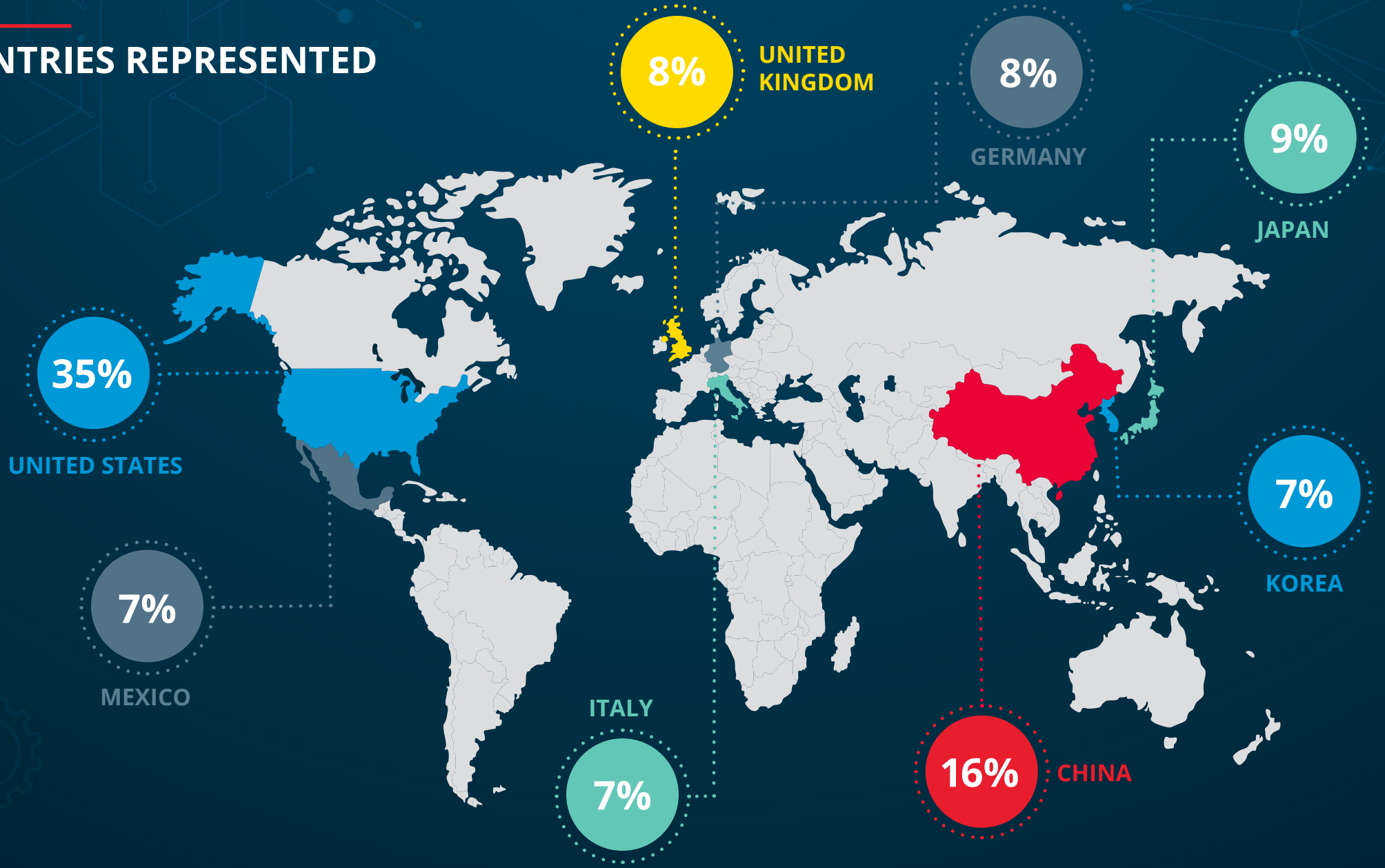
The survey was fielded in English, Simplified Chinese, Traditional Chinese, German, Japanese, Korean, Italian and Spanish. Responses were captured between October 6 and October 18, 2023.

Participants

A total of **756 qualified participants** completed the survey. All worked or currently work as part of a hardware design engineering team in a role that impacts the reliability of devices with connectors and other electronic parts. Participants were either directly responsible for system architecture or worked directly with the individuals or teams responsible for hardware system architecture in a design engineering or engineering manager role. The industries represented include but are not limited to automotive or transportation, consumer electronics or mobility, datacenter or cloud, defense or aerospace, energy management, healthcare or medical devices, industrial and telecommunications or networking.

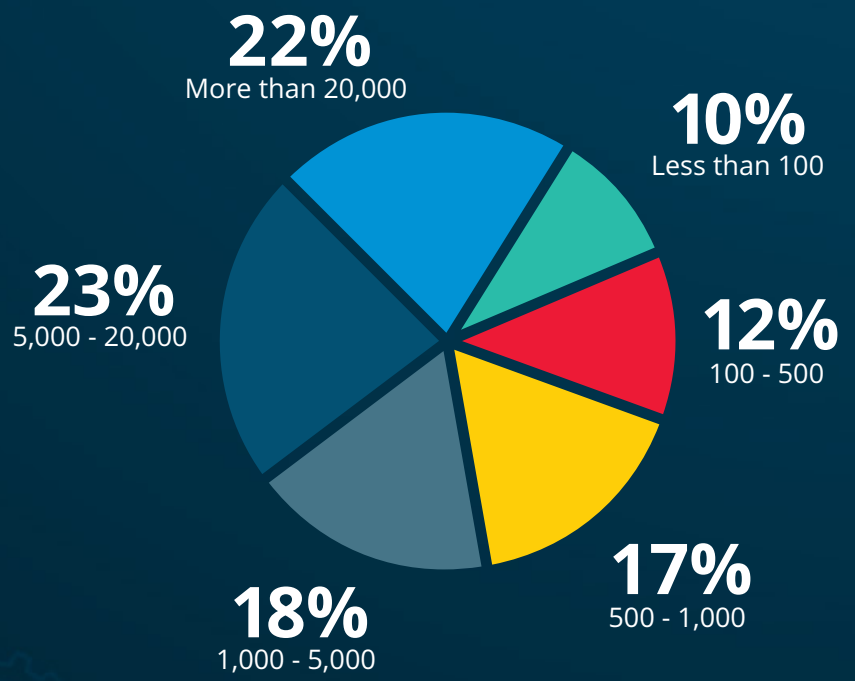
Percentages may not add up to 100% due to rounding.

COUNTRIES REPRESENTED

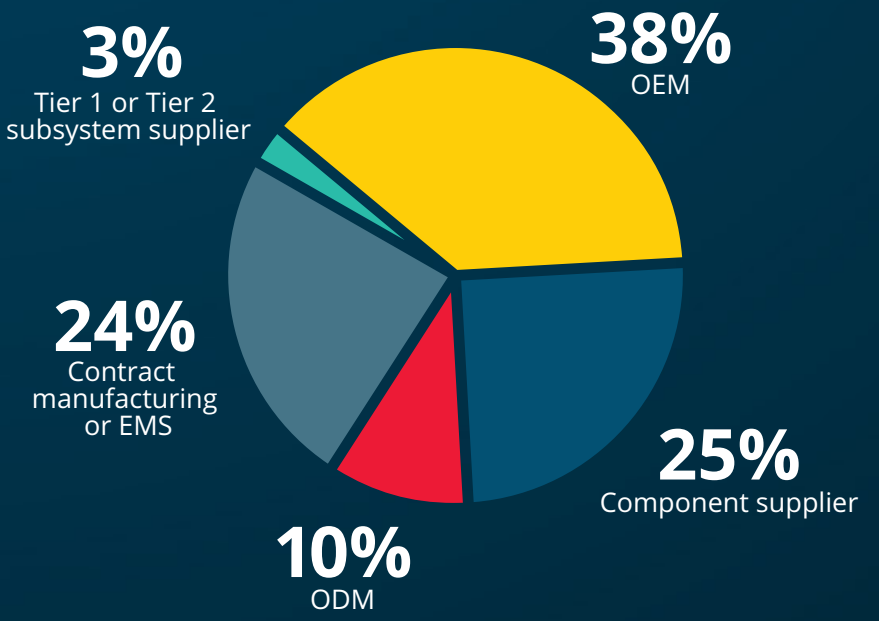


COMPANIES REPRESENTED

Company Size (# of employees)

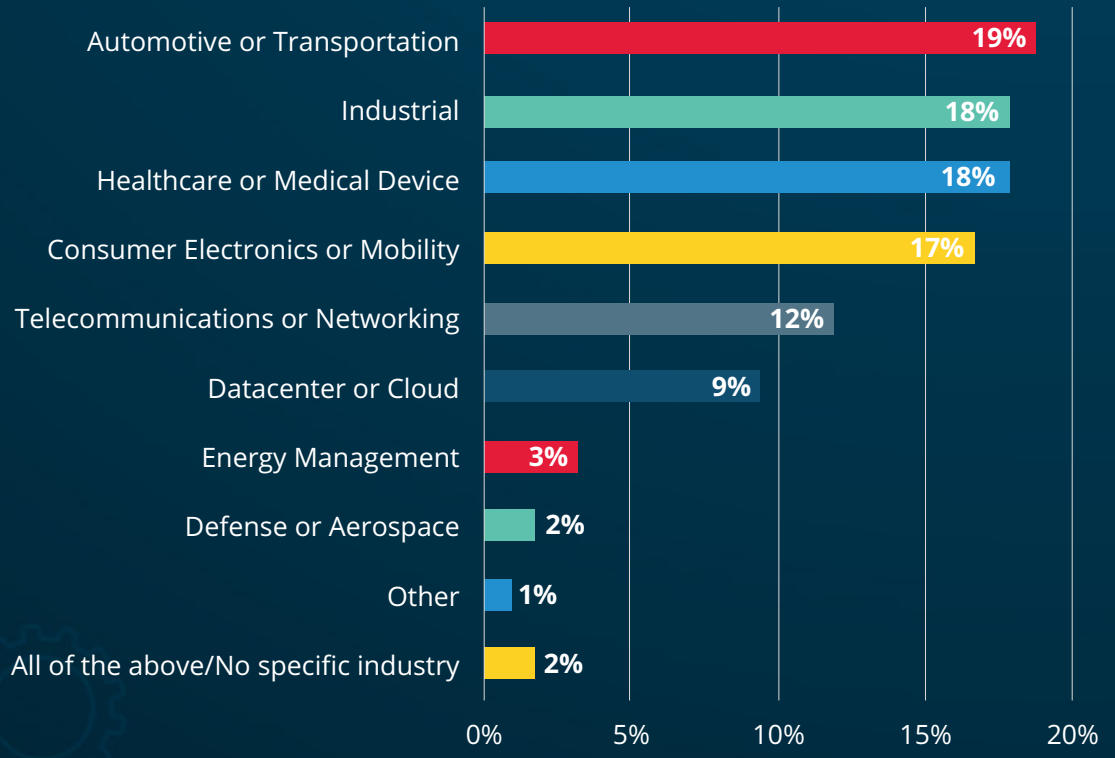


Type of Company

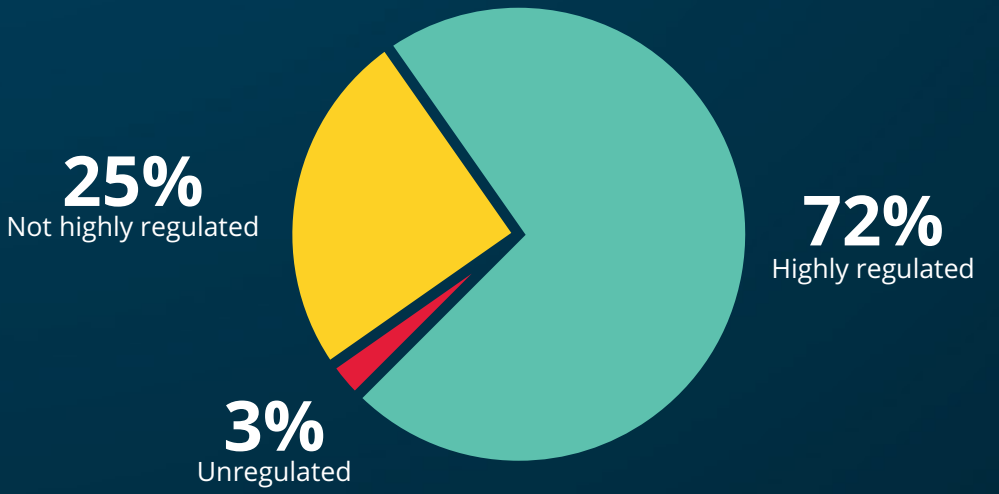


COMPANIES REPRESENTED

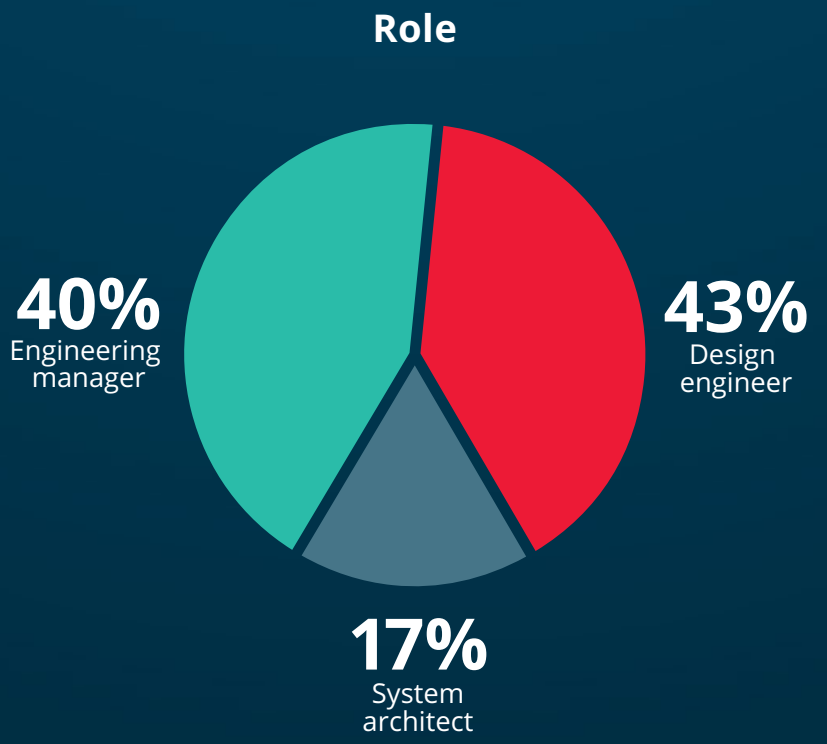
Industry



Level of Regulation



INDIVIDUALS REPRESENTED



DETAILED FINDINGS

The Current State of Reliability

THE CURRENT STATE OF RELIABILITY

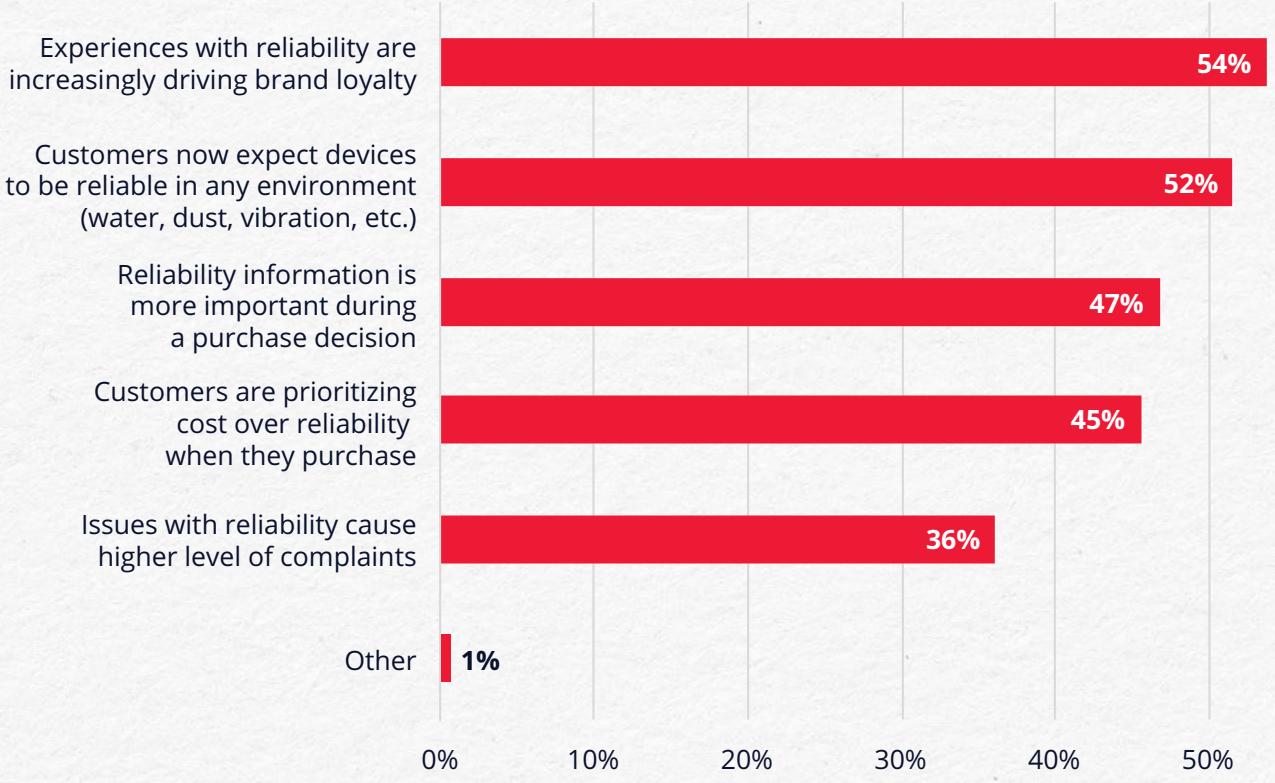
The current state of reliability is in flux and highlights the differing approaches leveraged to design reliability into their products. One thing is clear, though — reliability cannot be sacrificed. **54%** of engineers agree that end-user experiences with reliability are increasingly driving brand loyalty. In an era where customers have easy access to product reviews and device failures can rapidly go viral, having the process, team and methodologies in place to ensure products meet expectations is even more crucial.

But it isn't enough to just be reliable during ideal operating scenarios — **52%** of respondents agree that customers expect reliability to extend across any environmental condition, such as dust, water and vibration. Ruggedization must move towards the top of the list of design criteria and be proven with environmental testing, simulations and real-world use cases.

How are organizations resourcing reliability relative to ownership, design criteria and timing? And what metrics are being used to measure success?

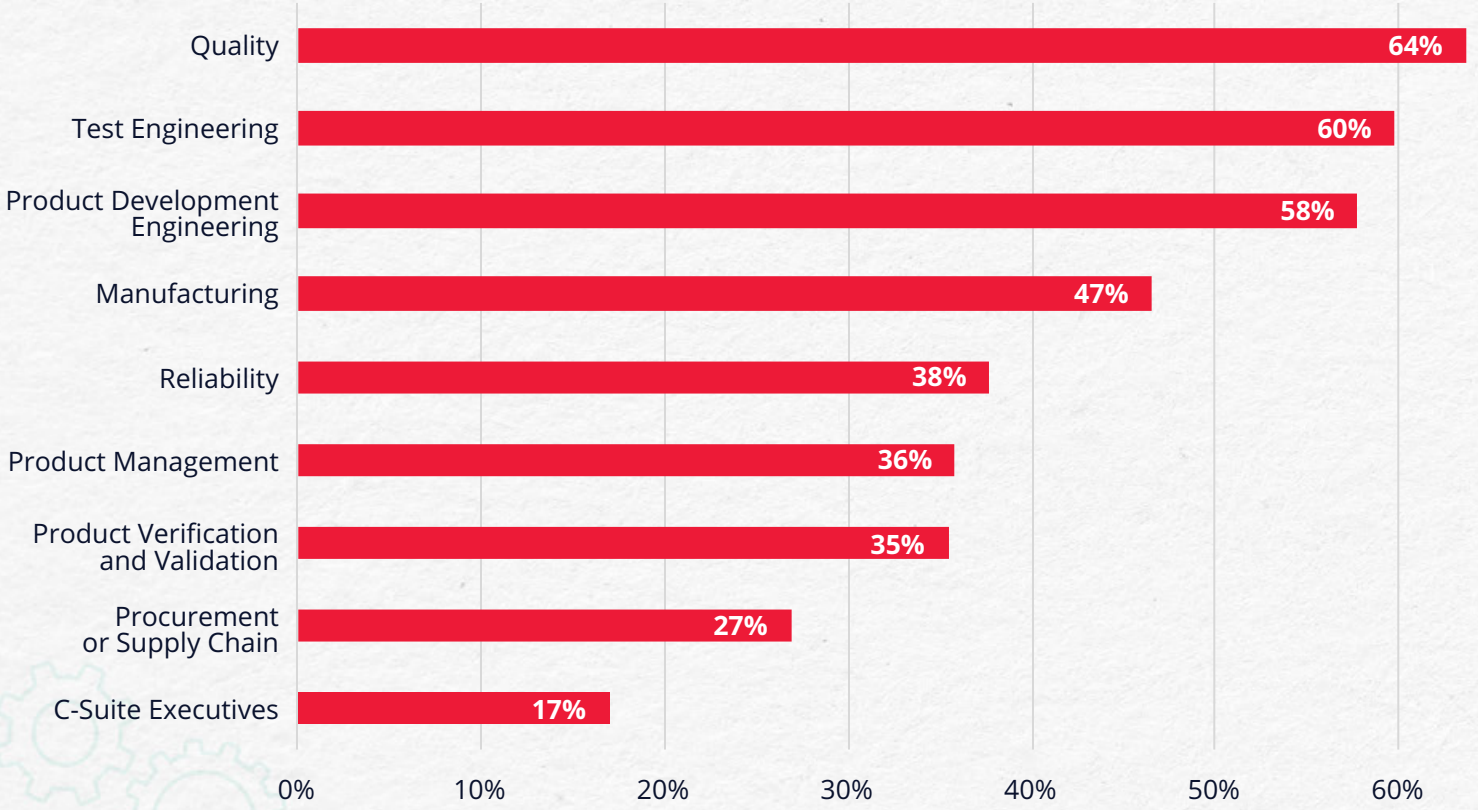
QUESTION:

In the past few years, how have expectations for product reliability changed among the end users of the products you design? Choose all that apply.



QUESTION:

At your company, what teams are involved in ensuring products meet reliability requirements? Choose all that apply.



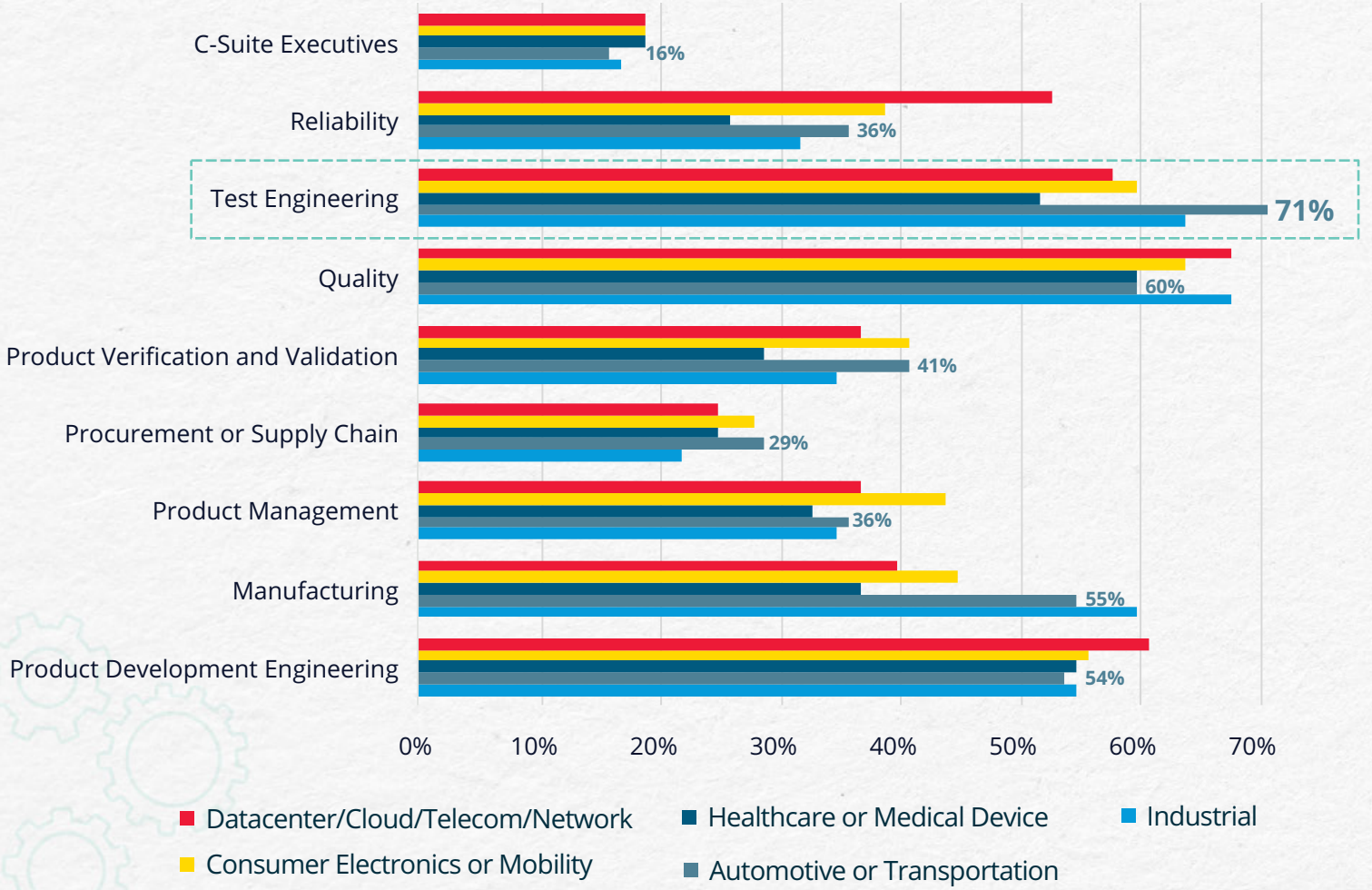
KEY TAKEAWAY:

Most companies **(64%)** rely on their Quality teams, followed by Test Engineering **(60%)** and Product Development Engineering **(58%)**. Although a small percentage compared to other roles, **17%** of C-Suite executives are involved in ensuring products meet reliability requirements.

INDUSTRY INSIGHT: Transportation

QUESTION:

At your company, what teams are involved in ensuring products meet reliability requirements? Choose all that apply.

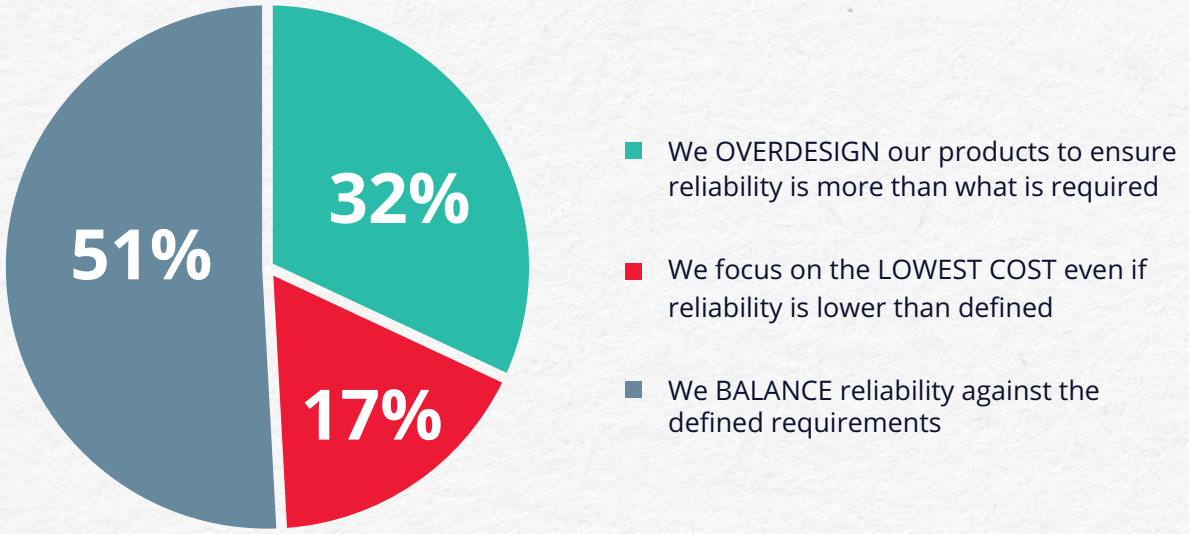


KEY TAKEAWAY:

Compared to other industries, the role of Test Engineering is more prominent in Automotive & Transportation **(71%)** in ensuring products meet reliability requirements. Given the growing number and complexity of subsystems in modern vehicles — autonomous capabilities, electric powertrains and many more — rigorous reliability testing is more important than ever before.

QUESTION:

Which of the following statements most closely describes your company's approach towards reliability?

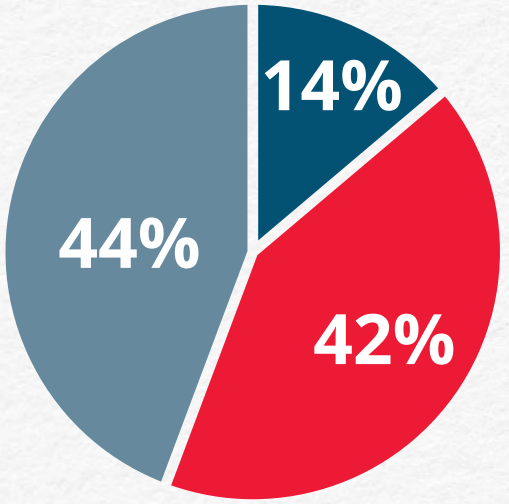


KEY TAKEAWAY:

Companies tend to prioritize overdesigning a product nearly twice as often as pursuing a lower cost solution. Just **17%** of respondents select the cheapest option at the expense of reliability. A slim majority **(51%)** of respondents seek a balanced approach.

QUESTION:

Which of the following statements best describes the way your company applies industry certifications and standards for reliability?



- Our goal is to meet minimum requirements
- We design to surpass current requirements
- We strive to meet possible future requirements in addition to current requirements

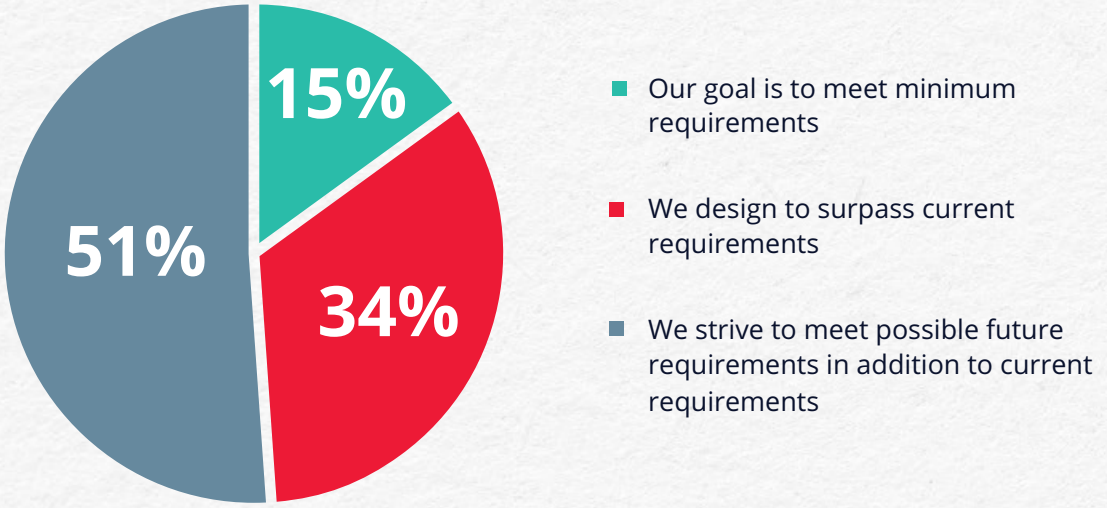
KEY TAKEAWAY:

Achieving the minimum is no longer sufficient for the vast majority of reliability stakeholders. In fact, **42%** are designing hardware with the goal of surpassing current industry certifications and standards while an even larger group **(44%)** is striving to align with possible future requirements. Staying ahead of these standards could be the motivation behind overdesigning products.

INDUSTRY INSIGHT: Datacom

QUESTION:

Which of the following statements best describes the way your company applies industry certifications and standards for reliability?

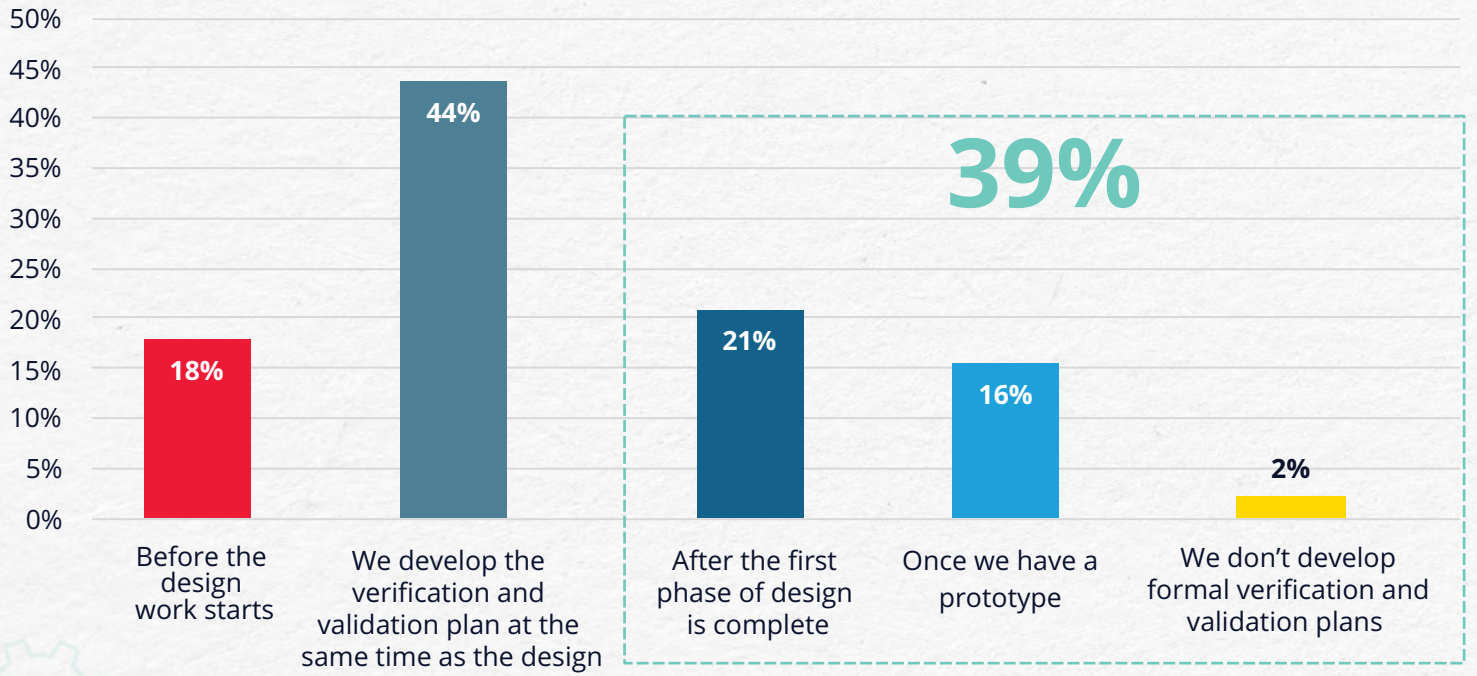


KEY TAKEAWAY:

Datacom is planning for the future to meet the anticipated demands of emerging technologies like AI. **More than half** of those surveyed from the datacom industry are working to address present needs, while simultaneously striving to meet potential future requirements as well.

QUESTION:

When in the product lifecycle are verification and validation plans developed? Choose the one answer that most closely applies.

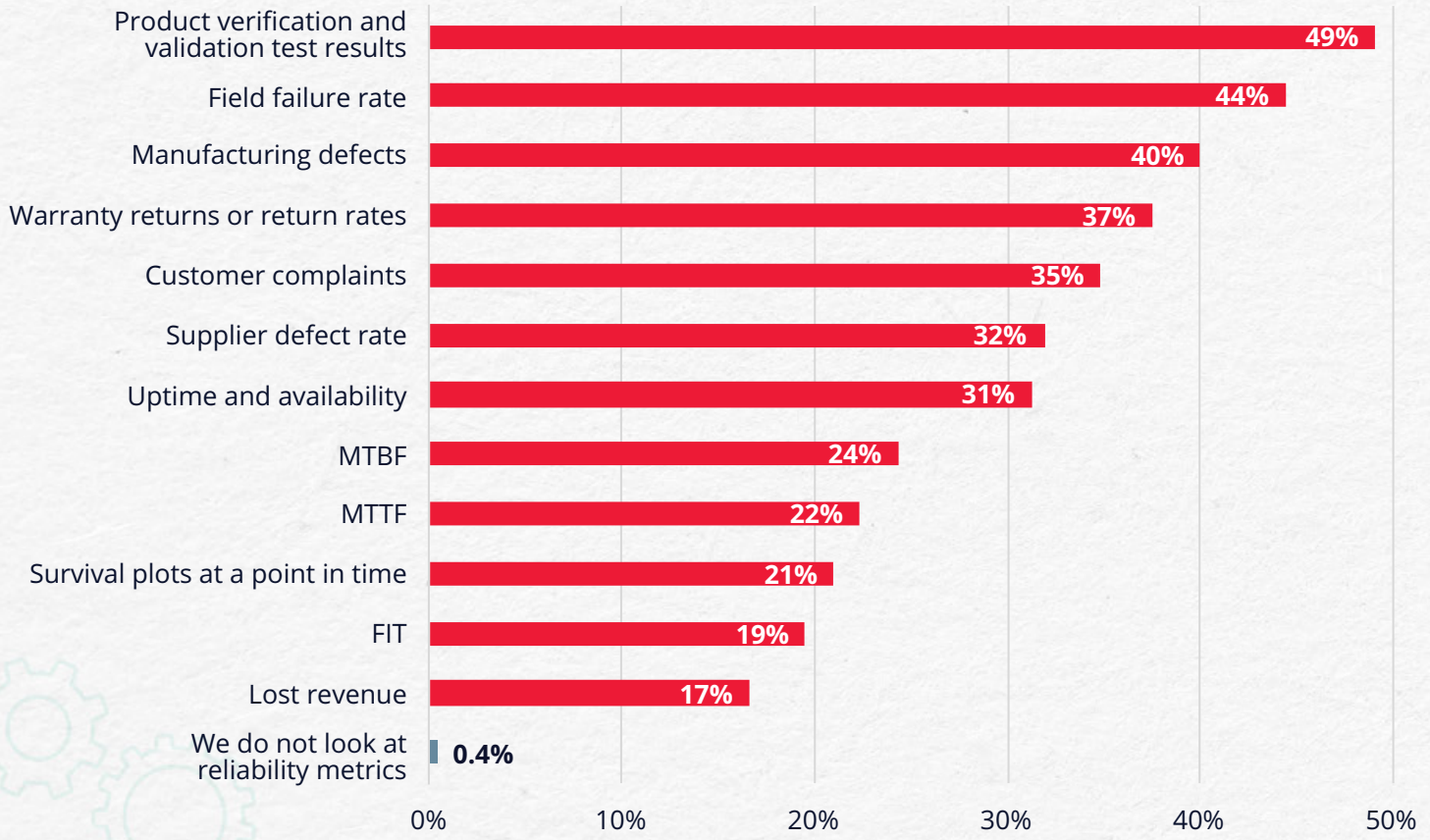


KEY TAKEAWAY:

Although reliability is critical, it is often considered later in the design process. Only **18%** of engineers develop verification and validation plans before the start of design. In fact, **nearly 40%** of respondents are not developing plans for reliability until after the first phase of product design.

QUESTION:

What metrics does your company use to measure product reliability? Choose all that apply.



KEY TAKEAWAY:

Virtually all respondents report using some form of hard data to measure reliability. Product verification and validation test results top the list at **49%**, followed by field failure rate at **44%**.

DETAILED FINDINGS

Today's Challenges to Delivering Reliability

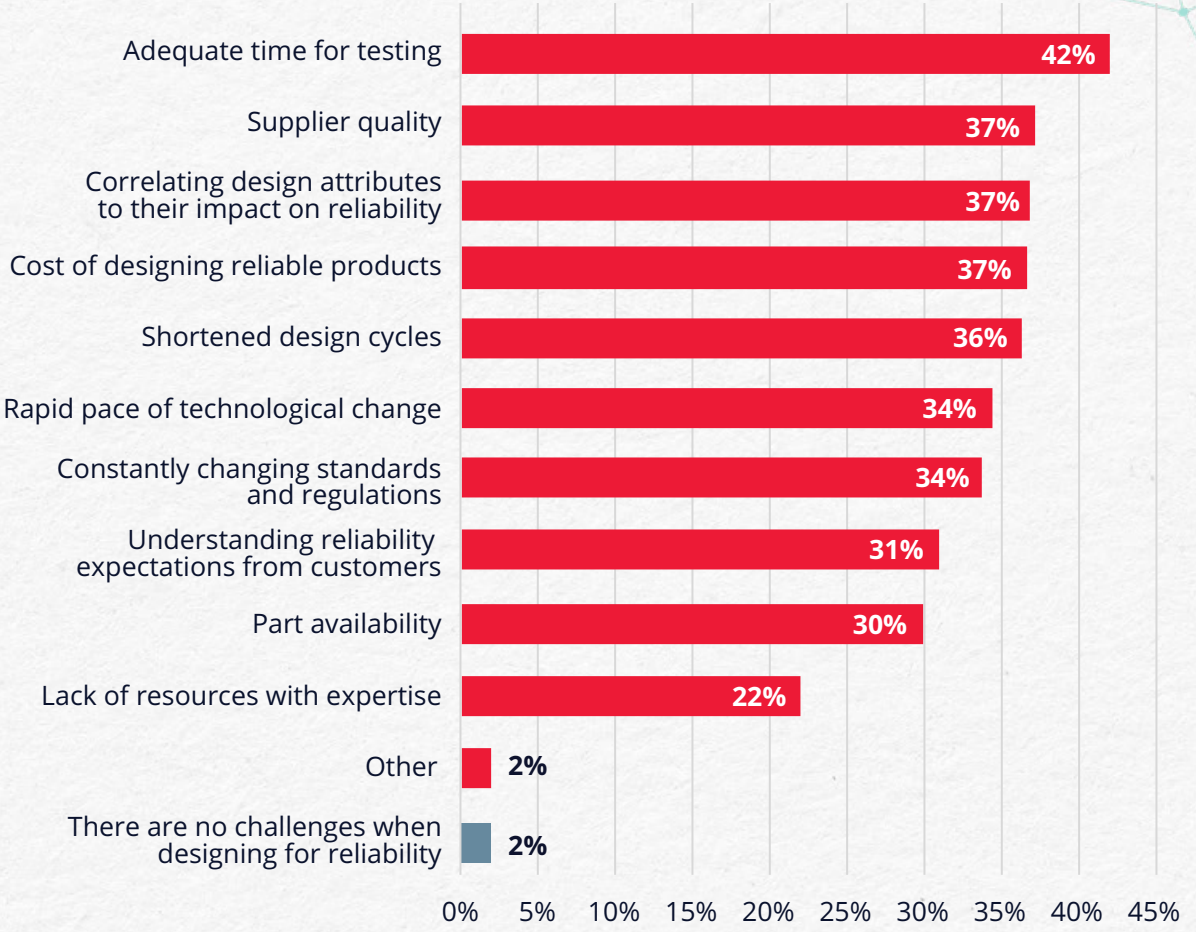
TODAY'S CHALLENGES TO DELIVERING RELIABILITY

In today's age of shortening design cycles, growing product complexity and the consumerization of user experiences, system architects and design engineers must not only navigate but overcome a variety of challenges. A nearly unanimous **98%** of respondents report challenges designing for reliability, with time for testing **(42%)** topping the list. A question in the previous section demonstrated that development of verification and validation plans is often delayed until later in the product design process — the lack of time for testing highlighted here only further emphasizes the need for quick, accurate decision making, a task best held by experts.

Reliability is a complicated subject with a variety of interlinked influences across design criteria and business requirements. Small decisions and simple compromises can lead to hugely detrimental results. After all, no matter how well a product meets test and certification criteria, the final measure of a product's reliability hinges on customer satisfaction. What design tradeoffs are worth risking reliability? And how are engineers utilizing data and supplier partners to minimize those risks?

QUESTION:

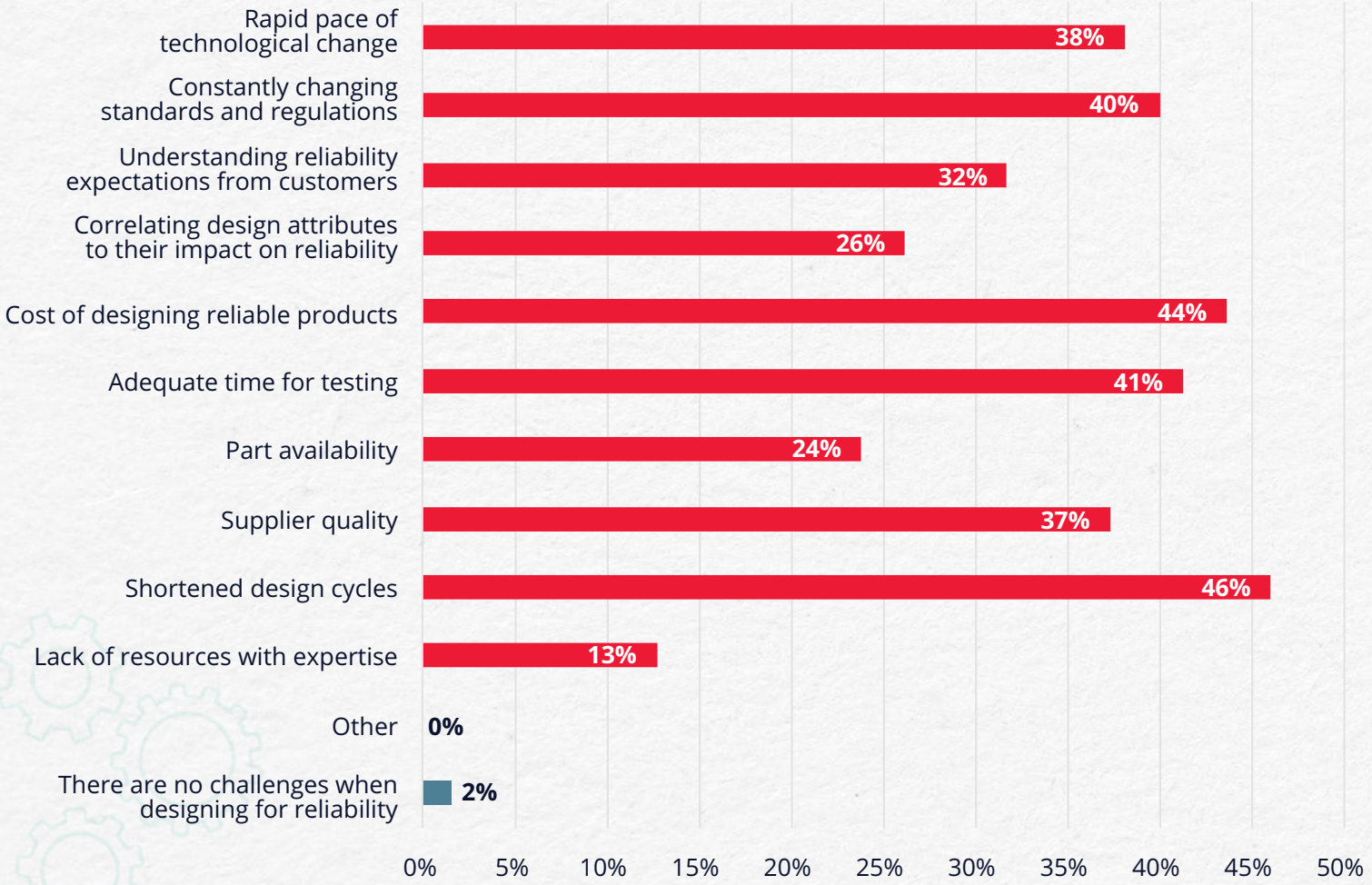
In your experience, what is difficult when designing for **reliability?** Choose all that apply.



INDUSTRY INSIGHT: Consumer Electronics

QUESTION:

In your experience, what is difficult when designing for reliability?
Choose all that apply.

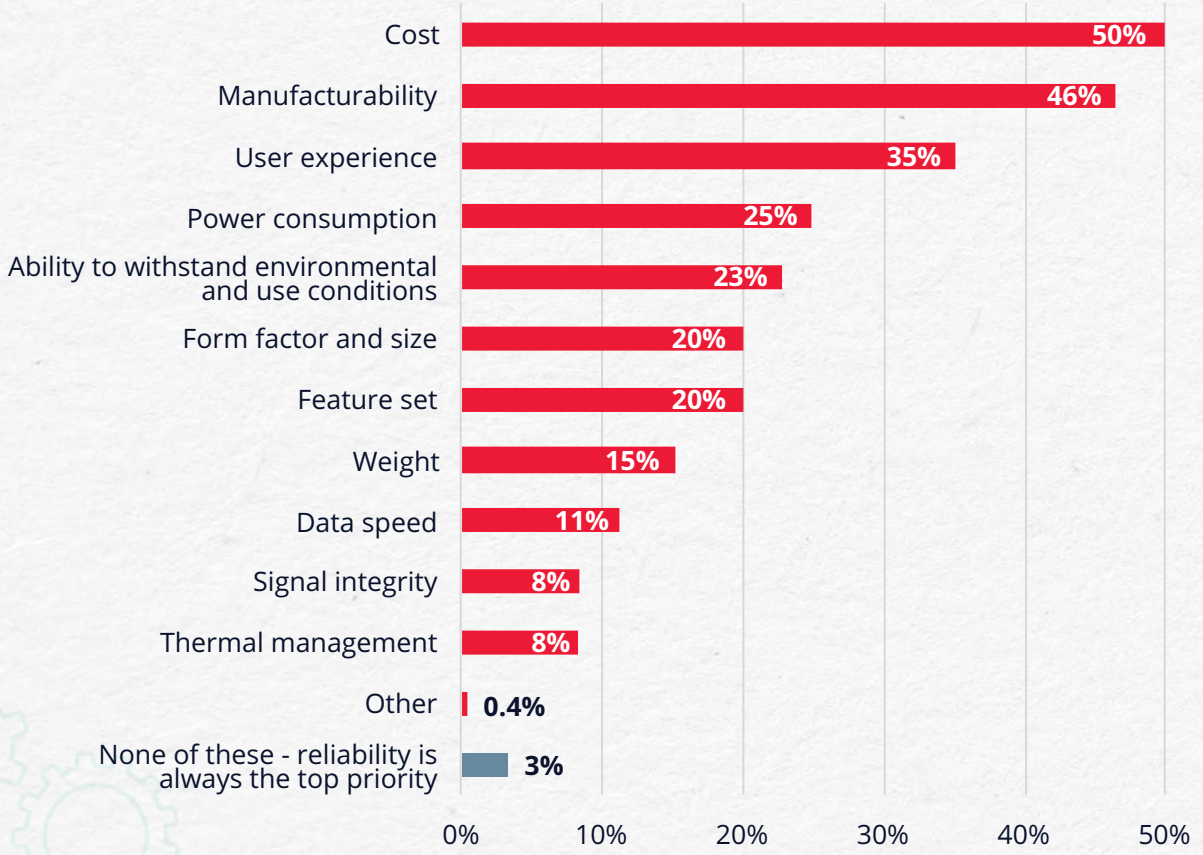


KEY TAKEAWAY:

Respondents from the Consumer Electronics industry identified their two greatest concerns as the shortening of design cycles **(46%)** and the increasing cost of designing for reliability **(44%)**. These statistics highlight the ever-growing consumer demand for faster evolving products at reduced costs.

QUESTION:

When evaluating design tradeoffs, which areas are MOST LIKELY to be prioritized over the reliability of a product? Choose up to three of the following.

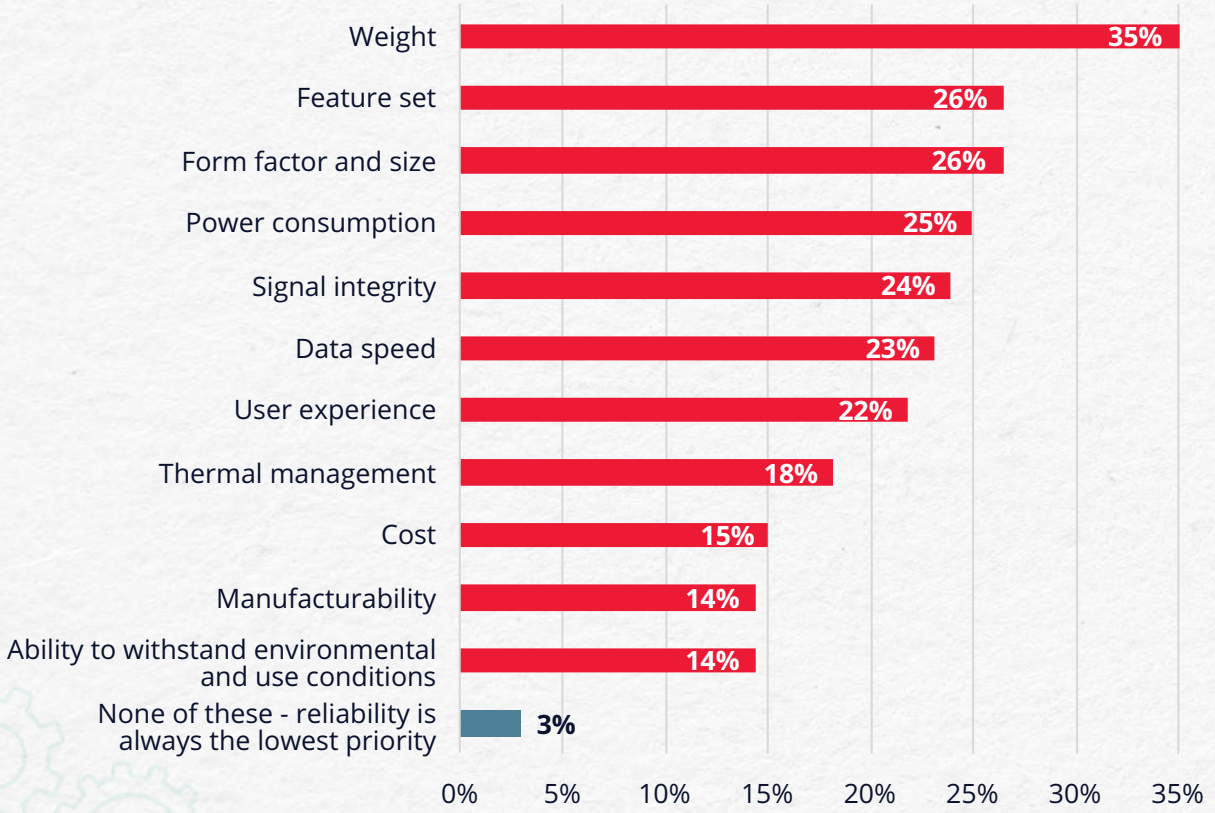


KEY TAKEAWAY:

When engineers are forced to make design tradeoffs, they are most likely to prioritize cost and manufacturability over reliability. Overall, **97%** of respondents report prioritizing other factors over reliability.

QUESTION:

When evaluating design tradeoffs, which areas are LEAST LIKELY to be prioritized over the reliability of a product? Choose up to three of the following.

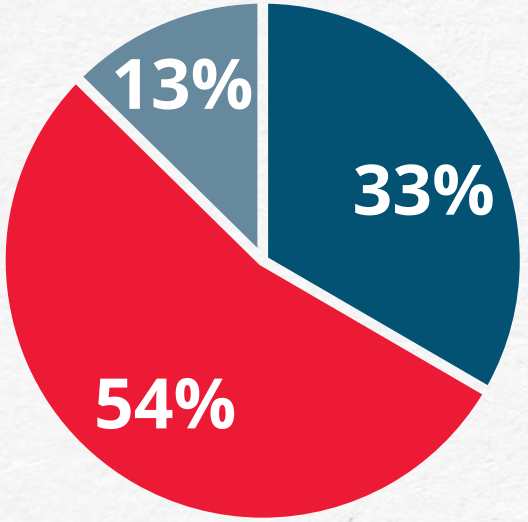


KEY TAKEAWAY:

Even in an era where consumers expect lighter, sleeker and more powerful devices, engineers are still unwilling to compromise reliability in favor of weight **(35%)**, features **(26%)** and form factor/size **(26%)** when making design tradeoffs.

QUESTION:

What approach does your organization typically use to make tradeoff decisions? Choose the one answer that most closely applies.



- We use data-based models to analyze the impact of possible tradeoffs during the design process
- We define clear priorities on what is most important for each project and follow those as we make tradeoff decisions
- Our designers make judgement calls about tradeoffs as they go

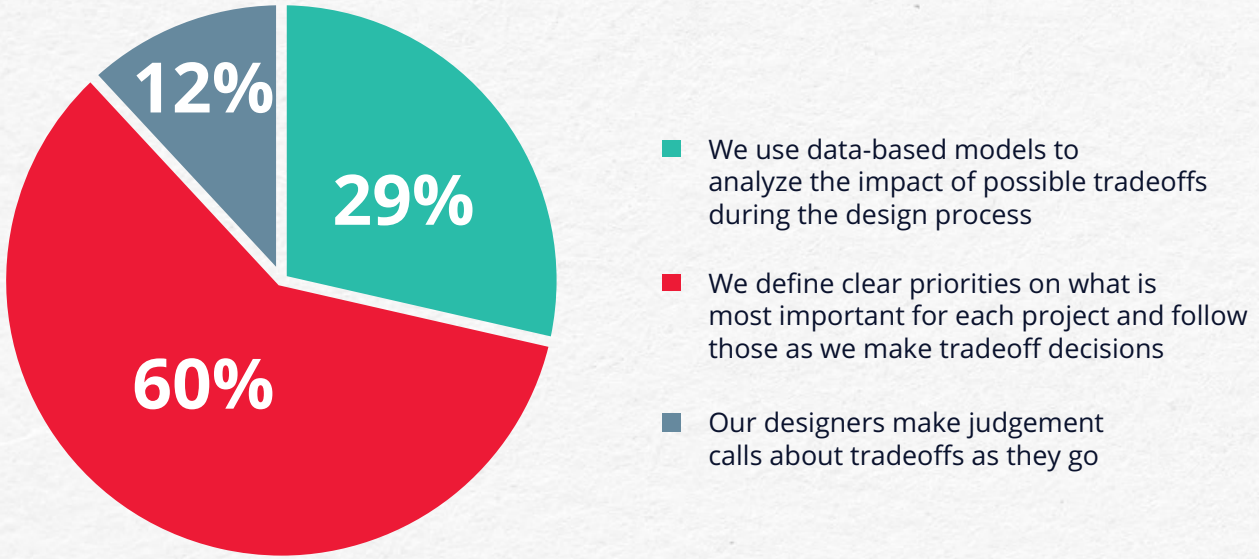
KEY TAKEAWAY:

Only **33%** of respondents use data-based models to help evaluate design tradeoffs. Most rely on a combination of predetermined design priorities and judgement calls. Highly experienced resources can support this decision making but employee turnover imposes risk to this approach.

INDUSTRY INSIGHT: Consumer Electronics

QUESTION:

What approach does your organization typically use to make tradeoff decisions? Choose the one answer that most closely applies.

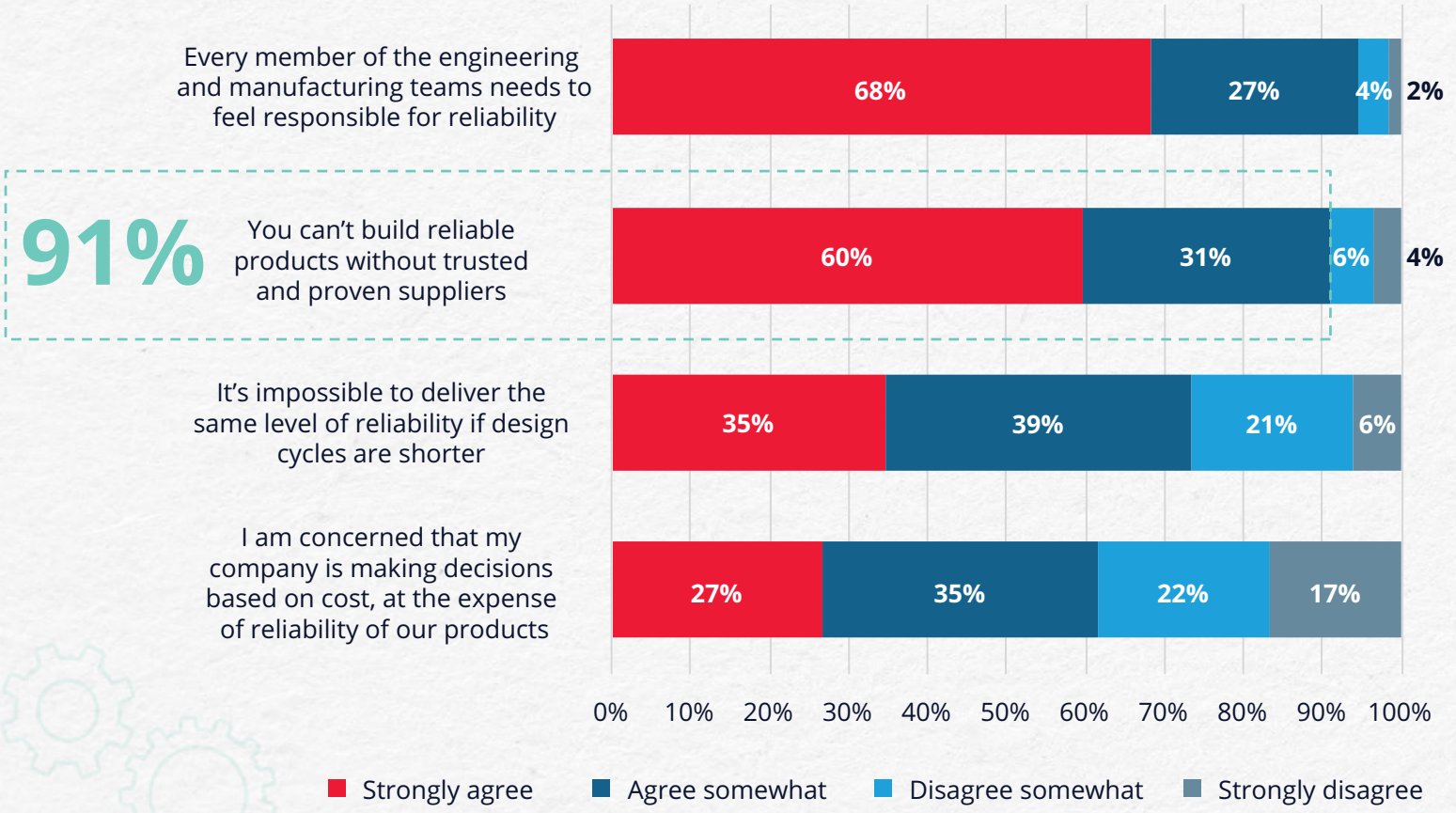


KEY TAKEAWAY:

In Consumer Electronics, tradeoffs are often identified as early as possible. **60%** of respondents stated that clear priorities are set at the beginning of a project, rather than making changes during design. This may reflect Consumer Electronics' sensitivity to reduced design cycles and cost and the resulting lack of flexibility once design kicks off.

QUESTION:

Please rate your agreement with each of the following statements.

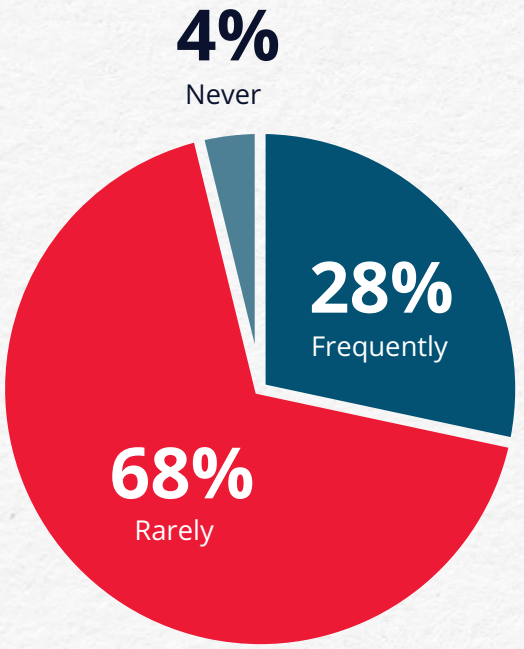


KEY TAKEAWAY:

Strong supplier relationships provide access to products as well as a wealth of knowledge, experience and data. A remarkable **91%** of those surveyed agree that reliable products can't be built without trusted and proven suppliers. Supplier expertise and engagement is even more critical when considering **74%** of engineers agree that reliability may be at risk due to shortening design cycles.

QUESTION:

How often does your company change suppliers for a part that has been designed-in because of reliability issues?



KEY TAKEAWAY:

There is almost no compromise when it comes to the role of suppliers. The survey found that **96%** of respondents have changed part suppliers due to reliability issues, and **more than a quarter** report changing suppliers frequently.

DETAILED FINDINGS

The Future of Reliability

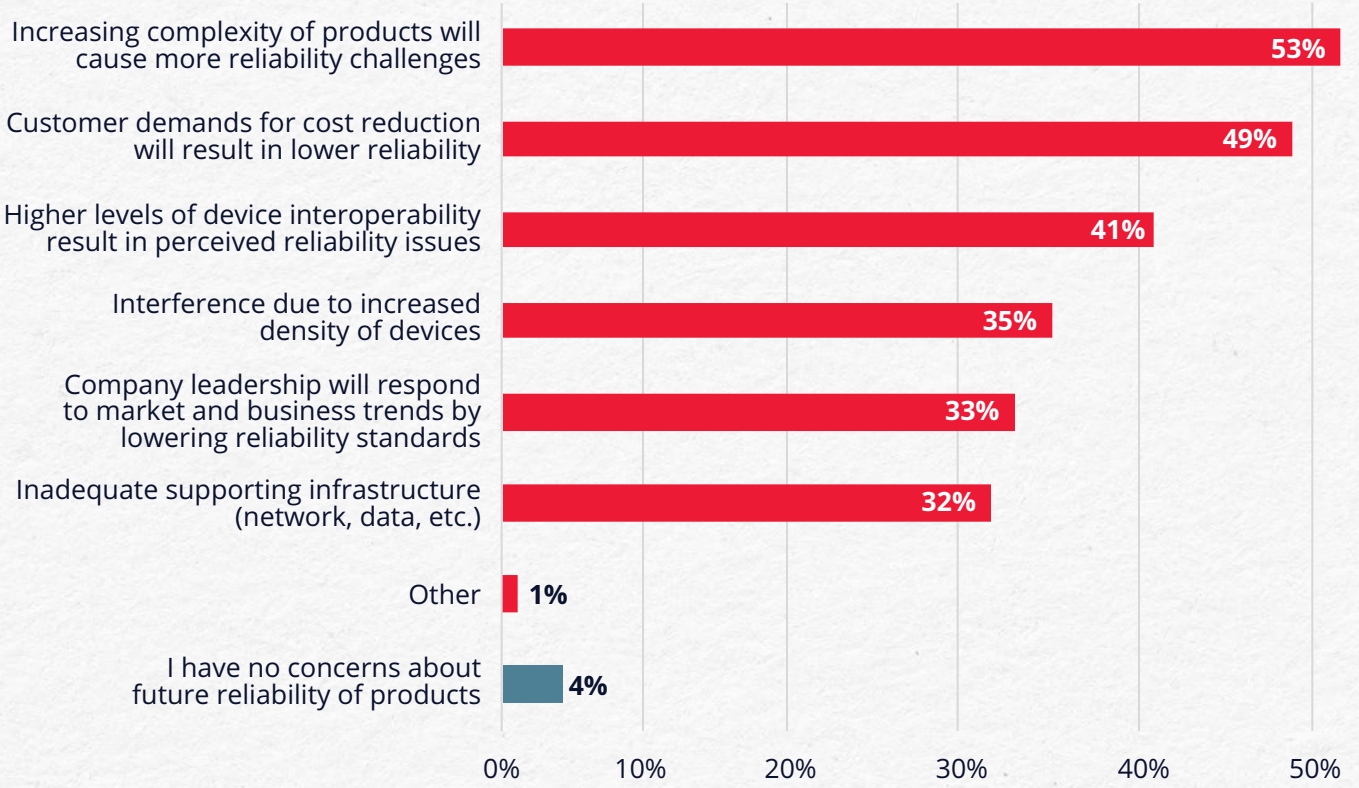
THE FUTURE OF RELIABILITY

The future of reliability sheds light on a variety of complex trends. Emerging issues in product development, an aging workforce and advancing technologies are first among them. The vast majority of respondents **(96%)** have concerns about overall reliability in electronics products, with increasing complexity of devices **(53%)** and growing customer expectations of reduced costs **(49%)** topping the chart. Further complicating the future outlook is the expected loss of reliability expertise to retirement. As highly specialized engineers exit the workforce, their roles are often replaced by generalists. Can those less experienced make the accurate decisions necessary under the pressure of accelerated go-to-market timelines and increasingly complex systems? Leadership isn't too sure, and for some industries, loss of talent may be devastating.

But where there's risk lies great opportunity. Engineers are optimistic that AI and other digital tools have the potential to offset some of the mounting obstacles to designing for reliability by improving processes, generating predictive simulations and advancing data analytics. Although these tools are not expected to be one-for-one replacements for retiring reliability experts, they may help expand the capabilities of less experienced and less specialized engineers to reduce negative impact.

QUESTION:

As you look into the future, do you have any concerns about the reliability of electronics products? When answering this question please think across all types of products that contain electronic parts, not just the ones your company makes. Choose all that apply.



INDUSTRY INSIGHT: Datacom

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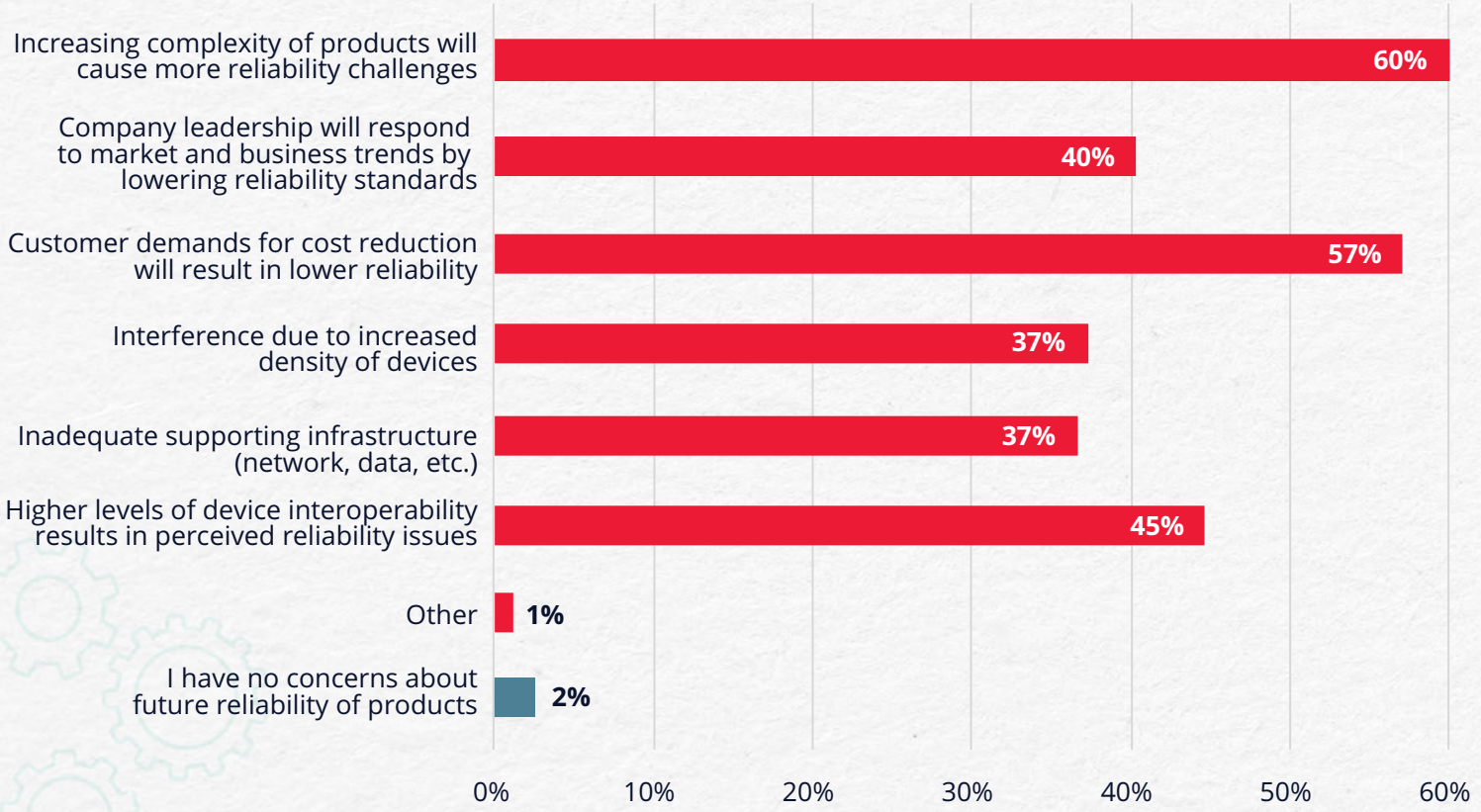
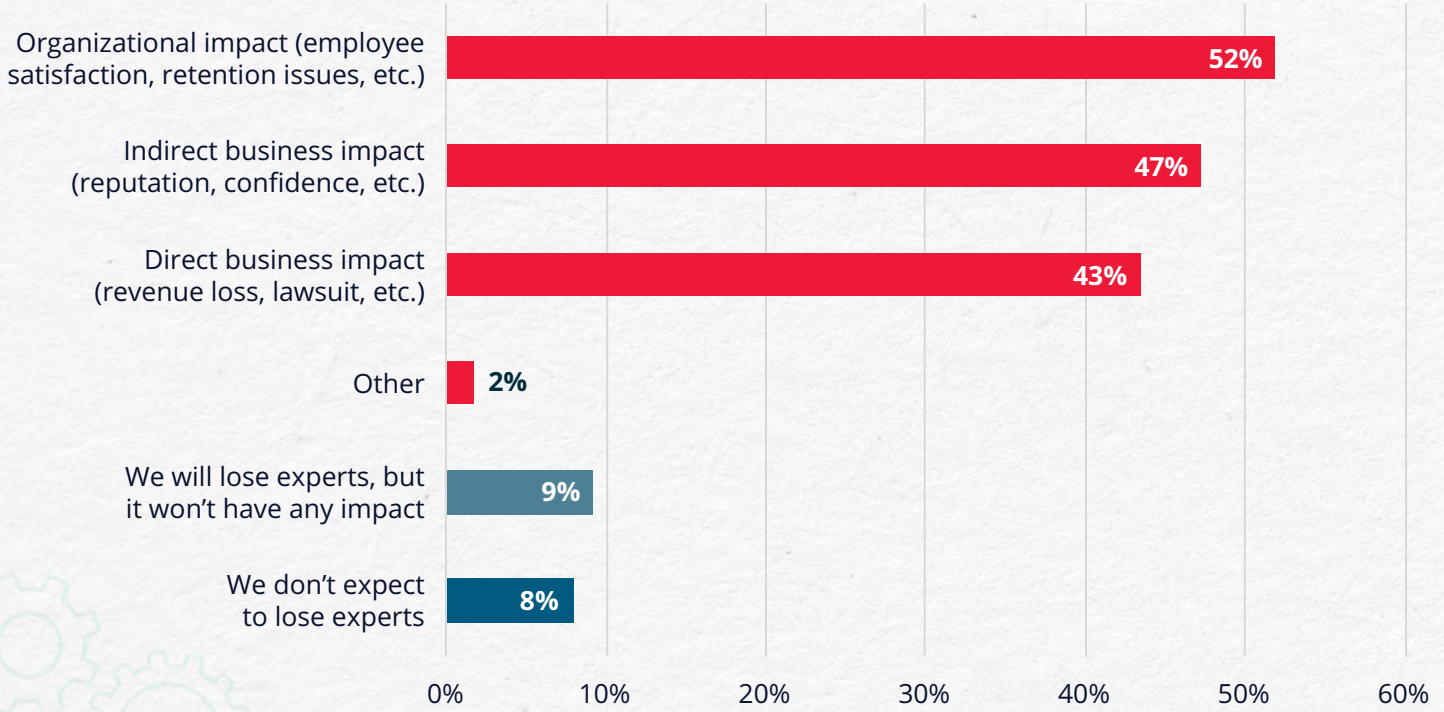


KEY TAKEAWAY:

Given our increasingly connected and data-hungry world, it should come as no surprise that **60%** of respondents from the datacom industry identify increasing product complexity as their leading reliability concern. With a constantly evolving landscape and new technologies such as 6G and 224 Gbps-PAM4 on the horizon, engineers will have a unique set of new challenges to tackle.

QUESTION:

In your opinion, what is the potential risk to your organization if key individuals with deep experience in reliability leave the organization due to retirement over the next five years? Choose all that apply.

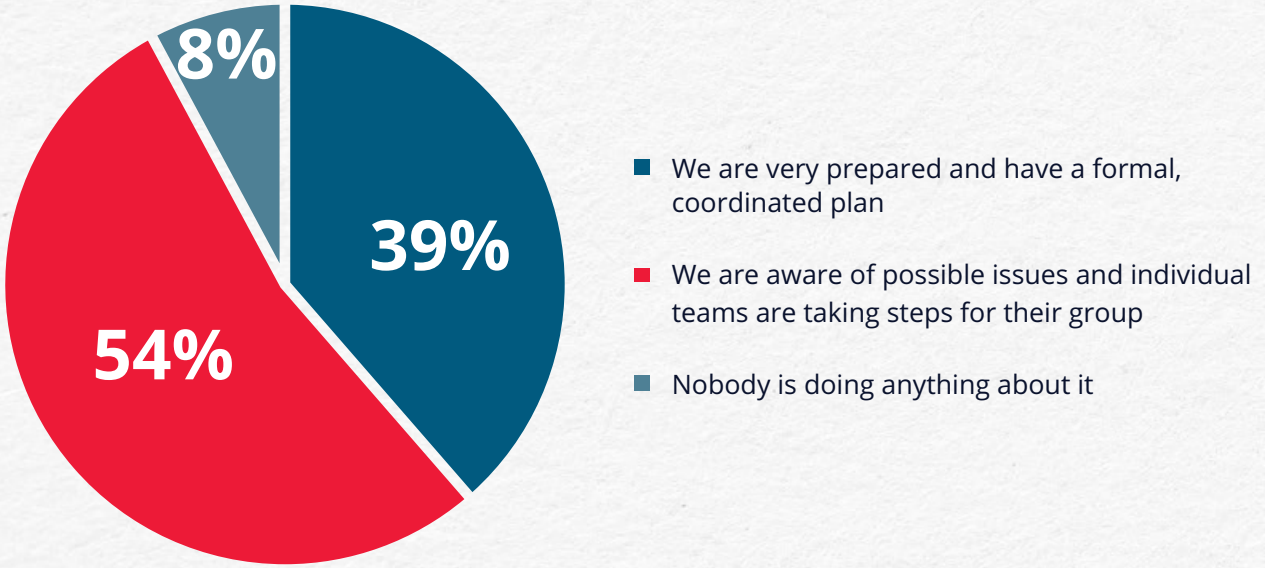


KEY TAKEAWAY:

In the next five years, **92%** expect to lose individuals with deep expertise in reliability to retirement, and **83%** believe that loss will create risk across employee satisfaction, brand reputation and even lost revenue. What precautionary measures are companies taking?

QUESTION:

What approach is your company taking to mitigate the risk of losing reliability expertise in the coming years? Choose the one answer that most closely applies.

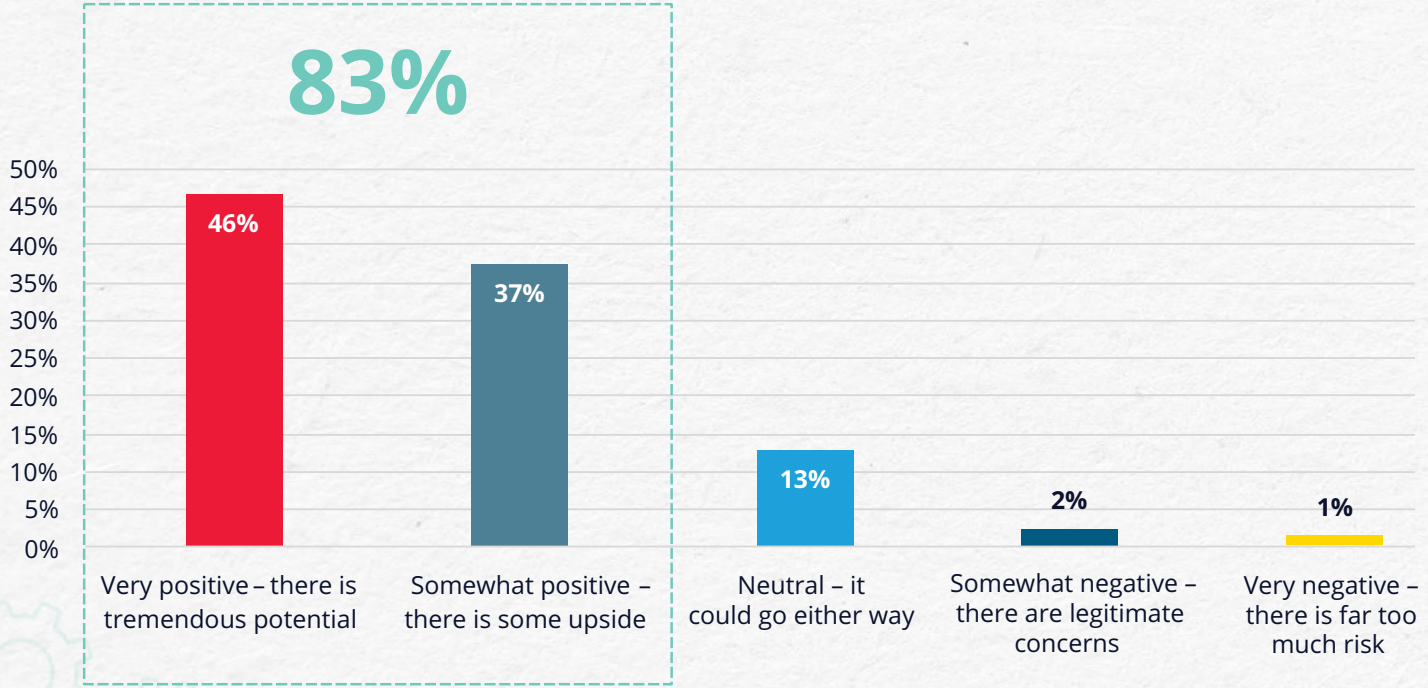


KEY TAKEAWAY:

The risk may be recognized, but many companies are not prepared for the potential “brain drain” in the coming years. Only **39%** have a formal, coordinated plan in place to mitigate risks associated with losing reliability experts.

QUESTION:

What is your personal opinion about the practical impact of AI on product reliability within the next five years?

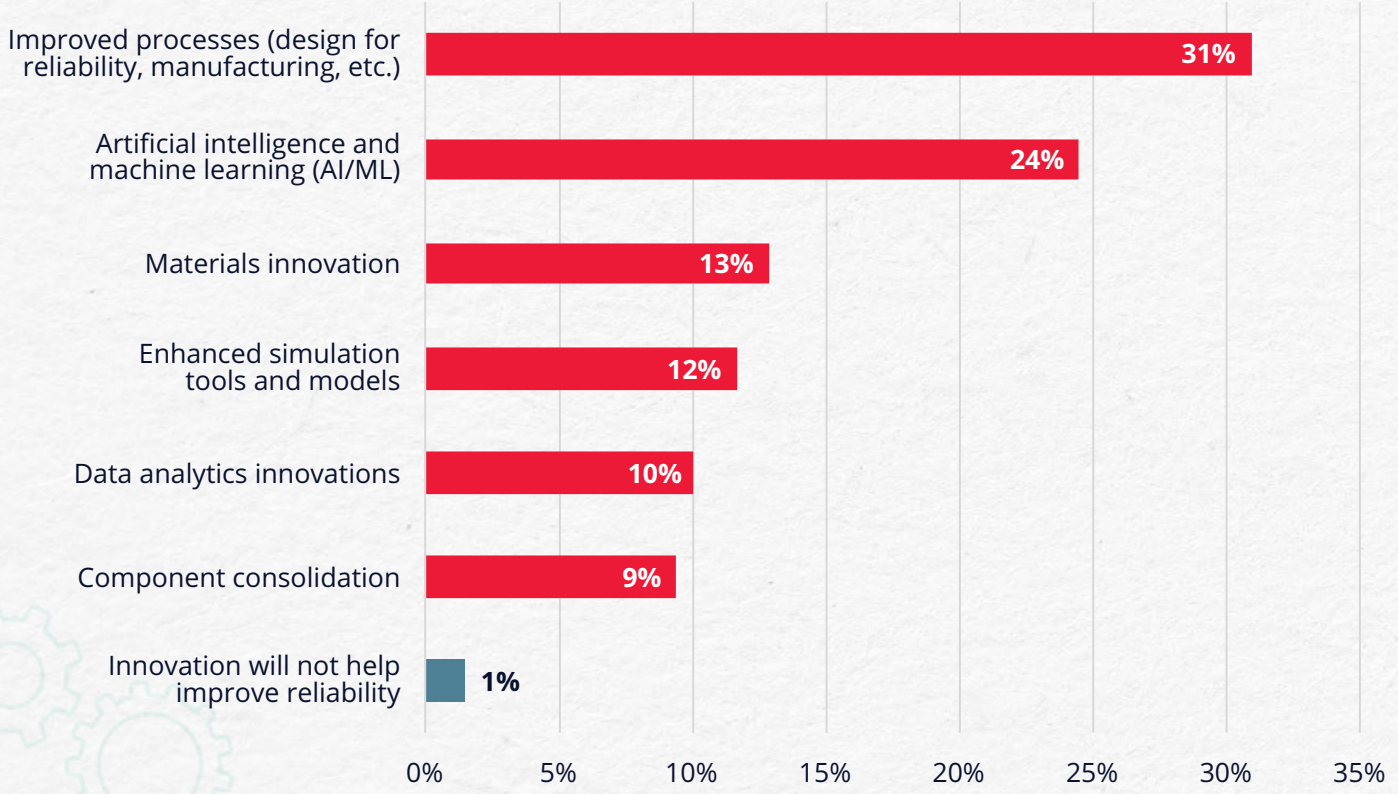


KEY TAKEAWAY:

Emerging technologies may minimize the impact of employee turnover. More than **4** out of **5** respondents are optimistic about AI's potential to improve product reliability. Only **3%** share an opposing view about the prospective impact of AI. This optimism may be what rescues companies from the knowledge lost with the retiring workforce.

QUESTION:

In your opinion, what innovation offers the BEST opportunity to improve the reliability of electronics products within the next five years? Choose the one answer that most closely applies.



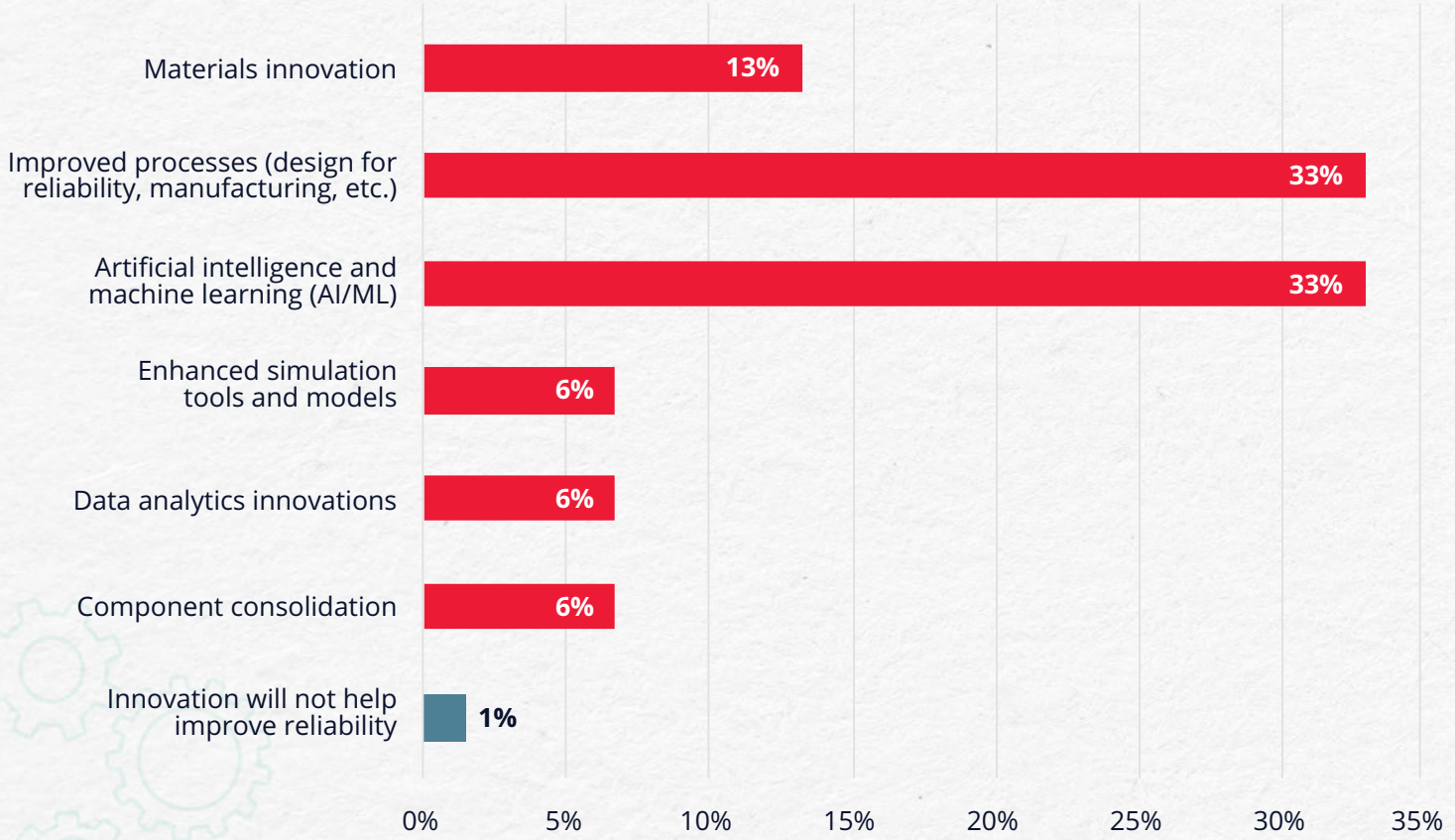
KEY TAKEAWAY:

Will data save the day? **Almost half** of respondents believe innovations in data-driven technologies — AI, machine learning (ML), simulations and data analytics— offer the best hope for improving the future reliability of electronic products.

INDUSTRY INSIGHT: Transportation

QUESTION:

In your opinion, what innovation offers the BEST opportunity to improve the reliability of electronics products within the next five years? Choose the one answer that most closely applies.



KEY TAKEAWAY:

Respondents from the transportation industry believe AI and ML present the greatest opportunity to improve the reliability of electronic products **(33%)** — the highest percentage of any industry surveyed. Interestingly, the opportunity for the other data-driven technologies (enhanced simulations, data analytics) in transportation ranked some of the lowest at **6%** each. This may be attributed to the advanced nature of the industry and the already longstanding use of enhanced simulations in automotive design.

RELIABILITY IS BUILT ON QUALITY, ENGINEERING EXPERTISE AND COLLABORATION

We began this report with a simple question, “What is reliability?” And the responses were clear. Reliability is the need to ensure products operate as expected under the pressures of shortening design cycles, growing product complexity, harsher environmental conditions and use cases, and other design and business considerations. Also made clear — brand reputations depend on reliability. Yet, as the challenge to ensure reliability grows, organizations risk losing their best means to overcome them: their experts. However, engineers are optimistic about the potential digital technologies like AI will have on improving product reliability and helping to balance the loss of expertise. But such tools are still emerging and there’s little room for error.

The Molex brand is grounded in providing the highest quality interconnect solutions, unmatched collaborative customer relationships and industry-leading engineering expertise. Our cross-disciplinary global engineering and manufacturing experts are already equipped with the latest technologies to predict, identify and address risks to reliability at the earliest stages of design. As an extension of your team, we rally around your critical product development requirements to ensure your customers are never left questioning the reliability of your product.

To learn more about reliability trends and design considerations, visit **molex.com/reliability**.

FOR MORE INFORMATION

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