THE CLOSER YOU LOOK
THE MORE YOU SEE

WORLD QUALITY REPORT

14th Edition | 2022-23

IN ASSOCIATION WITH:

MICRO FOCUS

WORLD QUALITY REPORT

2022-23

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INTRODUCTION

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Welcome to the 14th edition of World Quality Report, which is recognized as the industry's largest research study to provide a comprehensive assessment of the current state of quality engineering practices from around the world and across different industries. Over the last 14 years, this report has tracked and examined the most important trends and developments in quality engineering and testing by surveying 1,750 executives across multiple sectors and regions. It's a great honor for us here at Capgemini and Sogeti to publish this report, along with our strategic technology partner Micro Focus. We have ensured the topics covered are as wide and far-reaching as possible, so we can capture the nuances (the closer you look) and the trends in the industry. In this report you will see our key findings and recommendations for several key focus areas: agile quality orchestration, intelligent automation, test environment provisioning, test data provisioning and data quality, sustainable IT, quality engineering for emerging technologies, and value stream management. The expert findings are complemented with commentary, examples, and best practices from more than 10+ senior executives from various Fortune 500 organizations, who participated in deep-dive interviews around these topics.

CHANGING TIMES AGAIN

Over the last two editions, we discussed the impact of the COVID-19 crisis and how everyone and everything, including the quality engineering and testing functions in organizations, have adapted to the new normal. COVID-19 truly prompted faster and more impactful IT developments and digital transformation. In this year's edition, we are witnessing an even greater acceleration of that agenda on a global scale across all industries. To cope with all these changes, the development of unified digital platforms, agile solution delivery, hyper-automation, advanced analytics and AI, and business and IT fusion will all be required to push organizations forward. But, without the right level of focus on quality, we are putting brand reputations and business outcomes at stake.

If anything is clear from this year's survey it is that quality operations and quality engineers play a more pivotal role than ever in enabling organizations to achieve higher levels of flexibility and agility, while ensuring positive business outcomes and greater customer satisfaction.

New to this year's report are the topics of sustainable IT (what role has quality to play here?), and value stream management (will this help us in achieving better control of quality?). We have also introduced a chapter on the impact on quality of emerging IT technologies such as the metaverse, blockchain, and virtual reality.

THE CLOSER YOU LOOK

We have carefully selected the image of the drop of water to convey the key messages of this year's report. The waterdrop represents the agility and adaptability of the quality function, and the pureness of water reflects the growing importance of sustainability and sustainable IT. Water is an essential building block of life, just as quality and testing are essential building blocks of IT. Also, the waterdrop can act as a magnifying glass revealing the tiniest details, but can also become as broad and wide as the ocean. In the same way, quality and test engineers can validate and reveal minute technical details at component or API levels, but can also reveal and ensure quality at a macro-business process level, ensuring customer experience and acting as brand ambassadors.

A TEAM EFFORT

This report wouldn't have been possible without the significant contributions of many people. If you are one of the 1,750 executives across 32 countries who took part in this year's survey, we would like to thank you for your time and contribution in helping us gauge the prevailing moods and trends. We also have a special callout to the industry expert panel, whose insights have been valuable in illustrating the broader themes. We thank our partners at Micro Focus, and our lead authors and sector and regional subject matter experts (SMEs) at Capgemini and Sogeti, who together analyzed, interpreted, and provided expert commentary on the research data and interviews to build this

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report. In addition, we thank the report's production team: much work takes place behind the scenes to ensure this annual exercise bears fruit.

Finally, we thank you, our readers. It's your own experience and interest that gives the World Quality Report its reason for being. As ever, we hope this year's edition makes a rewarding contribution to your continuing efforts in software quality assurance, and that you can take advantage of these findings and recommendations to shape your quality engineering strategy, and perhaps even to challenge some of your current thinking.

'The closer you look, the more you see' is an apt motto for this year's World Quality Report. It applies to software quality engineering and testing, and to the larger digital value streams in which Quality Engineering & Testing (QE&T) exists. Indeed, 'Learning to See' is one of the seminal texts on Value Stream Management (VSM), an advance in process management that this report documents.

VSM is about many things, but one of those is looking closely at processes and seeing how they can deliver value with more assurance, less waste and greater flow. The closer you look, the more you see.

One thing that can be seen is how value flows through a Digital Value Stream (DVS) into testing and quality engineering, and how QE&T enables value to smoothly flow down the DVS to the end customer.

This report documents and quantifies the importance of both VSM and QE&T, their changing natures as cloud transformations continue apace, and their critical importance in an inflationary era buffeted by global instability. As a leading provider of world-class QE&T technology and of a cutting-edge VSM platform, we share this view of importance.

As part of that, we also heartily agree with the six pillars of Quality Engineering the report documents: orchestration, automation, AI, provisioning, metrics, and skill. Those are six nails in the coffin of manual testing. After all, brute force simply doesn't suffice in the present age. Fortunately, software quality technology and modern processes allow world-class organizations to move to Quality Engineering.

VSM is perhaps the most important of those processes and certainly the most modern. Its prescriptive approach is consonant with a quality ethos and actually elevates quality to a top value. Plus, it methodically focuses on the elimination of waste in all forms, not just software defects, but rework, low-value meetings, wait time, and more.

The road ahead remains challenging, full of insistent change and insufficient resources. However, this report makes clear that leading enterprises around the world are aware of those challenges and have prioritized the right approaches to meeting them. Those approaches include principles-based Quality Engineering and VSM.

We are therefore heartened by the discoveries of this World Quality Report and its conclusions. We are also proud to do our part in helping with the quality initiatives of world-class organizations and of those who aspire to be world-class. As the Report documents, those initiatives must include both Quality Engineering and VSM. The more you look, the more you see, and the more value you deliver.

One final note, I'd like to express my appreciation and thanks to our friends and partners at Capgemini and Sogeti, as well as to everyone who worked diligently to create this year's World Quality Report.
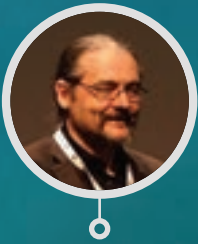
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Senior Vice President,
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World Quality Report 2022-23

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A NEW REALISM

Since the COVID-19 pandemic, we have witnessed an immense push for technological progress. The past two years have been characterized by faster-than-ever developments of digital platforms, modernization of the application landscape, transformation to cloud, and investment in data analytics and data management technologies. Advances in machine learning, AI technologies, and end-to-end automation are supporting all these developments.

But while the sun has been bright for IT developments, there are also several worrying and threatening clouds. Today, organizations face new and potentially even greater challenges than the COVID pandemic: geopolitical instability, supply chains breaking down, a serious shortage of skilled resources in almost all domains, spiraling global inflation rates, a potential economic recession, and continued environmental and social challenges. The changes are more impactful, and the pace of change is faster than ever.

One thing is clear in all this turmoil: to stay successful, organizations must be highly responsive to change. Also, they must more than ever focus on generating value for their customers. Continuous change is required. Value outcome is the objective. Agile development and digital transformation continue to be the key drivers for further investments in IT. All these developments have direct implications for the continued development of both IT quality and software testing. "The closer you look, the more you see" is the theme of this year's World Quality Report: by probing deeper and utilizing appropriate tools and resources, we can gain a better understanding of whether IT solutions will provide a benefit to our end customers and achieve valuable outcomes in terms of business performance. This, for us, is the essence of quality engineering.

This year's survey, as analyzed by our subject matter experts (SMEs) across geographies, technologies, and domains, and supported by deep-dive interviews with a select group of organizations, clearly demonstrates that the development and transformation of the quality assurance function from pure testing to actual quality engineering is needed now more than ever. Customer experience, time to market, security, and cost continue to be the core objectives of quality assurance. Indeed, in many organizations, there is a shift from simply improving time to market for development to quality outcomes at speed. Some organizations are even shifting from agile quality engineering to site reliability engineering. Quality experts and teams have a critical role to play in the agile transformation. As one of the organizations during our deep-dive interview put it: "The DevOps transformation should continue faster. And quality teams should be in the lead, as they are the best positioned for this task, centered between development and operations."

There are six essential pillars in this transformation from quality assurance to quality engineering:

1. Adequate orchestration of quality activities in and across agile development teams. While QA is increasingly embedded in feature teams, we also see a clear rise of the quality function or quality support team across DevOps teams.

2. End-to-end automation of quality and test activities across all types and levels of testing, from planning and design to execution and continuous quality monitoring. This end-to-end quality automation must be fully integrated within the IT development process.

3. Leveraging smarter quality technologies to assist quality experts in making the right quality strategic decisions early in the process.

4. More attention to test infrastructure and test data provisioning.

5. Defining, tracking, and monitoring of the right set of quality indicators to be able to respond immediately to potential quality breaches.

6. Increase the technological and domain skill levels of the quality teams in order to secure value outcomes for business processes and end customers. Quality experts will need to develop their skills further from testing and engineering skills to subject matter business expertise, alongside growing their knowledge of tools and technical platforms.

In addition to these six pillars, the latest World Quality Report survey reveals two new areas with a potential impact for quality engineering:

1. Sustainability IT was surveyed for the first time as part of this year's World Quality Report. While there is a clear understanding that the quality of applications has a direct relation to sustainable IT, it remains an emerging topic for many organizations. What the quality attributes are for a sustainable application, and how to measure and monitor them effectively, are still something most of us need to ascertain. Environmental consciousness is now a strategic imperative – and will be an additional driver and topic for quality teams to consider.

2. The concept of value stream management was another new area covered in this year's survey. This concept is gaining a foothold in several sectors. Here we see organizations intending to implement a practice aimed at managing, controlling, and visualizing the value of software development and delivery activities both for the business and for IT. Highly promising visualization tools have the potential to help quality teams elevate themselves from pure technical validation to assuring value outcomes for business. But the survey reveals that this is a journey that most organizations have yet to start.

We discuss the key findings, trends, and recommendations in more detail in the following chapters and sector analysis chapters. In summary, we present here the key recommendations from the full analysis of survey results and deep dive interviews.

KEY RECOMMENDATIONS

World Quality Report 2022-23

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Agile quality orchestration

- Make quality engineers an integral part of agile development programs, including enterprise systems. The right talent, offering a blend of technical and business skills, is critical for quality engineers in agile.

- Use package-specific tools for enterprise management systems that increase levels of automation with pre-built libraries for agile.

- Track and monitor metrics that are holistic quality indicators across the development lifecycle. For example: a "failed deployments" metric gives a holistic view of quality across teams.

Quality automation

- Embed an automation-first approach into the requirements and stories.

- Focus on what delivers the best benefits to customers and the business rather than justifying ROI.

- One tool doesn't do everything. Pick the best tools for the job. Don't try and make one tool do everything.

Quality infrastructure testing and provisioning

- Combine value streams into a single platform to build heterogeneous software delivery pipelines.
- Provision legacy environments using the power of cloud – at speed.
- Augment a new dimension to application reliability through cloud and infrastructure testing.

Test data provisioning and data validation

- Follow the many organizations that are moving non-production workloads to cloud.
- Make cloud testing an integral part of the overall software development lifecycle.
- Take advantage of the increasing automation of data provisioning and the growth in synthetic data generation.

Quality and sustainable IT

- Adapt and utilize existing quality frameworks and tools to achieve more sustainable design principles – how modular and reusable is the architecture? Is the programming language resource intensive? Can the number of interfaces and API calls be optimized?
- Customize application performance monitoring tools to support the measurement of environmental impacts at a transactional level.
- Bring quality to the center of the strategy for sustainable IT for a consistent framework to measure, control, and quantify progress across the social, environmental, economic, and human facets of sustainable IT, even to the extent of establishing "green quality gates."

Quality engineering for emerging technology trends

Organizations need to ask themselves:

- Will building quality engineering skills around blockchain, Web 3.0, and cybersecurity be crucial to the success of implementations?
- What capabilities will we need to test seamless user experiences between the physical and digital worlds?
- What would be the quality engineering strategy required for emerging technologies, even during the prototyping phase, to support successful implementation and scaling?

Value stream management

- Make sure you define with business owners and project owners the expected value outcome of testing and quality activities.
- Define concrete and measurable value indicators that are connected to business objectives for each project – and ensure that quality and test results are connected and related to these value indicators.
- Implement a value dashboard by which stakeholders and team members can continuously view the progress and development of the value indicators.

CURRENT TRENDS IN QUALITY ENGINEERING & TESTING

Quality Orchestration in Agile Enterprises

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> *True Agile is when everyone in the team is engaged in quality from their own perspectives*

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Director, Global Testing Services and DevOps, Subway

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Director of Product Management, Lifecycle and Portfolio Management, Micro Focus

Agile and DevOps have been around for some time, and they are still evolving. Their adoption is growing each year, advancing the way quality software is being delivered. There has been significant evolution in the last decade with maturing agile practices and shifting the focus toward newer practices, technologies, and trends. In this chapter, we'll be looking at all these trends.

Agile quality at pace

Agile development requires an approach that enables flexibility and speed with collaborative efforts of all team members to drive quicker turnaround of business needs.

Quality assurance (QA) in agile is critical to ensure application quality and reliability while moving at a faster pace with flexibility. Agile QA helps to ensure the two most important quality objectives for the agile enterprise: ensuring excellent customer experience and business outcomes. Agile QA therefore has to be an integral part of agile software development process.

Quality orchestration in agile enterprises continues to see an upward trend. Its adoption in agile and DevOps has seen an evolution in terms of team composition and skillset of quality engineers. Quality assurance practices, such as automation of test lifecycle, end-to-end testing across agile teams, flexible and easy provisioning of test environments and test data, service virtualization, and CI/CD integration are generally well leveraged in agile programs.

Our survey shows that key success factors for agile implementation include talent and skill availability, business focus and understanding of business priorities, and executive commitment and support toward organizational change management.

Fig 01 How much has each of the following areas improved since your organization adopted agile/DevOps?

Top 2 box: Excellent 30%+ and Very good improvement (by 21% - 30%)　　■ Global total

Area	%
On time delivery	64%
Improved predictability	63%
Reduced cost of quality	62%
Improved customer experience	61%
Improved productivity	59%
Better quality	56%
Faster releases	54%
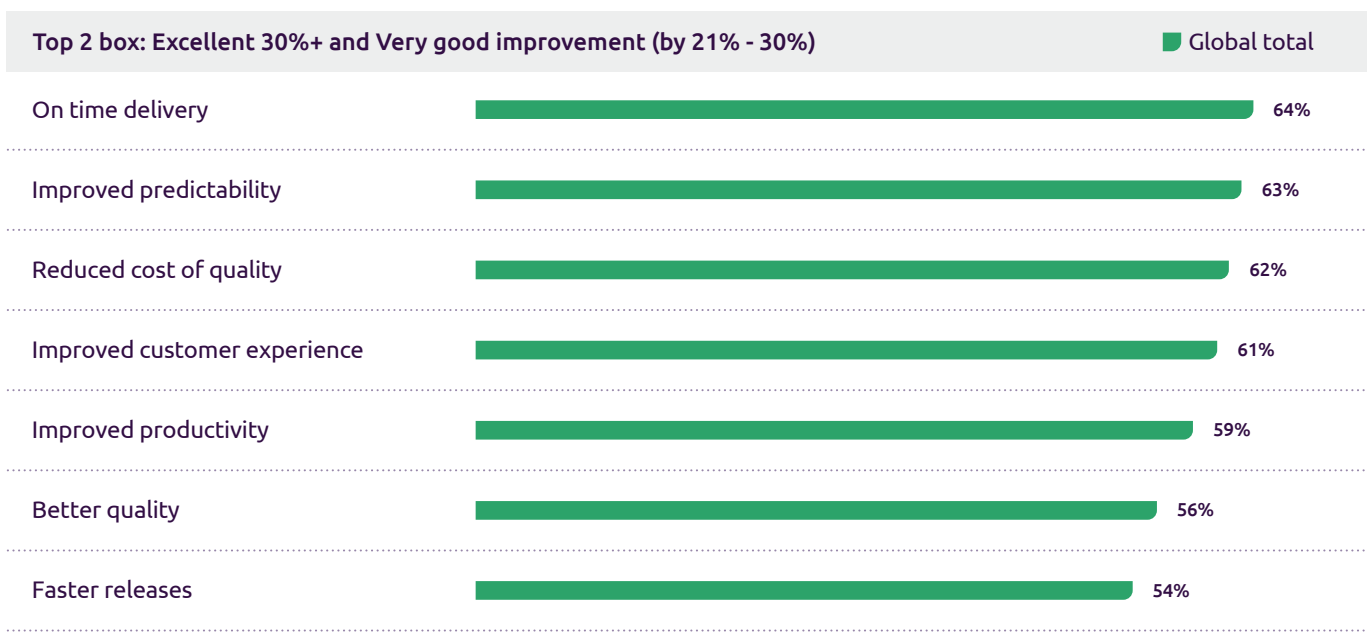
Base: All respondents (1,750)

Each bar shows the percentage of organizations that claim to have achieved significant (i.e., more than 20%) improvement in that area.

Agile improves lead time to deliver, enables high quality software, and allows frequent deployments

Agile and DevOps are impacting organizations in many ways. It's clear from the survey results that the agile approaches are leading to significant improvement in time to market and software quality and predictability while driving improved customer experience.

The above graph shows the percentage of organizations that have experienced more than 20% improvements in the mentioned areas of improvement since they have adopted agile/DevOps. On-time delivery, predictability, improved customer experience, and productivity improvement are the key outcomes owing of agile practice implementation. This enables better customer experience while deploying faster releases. Interestingly, the business-driven goal of faster releases has only been achieved by 54% of respondents, meaning it should get even more attention moving forward.

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As a business, we're adopting a DevOps culture. It's important for us that our quality engineering function should lead it, and that we should drive quality with a shift-left approach, working closely with our different business operations in their quality and test processes.
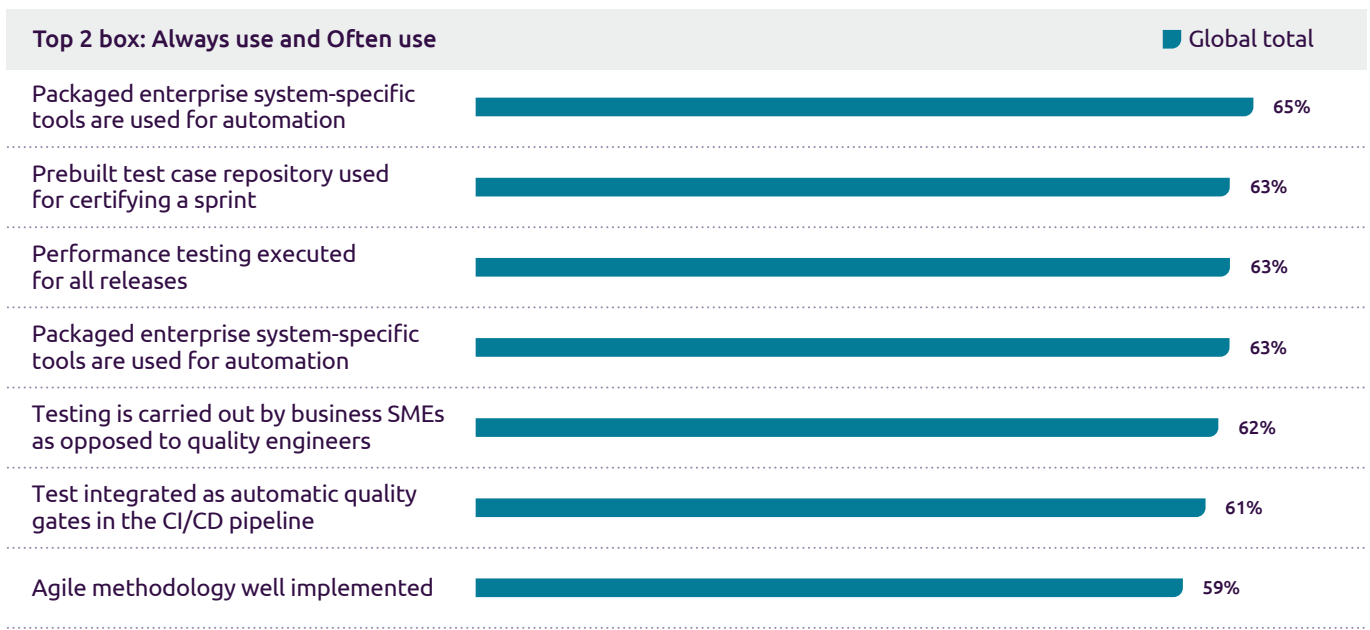
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SHIKHA HANDA
Director of Quality Engineering, LLA

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Fig 02 How frequently do your teams use the following quality and test approaches for testing of enterprise systems?

Top 2 box: Always use and Often use   ■ Global total

Packaged enterprise system-specific tools are used for automation	65%
Prebuilt test case repository used for certifying a sprint	63%
Performance testing executed for all releases	63%
Packaged enterprise system-specific tools are used for automation	63%
Testing is carried out by business SMEs as opposed to quality engineers	62%
Test integrated as automatic quality gates in the CI/CD pipeline	61%
Agile methodology well implemented	59%

Base: "VP Applications and QA/ Testing Managers and VP Directors of R&D" only (750)

Each bar shows the average percentage of teams that are using the mentioned QA and test approach for enterprise systems

The "safe" bet for enterprise systems

In the world of enterprise systems, the adoption of agile processes has just recently begun. The enterprise systems are complex and run critical business processes, which has made them start later in the agile adoption journey. One reason for the late adoption of agile for enterprise systems relates to the difficulty to break up the typically very large workflows for end-to-end business processes into smaller chunks that can be handled independently in shorter development sprints. However, over the last few years, agile adoption for enterprise systems has seen a positive shift, and we expect this to continue.

This year we surveyed what are the most predominant quality and test approaches being leveraged for enterprise systems. The majority of teams (65%) use package-specific tools for automation, 63% of teams use a pre-built test case repository for certifying a sprint, and 61% of teams have testing integrated as automatic quality gates in the CI/CD pipeline.

We've seen improvements in efficiency; the development of model-based testing — which is a real game-changer, minimizing unknowns — and we've also seen an uplift in people's skills. Test engineers are more T-shaped now: they have real breadth and depth.

MICHELLE CHRISTMAS
Head of Testing & Quality Assurance, RSA

Fig 03 How important are the following QA skills when executing a successful agile development program?
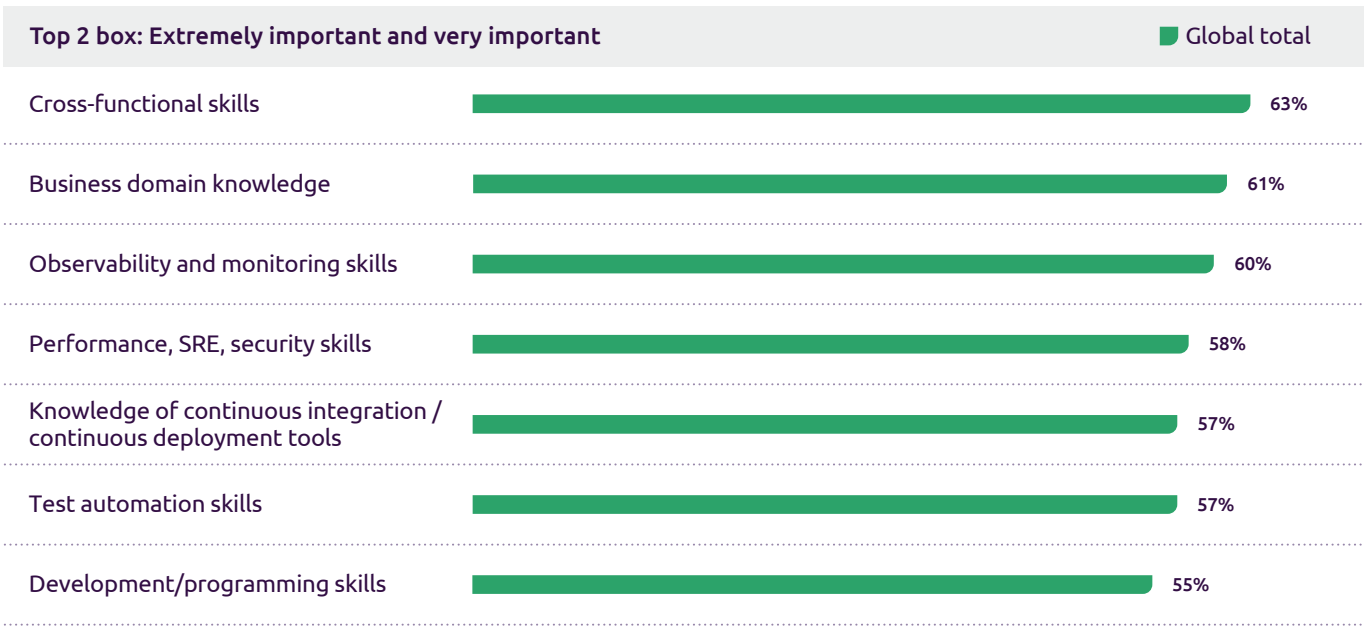
Top 2 box: Extremely important and very important	■ Global total

Cross-functional skills — **63%**

Business domain knowledge — **61%**

Observability and monitoring skills — **60%**

Performance, SRE, security skills — **58%**

Knowledge of continuous integration / continuous deployment tools — **57%**

Test automation skills — **57%**

Development/programming skills — **55%**

Base: "VP Applications and QA/ Testing Managers and VP Directors of R&D" only (750)

Each bar shows the percentage of organizations that have rated the skill mentioned as very important for Agile development programs

The concept of the full-stack quality engineer is evolving

This year's data shows an increase in the blend of technical and cross-functional skills of quality engineers embedded within agile scrum teams.

The graph above shows that "adopting an engineering mindset" while at the same time "embracing multi-skilling and upskilling" is becoming the new norm. Business domain knowledge and cross-functional skills are the top two important items for more than 60% of respondents this year.

Quality engineers are an integral part of agile teams

This year's data shows an increase in the presence of quality engineers embedded within agile scrum teams.

Presence of professional quality engineers in agile teams

🖌️⟶ Global total

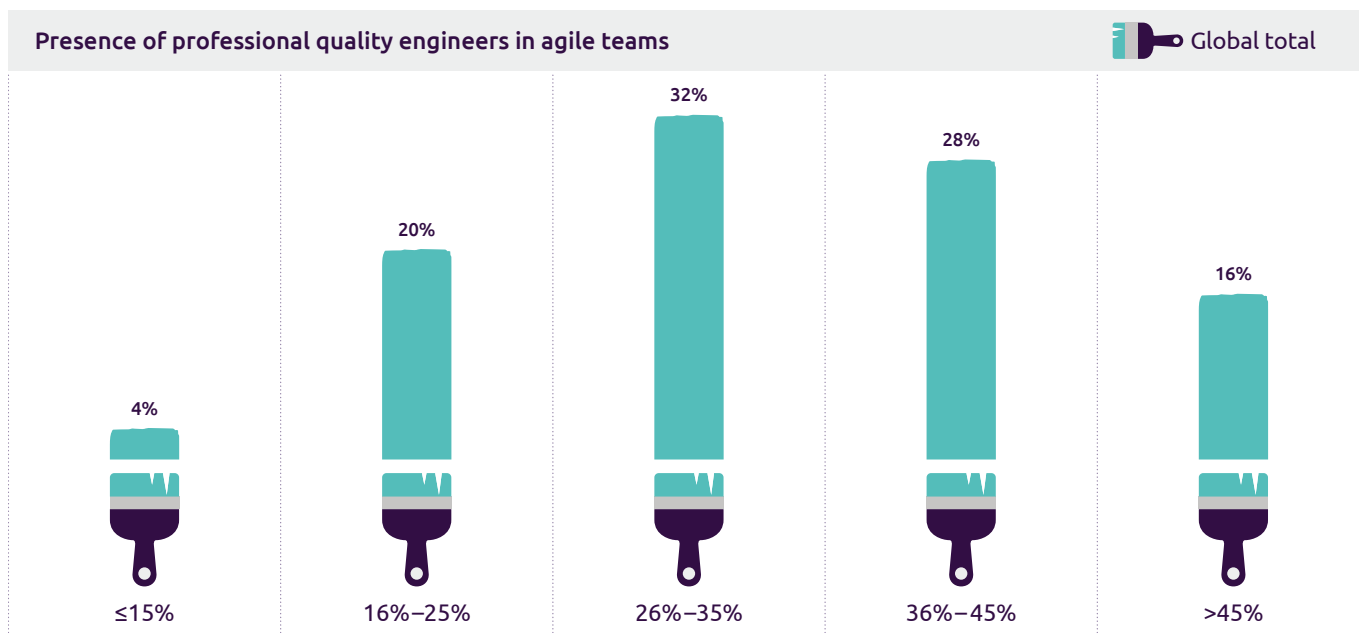|				
4%	20%	32%	28%	16%
≤15%	16%−25%	26%−35%	36%−45%	>45%

Each bar shows the percentage of organizations with that average proportion of professional quality engineers present in their agile teams.

The graph above shows that, on average, most IT organizations have <30% quality engineers within their agile teams. While 28% of organizations have up to 36–45% quality engineers, 20% of organizations have 16–25% of quality engineers within the agile teams.

Key recommendations for quality orchestration in agile enterprises

Agile teams rely greatly on effective collaboration and efficient communication across team members. Owing to frequently changing requirements and short delivery cycles, developers, business analysts, and quality engineers need to work hand in hand to deliver the releases. They need to collaborate, embrace change, and adapt quickly.

In this year's survey, we encountered the following key findings and best practices related to agile quality orchestration:

- Flexibility, ownership, and adaptability are key team attributes for agile programs.
- Cross-functional skills and business knowledge are critical to the success of agile programs.
- The pace of continuous delivery requires much higher levels of automation and quality processes.
- Agile/DevOps require a broader view of quality including shift left and shift right.
- Quality engineers in agile teams are evolving further towards full-stack quality engineers. These are engineers who bring a rich blend of technical and business skills. This will continue to evolve to match the flexibilities needed in an agile environment.

What should organizations focus on?

When it comes to agile quality methods, processes, and orchestration, we have six recommendations:

- Make quality engineers an integral part of agile development programs. The right talent and a blend of technical and business skills are critical for quality engineers in agile. While SDET roles are becoming the norm, business domain knowledge is an essential skill.
- Grow end-to-end test automation and increase levels of test automation across CI/CD processes, with automated continuous testing, to drive better code quality. This will enable improved product quality while reducing the cost of quality.
- Make sure that your automation tests are running as part of the regular CI pipelines so they can be easily integrated with the day-to-day work.
- As business owners are becoming more involved in testing activities, make sure they have the right tools and processes to allow them to test effectively.
- Use package-specific tools for enterprise systems and increase levels of automation with pre-built libraries that are fit to use in an agile approach.
- Track and monitor metrics that are holistic quality indicators across the development lifecycle. Example: failed deployments metrics give a holistic view of quality across teams.
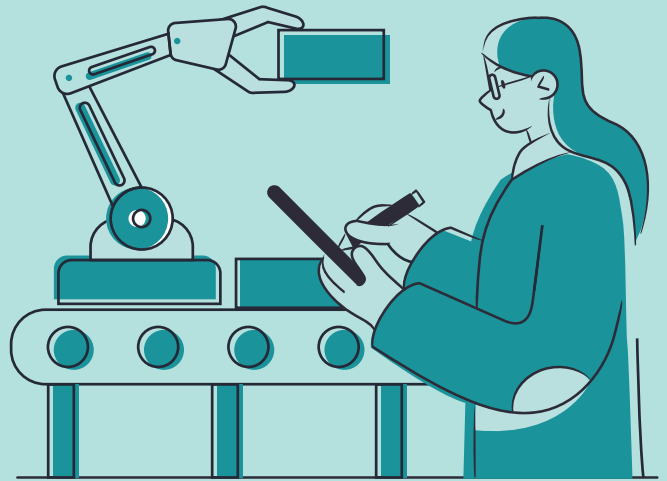
Quality Automation

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Senior Product Manager, Functional Testing, Micro Focus

Introduction

Test automation has been with us for decades now, and tools have evolved significantly. When we look at test automation through the lens of the World Quality Report, we see a lot of promise. However, we also see that organizations are still struggling to make it work.

Two very common challenges organizations face with test automation are the following:

- Test automation is not always naturally integrated into the development process but organized as a separate activity, independent from development and testing itself.
- Teams prioritize selecting the test automation tools but forget to define a proper test automation plan and strategy.

For test automation to succeed, you at least need good requirements, the right experts, the right tools (often more than one tool), and stable test environments with sufficient-quality test data.

All organizations need a proper level of test automation today as agile approaches are pushing the speed of development up. Testing, therefore, needs to be done faster, but it should not lose any of its rigor. To put it simply, too much manual testing will not keep up with development.

What's important to have a successful test automation approach?

| Fig 05 | What are the top three most important factors in determining your test automation approach? |

Rank 1/2/3 — Global total

Factor	Global total
Maintainability	46%
Business needs	44%
New technology	43%
Ease of use	39%
People/skills	34%
Cost of automation and tooling	33%
Historic decisions	33%
Automation ROI, value realization	26%
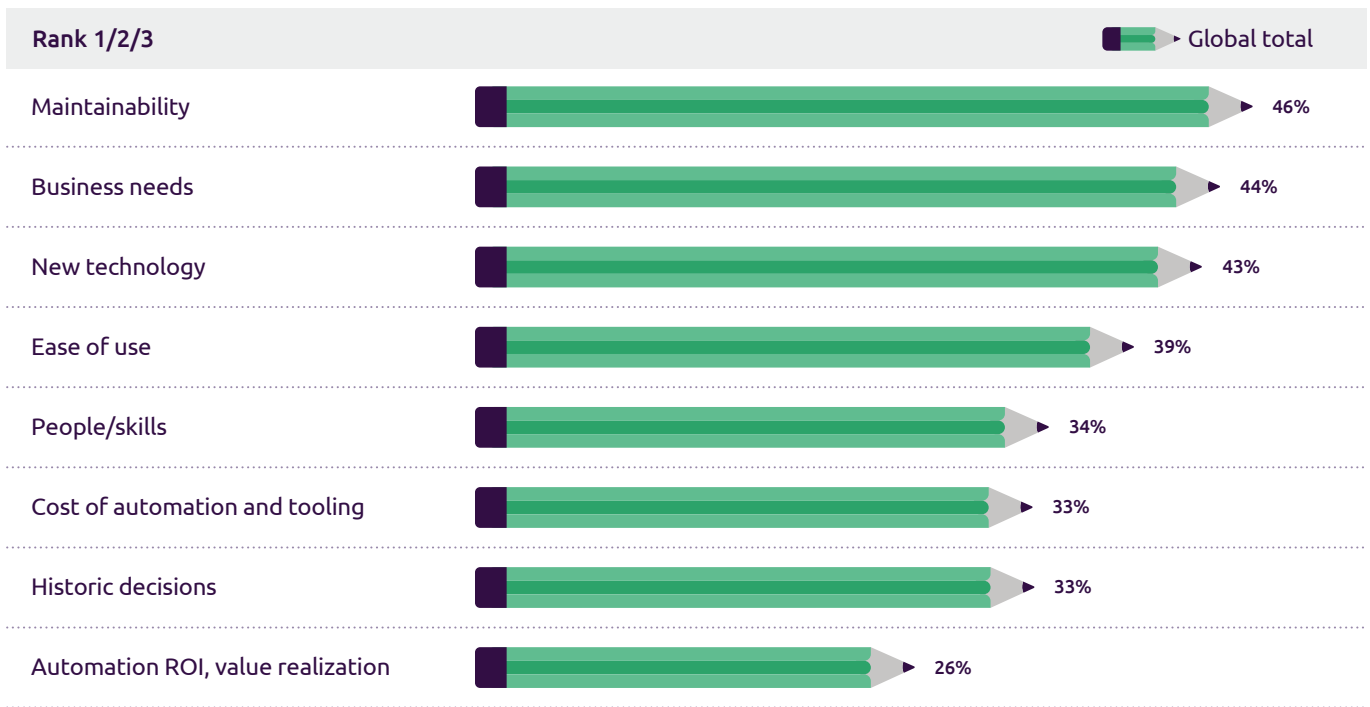
Base: All respondents (1,750)

We asked our survey respondents what was most important in determining their approach to test automation. We expected ROI to be a high scorer but, instead, maintainability was at the top – a welcome acknowledgment that, to be successful in automation, it needs to be seen as an asset that is looked after and developed.

There was a recognition that the needs of the business were also key, along with adapting to new technologies that need to be tested – partly driven, we think, by the continual shift into the cloud.

We find the priority for most organizations is meeting business needs rather than justifying the technical ROI of automation, and that the conversations in organizations have changed from how much a test tool costs to how much value it brings to the business.

Test automation teams do not deliver well enough on promised benefits

It's disappointing to see that the proportion of teams achieving the benefits expected from automation happens only about half the time. Even integration of CI/CD and automation was below expectations, despite the long-standing shift toward CI/CD driven through agile practices.
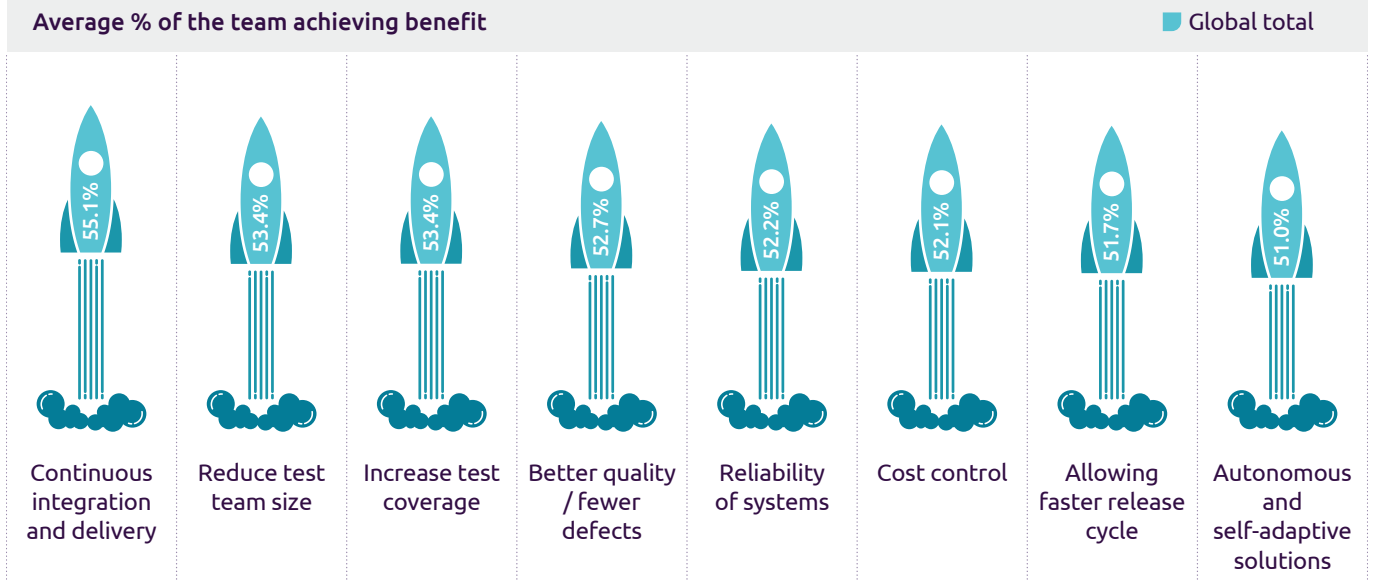
The challenge with test automation is finding the right people. It's hard to keep up with demand, and there's a lot of competition with other industries to attract talent.

HARISH RAJANI
Head of Change Delivery, Whitbread

Fig 06 What proportion (if any) of your team currently achieves the following benefits from test automation?

Average % of the team achieving benefit ■ Global total

Continuous integration and delivery	Reduce test team size	Increase test coverage	Better quality / fewer defects	Reliability of systems	Cost control	Allowing faster release cycle	Autonomous and self-adaptive solutions
55.1%	53.4%	53.4%	52.7%	52.2%	52.1%	51.7%	51.0%

Base: All respondents (1,750)

Why is this?

Is this a failure of the tools? Open-source and commercial tools are well established. Their capabilities are known and so are their limitations – at least among the people using them daily. From some of the in-depth follow-up interviews, it does seem that communications about what can and cannot be done are still not managed as well as they could be, especially when looking to justify the return on investment. The temptation to call out the percentage of manual tests as automated sets teams on a path to automate more than they should, without seeing if the manual tests are good cases for automation and would bring value.

The key question is: can you be certain about all parts of your solution? Even if your team is delivering on the promised benefits, given the global nature of the modern IT world and the complexity of the interconnected cloud / API-powered world, some parts might have been overlooked.

We have been researching the test automation topic for many years, and it is disappointing that organizations still struggle to make test automation work. The survey results indicate that teams with a mature agile process typically get more benefits from test automation activities. The message is clear: get the processes right, and have clear expectations, good requirements, and a team that can get behind them to see an increase in how often you achieve the benefits needed to succeed in the modern world.

> *Automation takes risk out of the test environment, because it's dependable and repeatable.*

DAVID TAYLOR

Director, Quality Business Acceptance and Support, Humana Clinical

Where does automation give you the most benefit?

Automation can deliver far more than testing the front end or testing a drop down in a unit test. For years, unit testing and functional testing have dominated the efforts to automate. Now with the need to build faster, get volumes of data, build environments and deploy code quality automation solutions bringing value into all these areas.

Fig 07 — At what key stages of the testing cycle do you currently realize the most benefit from test automation?

Rank 1/2/3	Global total
Development	48%
Requirements	47%
Functional testing	46%
Integration testing	45%
Data	37%
Non-functional	33%
In live	23%
Pre-go-live	20%
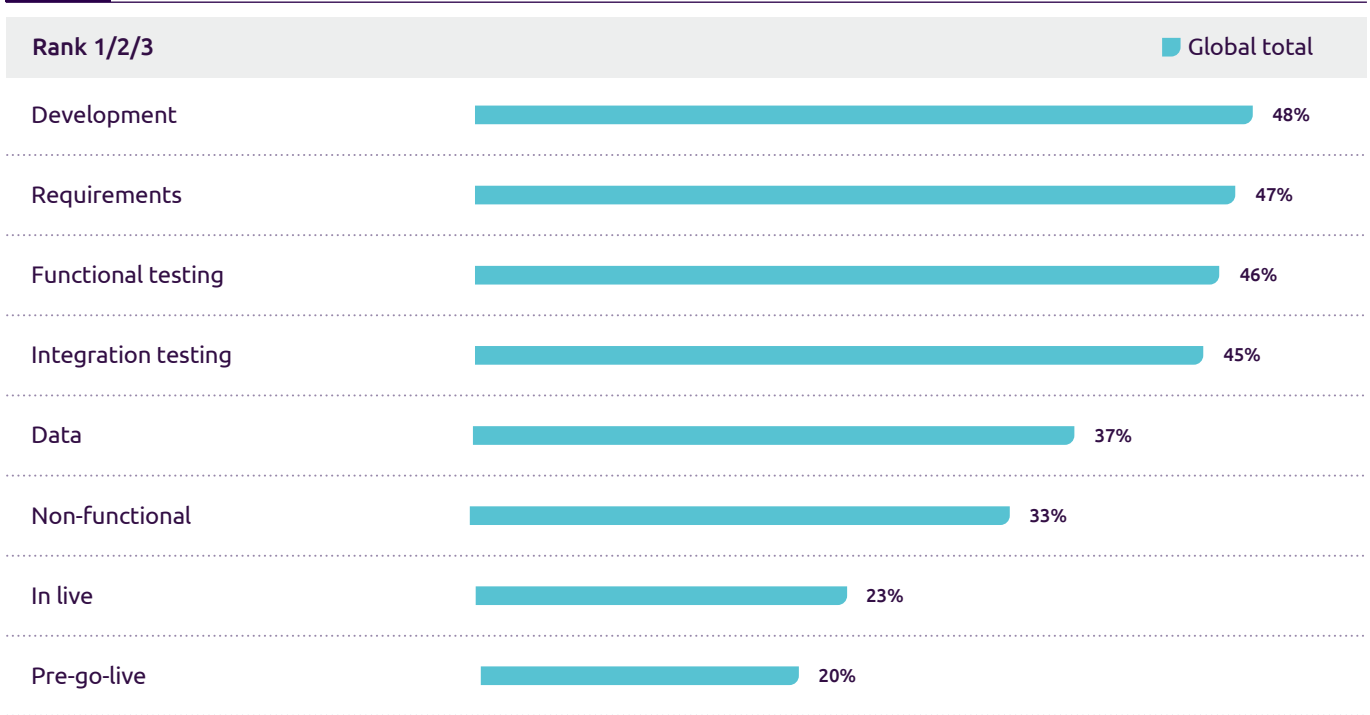
Base: All respondents (1,750)

Taking Stock

Low-code solutions continue to grow in popularity. Open source has a new tool every week. Established commercial tools continue to deliver. This means that, for automation, there is a richer and stronger toolkit than ever before. We see this in the number of tools using elements from the explosive growth in AI and machine learning to bring extra value, usability, functionality into the toolsets.

But some perceptions need to be addressed. Too many times, automation is not perceived as delivering on its promises. As an industry, we need to address automation as it is critical to delivering in the modern world at the speed and quality, which we all need to succeed.

What should organizations focus on?

Our research leads us to the following recommendations to increase the value of your quality automation initiatives:

- Work earlier with quality automation experts.
- Automation starts as the requirements are being created; build an automation-first approach into the requirements and stories.

- Get automation requirements agreed on before you start to automate.
- Focus on what delivers the best benefits to customers and the business rather than justifying ROI.
- Review your tooling and frameworks on a regular basis.
- Plan a roadmap for at least the next three years.
- One tool doesn't do everything. Pick the best tools for the job. Don't try and make one tool do everything.
- Invest in people. Stop chasing after unicorns and work with the people you have – they know your business.

The benefits of change aren't immediate. You have to allow time for the changes to come through your project pipelines and for mindsets to adjust and change. When they do, automation can deliver the value it has promised – not just half the time, but most of the time!

A final thought: sustainability is a growing and important trend – not just in IT, but across everything. We need to start thinking now about how automation can show its benefit and cost to the world. Do you know what the carbon footprint of your automation test is? How long will it be before you have to be able to report on that for your organization? Now's the time to start thinking about how and what so you are ready when that question is asked.

Quality Infrastructure Testing and Provisioning
—
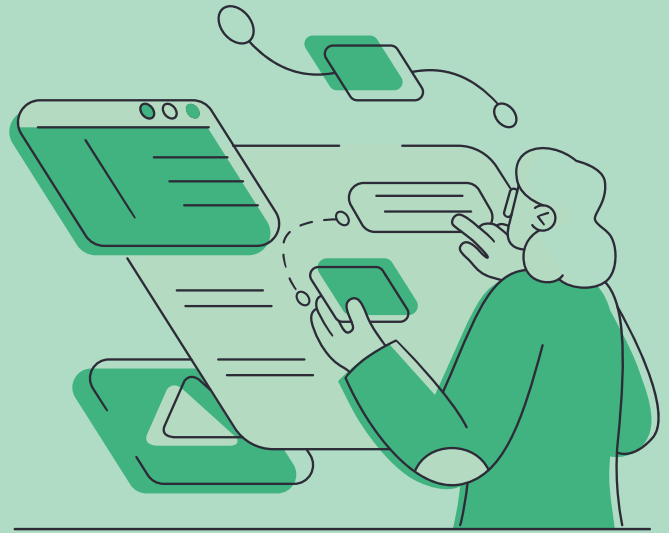
> ❝ It can be difficult when people don't understand environments outside their own areas. They say they want their own stable environment, but you can't fully test things in an unintegrated way. That's why dependency mapping is so important. ❞

LALIT MADAN
Director, Global Testing Services and DevOps, Subway

ANISH BEHANAN
Head, Quality Engineering & Testing, Capgemini UK

ABHISHEK ATHAWALE
Head, Quality Engineering & Testing, Capgemini, Continental Europe

AYAL COHEN
Director of Product Management, Functional Testing Portfolio at Micro Focus

MOTTI FINE
Senior Product Manager, Functional Testing, Micro Focus

Test environment management has always been an important part of the World Quality Report survey. This year we have analyzed how test environment provisioning is adapting and how cloud provisioning of non-production environments is taking off. Cloud testing is finding a greater place in the software development lifecycle, as more and more environments and applications get migrated to cloud. In this chapter of the World Quality Report, we have therefore examined the status and the adoption of cloud testing.

Test environment provisioning on cloud

As more workloads are moving to cloud, we asked organizations what proportion of their non-production environments are provisioned in the cloud. The results show clear progress, but there is still a long way to go in this space as almost half of all organizations provision only up to 25% of the non-production environments on cloud. Overall, 49% of organizations have more than 50% of their non-production environments on cloud. This cloud adoption of non-production environments is showing a positive trend, compared to last year's survey, when only an average of 23% of testing was done in a cloud environment.

Fig 08

Fig 08 What proportion of non-production environments are provisioned on the cloud?

Average: 30% ◉ Global total

None–0% of non-production environments are provisioned on the cloud	1%–10% of non-production environments	11%–25% of non-production environments	26%–50% of non-production environments	51%–75% of non-production environments	76%–99% of non-production environments	All–100% of non-production environments are provisioned on the cloud
	3%	48%	39%	10%		
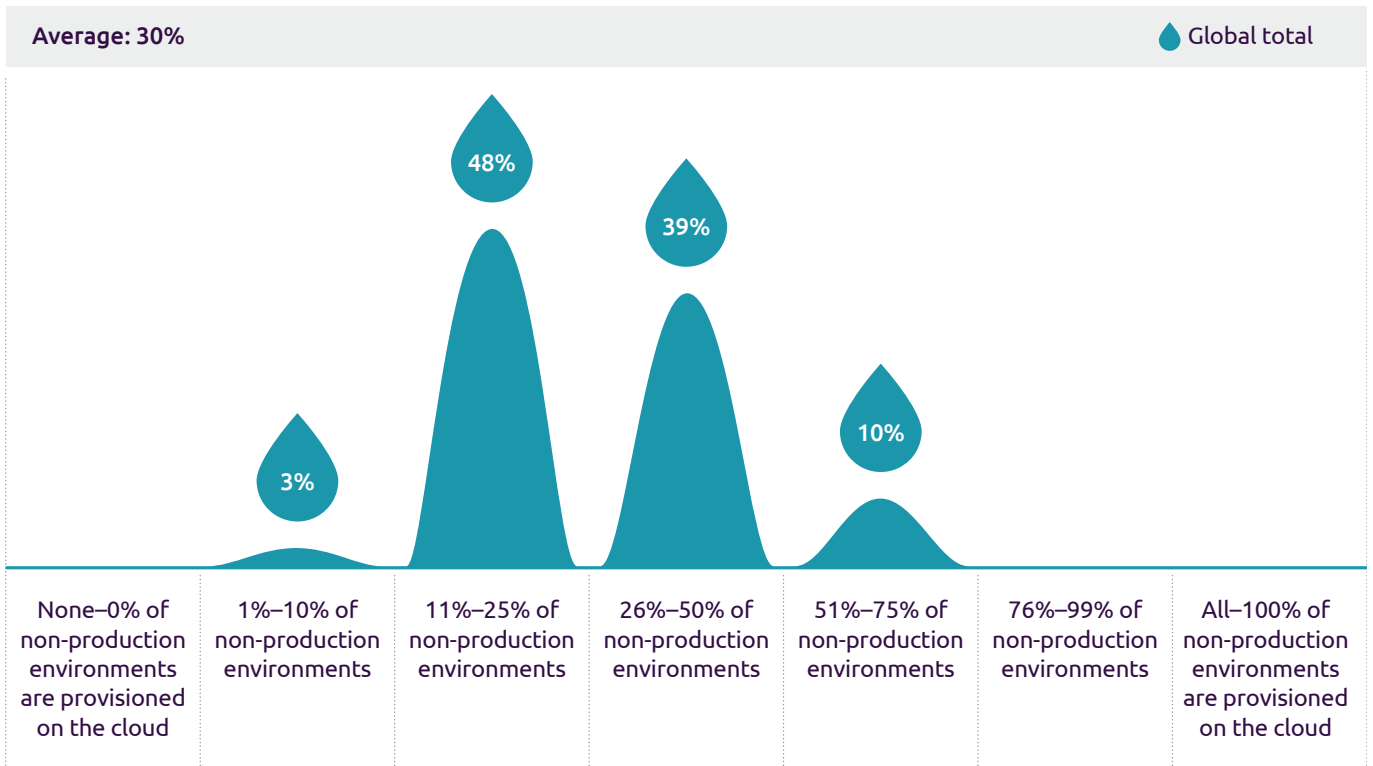
As we noticed that non-production workloads are increasingly moving to cloud, we also looked at the cloud platform strategies for non-production environments. The outcome is that many organizations (44%) currently use a hybrid (on-premises plus single cloud provider) environments strategy. Around 38% of the organizations have a multi-cloud strategy in place. Also, an average of 30% of the respondents have started to think seriously about moving test environments to a multi-premise (on-premises plus multi-cloud provider) model.

This data suggests that the move to cloud for non-production environments is far from finished. We expect to see an increase in the adoption of multi-cloud, multi-premise strategies for non-production environments, as these solutions have a positive impact on disaster recovery, security, and cost efficiency.

❝

We don't have the resources to build a fully comprehensive test environment, so we test within our production environments, while being sure to minimize risk. For example, we'll test against known and typical customer equipment scenarios.

❞

ERIC MAENDER
Senior Director, Operations Support Systems, Integration and Testing, Cox Communications

Fig 09 What is your cloud platform strategy for the provisioning of non-production environments?

Global total

44%

We have hybrid
(on-prem plus single-cloud)
cloud environments
strategy

38%

We have a
multi-cloud strategy

30%

Our strategy is to
have a multi-premise
(on-prem plus multi-cloud)
environment strategy

21%

We prefer only a
single-cloud platform
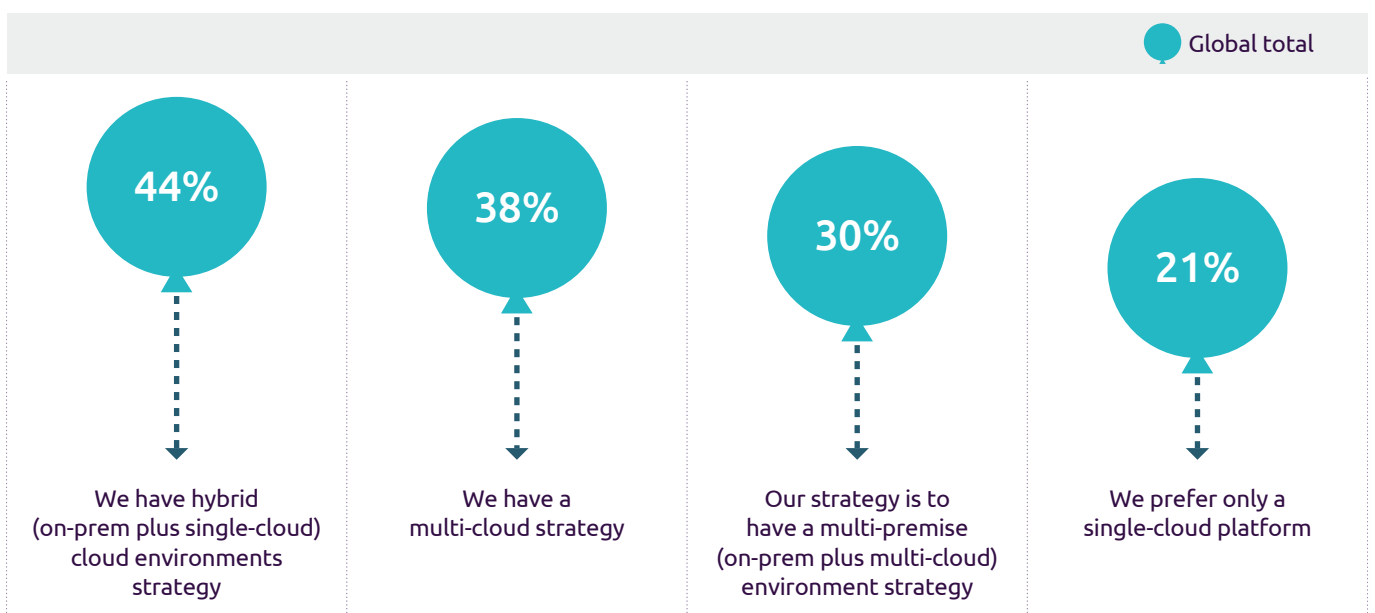
Base: All respondents (1,750)

Automation of test environment provisioning

A great advantage of moving non-production environments to the cloud is that a cloud solution makes automated provisioning of test environments much easier. We surveyed which tools organizations use for automated test environment provisioning. The outcome is evenly distributed across different available options. As many as 41% of the respondents use a hybrid tooling strategy with a mix of commercial off-the-shelf tooling along with open-source options. When it comes to cloud-native tooling, or a combination of in-house supplier-built tooling preferences, we observed that the outlook is similar.

One strategy that stands out from this analysis is that organizations are not ready to put all their eggs in the same basket. Therefore, a combination of tooling strategies is currently being followed. We see that organizations are taking a balanced approach when it comes to tooling, as many of the tools are new in this space.

Global total

41%	35%	32%	29%	28%
Hybrid strategy with commercial off-the-shelf and open-source tooling	Prefer cloud-native tooling	Enterprise-wide commercial off-the-shelf tooling	Open-source tooling preferred	In-house and supplier-built accelerators and scripting

Base: "VP Applications and QA/ Testing Managers and VP Directors of R&D" only (750)

Cloud and infrastructure testing

As organizations are deploying more of their environments into cloud, we also expect to see cloud testing grow in importance. With cloud testing, organizations validate the scalability, performance, security, reliability, disaster recovery, interoperability, and multi-tenancy of their environments and applications on cloud. When applications are migrated to cloud, the functional and non-functional aspects of the application must be tested to ensure the overall functions and performance remain as required. In our survey this year, we asked if organizations include cloud and infrastructure testing as part of their development lifecycle. It emerged that around 96% of all the respondents mention that cloud testing is now included as part of the testing lifecycle, with 57% having included cloud testing for most projects and 39% claiming to have included it at least for some of the projects.

This is a positive upward trend in the inclusion of cloud testing capabilities into the software development lifecycle. We strongly recommend that this trend continues and that cloud testing and infrastructure testing are included as a mandatory phase in the lifecycle.

Fig 11 Does your organization include cloud and infrastructure testing as part of the development lifecycle?

Rank 1/2/3 ▬▬ Global total

Yes - we include for all our projects where applications are hosted on cloud, this is mandatory	Yes - we include for most of our projects where applications are hosted on cloud, this but is not mandatory	Yes - we include for some of our projects where applications are hosted on cloud, this but is not mandatory	No - but we are aware of the requirement of cloud testing and its benefits but do not follow this as a standard practice	No - and there is no requirement to do this as a separate phase
3%	57%	39%	1%	

Base: All respondents (1,750)

We also asked our respondents what type of projects cloud and infrastructure testing is included. We saw a major shift from previous years, where this year, around 40% of the respondents mentioned that all their projects now have cloud testing included as part of their software development lifecycles. Around 27% of the respondents see this as applicable only to cloud migration projects. This trend is encouraging, as cloud and infrastructure testing used to be a phase that was conducted outside the typical software development lifecycle in data centers.

Rank 1/2/3 ◗ Global total

40%	**27%**	**23%**	**10%**
All projects have cloud testing included as part of the software development lifecycle	Only cloud migration projects have cloud testing included as part of the software development lifecycle	Only infrastructure related projects are now being considered in scope for infrastructure testing	Currently, no projects have cloud testing included as default as part of the software development lifecycle

Base: All respondents (1,750)

We see cloud testing as a trend that will gain acceptance and increased adoption in the coming years, and we are definitely seeing more organizations subscribing to cloud and infrastructure testing compared to previous years. This is even more pertinent due to the growing adoption of cloud and the increased attention to potential security and performance issues.

Cloud testing strategy

If cloud testing is of growing importance, it is also important to understand how mature organizations are in defining the cloud testing strategy for their projects. In this survey, it emerged that the cloud testing strategy is still far from effective and needs maturing. A full half (50%) of the respondents mentioned that their cloud testing strategy is only somewhat effective, while 37% of the respondents mentioned that it is moderately effective.

This result is a sign that the overall concept of cloud testing and related automation of cloud testing is only in the initial stages in most organizations. The key takeaway from this observation is that organizations should urgently begin to create an end-to-end cloud and infrastructure testing strategy that aligns with the overall cloud adoption strategy of the organization.

Fig 13 How effective is your organization's end-to-end cloud testing strategy?

Global total

1%	37%	50%	12%		

6 - Extremely effective (defined for all projects)
5 - Moderately effective
4 - Somewhat effective
3 - Slightly effective
2 - Not at all effective
Not applicable (no need for a separate cloud strategy)
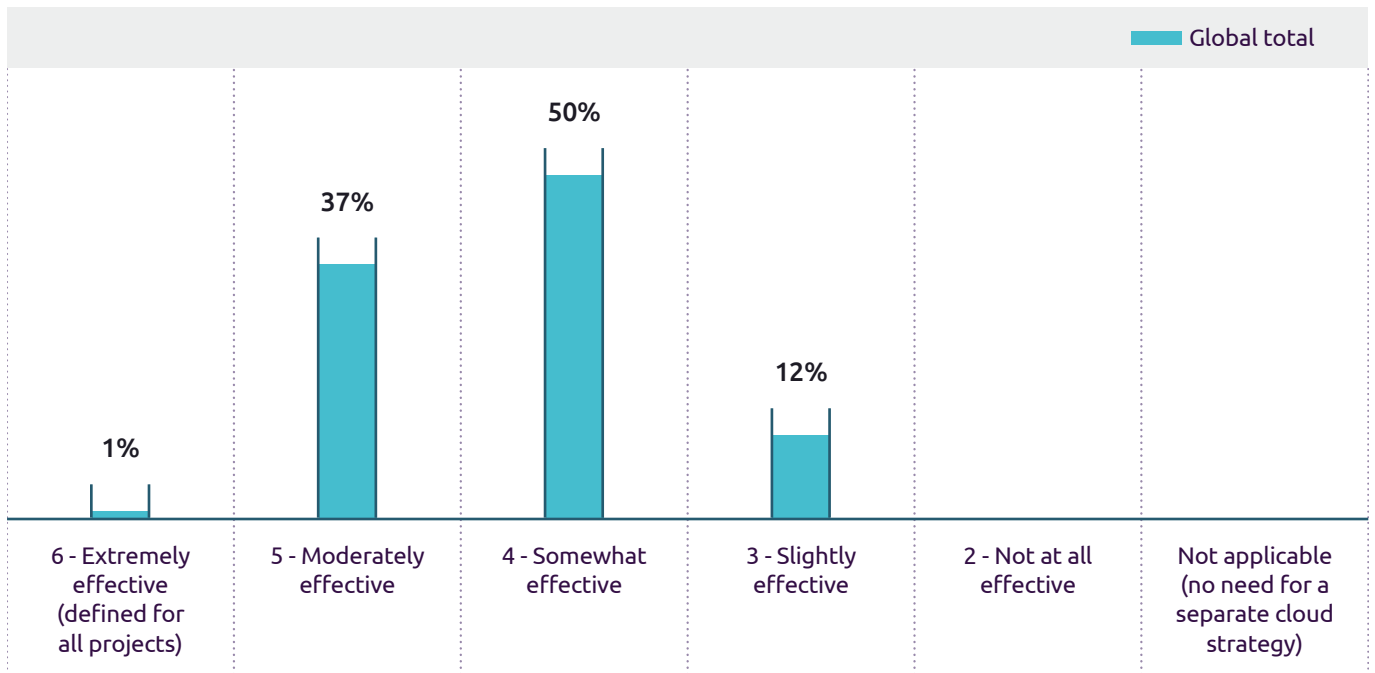
Base: All respondents (1,750)

> " Test environments weren't always front and centre for us, but that's where our focus is now. We are currently designing them to support the full gamut of quality engineering.

HARISH RAJANI
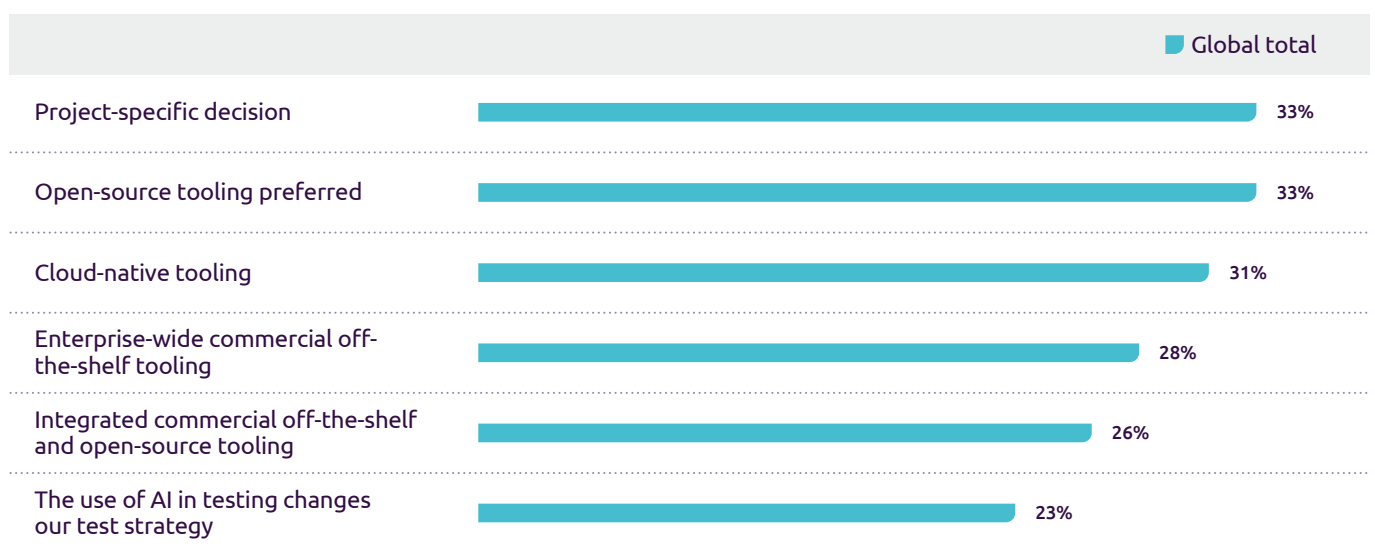Head of Change Delivery, Whitbread

Automation of cloud testing

We also investigated the approach that organizations take toward the automation of cloud testing and what type of tools they use for cloud test automation. Around 33% of our respondents answered that tooling for cloud testing is a very project-specific decision. The same proportion (33%) currently prefer open-source tooling in this space, while 31% prefer cloud-native tooling.

We observed that the tool strategies across organizations are very similar, and this also suggests that there is no single outstanding tool or strategy for cloud testing. So, for organizations, all options (open-source, off-the-shelf, hybrid, etc.) are open for consideration.

Our recommendation, considering various trends including the adoption of multi-premise cloud adoption strategies, is that organizations should seriously consider integrated commercial off-the-shelf and open-source tooling options to address various cloud architectures and project-specific requirements. This can also reduce the spending on tool licenses by standardizing tooling across projects.

Fig 14 What is your cloud testing tool adoption strategy?

■ Global total

Project-specific decision	33%
Open-source tooling preferred	33%
Cloud-native tooling	31%
Enterprise-wide commercial off-the-shelf tooling	28%
Integrated commercial off-the-shelf and open-source tooling	26%
The use of AI in testing changes our test strategy	23%

Base: Respondents with some element of cloud testing at Q30 and Q31 (1,582)

What should organizations focus on?

Overall, we are seeing positive trends around test environments management:

- More organizations are moving test environments to cloud, either in a multi-cloud or a multi-premise model.
- Organizations use mixed sets of tools for automated provisioning of test environments, ranging from cloud-native, commercial off-the-shelf to supplier or in-house built tools.

Our recommendations with respect to test environment management and provisioning are the following:

- Accelerate the adoption of multi-premise (on-premises plus multi-cloud provider) strategies for test environments to improve cost efficiency, security, redundancy, and data recovery options.
- Consider intelligent integration (including customizing specific features) to make the best use of commercial off-the-shelf and open-source tooling as a hybrid strategy for test environment provisioning.
- Further leverage the cost-benefit trend of moving non-production workloads to the cloud through the efficient design and architecture of non-production environments.

In this chapter, we also discussed positive trends with respect to the testing of cloud:

- Most organizations are considering cloud testing as an integral part of the software development lifecycle.
- There is a strong affiliation towards open-source tooling, although other options such as commercial off-the-shelf tooling are adopted too for the automation of cloud testing.

Our key recommendations with respect to cloud testing are the following:

- Include a cloud and infrastructure testing strategy in all your projects.
- Improve your end-to-end cloud testing strategy by considering all the cloud platforms and integrated environment architectures to ensure the performance, scalability, and functional aspects of your environments.
- Increase your focus on security testing as more data gets hosted on cloud and integration with third-party cloud applications increases.

Test Data Provisioning and Data Validation

> *We're working towards an RPA approach, that can spin up on the fly all the test data we need to run full tests. AI can play a big role here.*

LALIT MADAN
Director, Global Testing Services and
DevOps, Subway

ANISH BEHANAN
Head, Quality Engineering & Testing, Capgemini UK

SAGAR CHITRE
Head (Solutions), Quality Engineering & Testing, Capgemini UK

Introduction

Test data provisioning is an essential part of the software testing lifecycle. Over the years, with stringent regulatory and security requirements around data, organizations have increased their focus on provisioning test data safely and securely. In this chapter, we will look at the status and trends around test data provisioning. In addition, since we believe that data usage is of growing importance, we have surveyed the topic of data validation this year for the first time.

Test data provisioning strategies

This year we surveyed which test data provisioning strategies are in use by organizations. A clear outcome is that many organizations (41%) still use a project-centric approach for test data provisioning. It is promising that 31% of organizations have defined an enterprise-wide test data provisioning strategy, but are having difficulties implementing it efficiently. Only 20% of the respondents said they have a fully implemented, enterprise-wide test data provisioning strategy.

Organizations need to look at current regulations on data for their region and accelerate the creation of an end-to-end enterprise-wide test data provisioning strategy. This should also include an adequate focus on data security.

Fig 15 — Has your organization adopted an enterprise-wide data provisioning strategy as a standard across all line of business / projects?
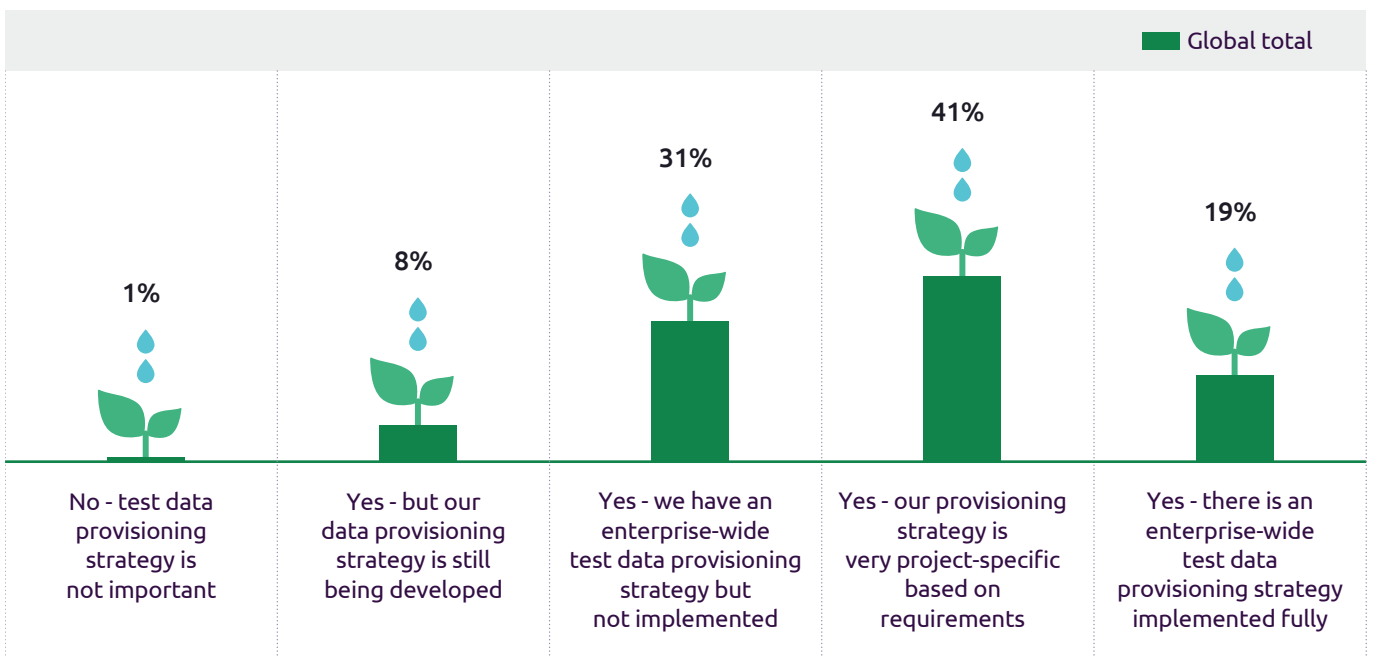
Base: "VP applications and QA/Testing Managers" only (580)

Test data deployment on the cloud

In this year's survey, 92% of the respondents claimed that they use the cloud for storing de-sensitized test data. Having a golden copy or a repository of de-sensitized test data in the cloud is a step forward in ensuring that test data is available on demand. However, when probing more deeply, we found that 89% of all the respondents mentioned that their organization's policy is to have all the test data on-premises. For 83% of the respondents, their cloud data strategy is a work in progress. A significant number of organizations (82%) mentioned that they either use a secure cloud platform to store test data, or that data is not stored in the cloud for long periods (78%). It has emerged that 66% of the organizations are synthetically generating data that is stored on the cloud.

The use of de-sensitized and synthetically generated test data, stored in the cloud, is a positive trend. However, the right approach will always be driven by specific project needs. We recommend a hybrid approach to deploy test data in the cloud. This could be a combination of on-premises and cloud, based on the project needs and the test data sensitivity.

Fig 16	Please tell us if you agree or disagree with the following aspects of how you currently deploy de-sensitised test data to a repository on the cloud?

Agree   Global total

- **89%** — Company policy is to have all data on-premises (test or production)
- **83%** — A cloud data strategy is being developed
- **82%** — All de-sensitized data is stored on a secure cloud platform
- **78%** — Only private cloud is used to store test data for limited time (project duration)
- **66%** — Only synthetically generated data is stored on cloud
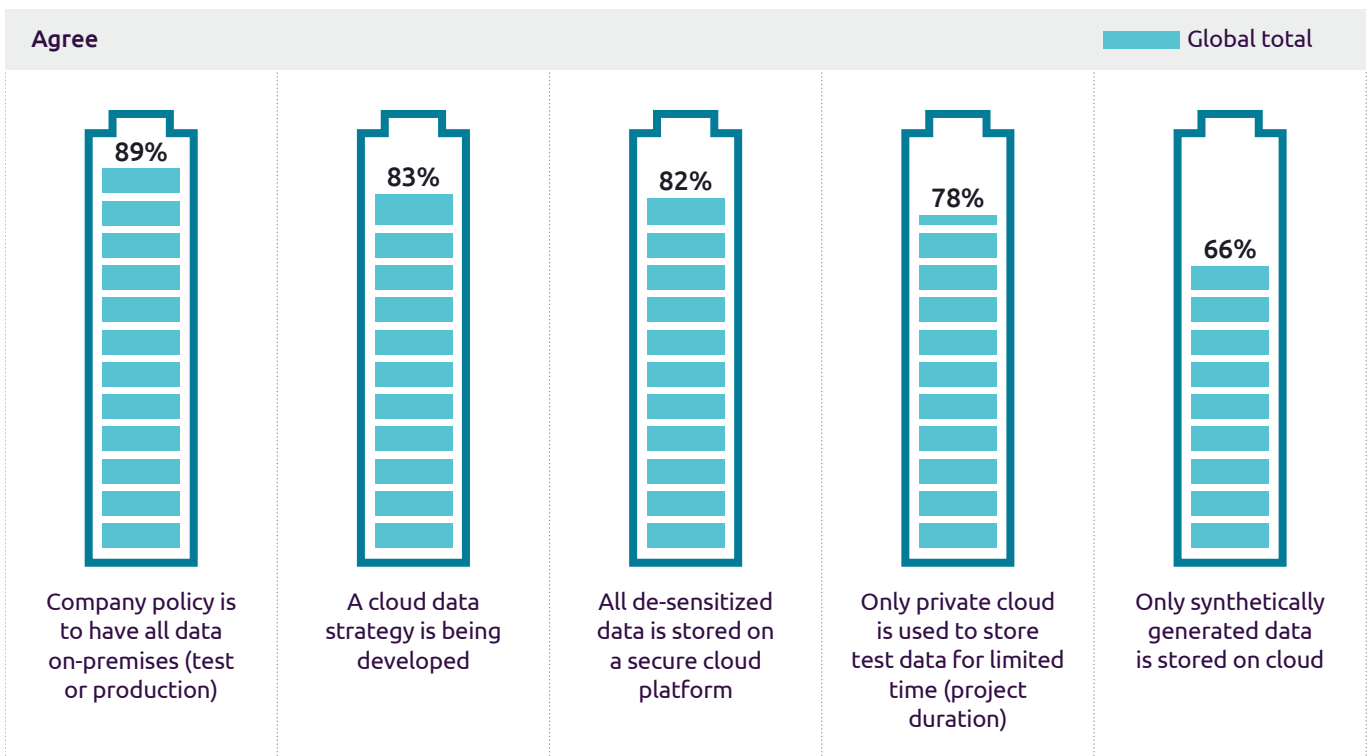
Base: "VP applications and QA/Testing Managers" only (580)

Provisioning of test data into CI/CD pipelines

While organizations are thinking ahead in terms of provisioning secure test data on demand, the test data pipelines are far from being integrated into the CI/CD pipelines. In 49% of organizations, the process of provisioning test data is automated, but this automation is independent of the overall CI/CD pipeline automation. For 42% of organizations, the manual provisioning of test data remains one of the top barriers to integrating the provision of test data into the CI/CD pipelines. Almost a third (31%) of the respondents believe that integrating test data into the CI/CD pipelines is often overlooked.

The key takeaway from this analysis is that organizations need to look at automated test data provisioning as an integral part of the continuous integration and delivery pipelines. We believe that value stream management related tooling can help to integrate test data provisioning to the CI/CD pipelines. This approach may also help in ensuring that the right test data is deployed to the right non-production environment in the cloud.

> *The availability of adequate test environments and test data can also be a problem; so can performance testing the end-to-end customer journey; and so too can security, especially in the context of moving to the cloud.*
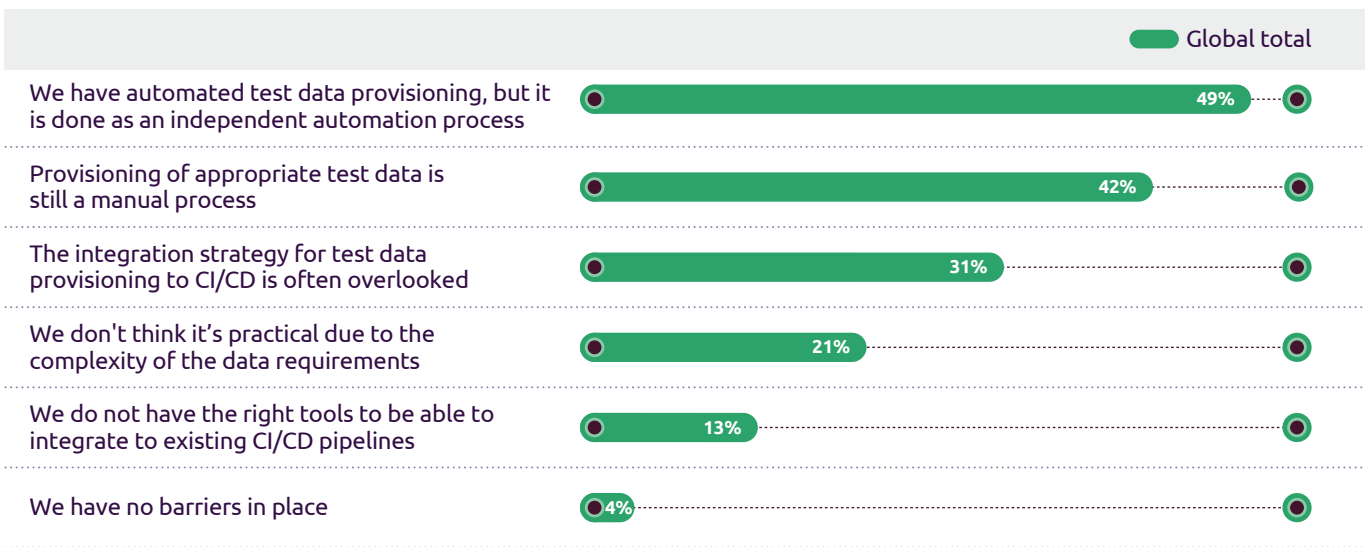
SHIKHA HANDA
Director of Quality Engineering, LLA

| Fig 17 | What are your organization's barriers to integrating provision of test data into continuous integration and delivery pipelines? |

Global total

We have automated test data provisioning, but it is done as an independent automation process	49%
Provisioning of appropriate test data is still a manual process	42%
The integration strategy for test data provisioning to CI/CD is often overlooked	31%
We don't think it's practical due to the complexity of the data requirements	21%
We do not have the right tools to be able to integrate to existing CI/CD pipelines	13%
We have no barriers in place	4%

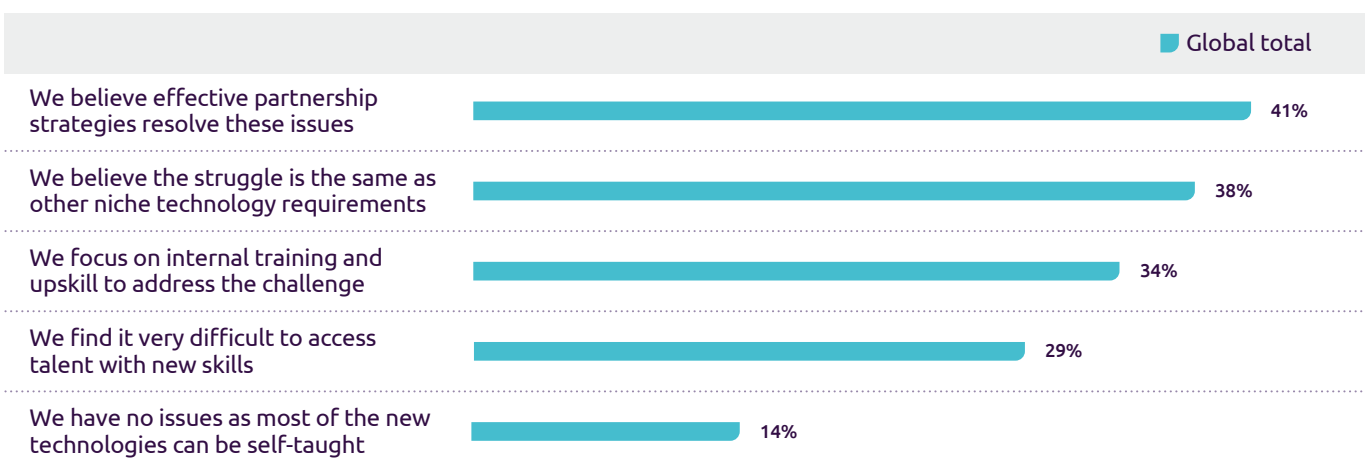*Base: "VP applications and QA/Testing Managers" only (580)*

Test data skills

Solving test data challenges cannot be done with tools alone. It is also important to look at how organizations develop the right skills for test data processes. In our research, we found that many (41%) of the respondents see partnership strategies with tool vendors or system integrators as the best solution to resolve the test data skills challenges. Almost as many respondents (38%) believe that this struggle for accessing the right test data skills is the same as that of other niche skills in other parts of the software development lifecycle. Only 14% of respondents believe that most of the test data-related skills can be addressed through self-learning.

| Fig 18 | With data provisioning tools sometimes demanding its own technology requirements, which of the following best describes your organization's ability to access the right talent/skills for these new technologies? |

Global total

We believe effective partnership strategies resolve these issues	41%
We believe the struggle is the same as other niche technology requirements	38%
We focus on internal training and upskill to address the challenge	34%
We find it very difficult to access talent with new skills	29%
We have no issues as most of the new technologies can be self-taught	14%

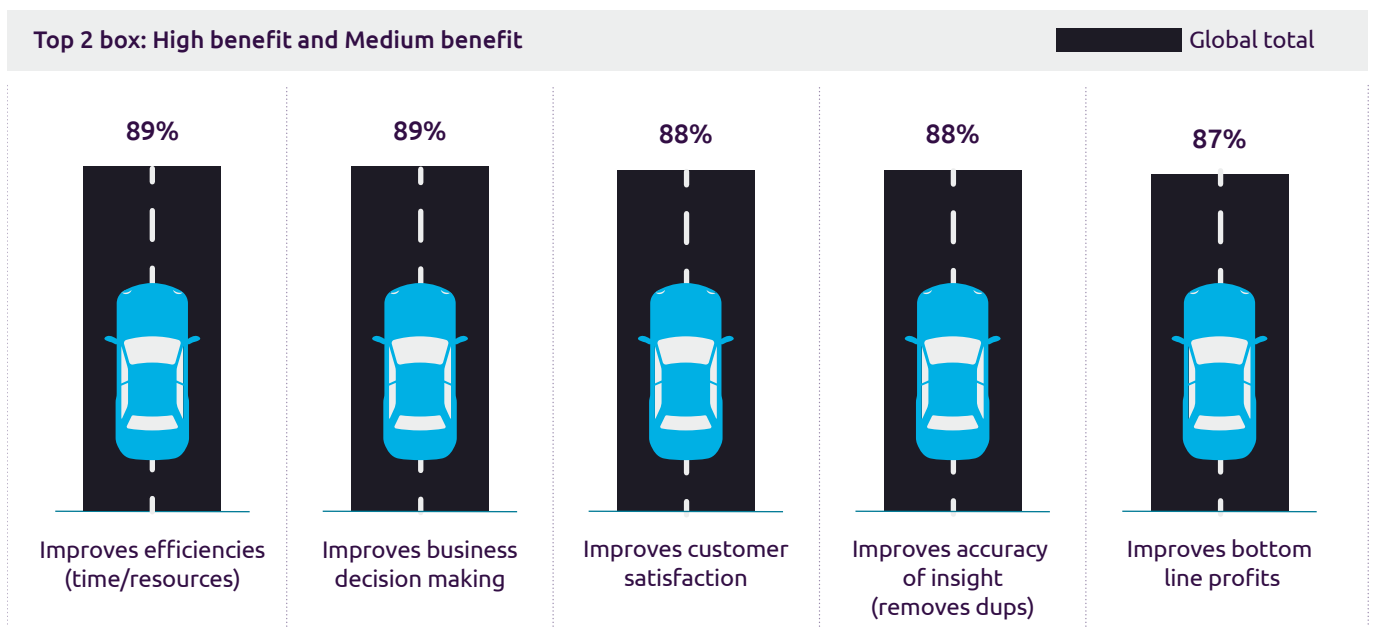*Base: "VP applications and QA/Testing Managers" only (580)*

33

Data validation approaches

With the growing use of data to drive business decisions, we expect that the validation of the accuracy and quality of data is becoming hugely important.

In our survey, it emerged that 46% of our respondents currently see data validation as a very important function and 44% of respondents agree that this area will be extremely important going forward. When questioned about the expected benefits of data validation, 89% of the respondents agree that a robust data validation capability will not only improve efficiencies in terms of time and resources but, more importantly, will help to improve business decision-making. At a similar level, (88%) agree that a robust data validation capability has a direct impact on customer satisfaction and accuracy of insights and that it will help to boost business profitability. There is an overwhelming conviction that effective data validation is of great importance to business outcomes.

| Fig 19 | To what extent does having a 'robust data validation capability' provide a benefit to your organization? |

Top 2 box: High benefit and Medium benefit ███ Global total

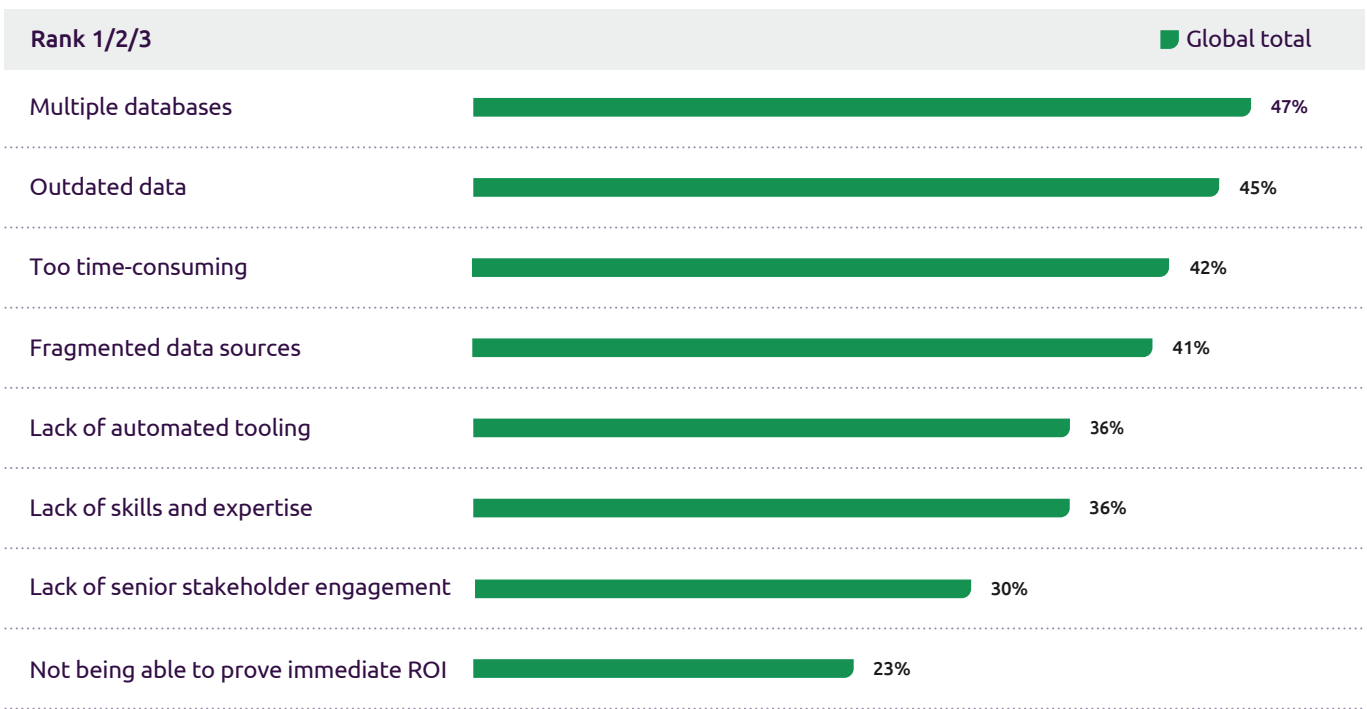| 89%	89%	88%	88%	87%
Improves efficiencies (time/resources)	Improves business decision making	Improves customer satisfaction	Improves accuracy of insight (removes dups)	Improves bottom line profits

Base: All respondents (1,750)

However, while data validation is undoubtedly of importance, many organizations have serious challenges with implementation. In this year's survey, we observed that some of the impediments to implementing an effective data validation strategy or approach lie in multiple complex database architectures. Many organizations (42%) see implementing data validation as a time-consuming exercise, while 47% of the respondents said that having multiple complex databases itself acts as a challenge. Having fragmented data sources is a barrier to effective implementation.

Hence, organizations need to devise strategies that include effective validation rules and related standards to address the barriers to effectively implementing data validation approaches.

Fig 20 What are the top three challenges in implementing an effective data validation for your organization?

Rank 1/2/3	■ Global total
Multiple databases	47%
Outdated data	45%
Too time-consuming	42%
Fragmented data sources	41%
Lack of automated tooling	36%
Lack of skills and expertise	36%
Lack of senior stakeholder engagement	30%
Not being able to prove immediate ROI	23%

Base: All respondents (1,750)

What should organizations focus on?

Our main observations from this year's survey on test data provisioning are the following:

- There is a growing tendency towards having an enterprise-wide test data management strategy, with cloud as a key driver to ensure the accessibility of test data on demand.
- While cloud is a key driver, many organizations still have their strategy biased toward on-premise copies of test data.
- An automated test data provisioning process integrated with CI/CD pipelines still needs to mature in most organizations.

It's not just the infrastructure that needs to be resilient. The data does, too. We need to understand the quality of data flowing through the system.

MICHELLE CHRISTMAS
Head of Testing & Quality Assurance, RSA

Our recommendations regarding test data provisioning are the following:

- Establish strategic partnerships with suppliers and vendors to improve your capability to manage and provision data.
- Accelerate the creation of an enterprise-wide strategy for test data provisioning, as more and more non-production workloads are moved to the cloud.
- Use value stream management tools to help ensure test data management becomes an integral part of the CI/CD pipelines.

Data validation is emerging as an important topic with progressively increasing importance for business results.

Our key observations around data validation include the following:

- The majority of organizations rely on commercial off-the-shelf tooling to perform data validation.
- An increasing number of organizations see data validation as an important task to be carried out for better decision-making.
- Most organizations agree that effective data validation has a direct impact on customer experience and business outcomes.

Our recommendations regarding data validation are the following:

- Consider a combination of data validation tooling options (open-source / in-house / off-the-shelf), as you likely will encounter varying needs and requirements in data validation within your organization.
- Keep data updated and reduce fragmented data sources to expedite data validation.
- Invest in skills and the right level of thought leadership in the area of data validation to get the best results and outcomes from data analytics.
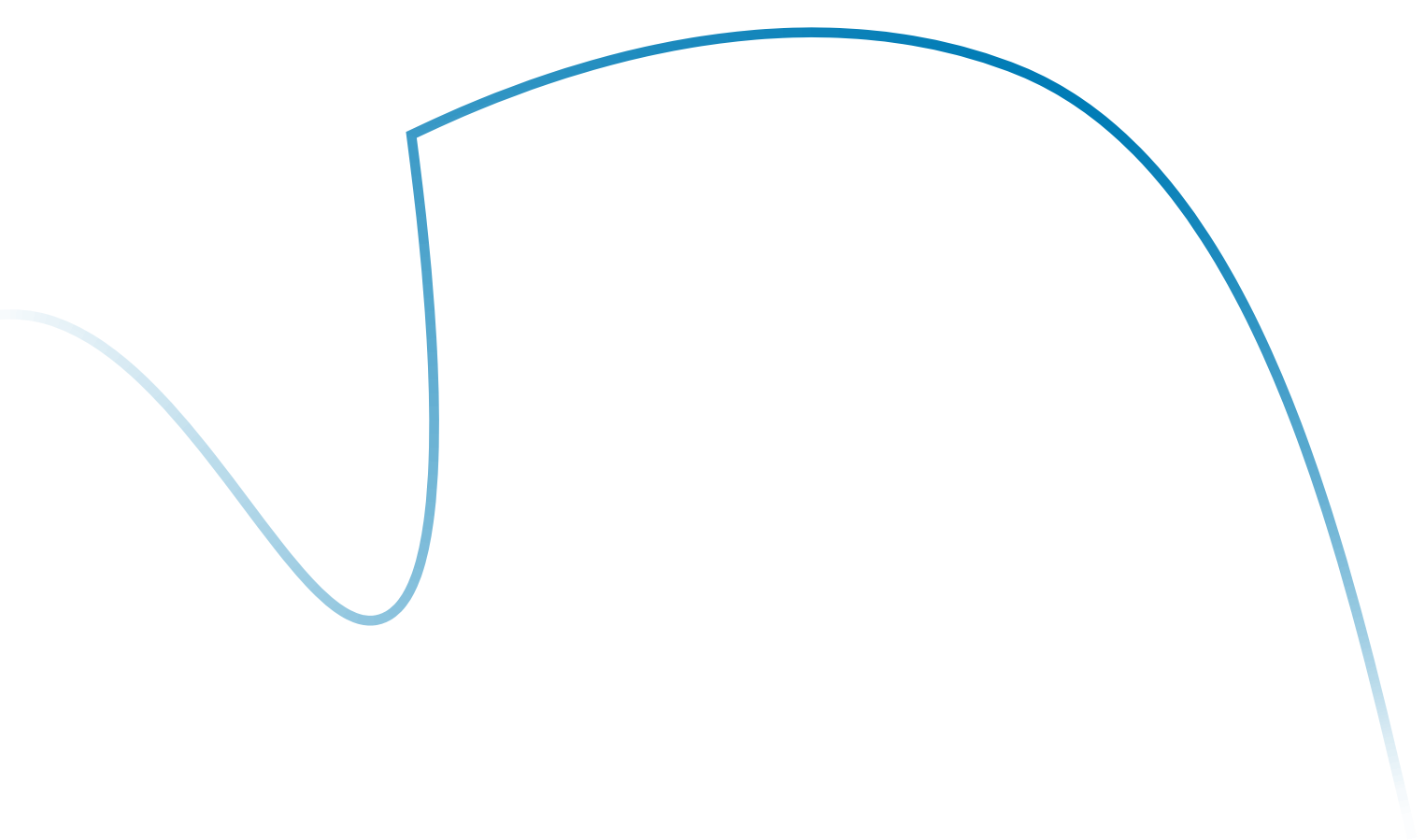
Quality and Sustainable IT

—

Sustainability is in Neste's DNA. It's the nature of our business and IT can contribute to it significantly. For instance, shifting left on quality can enable us to identify and eliminate an unnecessary code loop. By fixing it up front and stopping it from happening, we can reduce power consumption, impacting sustainability.

WOUT BOER
Testing Center of Expertise (TCoE Lead) , Neste

JEBA ABRAHAM
Associate Vice President, Quality Engineering & Testing, Sogeti USA

SARAH ATKINSON
Director, Environmental, Social & Governance (ESG), Micro Focus

Introduction

Sustainable IT, the practice of environmentally sustainable computing, is not new as the term has existed for years. One of the most well-known programs to promote sustainable computing was from 30 years ago (yes, 1992). It was a voluntary program by the US Environmental Protection Agency and was called the "Energy Star" labeling program promoting the visibility of the energy efficiency of computing devices. IT sustainability has since emerged from an intense focus on carbon emissions to a wider range of environmental, social, and governance aspects (ESG framework). Sustainability pertains to the ability of organizations to continue operations without causing any harm to the planet and society at large. Most organizations have moved to an execution phase in this mission with clearly defined goals and timelines.

Sustainable quality engineering is quality engineering that helps achieve sustainable IT. A higher quality ensures less wastage of resources and increased efficiencies. This has always been a keystone focus of quality as a discipline. From a broader perspective, any organization focusing on sustainable practices while running its business cannot do so without a strong focus on quality. "Shifting quality left" is not a new concept, and it is the only sustainable way to increase efficiencies. Simply put, there is no sustainability without quality!

The goal of this chapter is to delve deeper - to find out how organizations are utilizing quality frameworks and tools to drive higher sustainability on the road towards sustainable IT.

The role of quality within sustainable IT is still evolving

There is no clear winner when organizations rank the benefits of having sustainable quality engineering as a part of a sustainable IT strategy. Although brand value and loyalty are considered the biggest benefits to which quality engineering can contribute, they are not leading the other benefits by much. It is noteworthy that improving customer satisfaction is not perceived as one of the most important benefits. Why is that the case? Have organizations given enough consideration to the potential strategic contribution of quality towards sustainability initiatives?

Fig 21 | In your opinion, what, if any, are the most important benefits of having green quality engineering as a part of a sustainable IT strategy?

Rank 1/2/3
Global total

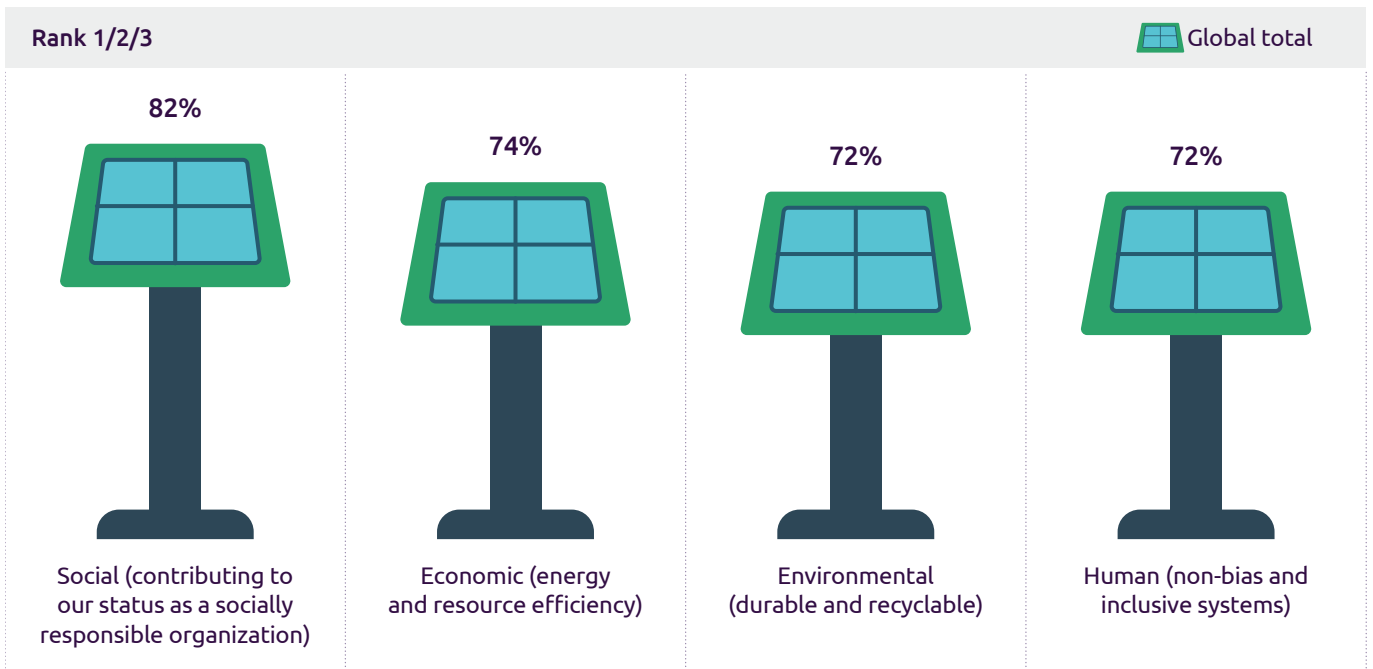|	
Improve brand value	47%
Improve consumer loyalty	46%
Improve supplier loyalty	46%
Improve total revenue	46%
Improve customer satisfaction scores	42%
Improve employee motivation levels	41%
Improve employee recruitment/ retention rates	33%

Base: "CIOs / CTOs / IT Directors / CDOs" only (1,000)

We see the very same perspective reflected in our survey, as over 82% of organizations think that quality engineering will have the most impact on the social aspects of sustainable IT. This is in line with the opinion that quality engineering embedded in sustainable IT delivers the most benefits to brand value, and by a larger margin. Only 72% of organizations think that quality could contribute to the environmental aspect of sustainable IT. If organizations want to be environmentally sustainable, they need to learn to use available resources optimally. A stronger strategic focus on quality is the way to achieve that. Quality needs to be a core part of the strategy to drive more sustainable IT.

Fig 22 In your opinion, what would be the most important benefits of sustainable IT that Quality Engineering can contribute the most ?

Rank 1/2/3   🔲 Global total

82%	74%	72%	72%
Social (contributing to our status as a socially responsible organization)	Economic (energy and resource efficiency)	Environmental (durable and recyclable)	Human (non-bias and inclusive systems)

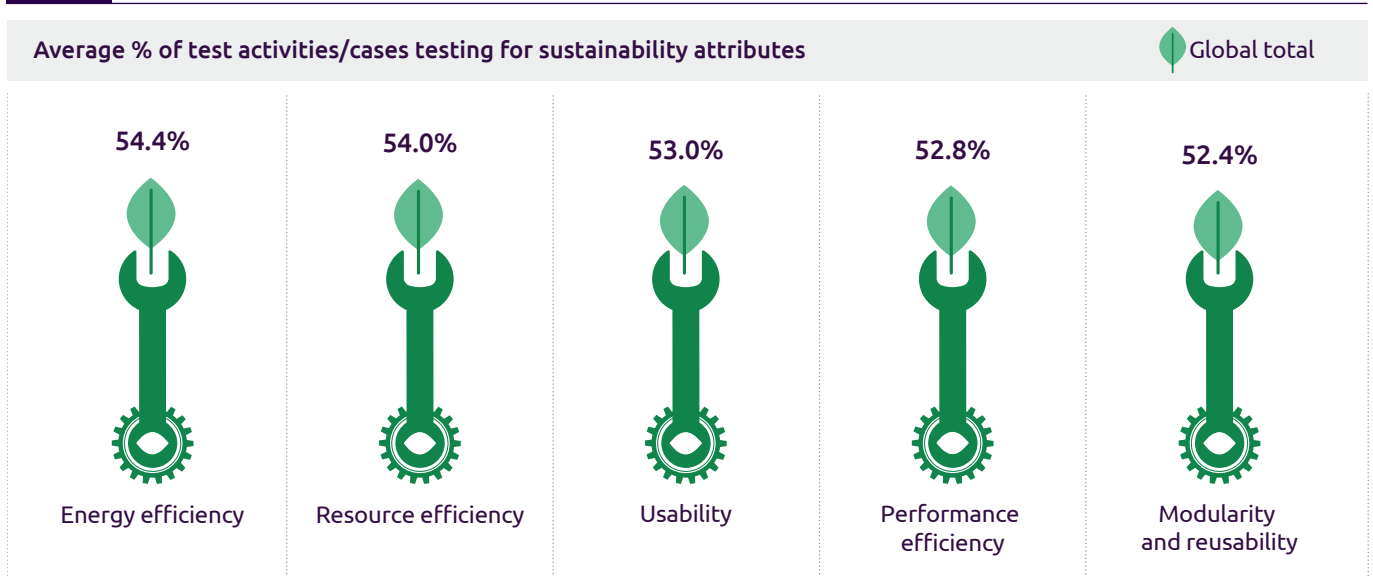*Base: "CTOs, VP Applications, IT Directors, VP R&Ds and Product Heads" only (905)*

Teams don't test for sustainability attributes consistently

In response to our question about what sustainability attributes teams test, and how frequently, we see an almost flat line across the board. Organizations report that their teams test for all attributes but only sometimes. While we need to consider this data in the context of how many of those organizations have adopted sustainability goals, the data doesn't point to any specific pattern or focus areas for teams. The quality engineering effort seems to be equally spread across all sustainability attributes, which feels like a step in the right direction.

Fig 23

Fig 23 How frequently are your teams testing for the following sustainability attributes?

Average % of test activities/cases testing for sustainability attributes

🌿 Global total

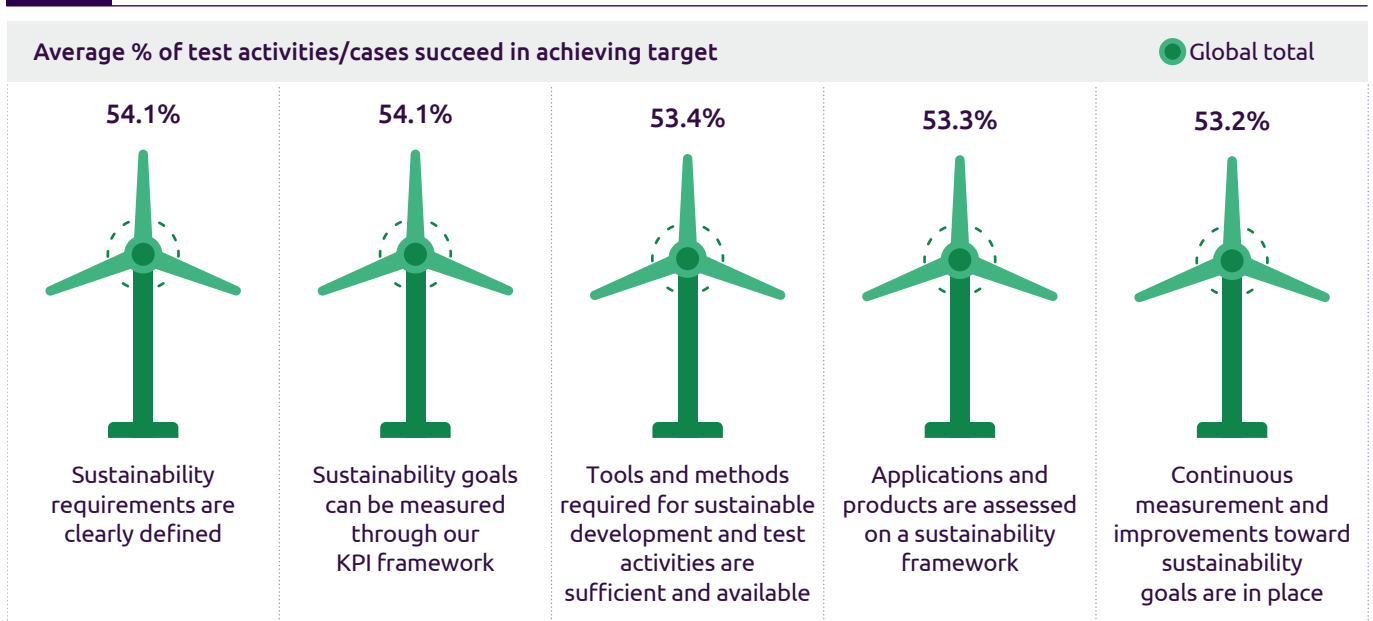| 54.4%	54.0%	53.0%	52.8%	52.4%
Energy efficiency	Resource efficiency	Usability	Performance efficiency	Modularity and reusability

Base: "CTOs, VP Applications, IT Directors, VP R&Ds and Product Heads" only (905)

When looking at how often teams succeed in achieving sustainability targets during application development, we see that driving sustainability attributes across the software development lifecycle (SDLC) is sporadic and doesn't happen habitually. Of course, adoption is closely tied to companywide mandates/targets. But organizations can achieve higher adoption by utilizing quality engineering frameworks, tools, and maturity models to consistently drive sustainability targets.

Fig 24 How often do your teams succeed in achieving the following targets for application development?

Average % of test activities/cases succeed in achieving target

● Global total

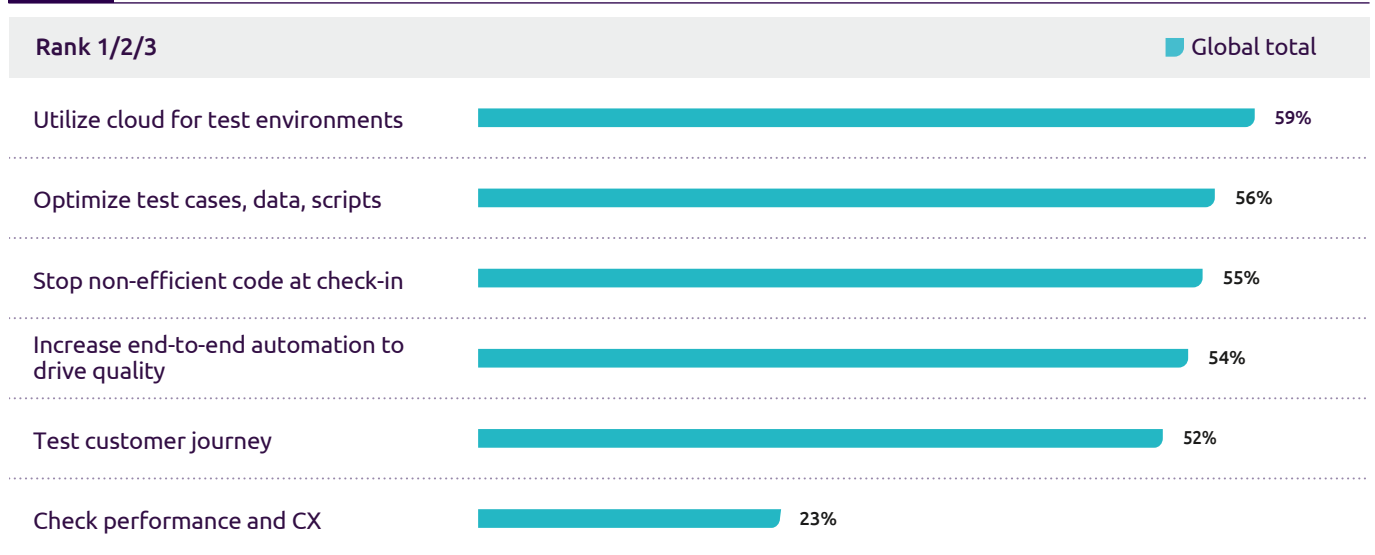| 54.1%	54.1%	53.4%	53.3%	53.2%
Sustainability requirements are clearly defined	Sustainability goals can be measured through our KPI framework	Tools and methods required for sustainable development and test activities are sufficient and available	Applications and products are assessed on a sustainability framework	Continuous measurement and improvements toward sustainability goals are in place

Base: All respondents (1,750)

What are the tactical benefits of quality towards sustainable IT?

When asked about the tactical benefits that quality can bring towards sustainable IT in the short term, organizations interestingly point to cloud environments, test optimization, and resource efficiency in general. Application performance and customer experience came in last. This is contradictory to some of the previous answers where environmental impact didn't stack very high on the impact of quality, while brand value did. Could it be that organizations are perhaps still working out how quality fits into sustainable IT in the long term? We agree that the only way to improve resource utilization is through higher quality and that this has a direct impact on reducing the carbon footprint of organizations. A quality focus will also help in improving the overall maturity framework towards defining, measuring, and controlling the implementation of all aspects (human, social, and environmental) of sustainable IT.

| Fig 25 | What factors of Quality Engineering will make the most important positive impact towards Sustainable IT in the short term? |

Rank 1/2/3 ■ Global total

Utilize cloud for test environments	59%
Optimize test cases, data, scripts	56%
Stop non-efficient code at check-in	55%
Increase end-to-end automation to drive quality	54%
Test customer journey	52%
Check performance and CX	23%

Base: All respondents (1,750)

Where do we go from here?

While looking at the key findings from the survey, we need to factor in some "survival bias", like the one proposed by mathematician Abraham Wald. He was analyzing which areas of military aircraft needed increased armor, by looking at a diagram plotting where returning aircrafts had been hit by bullets. During his analysis, he realized that instead of focusing on strengthening the areas which were hit most, one should focus on strengthening the undamaged areas, as he understood that aircrafts could still make it back to base as long as those areas were intact.

While the data indicates some aspects of the relationship between quality and sustainable IT, there is a bigger picture that can be drawn when we factor in "survival bias" or what the data doesn't directly show. There is a lot of room for quality to be more effectively used to drive sustainable IT objectives. A consistent framework is needed to measure, control, and quantify progress, even to the extent of establishing "sustainable quality gates." This is not possible without a strategic quality focus. There is no sustainability without quality. We believe very strongly that the connection between quality and sustainable IT will strengthen in the coming years, and we are looking forward to seeing it evolve!

What should organizations focus on?

- Bring true "shift left" to the application lifecycle to increase resource utilization and drive carbon footprint reduction.
- Adapt and utilize existing quality frameworks and tools to achieve more sustainable design principles – how modular and reusable is the architecture? Is the programming language resource intensive? Can the number of interfaces and API calls be optimized?
- Customize application performance monitoring tools to support the measurement of environmental impacts at a transactional level.
- Bring quality to the center of the strategy for sustainable IT for a consistent framework to measure, control, and quantify progress across the social, environmental, economic, and human facets of sustainable IT, even to the extent of establishing "sustainable quality gates."

> *We believe that we will achieve success in the following areas with the increase in quality:*
>
> 1. *Built-in quality shrinks the need for and cost of the inspection.*
> 2. *It decreases wasteful defects and reworks.*
> 3. *It targets unnecessary activities and frees those resources for more productive ends.*
> 4. *It eliminates minor workarounds that result in significant long-term added expense.*

BURÇ AKBAŞ
Technical Agility Unit Manager R&D, Business Applications, KoçSistem

SINEM MERVE YILMAZ
Software QA Lead, KoçSistem

Quality Engineering for Emerging Technologies

> *Some of the challenges we face are specific to our sector. For example, 5G is growing, which needs a lot of network engineering testing, and the growth of ecommerce brings pressures too. Finding people with the right skills is always a challenge. For us, this is especially because of the move to the cloud, and because of new software development approaches, particularly those involving the use of AI. It's important to us that we share information and skills within and across our teams.*

SHIKHA HANDA
Director of Quality Engineering, LLA

JEBA ABRAHAM
Associate Vice President, Quality Engineering & Testing, Sogeti USA

SATHISH NATARAJAN
Group Vice President, Quality Engineering & Testing, Capgemini & Sogeti, Americas

Introduction

Gordon Moore posited that the number of transistors in a dense Integrated Circuit doubles about every two years. This has held true for almost 50 years and, though the number of transistors is not strictly doubling every two years anymore, the pace of technological change is still exponential. Consider this single datapoint – the US Patents Office (founded April 10, 1790) granted 229 patents in its first decade of existence, the same number that it grants every 7.2 hours today! While the number of patents is not a perfect measure of technological advancement, it is certainly an indicator of accelerating innovation.

Any technology follows a clear trajectory over its lifetime called the technology life-cycle (TLC) which determines the lifespan of that technology. Some technologies have a long lifespan with minor variations over time while some have quite a short lifespan. This makes it interesting to unpack technological advancements.

Two dimensions need to be considered when looking at quality engineering for Emerging Technologies. The first dimension is the role of quality when these new technologies are implemented in real-world use cases. How should they be tested? Can existing tools and frameworks be used? Quality will play a central role in ensuring the success of these implementations.

The second dimension is the impact that emerging technologies have on quality engineering practices. We have looked closely at the impact of specific technologies like Artificial Intelligence (AI) on quality engineering before. Many more emerging technologies are steadily gaining relevance for the future. Therefore, it is not only interesting but imperative to study the bi-dimensional relationship between emerging technologies and quality, to keep abreast of innovation. In this chapter, we will attempt to understand which emerging technologies are an inherent part of organizational strategies, which have the biggest impact on quality engineering, and what changes, if any, are needed for quality engineering practices to adapt.

Technological big bets for the future

We were curious to understand what emerging technologies organizations were betting on for the future before we jumped into the quality engineering aspects of those big bets. Most organizations seem to be betting on a decentralization theme for the future. More than 80% of respondents to the survey picked blockchain and Web 3.0 as a priority for their IT strategy. We have all observed blockchain-based applications transcending the financial domain into contract management, digital assets, non-fungible tokens (NFTs), and more. Though Web 3.0 is still being defined and there isn't a universally accepted definition of what it means, it is related to the same decentralization theme and blockchain.

| Fig 26 | To what extent are the following technologies a priority for your current IT strategy? |

Top 2 box: High priority and Medium priority   ■ Global total

Technology	Global total
Blockchain	85%
Web 3.0	85%
Digital twins	78%
3D printing	76%
Quantum computing	76%
Metaverse	69%

Base: "CIOs / CTOs / IT Directors / CDOs" only (1,000)

Impact on quality engineering as a discipline

How do emerging technologies impact quality engineering? The survey results are intriguing, as they indicate that most respondents expect emerging technologies to help drive a seamless user experience and make leaps in managing test environments and data. The focus on blockchain and Web 3.0 as priorities would warrant a change in how test environments and data are traditionally managed. A less controlled and decentralized method of managing test environments and data could solve some of the current challenges. However, it would introduce new complexities too. Whatever the outcome, this is an interesting space to watch out for.
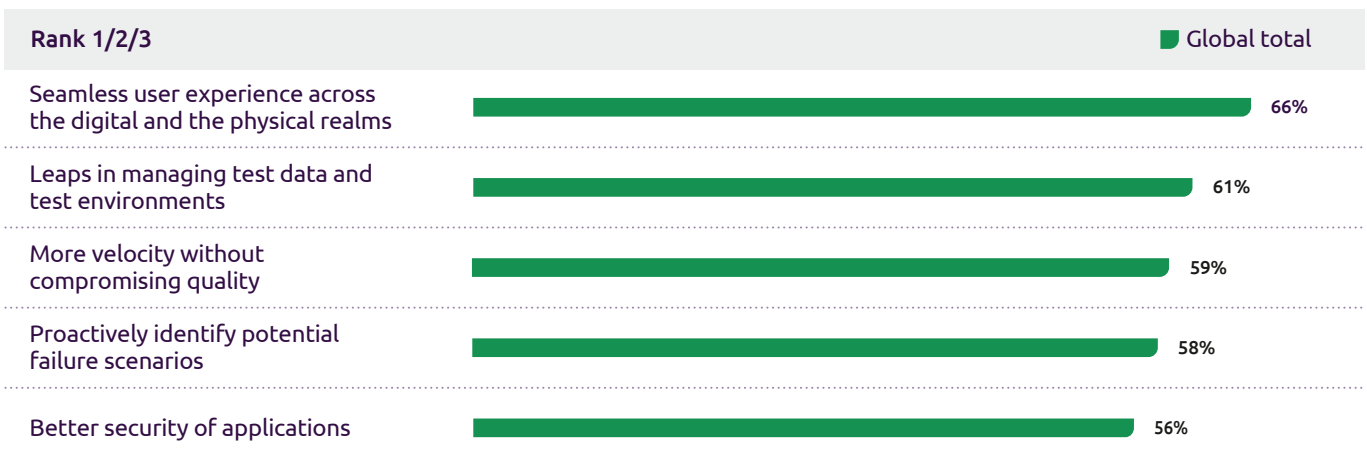
> *It's at the proof-of-concept stage right now, but we'll be using AI in some QA activities that are related to our digitization program over the next year or two. Ethics form part of it: using these technologies responsibly is very important. It's a question of trust – and also, it makes us look at things differently. It stretches different muscles for us.*

HARISH RAJANI
Head of Change Delivery,
Whitbread

Fig 27 — Which of the following are the greatest benefits of new emerging technologies improving quality outcomes?

Rank 1/2/3 ■ Global total

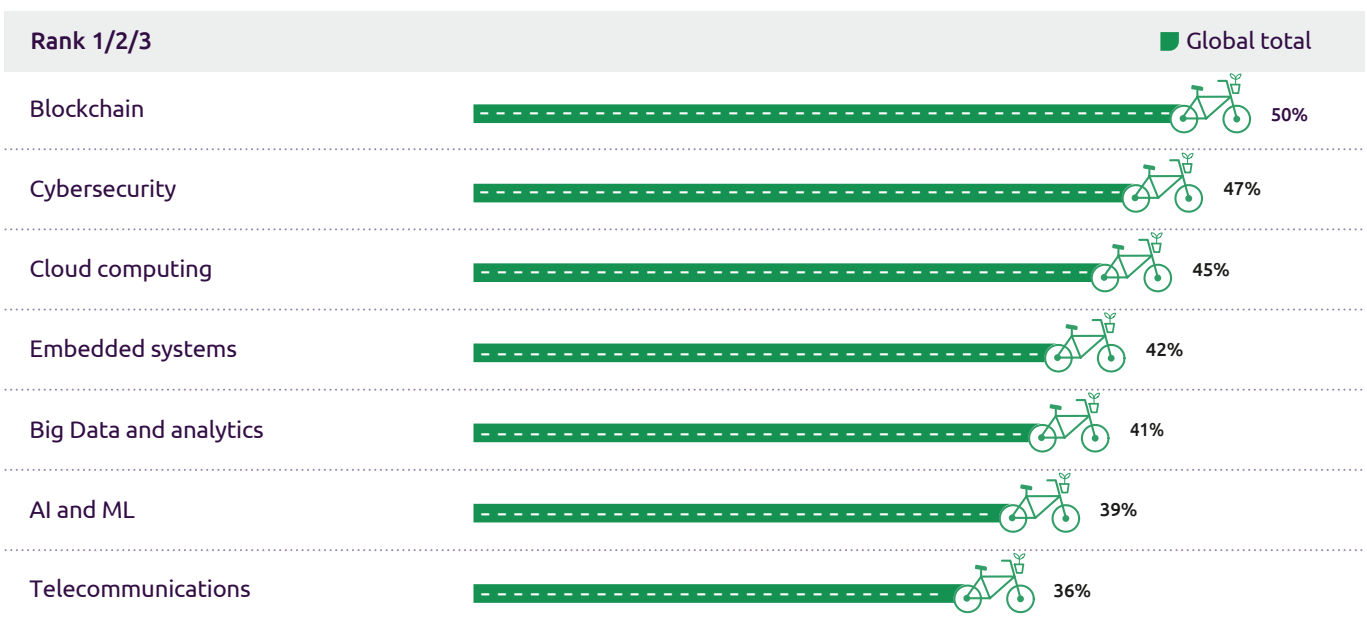|	
Seamless user experience across the digital and the physical realms	66%
Leaps in managing test data and test environments	61%
More velocity without compromising quality	59%
Proactively identify potential failure scenarios	58%
Better security of applications	56%

Base: All respondents (1,750)

It is expected that new skills will be needed for quality engineers as technology evolves. The skills that organizations think are important for the future line up nicely with their strategic big bets. Blockchain as the primary skill and cybersecurity as the associated skill are considered the most important. Embedded systems skills are needed to ensure a seamless user experience bridging the physical and the digital that organizations are looking to build. We were surprised to see that AI and machine learning (ML) skills are not among the most desired for the future. Maybe AI has moved from an emerging topic to a staple one.

Fig 28 — Which talent/skill areas are most important for testing new and emerging technologies?

Rank 1/2/3 ■ Global total

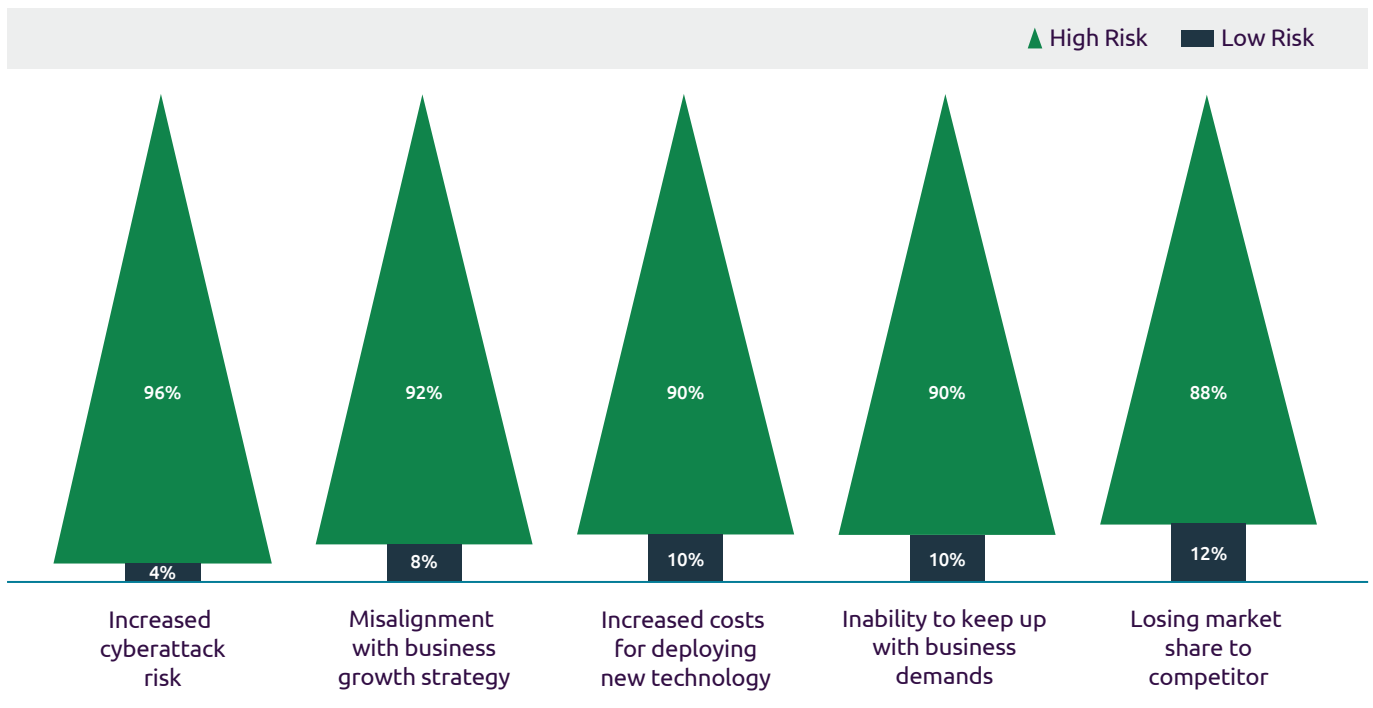|	
Blockchain	50%
Cybersecurity	47%
Cloud computing	45%
Embedded systems	42%
Big Data and analytics	41%
AI and ML	39%
Telecommunications	36%

Base: "CTOs, VP Applications, IT Directors, VP R&Ds and Product Heads" only (905)

Is quality engineering still relevant for the future of technology?

So, what are the risks of not having a quality engineering strategy for emerging technologies? That is the big question. The threat of cyber-attacks seems to be what keeps most leaders up at night, with 96% of respondents picking cyber-attacks as the biggest risk. It's near unanimous. At a similar level, 92% of respondents chose misalignment with business growth strategy, while 91% of respondents chose increased costs of deploying new technology as a risk of not having a quality engineering strategy. These are more traditional concerns, but they are a strong indication that quality has a central role to play in the implementation of emerging technologies into real-world use cases.

Fig 29 Using a scale of 1-3 (1 – low risk to 3- high risk), how would you rate the enterprise risks for not adopting a Quality Engineering strategy for emerging technologies?

▲ High Risk　■ Low Risk

96%	92%	90%	90%	88%
4%	8%	10%	10%	12%
Increased cyberattack risk	Misalignment with business growth strategy	Increased costs for deploying new technology	Inability to keep up with business demands	Losing market share to competitor

Base: "CTOs, VP Applications, IT Directors, VP R&Ds and Product Heads" only (905)

It seems obvious based on the survey results that irrespective of technology trends, quality engineering will continue to be a focus in the months and years to come, and that it will, if anything, become more relevant than ever.

Looking into the crystal ball

Technology is transforming not just organizations but entire industry segments and creating completely new ecosystems. There are some areas (such as 3D printing) that seem to have plateaued, whereas some areas (like Web 3.0) are just starting to be defined. Organizations that make the right bets on technology advancements stand to leapfrog over the competition by both enhancing their business models and by finding new streams of revenue.

What does this mean? Quality engineering will have a critical role to play in implementing technologies for real-world use cases no matter what the technology bets are.

We also think that DevSecOps will gain greater importance in the coming years as these new technologies evolve into multiple real-world implementations. Quality embedded in DevSecOps will need to cater to the functional and non-functional aspects of these implementations in both the digital and physical dimensions in a seamless manner.

Finally, the human element of quality engineering will be very important as a lot of strategies, frameworks, and approaches will need to be built. These human quality engineers will need to have an evolved skill set that is in line with the technology landscape.

What should organizations focus on?

Quality will take center stage in the implementation of emerging technologies. Organizations need to ask themselves:

- Will building quality engineering skills around blockchain, Web 3.0, and cybersecurity be crucial to the success of implementations?
- What capabilities will we need to test seamless user experiences between the physical and digital worlds?
- What will be the quality engineering strategy required for emerging technologies, even during the prototyping phase, to support successful implementation and scaling?

We use AI as part of our QA approach, and we'd like to do more with it. Right now, we use it in a code review bot, for example. It assesses developers' latest changes, identifies patterns and types, and suggests that those people talk to other developers who have experience relevant to the task in hand. We also use AI to assess which audiences, from which countries, and in which proportions should be included in rounds of performance and CX testing. Plus, smart test selection can tell developers which test cycles still need to be run, or at what point they can be sure that further tests will be redundant and that a line can be drawn under everything.

We're looking at virtual reality right now. Some companies have 'cameras on' policies for virtual meetings, but not everyone likes to be on screen, so we're exploring the development of avatars for Teams.

JEFF YIN
Partner Director of Engineering, Microsoft Teams

The application landscape is changing, and quality assurance needs to keep pace. For example, the use of blockchain is growing in foreign exchange, which is why banks like ours are investing heavily in this area.

DELIVERY HEAD OF A MAJOR GLOBAL BANK

Value Stream Management

—

> *How can we make our quality decisions based on data-driven analytics? What value can those decisions deliver?*

ERIC MAENDER
Senior Director, Operations Support Systems, Integration and Testing, Cox Communications

ANDREW FULLEN
Head of Innovation and Technology, Sogeti UK

JULIAN FISH
Director of Product Management, Micro Focus

TAL LEVI JOSEPH
Vice President of Product Management for Application Lifecycle Management, Micro Focus

Introduction

One of the expectations of the quality and test function is to assure and ensure that the software development process delivers the expected value to the business and end-users. However, in practice, many teams and organizations struggle to make the value outcomes visible and manageable.

One of the emerging and developing trends we have looked at this year – and the focus of this chapter - is value stream management and how widespread it is, how it is used, and what trends are developing around it.

Value outcome of quality assurance and test activities

As always, we have asked senior management what the most important objective for quality and test activities is. The outcome of this question indicates what the value is that organizations expect to get from the quality and test function.

Graph: Most important objectives for the quality and test activities

| Fig 30 | Looking ahead to the next 12 months, what, if any, are the most important objectives for your quality and test activities? |

Rank 1/2/3   ■ Global total

Business assurance (help the business growth, business outcomes)	49%
Ensure end-user satisfaction and experience	49%
Quality enablement (support everyone in the team to achieve higher quality)	45%
Protect the corporate image and brand	42%
Automate QA process (make QA and testing a smarter/automated process)	42%
Quality at speed	38%
Detect software defects before go-live	35%

Base: All respondents (1,750)

LEGENDA: Each bar shows the % of organizations that have selected the mentioned aspect as one of their top-three objectives

Business assurance (helping the business grow and supporting the business outcomes) and ensuring end-user satisfaction were tied as the most important objectives. Achieving quality at speed, which was in the top two last year, dropped in the overall outcome, but companies that said they had mature, automated and agile teams, were focused more on driving quality at speed compared to others that were earlier in the adoption of these ways of working.

Finding faults is not seen as a priority for most of the organizations we interviewed, which indicates that this is becoming a standard expectation.
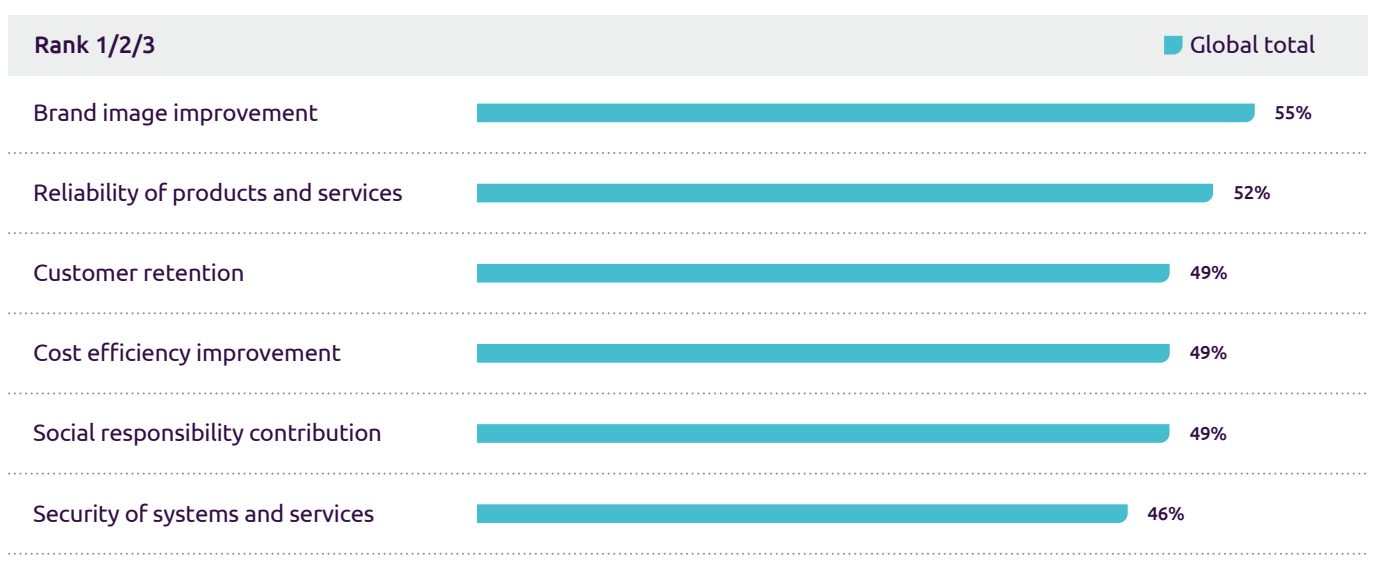
Of course, the outcome of this question will differ greatly from one organization to the next. We think it is imperative to ask this question in your organization so that expectations are clear. The follow-up question is then how to demonstrate this value outcome in a better and more manageable way.

Business value

If one of the most important expectations of the quality and test function is to assure business outcomes and value, it is important to align on what the expected business outcomes are. To understand this better, we surveyed what organizations consider to be of the most value. We did this by asking respondents to rate the top three most important focus areas that they believe are bringing the most value to their organization.

Graph: the most important value focus areas

Fig 31 What are the top three most important focus areas (if any) for bringing value to your organization?

Rank 1/2/3

■ Global total

Brand image improvement	55%
Reliability of products and services	52%
Customer retention	49%
Cost efficiency improvement	49%
Social responsibility contribution	49%
Security of systems and services	46%

Base: All respondents (1,750)

LEGENDA: Each bar shows the percentage of organizations that have selected the mentioned aspect as one of their top-three focus areas for business value

Brand image, reliability, and customer retention were in the top three. These aspects are very intricately linked. If your brand image is favorable, this is driven by customers staying (and joining) because they get the service they desire. In other words, the service is reliable, fit for purpose, and delivers results within a reasonable time. The security of systems and services is an important aspect, but according to the survey, it is not a clear value target.

The outcome of this question will differ from organization to organization, but asking this question for your organization is a step in the right direction toward value stream management.
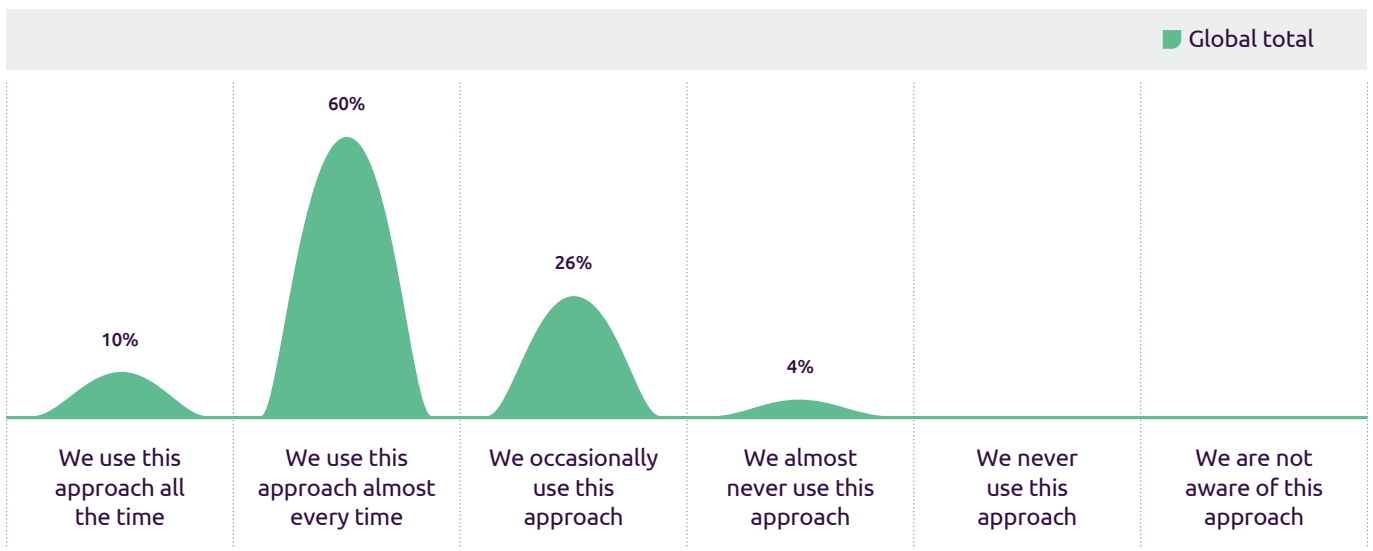
Once you know the key target values that your organization needs, value stream mapping, and value stream management can start to help your organization to manage value outcomes better and continuously.

Value stream mapping

We asked respondents if they are using the concept of value stream mapping today. It is promising that the majority (60%) of respondents claim they are using this approach almost every time.

Fig 32 How frequently, if at all, do you currently use the Value Stream Mapping approach to improve the testing process in agile/DevOps projects?

■ Global total

We use this approach all the time	We use this approach almost every time	We occasionally use this approach	We almost never use this approach	We never use this approach	We are not aware of this approach
10%	60%	26%	4%		

Base: All respondents except "QA/Testing Managers" (1,435)

Value stream mapping is a lean process that involves analyzing the current state of the material and information flow process through to the delivery to the customer. Seeing what is critical and identifying the time and loads at each stage shows where the information moves through and allows for decisions to be made to remove or reduce waste and improve efficiency.

Globally, we can say that value stream mapping is used extensively, but it varies massively across the world, with some countries having little involvement and others using it all the time.

While there are no international standards for value stream mapping and how to use it, the principles are well known and understood from lean approaches. As tools become more available and understood in this area, we expect to see comparisons of value stream mapping scores being used to measure different organizations to see which ones bring the best value to customers or investors.

The following graph shows the most important principles that organizations use in value stream mapping.
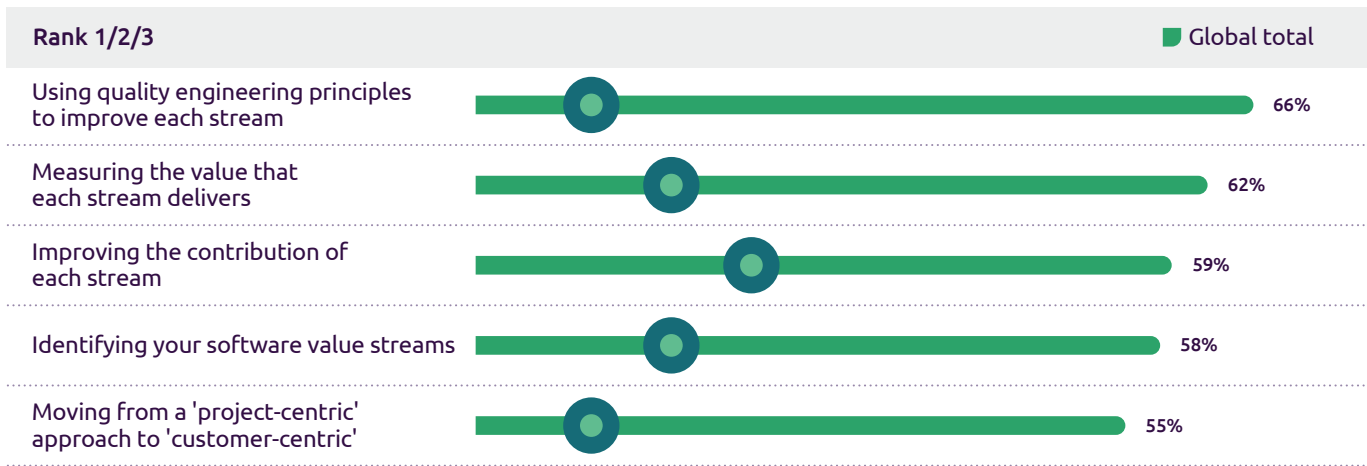
"

1. *You can't improve quality without metrics – and VSM will give us the visibility we need.*
2. *VSM will enable me to demonstrate the value of the efficiencies our new center of excellence will deliver.*

"

MICHELLE CHRISTMAS
Head of Testing & Quality Assurance, RSA

Graph: Value stream mapping principles

Fig 33 ▸ What are the top three most important principles, if any, when managing your current value streams?

Rank 1/2/3	■ Global total
Using quality engineering principles to improve each stream	66%
Measuring the value that each stream delivers	62%
Improving the contribution of each stream	59%
Identifying your software value streams	58%
Moving from a 'project-centric' approach to 'customer-centric'	55%

Base: All respondents except "QA/Testing Managers" (1,435)

LEGENDA: Each bar shows the percentage of organizations that identified that principle as one of the top three principles for value stream mapping.

This result shows that, for most organizations, there is a clear link between value stream mapping and quality engineering. Quality engineering is the most used principle to manage the value stream.

What should organizations focus on?

Value stream management and value stream mapping are important concepts that help organizations and teams ensure better control of actual value outcomes from software development. Our survey shows that the expectations of organizations from value outcomes develop over time. We have also seen that quality engineering and testing activities have a prominent role to play in assessing, measuring, and managing value streams.

For readers of the World Quality Report we have the following recommendations:

1. Verify that business objectives and goals for IT projects are defined and clear for all team members and stakeholders.
2. Define with business owners and project owners the expected value outcome of testing and quality activities.
3. Define concrete and measurable value indicators that are connected to business objectives for each project.
4. Ensure that quality and test results are connected and related to these value indicators.
5. Implement a value dashboard by which stakeholders and team members can continuously view the progress and development of the value indicators.

"

Teams in our company discard individual opinions and prioritize based on the customer's perspective

"

BURÇ AKBAŞ
Technical Agility Unit Manager R&D, Business Applications, KoçSistem

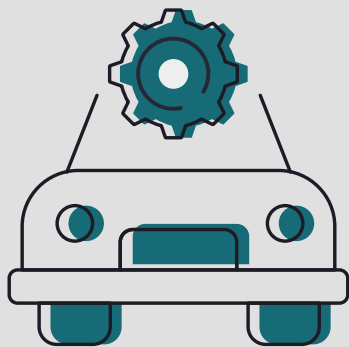**SINEM MERVE YILMAZ**
Software QA Lead, KoçSistem

SECTOR
ANALYSIS

AUTOMOTIVE

MAINTAINING CONSISTENCY IN A COMPLEX WORLD

AXEL SCHOENWALD
Sales Leader, Automotive, Sogeti Germany

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Business Group Manager, Automotive, Sogeti Germany

ANDY HOWARD
Vice President, Head of Automotive, Americas

SCOTT C FARR
Account Executive, Automotive, Capgemini Americas

The automotive industry is like a Rubik's Cube. Everything is interlinked. You can't address challenges in one area without factoring in the impact of your changes on everything else.

These interlinked areas include engineering, business models, infrastructure, technology, the global environment, and consumer lifestyle and expectations. So, for instance, to address drivers' preferences, you not only have to change the car, but the way it's manufactured, sold, and supported on the road. What's more, implicit in all these areas – and not just in the onboard technology – is all the IT, which needs to keep in pace with everything else. And this in turn means the role of quality engineering (QE) is absolutely vital.

The interconnectedness of things has meant that, in recent years, automotive manufacturers have been developing untraditional and highly complex partnership programs. What was simply a car is now effectively a repository for the functionality of many kinds – it has been called a smartphone on wheels – and so multiple partners are engaged in design, in build, and in operations, across all this functionality. Even the partners are morphing. For example, NVIDIA, known for graphic card manufacture, now also builds car control units.

Power sources are another case in point. Electric vehicles (EVs) need batteries, and they need charging points, which is why the major auto manufacturers are building networks of charging stations. They are either forming partnerships with battery manufacturers or developing their own.

Holistic complexity

Despite the complexity of these supply chains and partnerships, the ultimate responsibility for quality remains with the manufacturers. It's their name on the vehicle, so that's where the buck stops. This means quality engineering needs to be layered from end to end, like a single, high-quality, and uniform blanket, over the entire, integrated business ecosystem. It also needs to address the robustness, performance, and security of individual components. Agile development teams can help to work towards this holistic approach and manage the complexity, but it's a challenge, and new issues constantly arise. For instance, the systems that control and monitor the air-conditioning (AC) and the battery in an electric vehicle may each work fine, but if the AC is draining the battery, will the software alert drivers so they don't find themselves stranded on the highway?

If the larger auto manufacturers own the responsibility for quality, they also own the data – and it's hugely valuable. For example, a driver's routine may enable manufacturers to offer timely upgrade options, and vehicle tracking data can be shared with retail partners to generate alerts to drivers when they are near one of their stores.

Implicit in this complexity is a need for people who can maintain an end-to-end view of the technology landscape and who also have a broad knowledge of engineering and business principles. It's not just about skillsets – it's also about mindsets. They need to be people who can analyze and understand the context, and then determine which knowledge to apply, and how.

Also implicit in these elaborate ecosystems is a need for test automation. It's a need that's growing rapidly: there are so many software elements, interlinked in so many ways, and being updated frequently, and it's impossible to test them all manually. Test automation can help to ensure not just that they work together, but that they will continue to do so and meet warranty requirements as circumstances change.

Functionality on demand

As we've noted, vehicles are now repositories for many kinds of functionality, not just transport from A to B, and we're seeing a move towards a new design approach in which every conceivable service is built into the vehicle, and buyers then opt into those they want to be enabled. In fact, it's not just a design approach – it's also a new business model because it means manufacturers can sell base vehicles at lower entry points, and then upsell additional functionality, either permanently or temporarily, and either at the point of purchase or at a later point of need.

It's a business model that is on its way in the mainstream car market – and it's already becoming the norm in commercial passenger vehicles and fleet cars, where buyers can, for example, choose to enable predictive maintenance or specialist best route guidance for logistics businesses. Proliferation in this area will continue and, from a quality perspective, it will need to be managed well.

The road ahead

Traditional automotive manufacturers and EV start-ups alike are obliged to develop and manage these complex ecosystems we've seen, and at the same time, they need to maintain high levels of quality.

We compared all this earlier to a Rubik's Cube, but really, it's not that straightforward. It's a Rubik's Cube where every side is in a state of flux and, with each new technological or market development, the colors change shade. It's what makes quality engineering in this industry such a challenge – but it's also what makes it so exciting.

SURVEY WATCH: AGILE QUALITY MATURITY OF AUTOMOTIVE ORGANIZATIONS

56% of agile teams have professional quality engineers integrated

57% of agile teams have test automation implemented

49% of teams achieved better reliability of systems through test automation

51% of teams achieved faster release times through test automation

CONSUMER PRODUCTS, RETAIL, AND DISTRIBUTION

QUALITY: MORE IMPORTANT THAN EVER

AJITHKUMAR MADHAVAN
Vice President & Portfolio Leader CPG,
Capgemini USA

In last year's World Quality Report, we pointed out that the rate of digitization in the consumer products, retail, and distribution (CPRD) sectors had accelerated during COVID, and that, as the world started to emerge from lockdown, companies were thinking more strategically and more holistically about their technology in general and about their quality engineering (QE) in particular.

This year? Well, there's no denying there's a degree of caution now. It's not that there is any shortage of consumer demand – far from it – it's more that supply chain issues and inflation caused by macroeconomics and world affairs are causing disruption.

Positive trends

It's caution–not fear. We don't see last year's trends reversing. In the months to come, CPRD organizations do anticipate budget cuts, but transformation programs are nonetheless likely to get focus and therefore investment. For instance, we're seeing changes in approach to supply chain management and procurement as organizations re-evaluate long-established practices. One example of this is the modernization of legacy supply chain management systems to completely new systems on the cloud with IoT integrations – and QE is front and center in this innovation push.

We've observed increased momentum in other areas too. In security, CPRD organizations are recognizing that they have sometimes kicked the legacy IT can down the road because it's costly and difficult to address, and there has been no perceivable top-line benefit. In an increasingly digital post-pandemic world, it's not a position they can any longer afford to maintain. It needs fixing.

Similarly, sustainability is gaining traction. CPRD organizations have a major potential impact on the environment, and many organizations take their responsibilities very seriously. We're increasingly seeing sustainability factors being used as metrics in technology development proposals.

QE practices and skills

Quality engineering in CPRD sectors is highly business-driven, and it's no surprise to see so many organizations keen on the principle of value stream mapping. That is, they look at where they are now, at where they want to be in terms of the business outcomes they seek, and then map out the intermediate process stages. It's an approach that's greatly used in major programs, and particularly in digital transformation.

We also see organizations adopting quality automation, especially in larger transformation programs. There seems to be less appetite for automation in existing or legacy systems, where the perceived potential benefits are fewer.

Agile and DevOps adoption is continuing to increase, and quality and test engineers are being embedded in teams. In some instances, the lines between development and testing are blurring as people acquire composite skills, but more progressive CPRD organizations tend to maintain collaboration between peers with complementary skills.

This prompts the question of where the skills gaps might be – and the answer is that requirements in these sectors are pretty universal right now. Needs in tools and technologies such as test automation are joined by others in approaches such as agile, and still by others at a strategic level. These strategic needs include sustainability: as we just noted, it's an important factor among CPRD organizations, and businesses serving different markets must each be able to apply its principles in its individual circumstances.

Implicit in this argument is a further skill needed for QA engineers – and that's domain knowledge. For example, current economic pressures are making revenue growth management a challenge: how can businesses maintain their customers' sense of value and develop and sustain the technology necessary to deliver it? It's something that requires close familiarity with the specific market and its driving forces and, right now, it's more vital than ever.
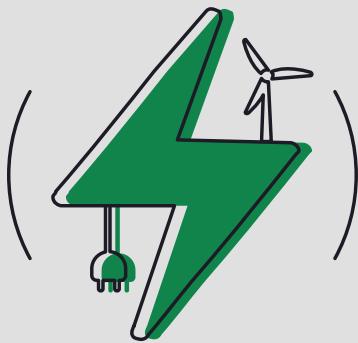
Enterprise-wide integration

It's universally acknowledged that, at its most successful, digital transformation in CPRD enterprises touches every part of the value chain – but in this post-pandemic world, we now see a marked difference. Organizations are thinking in a very integrated way – not just across functions such as manufacturing, the supply chain, and finance, but across technologies, processes, and geographies.

To make it all happen, they're going to need people who can think and act in a similarly integrated fashion – and this, in turn, means there is a big opportunity for quality engineering to assume a consultative role.

In CPRD, quality is set to become more important than ever.

SURVEY WATCH: AGILE QUALITY MATURITY OF CPRD SECTOR ORGANIZATIONS

54% of agile teams have professional quality engineers integrated

56% agile teams have test automation implemented

50% of teams achieved better reliability of systems through test automation

47% of teams achieved faster release times through test automation

ENERGY, UTILITIES, NATURAL RESOURCES, AND CHEMICALS

SETTING THE PACE OF CHANGE

MANISH SHARMA
Vice President, Market Unit Leader, Energy, Capgemini USA

DRU K. HAWKINS
Group Vice President, Energy Sector, Capgemini USA

JEFF LARSEN
Vice President, Natural Resources and Chemicals Industry Sector, Capgemini USA

The markets covered in this section of the World Quality Report are more volatile than most, and the repercussions of any shifts can be considerable. Last year, we reported that these industries had been particularly hard hit by the pandemic, and, as far as quality engineering (QE) was concerned, more determination might be needed.

That was then – and this is now. With the worst effects behind us, oil prices have risen significantly for several reasons. As a result of all this, the QE picture has changed in several major ways. As we shall see, it's no longer possible to point to a lack of resolve.

For example, in oil and gas, markets are ramping up once more, but the workforce reductions imposed during lockdown have increased workload pressures. Similarly, in natural resources organizations, demand for people is outstripping supply. This is why businesses in these sectors are on the hunt for talent, either on the payroll or via service providers, so they can quickly ramp back up and replicate best practices.

Another way of saying "ramp up and replicate best practice quickly" is quality at speed. Other than having more talented people, how can it be achieved? The answer is test automation, the use of which is accelerating across these industries. Many organizations in this sector are setting up test automation centers of excellence – and not merely as a stopgap, either, but as a new way of working.

Emerging technologies...

We're seeing increased interest, too, in several new and emerging technology areas. For instance, the infrastructure in the oil and gas industries is in many cases aging now because of underinvestment in recent years, and maintenance costs are high. With oil prices rising, any downtime in, say, an offshore rig, is even more costly.

This is why organizations develop and install intelligent systems that monitor operations with sensors out to the edge, centers of excellence, and smart, quality-assured tools that reduce the need for human intervention, reduce downtime, and keep people safe.

Some businesses are going even further. Embedded within remote monitoring is an application for digital twins, augmented and virtual reality (AR/VR) solutions, and bespoke metaverses. Using these approaches, 3D models of plant and processes can be created and tested offline, changing the way maintenance is handled. It may all sound futuristic, but it's really happening. Some natural resources and chemicals businesses are facing the same challenges and following the same path, although here, developments tend to be less part of the mainstream.

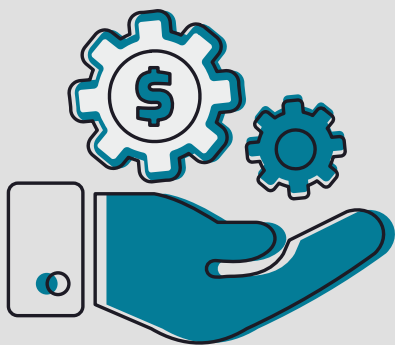## ... and the advent of green quality engineering

In energy and utilities, practical steps toward green quality engineering are already being taken. Most companies have announced sustainability targets not just for their core business, but for the technology used to deliver it. For instance, they are investing in ensuring the quality of the automated monitoring systems they are putting in place, so they can be certain of accuracy even when production assets are being gauged remotely.

Taking stock

The energy, utility, natural resources, and chemical sectors still face many challenges, and we can expect to see them continue to embrace and exploit automation in their QE efforts, in a bid to reduce human input and achieve greater speeds of delivery.

One lasting effect of the upheavals of recent years has been the extent to which it accelerated digital transformation. What will be critical is how we exploit the pace of technological change to the advantage of our industries. It will mean we make businesses more agile – and less susceptible to the volatility with which this article began.

SURVEY WATCH: AGILE QUALITY MATURITY OF EUC SECTOR ORGANIZATIONS

58% of agile teams have professional quality engineers integrated

56% of agile teams have test automation implemented

57% of teams achieved better reliability of systems through test automation

54% of teams achieved faster release times through test automation

FINANCIAL SERVICES

A CONSTANT DIRECTION OF TRAVEL

LISHA RAKESH
Senior Director, Financial Services, Capgemini India

SAGAR CHITRE
Head (Solutions), Quality Engineering &
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The financial services sector has always moved fast in quality engineering (QE). While there are some interesting developments this year, the general direction of transformation remains the same.

The route that financial services organizations are taking is toward integrated QE. We see fewer dedicated centers of excellence now for testing, indicating not only the extent of agile adoption and expectations, but also that they accept quality not as a discrete function but as part of the bigger picture. That's why we're seeing an increased need for people with rounded skillsets. For example, right across the financial services sector, we've seen organizations looking for T-shaped individuals with strong domain and technical skills, with the ability to manage CI/CD pipelines.

User-driven developments

The rise of mobile technology is part of the general direction of travel. The public's familiarity with and acceptance of mobile banking, mobile payments, and even mobile insurance transactions has grown. User experience is a bigger driver than ever before. People expect app responses to be fast, secure, and reliable, often switching providers if their expectations are not met. As a result, QE teams are reorienting to accommodate mobile apps as a key area of focus. In fact, in general, and despite the obvious importance of security, we'd say that more investment right now is taking place in functional than in non-functional testing.

As we've seen in previous years, financial services organizations are moving toward the cloud, but with caution. They still have misgivings about the security of public platforms and they are aware of reputational risk.

It's the smaller companies that are less risk-averse and more prepared to innovate. For example, we're seeing them use Web 3.0 in payment processing applications, especially in cryptocurrency trading, and we're seeing them explore the use of blockchain too.

This is not to say that large financial services organizations are completely conservative. This is a sector that's known for blazing trails, and QE teams are now supporting the use of artificial intelligence (AI) in multiple domain areas such as fraud prevention, and in technology areas such as test optimization and smart environment provisioning.

Test automation and test data

A further area in which neither pace nor direction has changed is the sector's enthusiasm for test automation. Some organizations want to automate just about everything – so the focus has changed from test execution automation to test lifecycle automation, including test design, test data generation, and reporting.

Test data is still a big challenge in the lifecycle. However, there are very few test data tools available that are appropriate to financial services. Some businesses are developing their own bespoke solutions, which are not scalable in the long run and cannot be used for other clients.

Be prepared

What are our main takeaways this year? The first and most important is that quality is, of course, still key and testing is still critical.

We're pleased to add that, in general, the focus and extent of QE are continuing to transform and grow. The focus is largely on automating functional testing. In addition to functional testing, two non-functional areas are of particularly high importance: first is performance testing, as financial institutions often deal with high transaction volumes. Peak load capacities of core financial systems need to be secured and customers always demand a high level of responses from financial transactions. The second important area is security testing, as financial integrity, protection from security breaches, and compliance with financial authority regulations are of critical importance.

Larger financial services organizations are wary of public cloud platforms, but the pressure created by the growth of mobile interactions will likely accelerate acceptance here. As a result, organizations are going to need to address the security implications of this development.

In short, big changes are coming in the sector, particularly in the evolution of its customer's expectations, technology platforms, and of emerging technologies such as Web 3.0 and quantum computing. Financial services organizations will need to embrace them – and this means that people will have to prepare.

SURVEY WATCH: AGILE QUALITY MATURITY OF FINANCIAL SERVICES ORGANIZATIONS

60% of agile teams have professional quality engineers integrated

62% of agile teams have test automation implemented

59% of teams achieved better reliability of systems through test automation

59% of teams achieved faster release times through test automation

63

HEALTHCARE AND LIFE SCIENCES

GETTING AHEAD, STAYING AHEAD

AZFAR MALLICK
Executive Vice President, Life Sciences,
Capgemini Americas

Did the global pandemic establish a new normal, or simply accelerate the pace of change? Probably both. In healthcare and life sciences, which was on the front line during the crisis, the effects were intensified. We've seen a greater investment in new quality engineering (QE) technologies, and it hasn't diminished since we came out of lockdown.

We've also seen a ramping up of QE in relation to SAP S/4HANA transition programs as part of the universal appetite for digital transformation. This is partly because COVID increased patient interaction levels and remote engagements. It's also because the health crisis created a need for new solutions, which increased the general quality assurance workload.

It's safe to say, then, that the ground rules have changed, but in our view, that will likely only last for a few more years. That's the thing with a new normal: it morphs in line with circumstances until a new "new normal" takes its place. For instance, we're already seeing the effects of the latest global economic challenges: organizations are realizing they can't give themselves the luxury of a long-term plan, so they are increasingly adopting agile and DevOps models to accelerate their development processes.

The need for speed is also creating an appetite for risk-based testing using artificial intelligence (AI) and machine learning (ML). It means more scenarios can be scoped faster and at a lower cost.

Great expectations from patients – and from the business

The increased patient interaction we just noted has meant that, in addition to time-to-market pressures, customer experience has become a more important quality assurance (QA) driver in healthcare. Patients especially want to know that their data is secure – and, to continue to provide reassurance in this area, organizations must maintain robust standards during their transition to cloud platforms. For the same reason, they also need to invest in the generation and maintenance of synthetic test data, which is both a major challenge and a continually changing need.

Patients also want a straightforward customer journey because they bring their consumer expectations with them into their healthcare concerns. This is why we see organizations in this sector putting QA effort into ensuring a good customer experience across multiple platforms and multiple device types.

Patients aren't alone in having expectations of technology. The business does too. For example, test automation is becoming widespread now. The tools are more mature, teams are becoming more adept in their use, and benefits are being felt in terms of throughput. The challenge, though, is the anticipation that progress engenders: the greater the success, the more the business wants, and the faster it wants it.

Skills issues

The growth of agile and DevOps adoption is changing the way healthcare and life sciences enterprises approach quality engineering. In some cases, dedicated quality engineers are embedded in individual development teams, while in others, team members are assuming hybrid development-and-test roles. Either way, the net effect is that quality is becoming more deeply embedded in the development process – and that's a good thing, because it means QE processes are brought closer both to technological function and to business needs.

Implicit in this evolution is a need for a greater breadth of skills. As we've seen, technologically, test automation represents a huge need in this sector right now; but at the same time, healthcare and life sciences businesses also need quality engineers who understand the domain. In fact, in some instances we've seen organizations seeking people with sector knowledge and then training them in technical QA skills rather than vice versa.

Looking ahead

In general, the mood in healthcare and life sciences QE this year is upbeat. The pace of business digitization is growing, and we expect it to do the same next year too. As a result, organizations are investing heavily in their quality engineering.

It's only right that they should. They need to stay ahead of the game – after all, no one knows if the world is about to be turned upside down. You only need to look back two or three years to see the truth of that.

SURVEY WATCH: AGILE QUALITY MATURITY OF HEALTHCARE & LIFE SCIENCES ORGANIZATIONS

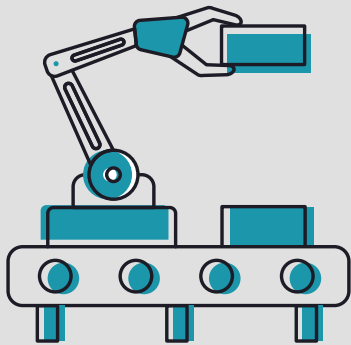**51%** of agile teams have professional quality engineers integrated

54% of agile teams have test automation implemented

53% of teams achieved better reliability of systems through test automation

52% of teams achieved faster release times through test automation

MANUFACTURING

EXCITING TIMES AHEAD AS OPERATIONAL TECHNOLOGY CONVERGES WITH IT

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This is the first year in the World Quality Report that we've addressed manufacturing as a sector. Aside from automotive, which is covered separately, we're talking here about pretty much any industry in which physical things are made – from heavy machinery to consumer goods, from paper and pulp to building materials and to buildings themselves.

Across these industries, operational technology has always been more important than IT, but in recent years we've seen the two fields increasingly come together: for instance, the Internet of Things is being embedded in factory floor processes to gather data that can be used to optimize production.

These same factory-floor smart sensors are enabling market entrants to personalize products more readily. Mass customization is emerging as it becomes simpler to reconfigure production line equipment to specific circumstances. As the products themselves become smarter, some of these more enterprising businesses are effectively positioning themselves as software companies. A few of them are going further still and are moving to as-a-service business models.

This in turn has increased the focus on quality engineering (QE) because, when you're effectively leasing out a product rather than selling it, it's even more incumbent on you to optimize its uptime in order to protect margins and maintain customer goodwill. This is why these businesses are also keen to try new approaches to quality assurance (QA), such as using artificial intelligence to select test cases.

Testing on the factory floor

For many industries, quality is largely driven by the customer experience – but it could be argued that it was in the manufacturing sector that the notion of quality was born. In this sector, quality has always been driven not just by end-user

expectations, but also by the degree to which it can improve productivity. Achieving quality requires sophisticated thinking and the capacity to accommodate complexities in products, production, and the relationship between operational technology and IT that we mentioned earlier.

Test automation has a role to play here, but there are challenges – partly because any technology that is integrated into physical systems brings potential difficulties, and partly because of the difficulties of scale: it is simply unrealistic to test a full conveyor belt system, for example. Instead, companies will often use automation to test one physical element of the line, and they will then simulate the rest.

For the same reason, and despite some hesitancy, we're seeing growth in the use of digital twins. When machines with inbuilt intelligence are too expensive, too large, or too hazardous to test, it makes sense to replicate them virtually. They are being used not just in production design, but in operational and maintenance scenarios too – and, in every case, QE helps with optimization.

However, simulation brings additional challenges because it's predicated on close familiarity with the physical processes. It can be hard, for example, to create a credible fault in a digital twin for testing purposes. As a result, manufacturers and their service providers are increasingly tapping into that deep domain knowledge so they can work it back into their smart test design techniques.

Emerging technologies

This year's survey considers various new and emerging technologies, several of which are being adopted in manufacturing. Digital twins, which we've already mentioned, are among them. Another is quantum computing, which raises fundamental QE questions.

Just as testing AI and machine learning systems can be a challenge because outputs vary with the solution's increasing knowledge, so too quantum computing is a moving target, solving tasks in line with circumstances and at different speeds. Quality engineering must accommodate these variables, which means looking at the principles and frameworks that might apply to ensure consistent quality outcomes.

In manufacturing, we're also seeing the adoption of the metaverse. It's being used in training, product development, and supply chain management, where enterprises can replicate their supplier ecosystems and run quality checks to see what might work in different projected circumstances.

It's no surprise that new approaches are being explored in this area. Supply chain issues are always key for manufacturers, and the disruption to the availability of materials and components caused by the pandemic has raised the stakes in the last couple of years. So too has the need to embark on transformation initiatives, including transitions to SAP S/4HANA. Investments here are both large and complex, and the implications are extending beyond new QE developments such as the metaverse into every area of quality and test.

Redefining quality engineering

Technology in general, and quality engineering in particular, are often regarded as intangible. Sure, they have value, but they don't necessarily have substance. However, in the world of manufacturing, technology and QE are highly tangible, because they are increasingly critical to the success of things that are made. The convergence of operational and information technology is going to accelerate, and the nature and practice of quality engineering is going to be redefined. These are exciting times.

Quality is key

In manufacturing, we're seeing the convergence of information technology (IT), operational technology (OT), and engineering technology (ET). the transformation is taking place across the board: it's a race against time from product design, to engineering, smart manufacturing, supply chain management, smart connected products, sales and marketing, customer experience and engagement, and service and servitization. We also see a lot of movement among manufacturing organizations in sustainability, security, AI, and predictive and preventative maintenance.

Quality assurance is a key component throughout this lifecycle to ensure a great quality end product. It helps with three critical components – safety, money, and time.

SURVEY WATCH: AGILE QUALITY MATURITY OF MANUFACTURING ORGANIZATIONS

60% of agile teams have professional quality engineers integrated

59% of agile teams have test automation implemented

52% of teams achieved better reliability of systems through test automation

62% of teams achieved faster release times through test automation

PUBLIC SECTOR
SERVING CITIZENS

GUNNAR MENZEL
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Global Offer Leader, Data & AI in Public Sector,
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Public sector organizations do everything businesses do, but with a democratic imperative and generally on tighter budgets. Like everyone else, they have customers to serve, books to balance, and infrastructure to maintain – and that infrastructure of course includes all the IT systems.

We see several trends. First, many organizations in central and local government and beyond are moving from legacy platforms to the cloud, and since the pandemic the pace has increased. It's slowly and more broadly being recognized that IT is not a low-level, back-office function that only delivers file, printing, and email services, but an essential and core business capability.

Secondly, in light of increasing geopolitical and criminal threats, they are focusing on trust and security issues to a greater degree. They're looking at how to operationalize accountability and governance, while at the same time maintaining high levels of quality assurance.

Thirdly, there is an increased recognition of the power of data and the insights that can be gained from it, as well as of the importance of sharing data across the sector – particularly when doing so is of benefit to the citizens being served. We're seeing artificial intelligence (AI) used here, not just to gain those insights, but to protect benefits services, transport systems, hospitals, and more against fraud.

And fourthly, there's the prevalence of agile transformation. The progress being made in agile varies from country to country, and from one part of the public sector to another, but it's an important direction of travel, because it affects how quality engineering (QE) is done. Mainly driven by agile transformation, quality and test are less centralized now. They are being handled much more within teams. However, it's fair to say that the public sector is still rather waterfall-oriented, and many organizations are struggling to change, because implicit in the agile approach is the need to empower teams. The result is that teams are often hybrid, with QE sometimes embedded and sometimes handled by dedicated team members, meaning that results can be patchy.

As ever, there are skills needs, but it's now reaching a point where it could be described as a war for talent. Specifically in demand are skills in DevOps engineering, reliability engineering, and cloud platforms, while generally, what's needed are the kind of people who will accelerate the shift to agile – in other words, cross-functional experts who are both informed and empowered. Attracting such people is a challenge: the public sector finds it hard to compete with commercial organizations on rates of pay.

The importance of test automation

Time to market is as important in the public sector as it is in business, and test automation helps to maintain or increase the pace, which is why we see its growing adoption. It's a good thing in many other ways too: functionality, reliability, scalability, response times, security – all these quality criteria benefit. In our view, all key development and test professionals ought to be certified in the use of key test automation tools.

The challenge, though, with test automation is that you can't just flip a switch. Organizations need to think ahead, and to audit and quantify the relevant processes. Only then can they design the automation approach. This is yet another reason why it's so important to attract and retain informed and empowered people.

The additional importance of data ethics – and also of the green agenda

Data privacy is always a prime concern for public sector organizations and the EU's General Data Protection Regulation (GDPR) has raised the stakes. Test data must be anonymized and there are areas of compliance specific to the sector that need to be met. One example is the UK's Data Ethics Framework, which guides appropriate and responsible data use in government and the wider public sector. It's an issue that is likely to grow in importance in years to come and we will see an increase of AI technologies to manage the data.

Sustainability is another topic of growing importance and it's no surprise that the public sector is among those blazing the trail. Just about every large public sector IT tender has mandatory green IT elements, and IT companies and service providers can also score points in their favor in the bidding process.

Because this is still a new area, we find that metrics for gauging the greenness of approaches to IT are often a matter of discussion between public sector organizations and their service providers. Organizations and their service providers discuss the longevity of data too: how long do people want or need to keep their information? In our view, everyone needs to play their part. Hyperscalers can and should make a difference – not just for PR reasons, but because it's the right thing to do.

Taking stock

As we've noted, it may be the case that some public sector organizations are struggling to free themselves of their waterfall legacies, but even so, great progress is being made in agile transformation, and credit must be given where it's due: it's doing wonders for quality.

Once agile approaches become the norm, it's likely that the rate of improvement will level out. But when that day comes, the bar will be that much higher, which is no bad thing – and what's more, practices such as value stream mapping and test automation will help in the next phase.

Ultimately, quality improvements will help public sector end users, and they will help citizens too – and it's among all these people that the focus needs to be.

SURVEY WATCH: AGILE QUALITY MATURITY OF PUBLIC SECTOR ORGANIZATIONS

53% of agile teams have professional quality engineers integrated

52% of agile teams have test automation implemented

56% of teams achieved better reliability of systems through test automation

53% of teams achieved faster release times through test automation

TECHNOLOGY, MEDIA, AND TELECOMS

IN FAST-MOVING SECTORS, IT HELPS TO BE AGILE – AND TO CREATE VALUE

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We've said it in previous years, and it's still true: the technology, media, and telecoms (TMT) industries like to move fast and blaze trails. The pandemic of previous years forced rapid change and established a new status quo. It's been followed by international economic and geopolitical upheavals, so businesses in these markets are still investing in innovations such as robotic test automation and quality engineering (QE) in general. We're seeing a greater focus on non-functional testing in areas such as security, robustness, performance, and scalability.

We're also seeing organizations looking at their CI/CD programs, and they're wondering how to improve through testing. "How can we address that problem, and do it fast? And how do we isolate issues so we can focus on them – so we don't have to take an entire call center offline, for instance, in order to fix a problem?" It's an attitude that might, in short, be called resilience by design: planning ahead, keeping things under control, failing (and fixing) fast, and focusing on business continuity.

That said, some mobile telecoms operators are struggling with their legacy systems. They want to move from a cost-driven, waterfall-based ethos of industrialization towards an agile-based, quality-driven mindset. Why? Because that's what end users want. Customers are accustomed to interacting with Amazon and Google, and they want that simple, accessible experience in other parts of their lives, whether that be insurance

or healthcare, for instance. As a result, quality assurance teams are becoming brand ambassadors – and they're pushing for that resilience-by-design approach we just mentioned.

Test data – and green QE

TMT businesses are looking for new ways to create synthetic test data. Much of this has been catalyzed by the EU's General Data Protection Regulation (GDPR) and as a result, things are moving in a good direction and new tools are being introduced. However, the management of test data is still a big problem. It's not cheap to develop and maintain large data sets.

It's not sustainable either, and that's an issue that is growing rapidly in importance and becoming more urgent. Companies in TMT markets will need to hit sustainability targets, and their approach to QE will play a big part in their efforts. The end-user-driven brief is broadening from functionality and customer experience to the inclusion of carbon impact as a metric in performance testing.

Skills needed – and in breadth

In the TMT sector, as in so many others, one of the greatest skills needs right now is in test automation. It's a clear prerequisite, and scriptless test automation skills are especially in demand. Until quite recently, practitioners used to be well versed in just one automation platform, but now, QE teams are looking for people who are more broad-based.

Organizations also need team members with test environment management skills – people who can not only run an environment but think ahead, so they can develop a pipeline for continuous testing to maintain the momentum. As a corollary to this, good test data analysts are in demand.
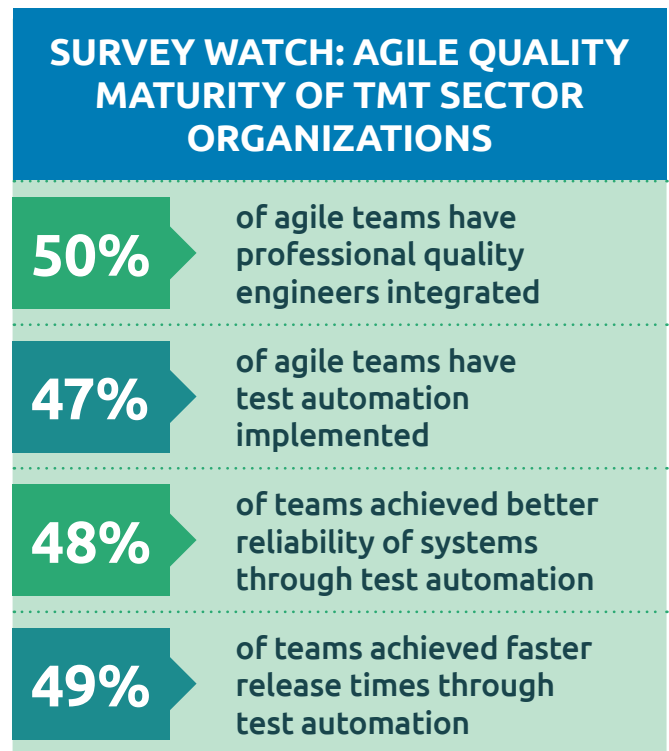
More interesting, perhaps, than any of these fairly common skills needs, is a requirement for QE practitioners with domain knowledge. TMT organizations need people who understand the implications of their work for end customers and consumers – team members who understand not just the testing-specific key performance indicators (KPIs), but who are also familiar with the business KPIs.

This doesn't mean conventional QE skills are any less important. Far from it. It's rather that what TMT businesses now need are people who can layer domain knowledge on top of their testing and general technology expertise, who have an architectural understanding of the IT infrastructure within which they're working, and who can collaborate too. That's quite a shopping list, and any candidates who can tick all the boxes are sure to be in high demand.

Pursuing value

The TMT sector in general and its approach to QE in particular are currently in a state of flux – but isn't that always true? Right now, what's changing is a need for businesses to evolve from quality as an assurance discipline to something that generates more value. As the business model evolves, businesses will need to use new techniques, tools, and skills, and to bring together the hitherto separate network and IT functions to ensure high levels of customer experience can be maintained. They'll need to ensure that QE isn't restricted to individual process areas and that it covers operations from end to end.

To do all this, they're going to need to continue on the path of resilience by design we described earlier in this analysis. They're going to need those multi-skilled people we just identified – and what's more, it might be a good idea to work with experienced and knowledgeable service providers too.

SURVEY WATCH: AGILE QUALITY MATURITY OF TMT SECTOR ORGANIZATIONS

50% of agile teams have professional quality engineers integrated

47% of agile teams have test automation implemented

48% of teams achieved better reliability of systems through test automation

49% of teams achieved faster release times through test automation

ABOUT
THE STUDY

World Quality Report 2022-23

The World Quality Report 2022-23 is based on research findings from 1,750 interviews carried out during April and May 2022 by Coleman Parkes Research. The average length of each interview was 30 minutes and the interviewees were all senior executives in corporate IT management functions, working for companies and Public Sector organizations across 32 countries.

The interviews this year were based on a questionnaire of 45 questions, with the actual interview consisting of a subset of these questions depending on the interviewee's role in the organization. The quantitative research study was complemented by additional in-depth interviews to provide greater insight into certain subject areas and to inform the analysis and commentary. The main themes for all survey questions remained the same, though a few objective responses were also added for the first time this year. Quality measures were put in place to ensure the questionnaire was understood, answered accurately and completed in a timely manner by the interviewee.

Research participants were selected so as to ensure sufficient coverage of different regions and vertical markets to provide industry-specific insight into the quality assurance and testing issues within each sector.

To ensure a robust and substantive market research study, the recruited sample must be statistically representative of the population in terms of its size and demographic profile.
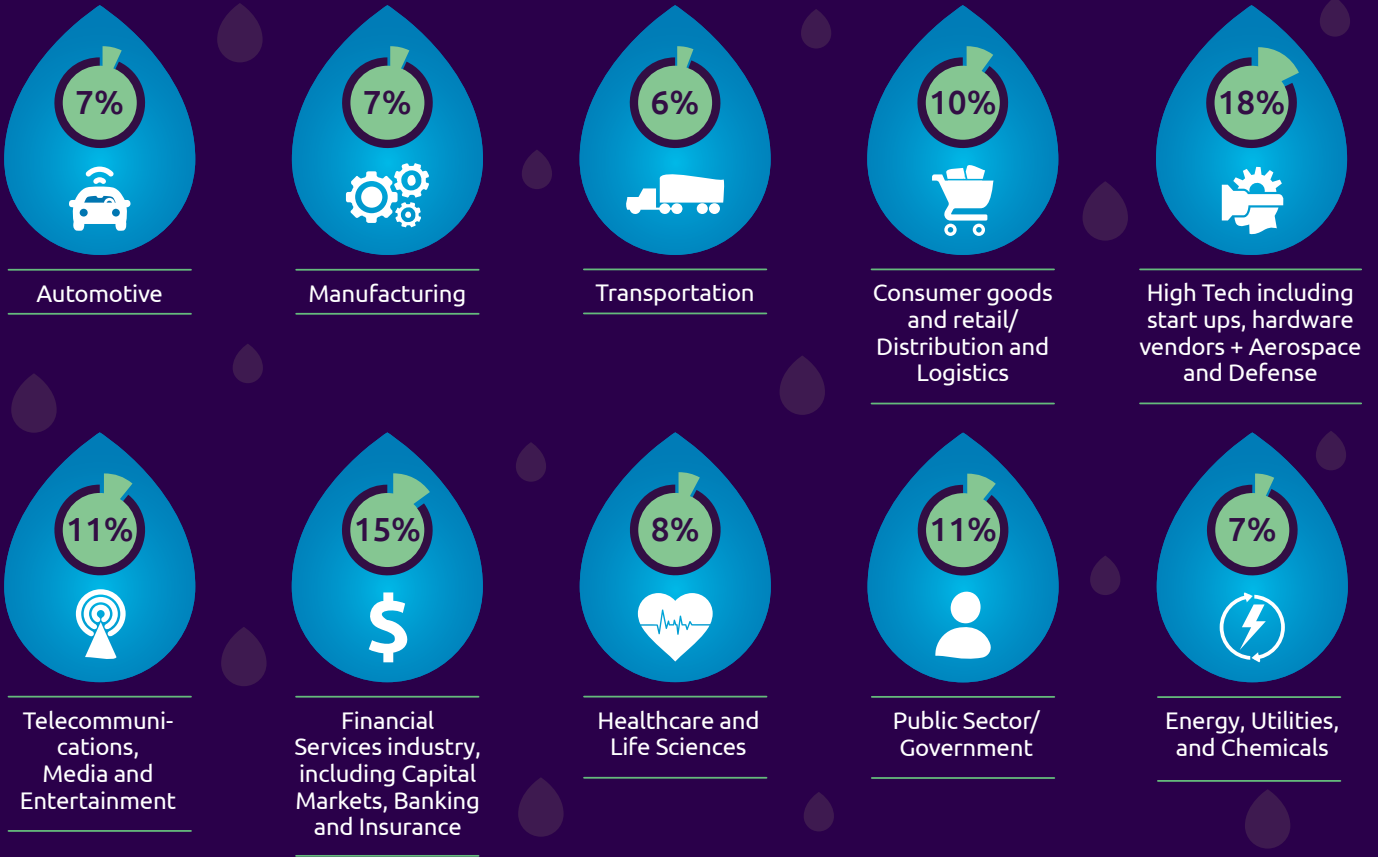
The required sample size varies depending on the population it represents – usually expressed as a ratio or incidence rate. In a business-to-business (B2B) market research study, the average recommended sample size is 100 companies. This is lower than the average sample size used for business-to- consumer (B2C) market research because whole organizations are being researched, rather than individuals.

As mentioned above, the B2B market research conducted for the World Quality Report 2022-23 is based on a sample of 1,750 interviews from enterprises with more than 1,000 employees (23%), organizations with more than 5,000 employees (33%) and companies with more than 10,000 employees (35%). The approach and sample size used for the research this year enables direct comparisons of the current results to be made with previous research studies conducted for the report, where the same question was asked.

During the interviews, the research questions asked of each participant were linked to the respondent's job title and the answers he/she provided to previous questions where applicable. For this reason, the base number of respondents for each survey question shown in the graphs is not always the full 1,750 sample size.
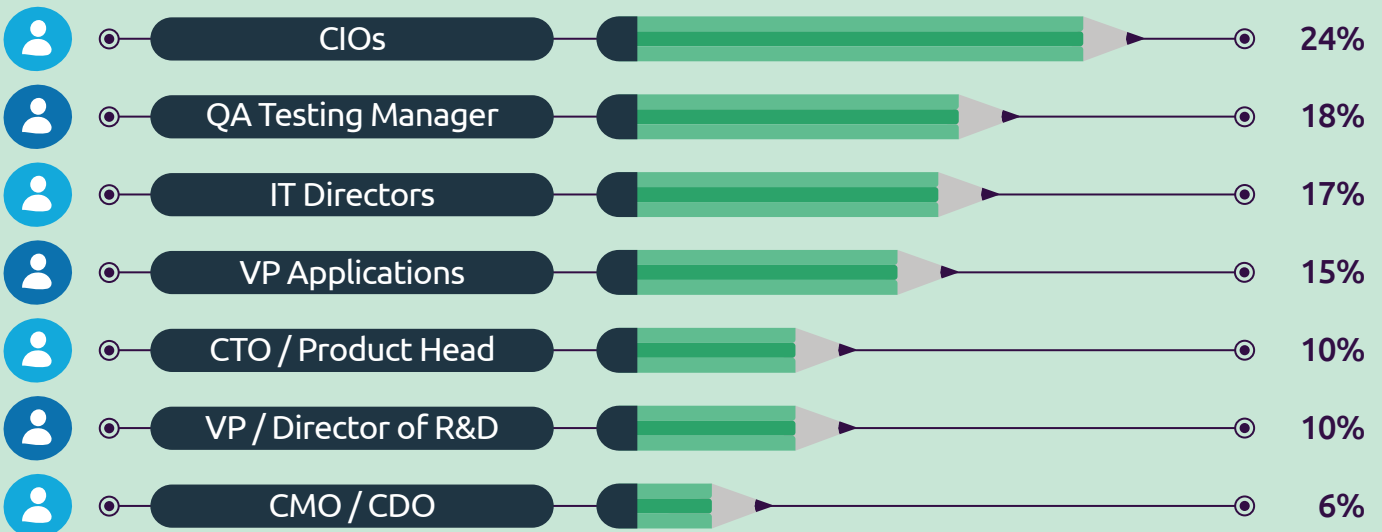
The survey questionnaire was devised by Quality Engineering experts in Capgemini, Sogeti and Micro Focus (sponsors of the research study), in consultation with Coleman Parkes Research. The 45 question survey covered a range of software quality engineering and digital assurance subjects. The analysis of the survey results was enriched by qualitative data obtained from the additional in-depth interviews.
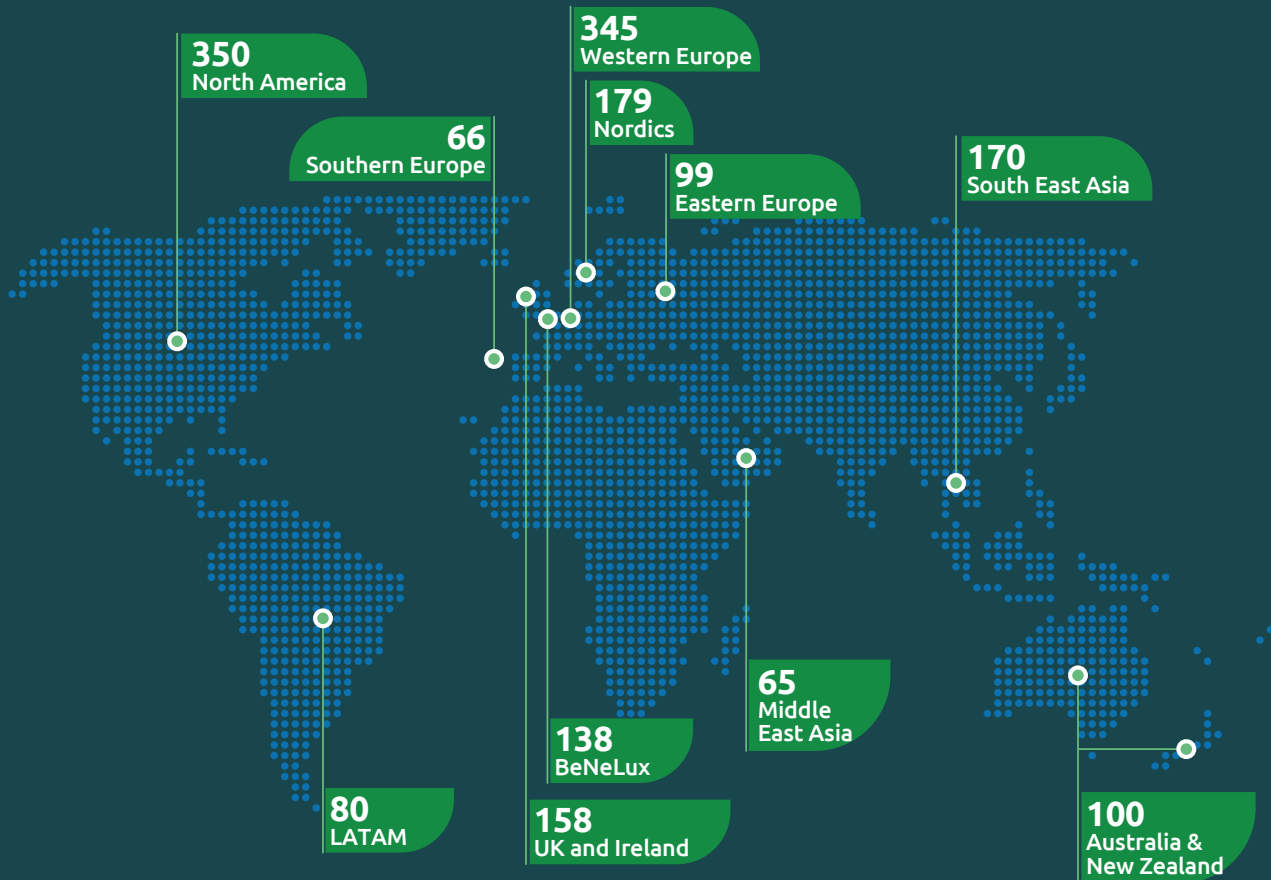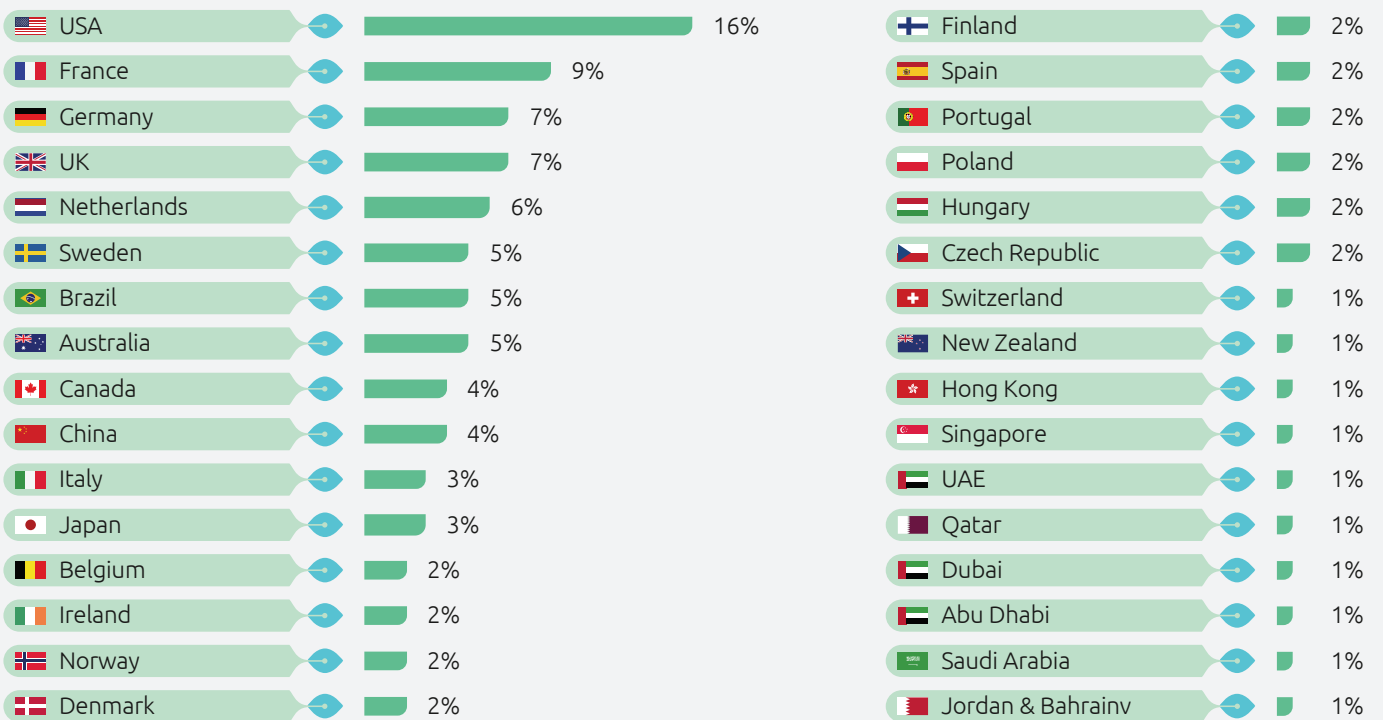
INTERVIEWS BY SECTORS

7% Automotive

7% Manufacturing

6% Transportation

10% Consumer goods and retail/ Distribution and Logistics

18% High Tech including start ups, hardware vendors + Aerospace and Defense

11% Telecommuni- cations, Media and Entertainment

15% Financial Services industry, including Capital Markets, Banking and Insurance

8% Healthcare and Life Sciences

11% Public Sector/ Government

7% Energy, Utilities, and Chemicals

INTERVIEWS BY JOB TITLE

Job Title	Percentage
CIOs	24%
QA Testing Manager	18%
IT Directors	17%
VP Applications	15%
CTO / Product Head	10%
VP / Director of R&D	10%
CMO / CDO	6%

INTERVIEWS **BY COUNTRY**

⊙ **1750** TOTAL

350 North America

345 Western Europe

179 Nordics

99 Eastern Europe

170 South East Asia

66 Southern Europe

138 BeNeLux

65 Middle East Asia

80 LATAM

158 UK and Ireland

100 Australia & New Zealand

32 COUNTRY

Country	%		Country	%
USA	16%		Finland	2%
France	9%		Spain	2%
Germany	7%		Portugal	2%
UK	7%		Poland	2%
Netherlands	6%		Hungary	2%
Sweden	5%		Czech Republic	2%
Brazil	5%		Switzerland	1%
Australia	5%		New Zealand	1%
Canada	4%		Hong Kong	1%
China	4%		Singapore	1%
Italy	3%		UAE	1%
Japan	3%		Qatar	1%
Belgium	2%		Dubai	1%
Ireland	2%		Abu Dhabi	1%
Norway	2%		Saudi Arabia	1%
Denmark	2%		Jordan & Bahrainv	1%

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World Quality Report 2022-23

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THANK YOU

Capgemini, Sogeti and Micro Focus would like to thank

The 1,750 IT executives who took part in the research study this year for their time and contribution to the report. In accordance with the UK Market Research Society (MRS) Code of Conduct (under which this survey was carried out) the identity of the participants in the research study and their responses remain confidential and are not available to the sponsors.

All the business leaders and subject matter experts who provided valuable insight into their respective areas of expertise and market experience, including the authors of country and industry sections and subject-matter experts from Capgemini, Sogeti and Micro Focus.

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World Quality Report

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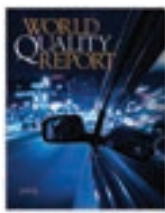
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