



World Quality Report

2017–18 | Ninth Edition

World Quality Report 2017–18

Ninth Edition

Regional and country reports are available online from www.worldqualityreport.com or from Capgemini, Sogeti, and Micro Focus local offices covering: North America, United Kingdom, France, Germany Benelux, Southern Europe (covering Italy, Spain, and Portugal) Eastern Europe (covering Poland, Hungary, and the Czech Republic), China, Australia and New Zealand, the Middle East, and the Nordic Region.

Previous editions

World Quality Report



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Edition



2010–11
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Introduction



Hans van Waayenburg

Capgemini Group Executive Leader,
Testing Service Line

Welcome to the ninth edition of the World Quality Report by Capgemini, Sogeti, and Micro Focus—an objective analysis of trends shaping Quality Assurance (QA) and testing.

This year's report highlights the acceleration of digital and test automation initiatives captured through the responses of 1,660 executives from 32 countries. Also on board are patterns in the adoption of Agile and DevOps methods, and newer approaches to industrializing the testing value chain. In addition, you'll find expert analysis of trends in the survey data.

Together, the survey respondents and subject matter experts are the driving force behind the World Quality Report 2017–18—thank you for your time and contribution.

Three key trends are rapidly altering the dynamics of QA and testing:

- The digital economy, including the emergence of smart devices
- Increased levels of automation
- Adoption of Agile and DevOps methodologies.

The digital economy has firmly positioned software at the center of everything businesses must do. Customer

engagement is clearly an important element in this equation, but digitization enables you to do more. Responsive firms continue to expand digital projects across the enterprise—to the very core of their operations, their supply chains, and even trade and commerce.

Software quality, then, has emerged as a lever of differentiation in the marketplace, as some of the findings in this year's survey confirm.

Test automation presents the potential to combine quality with speed. To that effect, we've included a separate chapter on Automation, Continuous Testing, and Bimodal Solutions in the World Quality Report 2017–18. It records early-stage efforts in adopting a standardized approach to smart test automation.

Last but not the least, the demand for speed-to-market is also driving wider adoption of Agile and DevOps methodologies. To make the most of them, businesses must overcome associated challenges by rethinking their approach to the QA and testing organization.

You'll find detailed analyses of these and related trends, and their interplay with QA and testing budgets presented in an engaging format through the pages of the report. There's also the evidence of transformation within QA and testing as a function and the growing acceptance of its role as a brand custodian.

We hope the report offers a balanced perspective on the state of QA and testing across sectors, regions, and market caps. For more on how you can apply those insights, write to the relevant Capgemini and Sogeti experts listed on the back cover.



Raffi Margaliot

Senior Vice President and
General Manager,
Application Delivery Management,
Micro Focus

Change is a universal constant, as almost every business transforms toward digital models in order to better serve today's customer and to compete for their next generation of customer. The shift to digital enterprise drives creation of new applications and channels and often disrupts many traditional industries. Coupled with the shift to digital is a dramatic escalation in expectations from our business partners and their end users. They demand delivery of new capabilities faster than ever, and they expect applications to be highly available, reliable, and secure. They simply have no tolerance for IT solutions that fail to function, fail to load and perform, lack security, or fail to deliver an engaging user experience.

In response to these trends, we've witnessed the rise of Agile and now DevOps across enterprises of all shapes and sizes. The practices of enterprise Agile and DevOps are moving rapidly into the mainstream and enabling IT leaders around the world to find ways to accelerate IT and meet the rapidly evolving needs of their business customers.

The results from this year's World Quality Report provide timely insight into how IT leaders are responding and adapting to these challenges, and as a result, delivering applications faster than ever with higher-quality code. Across every region and industry, regardless of the type of application, it is clear to me that quality is more important than ever.

For the past 25 years, our business has been focused on helping our customers build and deliver world-class applications to meet their business needs and delight their customers. In the spirit of change, this year we are embarking on a new chapter as the "new" Micro Focus. As the industry leader in application delivery management software, we are continuing to invest in innovation and integrated solutions to help you overcome the challenges that we face together.

I encourage you to explore and use this exceptional research to help plan and manage your unique digital transformations. This report will help you understand how the digital transformation is impacting your peers and how trends like Agile, DevOps, and IOT are being addressed around the world.

In closing, I want to thank our partners at Capgemini, Sogeti, and all of you who participated in the research for your contributions to this ninth edition of the World Quality Report.

Executive Summary





Mark Buenen

Vice President
Global Leader, Digital Assurance and
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Govind Muthukrishnan

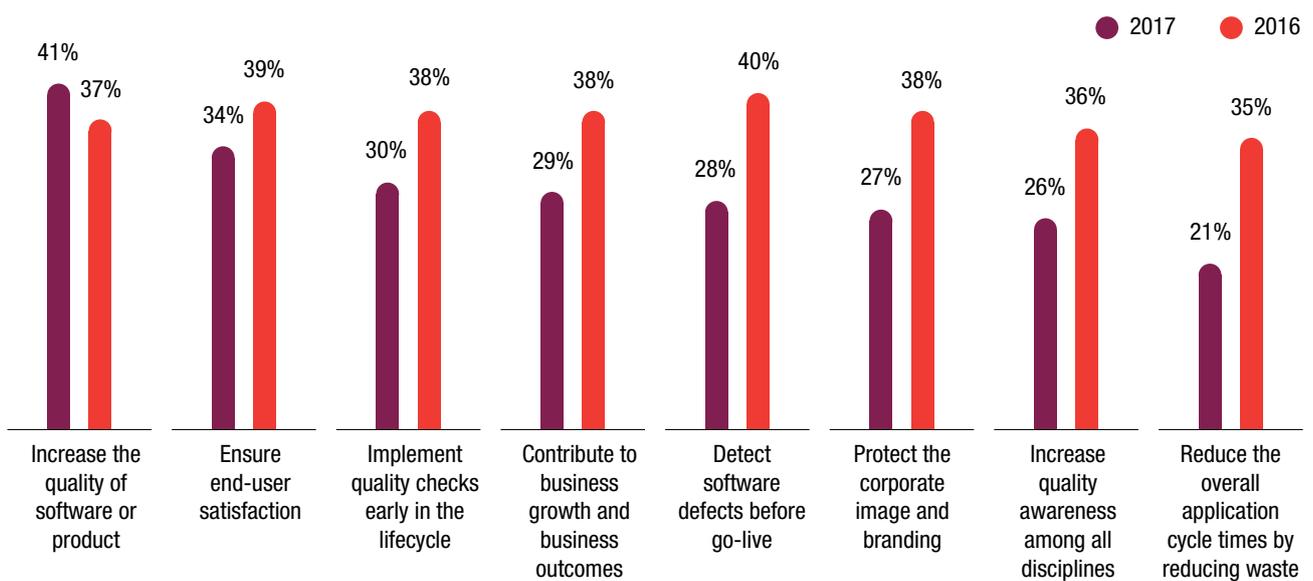
Executive Vice President
Testing Leader, Financial Services
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Quality Assurance and testing professionals have embraced and supported the unrelenting pace of the digital agenda by working faster to provide a greater variety, complexity, and number of tests. In a period of a few years, quality has returned as a top priority. Based on a survey of 1,660 CIOs and senior technology professionals in 32 different countries, this year’s World Quality Report identifies a return of the objective, improve the quality of the software or product under test and the quality of the software development process,

for the QA and testing function. This is the top priority in the 2017 survey and the only priority to increase in importance over the last year (see Figure 1). End-user satisfaction, a vital success factor in digital business, is second while desire to implement quality checks early in the lifecycle, is third. Finding software defects before go-live, one of the most common practices over the last few years, is no longer a preferred choice, because of the focus on defect prevention.

Executive Management Objectives with QA & Testing

FIGURE 1



Trends in quality assurance and testing go hand-in-hand with other changes in software development. The popularity of agile and DevOps is climbing rapidly as IT teams see them as important tools in sustaining the pace of digital transformation. In response, QA and testing operations are changing too. Central governance and control is being reduced, offering greater freedom to individual teams to choose their methodology and technologies for development, as well as their approach to QA and testing. Combined with the increased speed of deployments and growing complexity of the application landscape, these trends increase the risk of introducing serious errors and software failures. Furthermore, the end-customer today has zero tolerance of errors or slow performance, and poor quality of software can result in serious damage to the brand value of an organization and often incurs huge repair costs. At first glance of the survey findings, it is surprising that corporate image and branding is no longer within the top five objectives of QA and testing. This shift in priorities demonstrates that organizations today have become more mature in adapting QA practices to the objectives of digital transformation. Organizations are clearly aware that brand and corporate image are protected by effectively finding defects early in the lifecycle.

This year's survey shows that end-user satisfaction and security are the two most important elements of an IT strategy. Organizations need to assure quality in the functionality across all applications, including back-office systems, mobile devices, wearable technology, and the internet of things. The mature QA and test function must also focus on cost optimization and prioritize spending in higher risk areas. The ambition to find the right balance between cost and assurance is critical to the IT strategy, based on our survey responses this year.

There are three main areas the modern QA and test function will have to focus on:

- Intelligent test automation and smart analytics
- Smart test platforms
- Agile organization of the QA and test function

Intelligent test automation and smart analytics

Intelligent test automation and smart analytics will become essential to support testing as they enable smart decision-making, fast validation, and automatic adaptation of test suites. The scope of test automation has evolved from simply automating the test activities (plan, design, and execution) to automating test environments and test data provisioning. Instead of only automating current test processes, leading organizations today take the opportunity to automate newer areas like API validation and service integration which were

previously impossible in the world of manual testing. It is not only speed that will drive the need for more intelligent automation, but also the emergence of smarter applications and smarter products that demand an integrated, intelligent, and automated approach to testing these continuously changing products and business environments.

It is worrying, then, that our survey results show automation is currently under-exploited in QA and testing. While we see a rise in the number of organizations benefiting from automation, the value they generate is largely unchanged and the level of test automation is still low (below 20%). Transforming to DevOps or increasing the role of smart devices requires smart, automated testing. A focused approach designed to increase automation levels is required. Organizations following this path will see a return on investment in automation by generating value in reaching business objectives, such as time-to-market, rather than achieving incremental benefits in cost and efficiency.

Smart test platforms

Smart test platforms are required to deal with the growing challenges of test environments, data, and virtualization. The vision of truly smart test platforms goes beyond lifecycle automation. It is the promise of fully self-aware and self-adaptive environments that are automatically provisioned, coupled with automated test data generation and test data management that supports QA and testing for the complete application lifecycle. Test environments and test data are the most cited challenges for core enterprise applications, like those supporting ERP, HR, and finance, as well as more fluid IT applications developed in short cycles, often deployed on smartphones, tablets, or a web browser, to provide business dashboards or to engage external consumers. Managing the size of test data sets, creating and maintaining test data sets, and complying with data regulations for test data are the top challenges faced by more than 50% of the survey respondents. QA teams need to help their organizations comply with new data laws such as the EU's General Data Protection Regulation. Looking at test environments, we see a shift towards cloud-based environments and away from permanent environments, which is a first step to smart test platforms. Enterprises increasingly demand techniques such as service virtualization to help test integrations when developing applications. These three challenges—environments, data, and virtualization—provide a huge opportunity for automation in itself. Combined with intelligent lifecycle automation, this will take QA and testing to its next evolutionary phase, which we call Smart QA. The need for Smart QA emerges as the single most important critical success factor for the QA and testing industry in 2017.



Agile organization of the QA and test function

The third area organizations need to focus on is the adaption of the QA and test function to fit with the move towards Agile development processes. Historically, organizations industrialized testing in test centers of excellence (TCoEs) or test factories, but in Agile and DevOps models we see testing move from central teams into decentralized units. The test organization of the future will combine flexibility and agility with efficiency and reuse. In so doing, the test center will transform into decentralized test operations within the IT teams of the various lines of business supported by a Test Excellence Center which provides the environments, test data, test expertise, and skills. In most organizations, the traditional world of core legacy systems and the nimble agile world of digital applications coexist. Each of these areas demands its own industrialized approach to QA and

testing. But across these worlds, the test excellence center (TEC) will provide unified guidance and coherent choices of technologies.

As organizations embrace a greater number of applications and features delivered through Agile and DevOps methodologies to support digital transformation, the pressure on the QA budget will only increase. The current expectation is that QA and test budgets will rise over the next two years, fueled by the realization that organizations will have to secure the quality of an increased number and complexity of IT applications and their attendant QA platform solutions. Organizations can find a way out of this budgetary spiral by moving to smarter, automated, test solutions across their development portfolios.

World Quality Report Findings

A back-to-basics focus on application quality shows testing has come of age in the new context of agile applications

In this year's survey, achieving product quality is rated as a very important objective of QA and testing by more respondents than any other category. It is the only objective to have risen during the last year, from 37% of respondents in 2016 to 41% in 2017. Last year's most-cited objective, detection of defects before go-live, fell from 40% to 28% of respondents, while the second one, end users satisfaction, fell from 39% to 34%. It is a sign of progress that the focus is returning to overall product quality in the face of complexity in development and environments, and the speed of digital transformation.

Customer experience and enhanced security are the top two aspects of IT strategy. The aspect of enhanced security fell dramatically from 2016 to 2017 from 65% to 35%. Cost optimization of IT (or doing more for less) entered the top three aspects of IT strategy this year, confirming that the QA and testing industry has managed to cope with the rapid change over the last few years.

Other areas which saw a significant fall in the importance to the IT strategy include responsiveness to business demands, implementation of software-as-a-service, and implementation of Agile and DevOps. This reduction in Agile and DevOps implementation, which fell by more than half, from 38% of respondents to 17%, is a sign that these development methods are becoming more mainstream.

Test automation: on the way to smart, intelligent, and cognitive QA

Automation is currently under-exploited in QA and testing. The average level of automation for test activities is around 16%. While we see a rise in the number of organizations benefiting from automation, the value they generate is largely unchanged. Test automation should not only replicate existing manual test processes: between 38% and 42% of organizations see cognitive automation, machine learning, self-remediation, and predictive analysis as promising emerging techniques for the future of test automation. Organizations see these intelligent solutions as an opportunity to support new ways of working in DevOps, mobile, and IoT. By increasing the adoption of intelligent automation approaches, organizations not only

expect to increase their ability to meet increased time-to-market pressure with the right levels quality to secure business outcomes. They also believe that adopting smarter automation solutions will be essential to cope with the emergence of smarter applications and smarter products that demand an integrated, intelligent, and automated approach to testing these continuously changing products in their rapidly changing business environments.

The challenges with testing in agile development are increasing

The overwhelming majority, 99% of respondents, face some kind of challenge with testing in agile development. Lack of data and environments is the most serious challenge, cited by 46% of respondents, up from 43% in 2016. Difficulty in reusing or repeating tests across agile sprints or iterations is second at 45%, up from 40% in 2016. The only areas in which the number citing a challenge fell are: difficulty in identifying where tests should focus and early involvement of test teams in sprint planning or inception.

The automation of testing and test environments will help organizations address most of the challenges laid down by devolved testing in agile and DevOps modes of development. These smart test solutions promise to achieve the right quality at the right speed in an increasingly complex and integrated IT landscape.

QA organization evolving to meet bimodal needs

When we look at the structure of QA and testing operations, we see approaches diverging. While there has been a trend to industrialize testing in test factories or so-called Test Centers of Excellence (TCoEs)—where end-to-end responsibility of all test operations resides. In 2017 we see a more even split between centralized and decentralized models. In many organizations the TCoE from before has transitioned to a more nimble Test Excellence Center (TEC)—where the focus is on support and enablement than on the actual execution of test activities.

TECs are becoming the most popular (cited by 30%) by a narrow margin, fueled by the adoption of agile and DevOps methodologies.

Industrialized test organizations will not only serve agile and DevOps methodologies as waterfall-style development will

still be practiced for a long time to come. The enterprise of today is running agile projects alongside traditional waterfall-style development, creating a mixed picture in terms of resources, management, and governance. For example, when we look at where organizations choose to locate software development engineer testers (SDETs), we see 36% in the agile scrum and 47% in the TCoE.

Test environments and test data continue to be the Achilles heel for QA and Testing

We see promising signs of improving efficiency in test environment management: 73% of organizations have adopted a cloud-based environment especially to run non-functional test activities, while 15% of the organizations adopt containerization. With the container approach to provisioning environments, organizations can create an executable version of the environment where developers and testers can both work. It is this trend in environments which promises the most to reduce the testing lifecycles.

However, challenges with test environments are cited by more organizations than last year: 48% of respondents have issues managing the excess need for test environments and 47% have challenges with visibility on utilization and upcoming demand for test environments. A lack of sufficient development and test environments for agile developments is cited by 56% of respondents, while an inability to integrate at the early stages of testing because of environment limitations is named by 51%. Automation can address both of these challenges.

On the topic of test data management, the percentage of respondents that claim to have challenges is increasing: 56% have challenges with managing the size of test data sets; 52% have challenges with creating and maintaining

synthetic test data; and 50% have challenges with complying with regulations related to test data.

Test environments and data are growing challenges for organizations as the demands of ecommerce applications and big data analytics coincide with regulatory compliance. While poor communication between teams can hinder the ambition to improve cycle times, the container approach to provisioning environments presents an opportunity to improve performance in the way digital business continues to demand.

Test budgets fall, but are expected to rise again

The proportion of total IT spending dedicated to quality assurance and testing is 26%. It has fallen from 31% in 2016 and 35% in 2015. This is a sign that spending is falling back to the reasonable 25% proportion that marks a good balance between feature creation and feature validation activities. However, demand for testing in digital transformation, mobile applications, and Internet of Things is driving the industry to forecast an increase in the proportion of IT budgets allocated to testing in the future. By 2020 they expect it to rise to 32% of the total IT budget.

The survey shows a significant shift in allocation of budgets away from human resources towards hardware and infrastructure. The proportion of QA and test budgets spent on hardware and infrastructure increased from 40% in 2016 to 46% in 2017. The proportion spent on HR fell from 31% to 21% over the same period, which we explain as a combined result of increasing levels of automation and the transfer of budget responsibility of testers from independent test teams to agile and DevOps teams.

Key Recommendations

1 Increase the level of smart test automation

Automation is the key to meeting increasing demands on testing from digital transformation, and the different approaches to testing resulting from the coexistence of Agile, DevOps, and waterfall development.

We recommend that organizations start by establishing a central strategy to define the enterprise's preferred test tools and a central function to keep track of new developments. Next they should define the strategic business objectives for automation initiatives and identify metrics to measure the results.

Rather than becoming a separate process, test automation should be part of a continual approach to development. It will require speed of deployment. Here, investment in analytics-based automation solutions will be the first step in transforming to smarter QA and smarter test automation.

With a central test strategy, clear business objectives, and analytics-based test automation in place, test organizations can explore the integrations of environment and data initiatives in their test automation approach. The recommendation is to implement this in discrete pockets.

2 Transform QA and test function to support agile development and DevOps teams

Agile development and DevOps organizational structures represent a significant challenge to testing professionals. To rise to the challenge, QA and test functions need to establish an integrated DevTest platform that enables continual test automation. Moreover, the QA and test function should ensure test quality in agile development groups by integrating DevOps QA experts in the DevOps teams.

The skills of testing professionals need to change too. They should become more technically skilled in development, analytics, and business processes. We recommend organizations build focused workforce transformation programs to re-skill test professionals to adapt to agile and DevOps models of operation. To do so, they will need to understand the best split between centralized and decentralized test responsibilities.

Finally, we recommend QA and testing organizations invest in a DevOps Quality Management Office; a function of

enterprise IT designed to enable and collect best practices for decentralized engineering practices and drive quality in DevOps methodology.

3 Invest in smart test and QA platforms

The only way to secure quality of development in an increasingly complex IT landscape is to create fully aware smart test platforms.

In order to achieve this, we recommend organizations establish a dedicated team to introduce smart analytics and robotic solutions into test processes and platforms on a continuous basis.

In the first step to achieving self-aware smart test platforms, the QA and test function should increase the level and usage of containerization and virtualization solutions to provision the test environments to individual teams and programs.

Secondly the QA and test function must also invest in test data generation solutions to provide more and better synthetic test data that complies with all regulations.

Then, by integrating the elements of containerized environments, virtualized services, and automated test data provisioning in one common and accessible process and platform, organizations can develop a coherent approach around all test activities.

Finally, the QA and test function must invest in continuous monitoring, predictive analytics and machine-learning tools to derive patterns from operations data. These tools will provide valuable insights in defining test strategy and test coverage based upon actual risks and issue from the field.

4 Organizations need to define a test platform strategy on an enterprise level

Organizations today need to ensure sufficient flexibility and adaptability in their choice of QA and test tools. Open source and as-a-service solutions are plentiful and easy to consume. However, exchanging and connecting data across multiple repositories can become a challenge, which leads to a lack of transparency in quality status at the enterprise level. To solve this problem, organizations should spend the time making a strategic decision for their test platforms.

One option is to pursue a single platform strategy in which a few selected technologies are earmarked as the leading tools of choice. Alternatively, they can create a best-of-breed tooling strategy, which involves multiple tool solutions from different vendors.

If there is a single-platform strategy, a strong TEC can drive tooling across the different test factories within the enterprise. If the organization selects a best-of-breed strategy, a thin TEC can support different customizations across multiple implementations in different test factories. Either choice will affect the requirement for QA support functions, whether centralized or decentralized.

5 Define QA analytics strategy on an enterprise level

Enterprises and organizations that are maturing in QA will rely increasingly on intelligent and cognitive QA services. The first step in that journey is to adopt smart analytics in the QA and test process.

In order to get the best return from investments in smart QA (intelligent test automation and smart test platforms), we recommend that organizations define an enterprise-wide QA analytics strategy.

This QA analytics strategy defines the objectives and areas in which analytics and cognitive solutions should be deployed. It defines the roadmap for intelligent technologies across QA operations. The QA analytics strategy should be connected

to the overall organization strategy and it should describe how it enables the overall organization objectives.

The implementation of the QA analytics strategy will be affected by the enterprise test platform strategy and the organization of the QA function.

In a single-platform strategy, pre-defined analytical rules and use cases are available from the industry and selected tool vendors to meet early analytical and predictive QA needs. Organizations can start the QA analytical journey with a small team of analytics experts. However, a stronger central team to support uniform tool adoption across the decentralized units may be necessary, as described in the previous recommendation.

In a best-of-breed platform strategy, the implementation of the same analytical rules requires more customized development and adjustment, as it will be necessary to tap in to various data sources and repositories from different tools. This may require a larger team of analytics experts and data scientists to make progress in QA analytics.

In order to start the journey towards smart QA, we recommend that organizations start with an enterprise test maturity assessment that takes into account their analytics-platform-function combination.

“ Planning on testing is becoming much more proactive and up front. There is a greater realization that testing becomes a bottleneck without upfront planning. ”

Head, Product Business Unit,
Financial Services, India



Current Trends in Quality Assurance & Testing

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Digital Transformation

IoT, mobile technology, and third-party relationships escalate testing complexity

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Services

The confluence of changing business and computing models is creating new challenges for quality assurance (QA) and testing in a digital-first market. Digital transformation is well underway in almost all sectors, but not without the complexity it brings on account of new technologies and organizational changes. For instance, cloud computing and agile development promise speed and quality at reasonable cost. However, both call upon a mindset change and a radically different approach to testing software and devices. The findings of this year's survey contain evidence of how leadership is involved in addressing this complexity.

The proportion of organizations appointing Chief Digital Officers (CDOs) to create the necessary changes in process, technology, and culture has increased—40% in 2017, compared to 33% in 2016. Nevertheless, a large number of respondents purport not to need a CDO because transformation is embedded within the business leadership—25% in 2017, versus 16% in 2016. Meanwhile, the number of respondents saying digital transformation is not part of their plans dropped from 16% in 2016 to 6% in 2017.

Testing times for mobile applications

While consumer firms try to engage customers through mobile applications for e-commerce, marketing, and services, B2B firms use them to improve employee productivity and enhance client and supplier communications. Our findings confirm that testing mobile devices and applications presents increasing challenges.

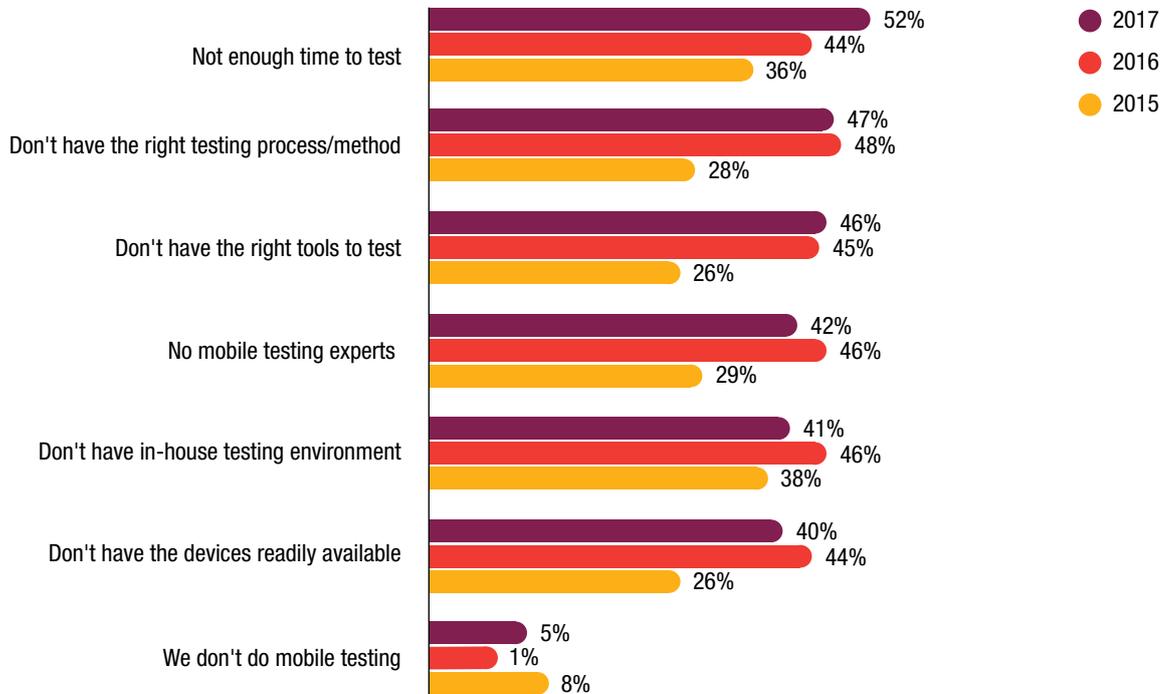
The number of organizations claiming that they struggle to find the time to test mobile applications has increased over the last three years, from 36% in 2015 to 52% in 2017. At the same time, nearly half of the respondents do not have the right process or method (47%) nor the right tools (46%) to test mobile applications. There is a relationship between the difficulties test teams experience in mobile landscapes. Those lacking suitable testing methods will be inefficient and run out of time to test the application or service.

Mobile applications developers are challenged by the combinations of specific hardware, operating system, network connectivity, and performance. If the provision of back-end applications and data in the cloud are thrown in the mix, organizations face an exponential increase in testing complexity because they must ensure enhanced user-experience, performance, and security.

The shift to mobile applications is prompting organizations to increase their focus on the overall efficiency and performance of applications. This implies that testing teams are beginning to understand the impact of network performance, latency, and speed on user-experience and functionality. A better understanding of mobile environments helps them factor in those latencies or limitations.

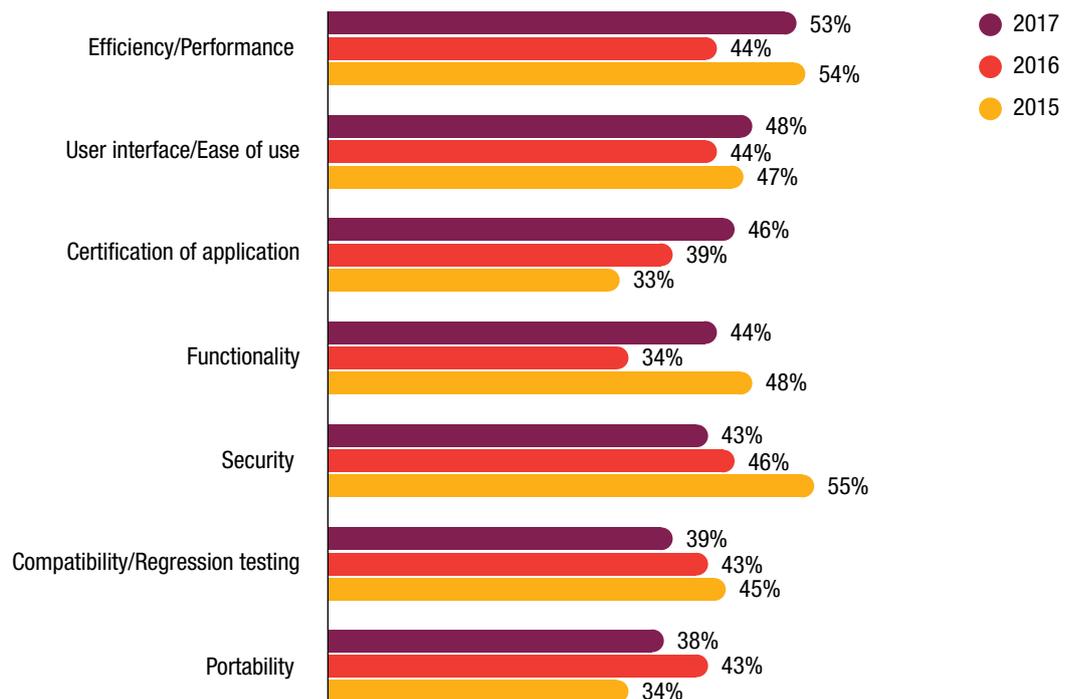
Challenges in testing mobile applications, including devices and wearables

FIGURE 2



Focus areas in testing mobile applications, including devices and wearables

FIGURE 3



Because time-to-market for some mobile applications is of paramount importance, organizations strive to reduce solution functionality, at least in the first release. The approach allows them to focus on testing performance and the efficiency of multiple-user scenarios. New features can be added once they understand the basic performance parameters affecting the solution.

It's not just mobile—testing for customer experience across multiple channels is complicated. While it appears that automation can help, 32% of respondents find it challenging to automate customer-experience testing. There is a wide variety of automation tools to help with testing applications and the complexity of the multi-channel ecosystem makes it especially challenging to fully automate it all. Coupled with a lack of processes and skills, it is not surprising that many organizations still struggle with automating multi-channel testing.

Even if they're not exploiting automation, organizations can use virtual environments to make the test lifecycle more efficient. Nearly two-thirds (63%) of the respondents use some form of virtualization in testing. This leaves 37% who use no virtualization of digital applications.

Monitoring and tracking real end-user experience is becoming more and more important: 97% of organizations do it in one way or the other. The survey also shows that such end-user monitoring is performed using multiple methods and sources of information such as monitoring direct feedback from users (20%), tracking usage of digital apps (20%), tracking commentary on social media (19%), or monitoring it through in-built bots in digital applications (19%).

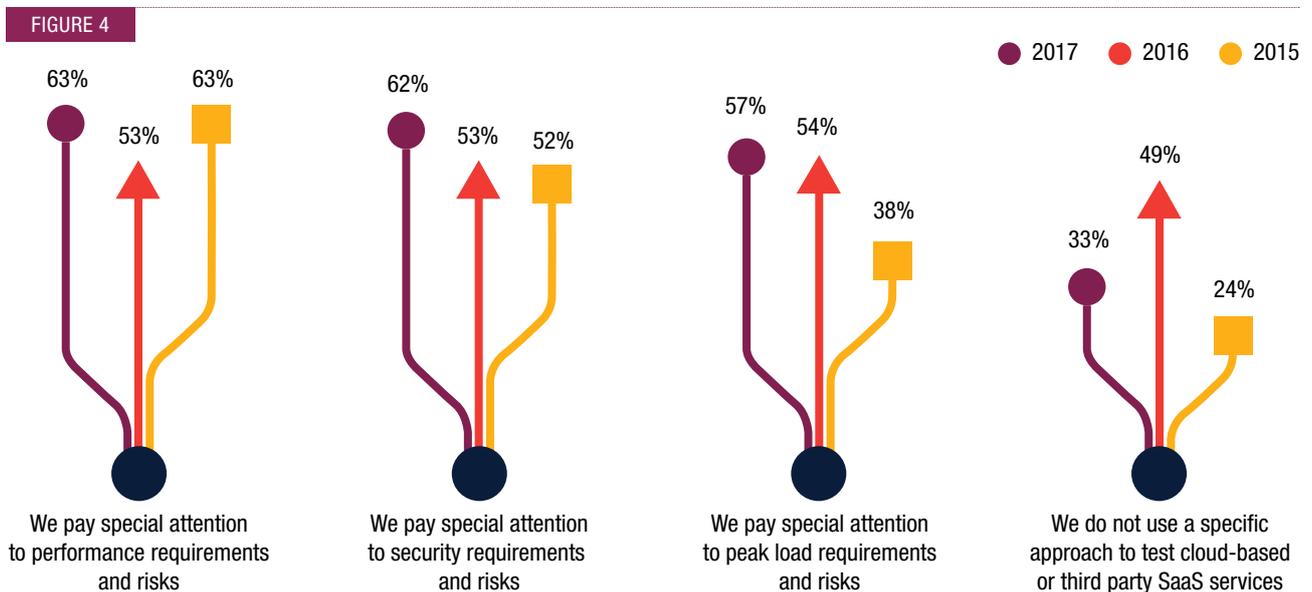
Clearly mobile solutions are a pillar of digital transformation, but the challenges to master the actual quality and end-user value of the digital applications are the new frontiers to be conquered this year.

Sharing responsibility with third parties

Digital transformation will defacto rely on cloud-based and SaaS-style applications and infrastructure. These computing models allow businesses to move at speed to take digital opportunities. Yet, organizations must consider how they test performance, security, and peak-load requirements.

Almost 76% of applications run in one or the other form of cloud (private, public, hybrid, or on-premise). But year-on-year, there are increased concerns around performance (63%, up by 10 points), peak load (57%, up by 3 points), and security (62%, up by 9 points). The business implications of security and performance parameters of cloud services

Approaches to testing cloud-based and/or third-party SaaS services





are real. Relationships with cloud providers, for instance, could have a direct impact on businesses relationships with customers.

Input from security and testing professionals can be vital to protecting the business when drawing up contracts with cloud providers, but too often they are not consulted when these relationships are formed. Security is often forgotten as organizations struggle to clarify the performance and financial details of the contract. If and when there is a show-stopping security incident, it is the corporate brand that suffers. Recovering from such incidents can be time-consuming and expensive.

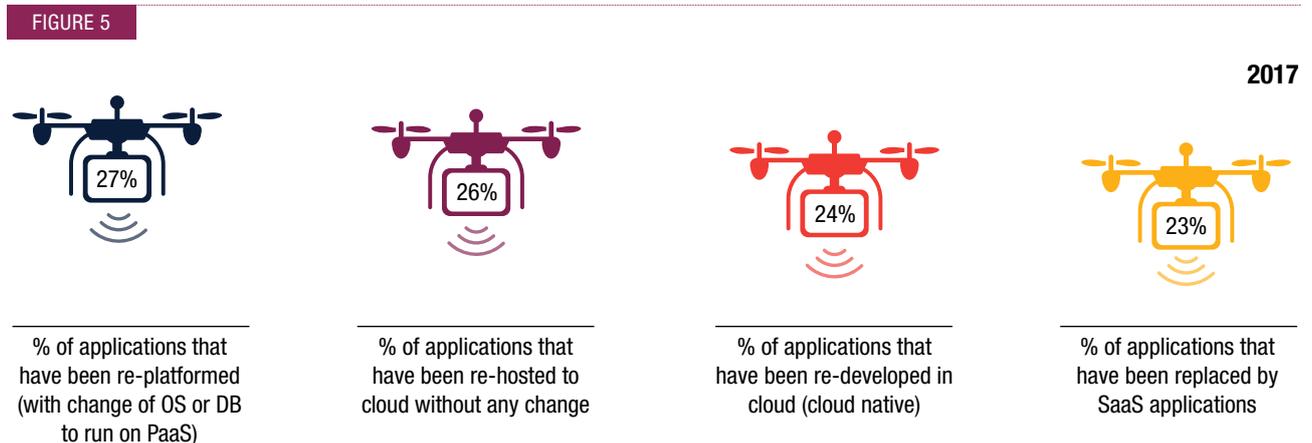
The method organizations employ to move their applications to the cloud also raises questions. The research shows an even split between:

- Building the application with a new OS or database

- Running it as a platform-as-a-service
- Simply re-hosting the existing application without change
- Entirely redeveloping the application for the cloud and buying a new application to runs as-a-service

Up to 47% of applications have truly transformed to cloud-based solutions, while 53% of applications are still in the early stages of moving to cloud. More than a quarter of the respondents (26%) have chosen to adapt their applications to the cloud by re-hosting without any change. Although this may be the easiest and most straightforward approach to moving to the cloud, organizations risk missing out on the advantages that come with re-platforming applications, such as improved performance, scalability, and reliability. In addition, exposure to security vulnerabilities cannot be ruled out in such cases.

Approaches to migrating applications to the cloud

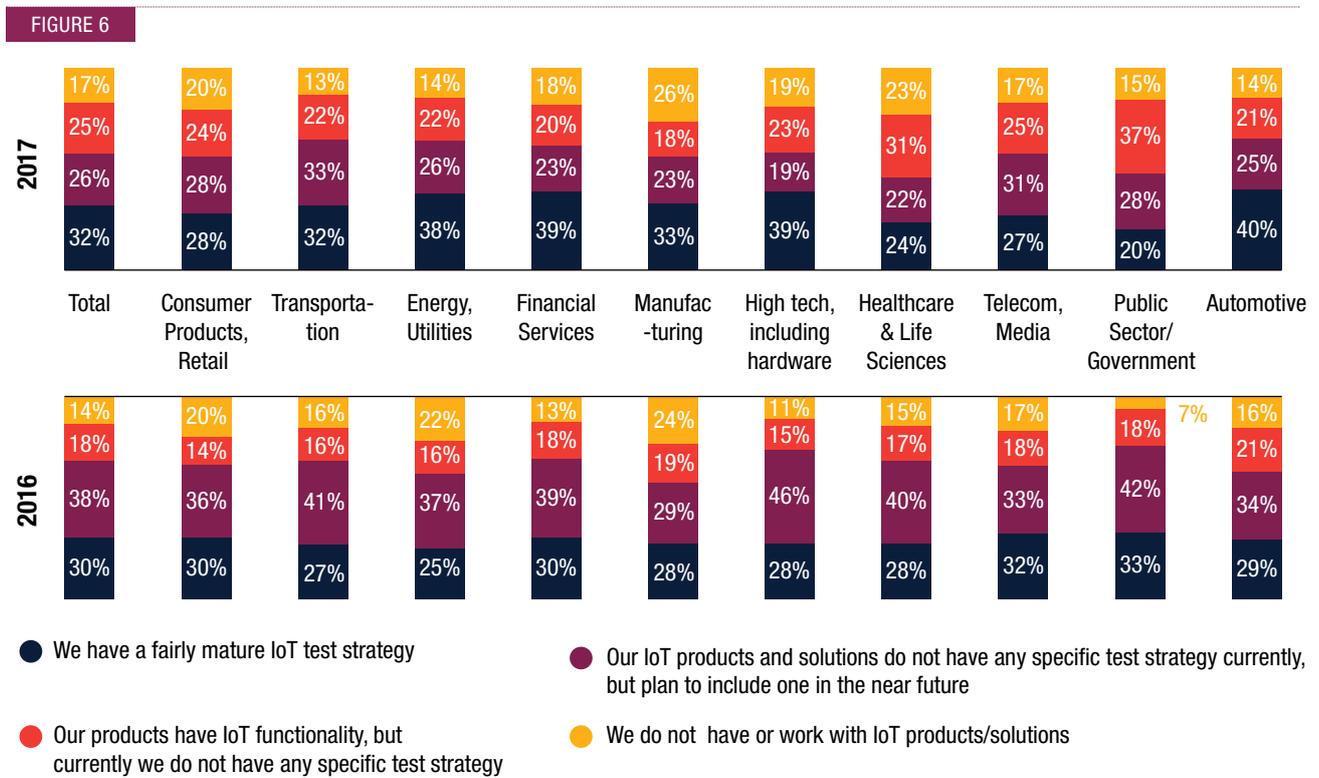


IoT presents increasing challenges to validation and verification

The Internet of Things promises operational data at a level of detail never seen before. Rich in patterns of consumer behavior, this data can be mined for feedback on a variety of business initiatives, from product development to marketing campaigns. Naturally, IoT adoption in organizations remains

high at 83%, according to the survey. In fact, compared with last year, the percentage of companies that do not have specific strategies for IoT testing has decreased from 56% to 51%.

Strategies to test in an Internet of Things environment



However, IoT solutions can be quite complex because they rely on a cloud-based integration layer that is often provided by a third party—either an equipment manufacturer or an independent supplier. Testing integration with these solutions was rated as the most challenging aspect of IoT testing by 27% of respondents. As with cloud applications, these solutions raise the question of who shares testing specific liabilities and how that is described in the supply contract.

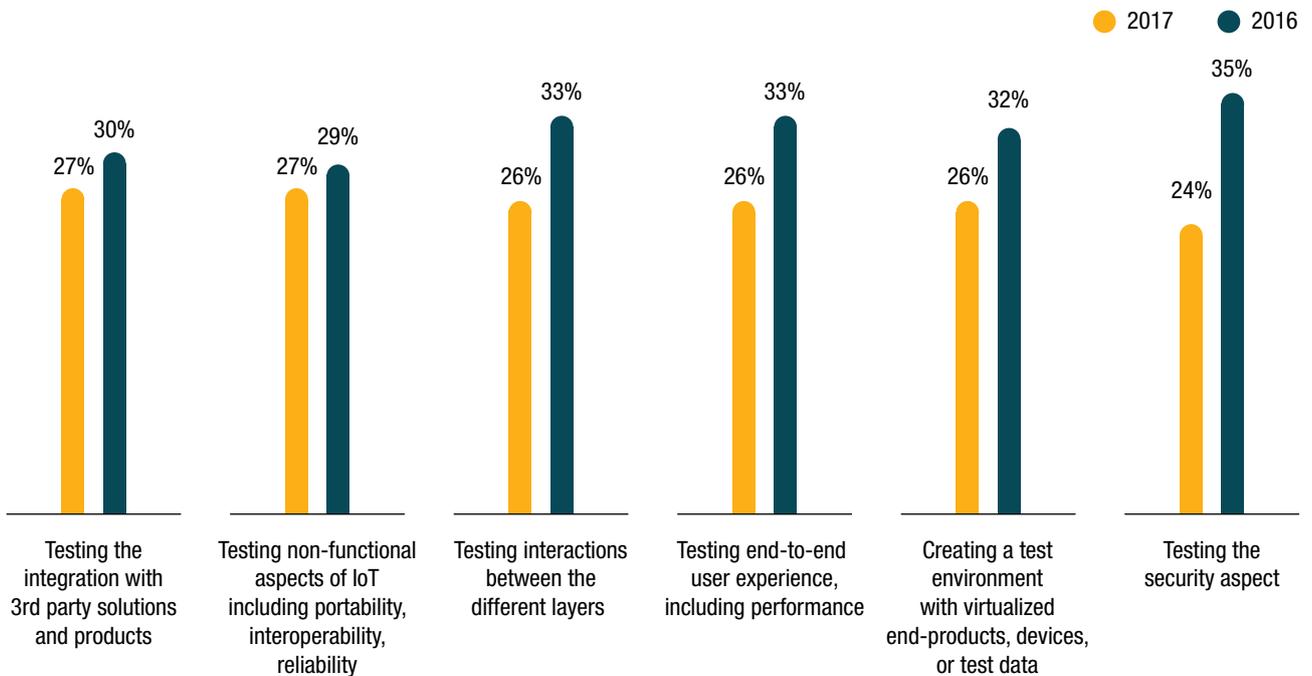
Relationship with third-party suppliers is also vital regarding operational intelligence. While test departments may collect their own operational data, IoT platform providers see the data as part of the benefits they can gain from introducing the

technology. In contract negotiations, the two parties need to clarify who has right to store, process, and exploit this data.

This year's survey shows that the challenges of IoT testing have only increased year-on-year. Up to 52% feel IoT solutions have an unlimited number of situations to test, and that they need "Artificial Intelligence/Machine Learning" capabilities to test them thoroughly. This figure is up 4% over 2016. Similarly, half of the respondents say they would like to conduct more IoT-experience testing than mere functional testing. And a sizable proportion (47%) feels that the challenges with IoT testing are in testing the "thing" part, such as end-products and remote sensors.

Challenges with testing products in the Internet of Things environment

FIGURE 7



Summary

Digital transformation is gripping all industries, and it presents challenges for test organizations on all fronts. Mobile applications can exponentially increase the test scenarios organizations must consider. Only through intelligent application of test automation can they hope to employ mobile technology without slowing down business.

Expansive use of cloud services in many forms of digitization means organizations must ensure responsibilities for performance and security testing are clearly defined at the contract stage. Too few businesses explore these questions before seeking benefits from the cloud model.

Finally, IoT adds further complexity as test scenarios must capture interactions across four elements that make an IoT solution: the “thing,” communication, data storage and analytics, and application and user interface. Here too, businesses should question the responsibilities of third-party platform providers in terms of up-front testing. They also need to consider who owns the operational data resulting from IoT as it will be useful for future testing. By rising to these challenges, test teams will not only demonstrate technical expertise but also their value to the business.

“ Digital transformation has put software quality to the fore, resulting in the CIOs spending more on quality assurance and testing. ”

IT Director,
IT/Hi-Tech, India

Agile and DevOps

Agile and DevOps transformation continues to put pressure on QA

Deepika Mamnani Senior Director, Financial Services, Capgemini

Andrew Fullen Solution Director, Enterprise Architect, Sogeti UK

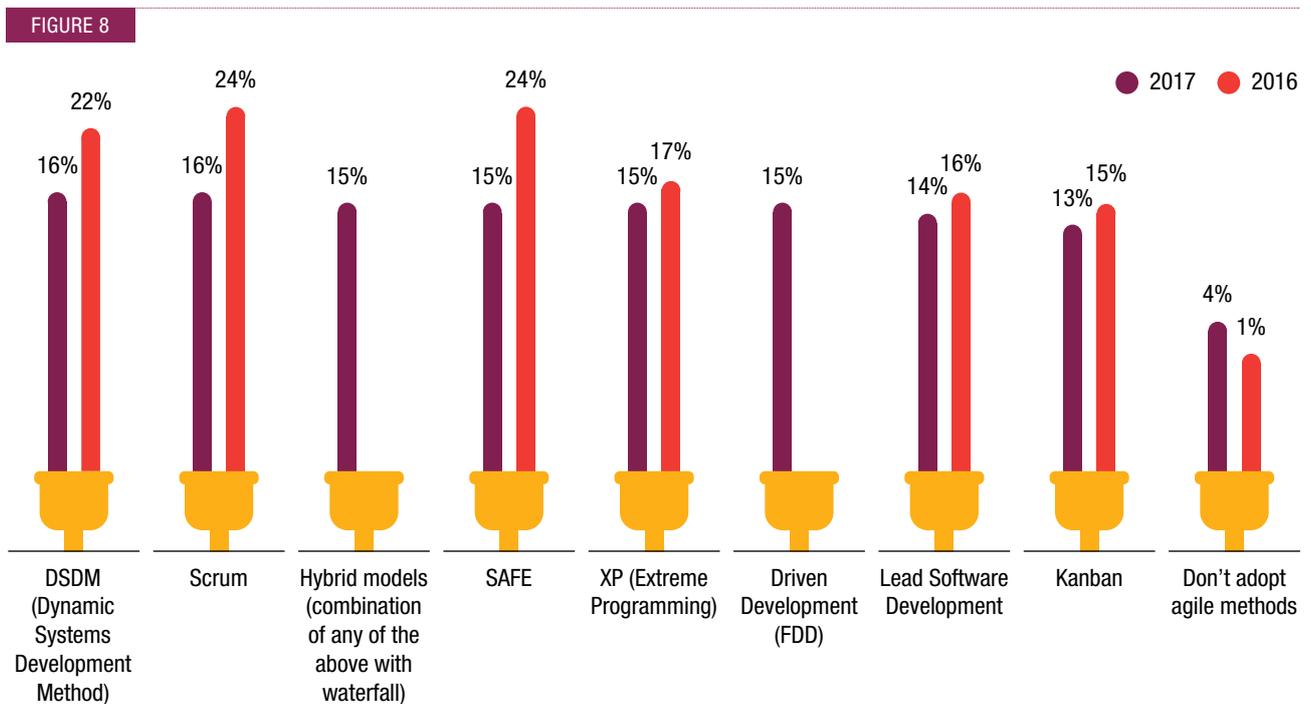
Tinus Vellekoop Community Lead, Digital Assurance & Testing and Unit-Manager, Testing Services, Sogeti Netherlands

AJay S Walgude Vice President, Financial Services, Capgemini

As the world becomes increasingly digital, more organizations are turning towards agile methodologies to improve time-to-market, competitive advantage, and efficiency. According to this year's survey, 96% of organizations have adopted agile methodology for at least some of their projects. However, there is no one-size-fits-all when it comes to Agile and there are clear indications that different organizations are

adapting agile in different ways to best meet their particular requirements. Our survey results indicate that the hybrid agile framework is the new norm, with organizations adopting a combination of SAFe, Scrum, Kanban, XP, DSDM, and waterfall models in varying combinations.

Proportion of projects using agile methods



Combining agile approaches with waterfall methods is the preferred standard for testing

This year’s survey results demonstrate how organizations adopting agile methodologies are trying to maintain a sense of continuity with earlier waterfall models by creating hybrid models.

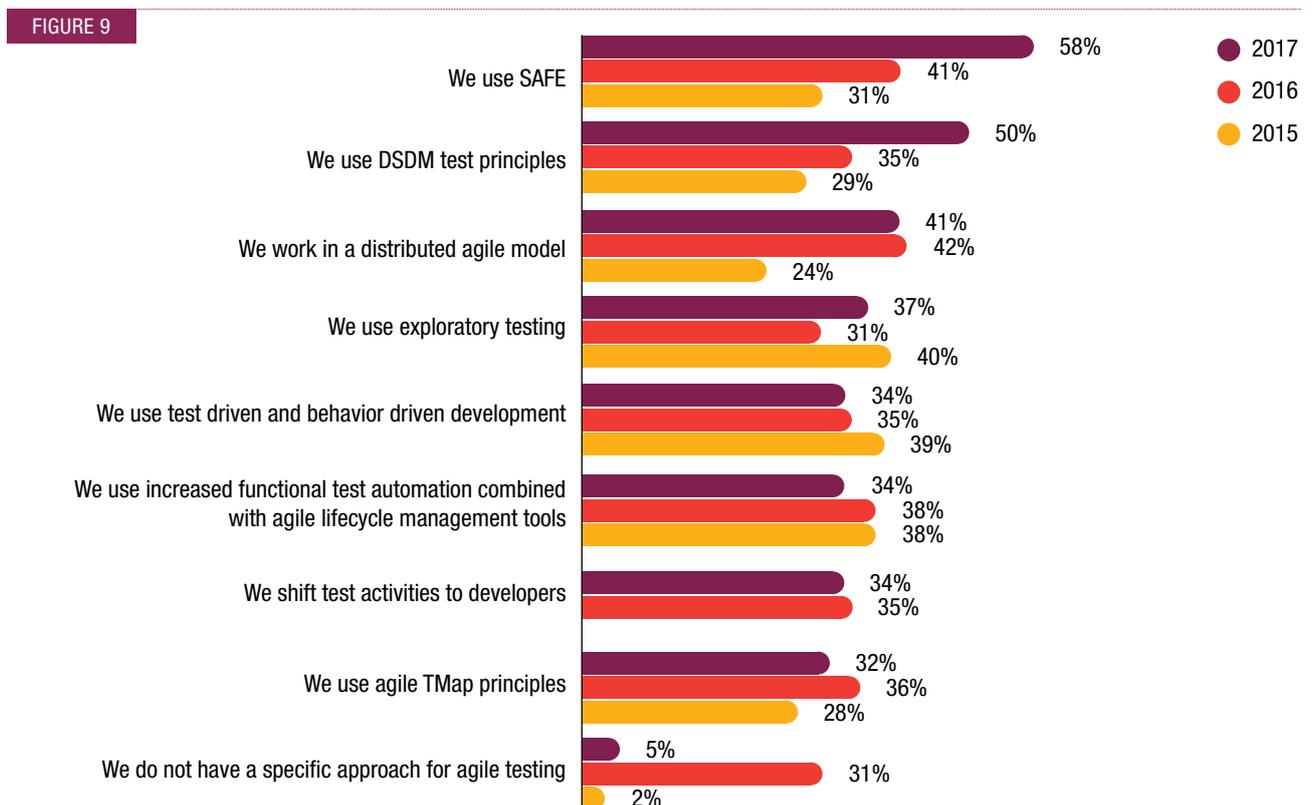
Among the various Agile methodologies, the Scaled Agile Framework (SAFe) and the Dynamic Systems Development Method (DSDM) have exploded in popularity over recent years. SAFe has grown from 31% in 2015 to 58% in 2017 while DSDM has grown from 29% to 50% over the same period.

It’s easy to explain the popularity of an approach like SAFe. Firstly, it is a framework for enterprise-wide Agile implementation. Companies that have successfully experimented with agile and want to extend these methodologies across the organization are moving to SAFe. SAFe has proven to be successful across sectors, not only because it consists of practices from proven agile frameworks such as Scrum, XP, Lean, and DSDM but

also because it resonates with senior managers’ needs by offering the best of agile development practices while maintaining the reporting and command and control features of the waterfall model. It also has ceremonies in place for agile governance, lean budgeting, and release management that existed in traditional waterfall models as well as newer engineering practices for continuous delivery, architecture, and building in quality. Unlike other frameworks, SAFe can create a connection between waterfall, management, development, and engineering practices—and this explains its growing popularity.

While SAFe may be used for reporting, other test methods are being used under the radar at the developer level. For example, the popularity of DSDM can be explained from the fact that the approach is flexible and based on a set of principles that are easy to apply, such as the timeboxing principle and the prioritization of items to develop. The rise in exploratory testing, from 31% in 2016 to 37% in 2017, can be explained by vendors increasingly promoting software

Approaches to testing in Agile



tools designed for this style of testing. Additionally, this rise in popularity is due to the fact that exploratory testing can be applied to development, as long as the organization has skilled testers with sufficient technical and business understanding. Meanwhile, test and behavior driven development adoption are stable at around 34%.

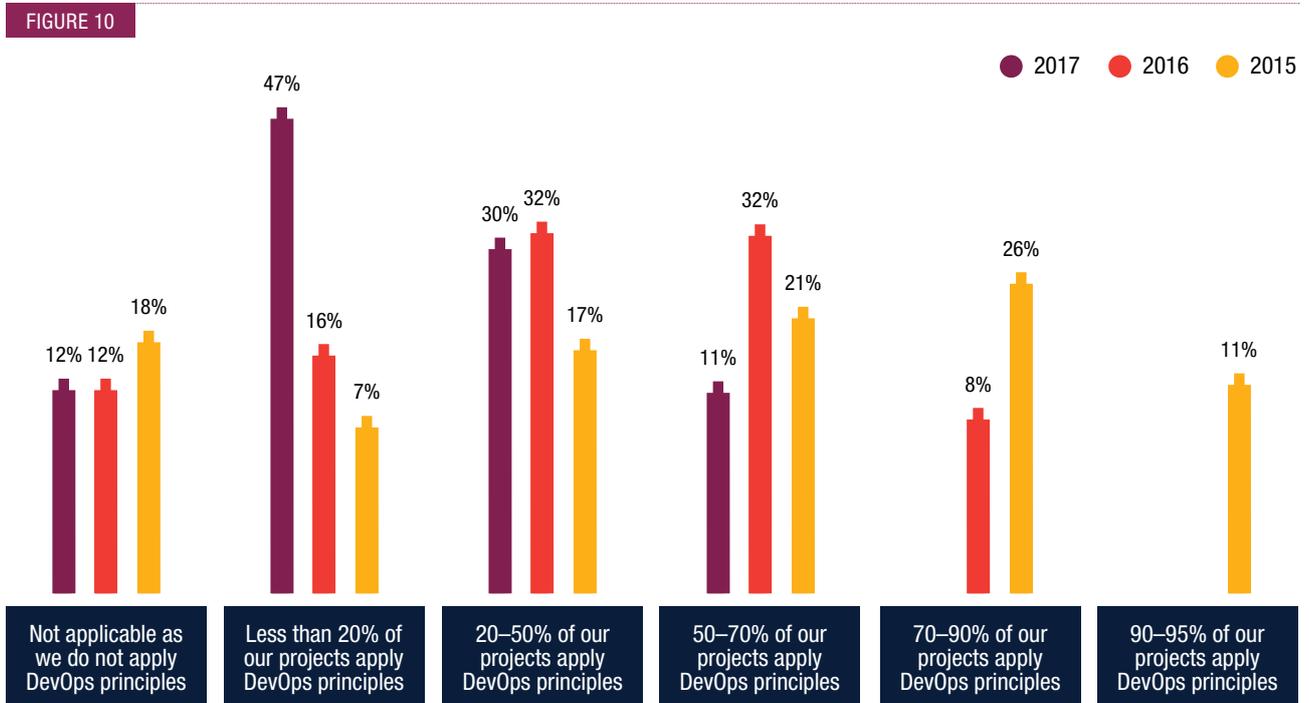
The number of respondents without a specific approach to agile testing has fallen dramatically from 31% in 2016 to 5% in 2017, a sign that agile testing is reaching greater maturity and development teams are more aware of the implications for testing.

DevOps adoption is slowly growing

DevOps brings together separated development and operations teams into a single agile unit. Together they promise faster development and deployment of more reliable software with testing woven into each build cycle. 88% of the companies surveyed this year use or experiment with DevOps principles. Most seem to be at the beginning of their DevOps journeys. This is further corroborated by the survey results, where the proportion of organizations using DevOps for less than 20% of their projects has risen from just 7% in 2015 to 47% in 2017.

It is important to remember that for the purposes of this report we surveyed medium and large enterprises which, because of their multifaceted nature and variety of IT systems, will always employ a number of methods for software development. Thus, there are many organizations where Agile and DevOps are employed for outward-facing digital transformation projects, while waterfall is retained for the enterprise systems that run the business.

Proportion of projects using DevOps principles



Balancing agility, scale, and quality

Despite the widespread adoption of agile methodologies over many years, 99% of respondents say they have difficulties with testing in agile development. This is extremely worrying, particularly as challenges persist across the board, with little change since last year’s study.

For instance, when asked about the biggest challenges with regard to carrying out testing activities in an agile environment, respondents gave the highest weight to “challenges with test data and test environment management” followed by “difficulty in re-using tests across sprints/releases’ and ‘lack of a good testing approach that fits with Agile and DevOps methodologies.” Apart from these three factors, “lack of professional test expertise in agile teams,” “difficulties in slicing test activities for more than one location for distributed

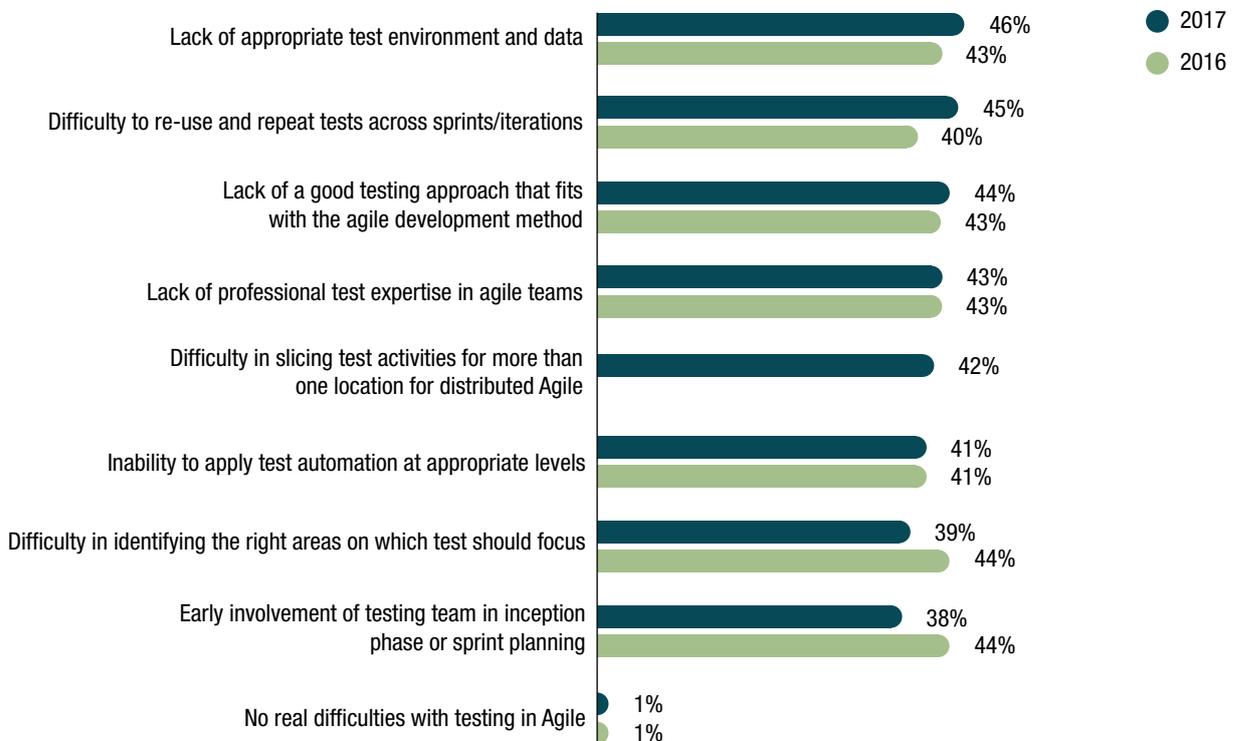
Agile,” “inability to apply test automation at the appropriate levels,” and “difficulties in identifying the right areas on which test should focus” were some of the other common challenges pointed out by respondents.

At the same time, there have been significant improvements when it comes to tackling some of these challenges. For instance, challenges with the “early involvement of testing team in inception phase or sprint planning” has fallen from 44% in 2016 to 38% in 2017. It should be noted that even 38% is high for a methodology designed to make testing integral to the process.

Clearly, organizations still have serious difficulties in building testing into the agile methodology.

Challenges faced in applying testing to agile development

FIGURE 11



Cloud adoption and smart test ecosystems underpin quality in Agile and DevOps

In our survey, 87% of CIOs and senior technology professionals say they are using or planning to use cloud-based test environments. Use of environment virtualization is also increasing, with 88% of survey participants indicating that they are already employing or plan to leverage this technology in the near future.

Another important DevOps practice is the containerizing of applications which is a prerequisite for deployment ease, speed and efficiency. This trend is also in line with our survey results: 74% of respondents say they are using or planning to use infrastructure as a code. However just like in code, the infrastructure code recipes are not defect free. Clients recognize this and we anticipate that testing of infrastructure as a code will be the responsibility of the testing community in the future.

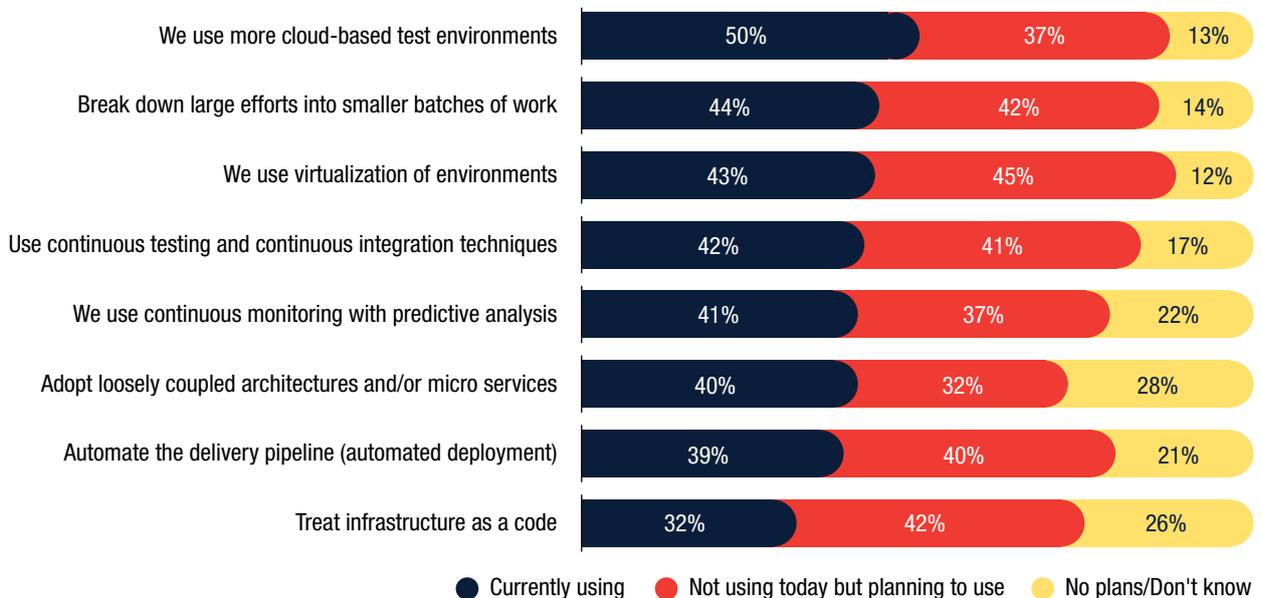
Another practice is the building of an architectural runway which underpins agility and automation, particularly for IoT

and digital initiatives. Loosely-coupled and fine-grained software in the form of micro-services is a winner in this space as it facilitates quicker, more frequent deployments and aids early automated testing. Organizations recognize this trend, with 72% of respondents reporting that they use or plan to use micro-services.

Finally, predictive analytics and machine learning, based on data from continuous monitoring, a trend identified in 2016, which has today emerged as an effective mechanism for the testing community in two ways. First, as a mechanism to intelligently derive areas that for testing; and second, to identify repetitive patterns based on data, through which artificial and synthetic test data can be created. Use of analytics from production to optimize test cases was cited by 40% of our respondents, a number that we expect to rise.

Popular DevOps practices in use

FIGURE 12



Skills at the root of agile development challenges

A lack of professional expertise (steady at 43%) is likely to be the underlying cause of a number of the other challenges associated with agile development. For example, despite the

increasing number of automation tools on the market, there are still significant challenges with applying automation at the appropriate level (41%). Developers may be aware of the

market for test tools in Agile, but without the right expertise in testing, they are unlikely to use them appropriately.

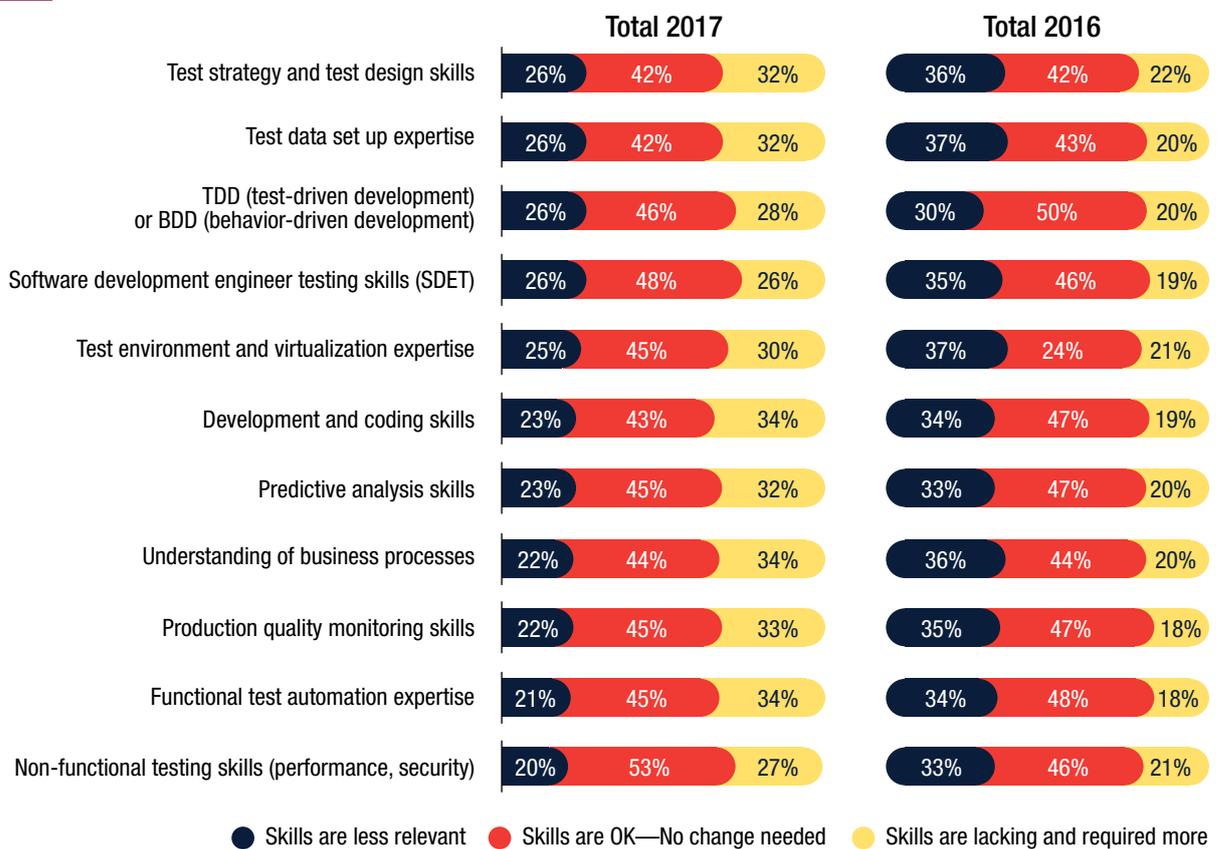
Today, there is growing recognition of the importance of specialist test skills required for both Agile and DevOps as well as an awareness of the shortage of such skills among QA and testing professionals. Our research shows that the proportion lacking skills in test strategy and design has grown from 22% in 2016 to 32% in 2017, while the lack of

test data set-up expertise has grown from 20% to 32% over the same period.

We welcome this recognition of the importance of test skills. We are seeing the introduction of testers in DevOps and agile teams, particularly those specialists with knowledge of both testing and development, the so-called “T-shaped testers.” We also see DevOps teams receiving more training on testing techniques relevant to the model of development.

Changes required in QA and testing skill sets on account of Agile and DevOps adoption

FIGURE 13



Summary

The agile and DevOps models of software development are becoming the cornerstones of digital delivery. They promise the speed businesses desire, while offering the quality product necessary to protect and enhance brand

reputation. However, they will only do so with the right testing skills and tools in place. While there is evidence of progress, organizations will need to continually focus of these areas to keep up with the rate of change in digital transformation.

Test Automation

On the way to smart, intelligent, and cognitive QA

Will Murray

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Capgemini Sogeti Ireland

Prabhakaran Karupiah

Vice President, Financial
Services, Capgemini

Christopher Stancombe

Vice President, Head Automation & Industrialization,
Capgemini Group

The development and adoption of automation in IT products and services is rapidly growing. Software robots, machine learning, and artificial intelligence will become embedded in applications to perform tasks once reserved for humans. These technologies can be applied to QA and testing too, but organizations must carefully assess the benefits of test automation and its role in their test strategies.

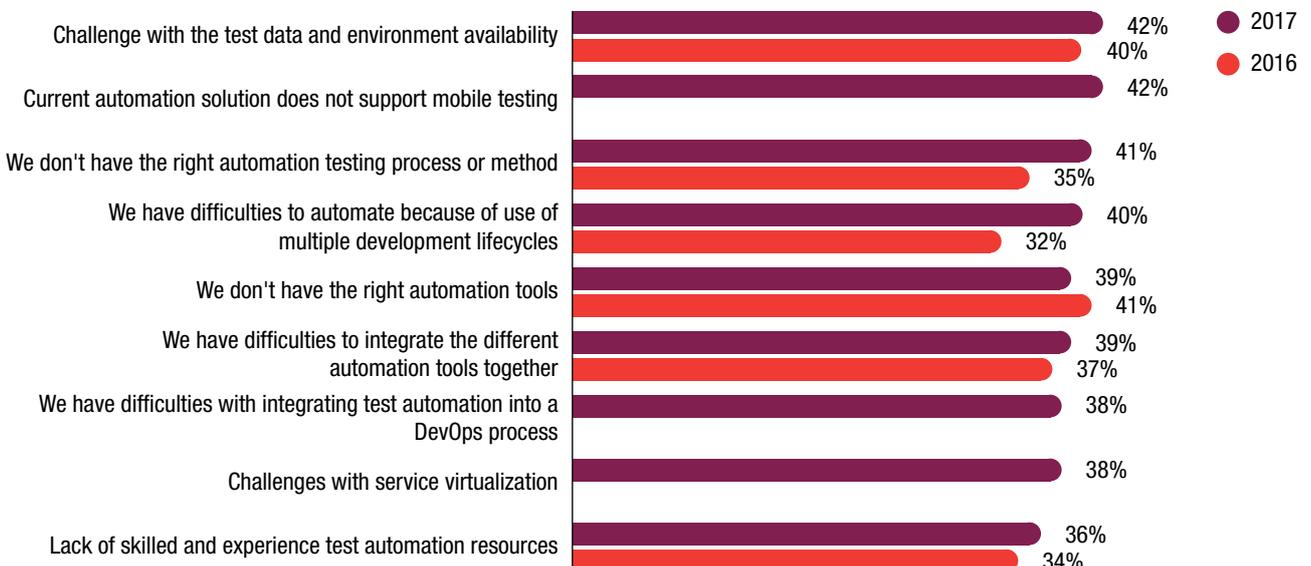
Basic, functional test automation is well established in waterfall development practices. In the world of Agile and DevOps, fully integrated test automation is an essential part of the model. The survey demonstrates that only 15% to 16% of common test activities are performed with automation technologies. This ranges from functional test execution, functional test case design and test data generation to testing of end-to-end business scenarios.

Many organizations still follow siloed approaches in test automation, where only parts of the testing process are automated. Typically, they only focus on automating functional regression testing or deploying an easy-to-use scriptless tool in an agile team. This sub-optimal approach leads to an increase in common challenges around test automation. Test environment and test data availability, and the lack of support for mobile testing in current automation solution are together the top challenges for successful test automation, cited by 42% of organizations.

Meanwhile, 41% of organizations lack a solid test approach that includes standardized automation. The challenges of test automation continue to increase as evidenced in the data. The proliferation of multiple tools that offer partial automation solutions, combined with the lack of centralized strategies

Challenges in achieving desired levels of test automation

FIGURE 14



to analyze and decide on enterprise automation solutions, is not helping organizations to overcome this problem.

It is widely accepted that agile and DevOps development models can only be successful with quick-to-use and easy-to-adapt continuous test automation technologies, so it is a cause for concern that 38% of respondents say they are having difficulty integrating test automation with DevOps.

Given the lack of integration among automation tools across different phases within the test life cycle, it is imperative that organizations follow a centralized approach for automation across the enterprise. They should start with a central automation and tooling strategy and then customize the implementation across the different lines of business. As existing waterfall methods are integrated with Agile, decentralized testing can pose a serious hurdle in standardizing automation and tools strategy.

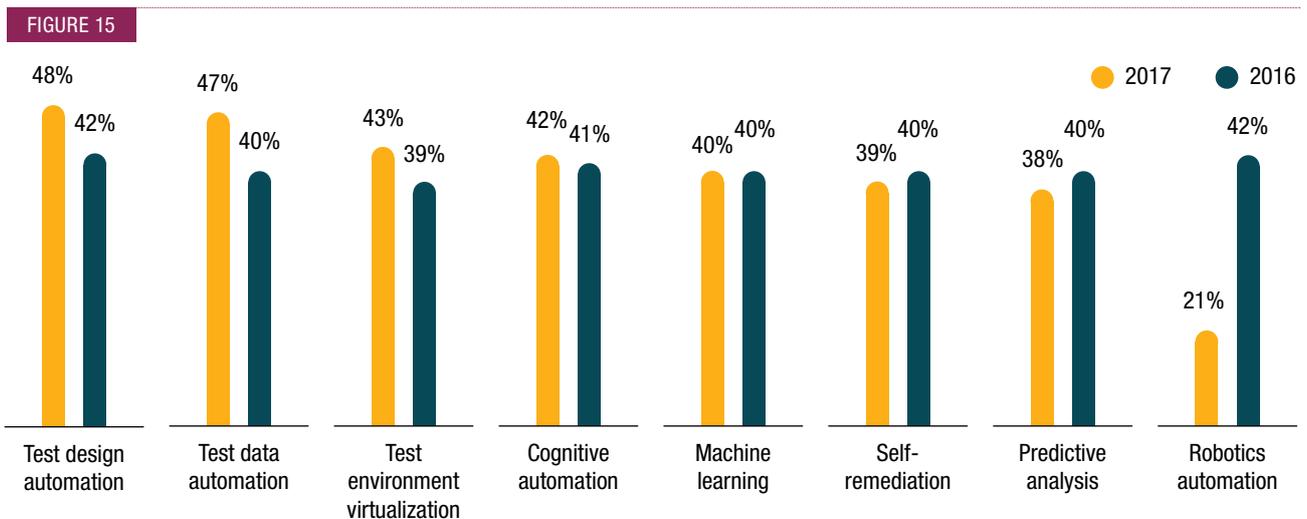
Intelligence in test automation is the future

Findings confirm that the automation opportunity is under-exploited, largely due to the lack of specialist in-house knowledge of the depth and range of automation techniques. Organizations feel the technology has the potential to offer benefits, but they become swamped in a myriad of tools and buzzwords that appear in the vendor marketplace as new trends emerge. Emerging trends are sometimes embraced as potential saviors by organizations: 48% strongly believe in the automated design of test cases as a next step, 47% of the respondents see test data automation as the next important trend. And 43% look favorably upon test environment virtualization. The cognitive, intelligent, and smart analytics trends are only slightly lower in popularity, with percentages ranging from 42% to 38%. It must be noted

that test automation solutions in the intelligence area are not well established yet. However, organizations will need to plan their next steps to be ready for these technologies in the near future.

The survey reports a pattern in how organizations report challenges. In the top three categories of test design automation, test data, and environment virtualization, the constant theme is their continued desire for integrated automation and end-to-end automated flow. There is a similar trend in the challenges organizations identify, with a lack of end-to-end automation being the first challenge when implementing automation strategies.

Emerging automation techniques



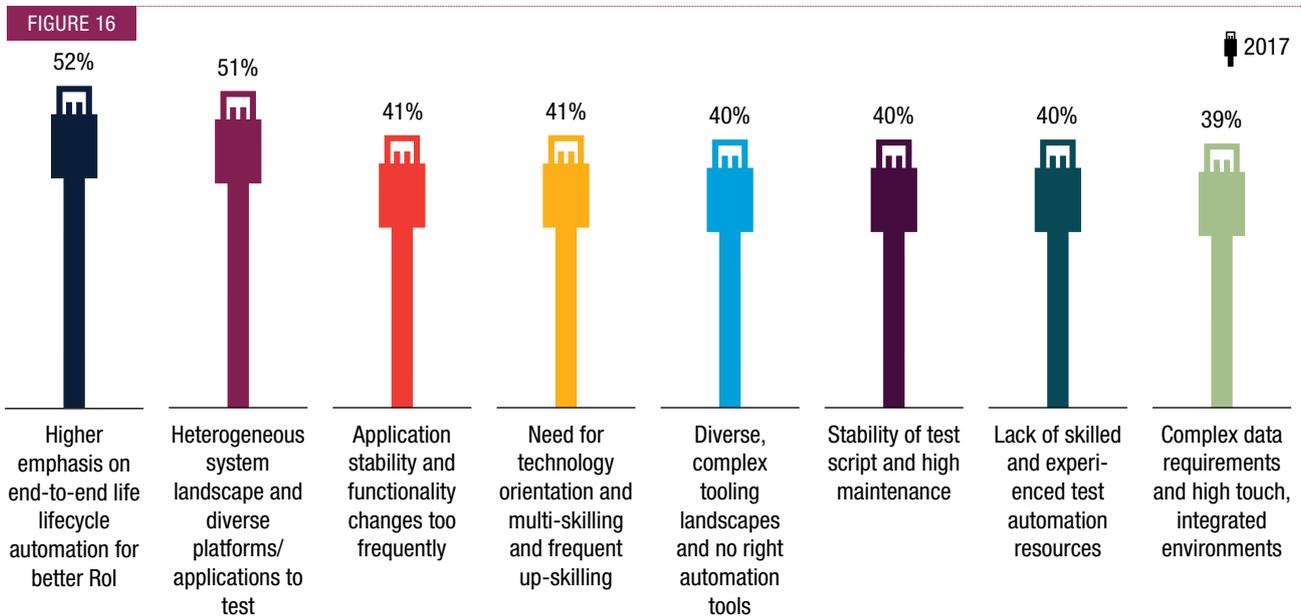
The survey also shows that organizations are still confused about how to adapt and use smart test automation techniques. The challenges are in selecting the appropriate methods of applying these techniques in order to make the most from them. A good starting point for organizations is to establish an automation index—a measure resulting from the product of potential value and tool maturity—to help decide which technologies to use first, and where.

The answer may lie in how they address the key challenges in introducing automation. The top challenge here is

implementing end-to-end lifecycle automation, cited by 52% of the respondents. The second highest challenge is the increased complexity and number of application and platforms across which test automation would have to operate, cited by 51% of respondents.

It is positive that respondents are considering the end-to-end test lifecycle, rather than individual phases. The transformation towards more intelligence in test automation will be the next frontier to be conquered by QA organizations, tool vendors, and service providers together.

Key challenges in implementing automation



More transparency on benefits of test automation needed

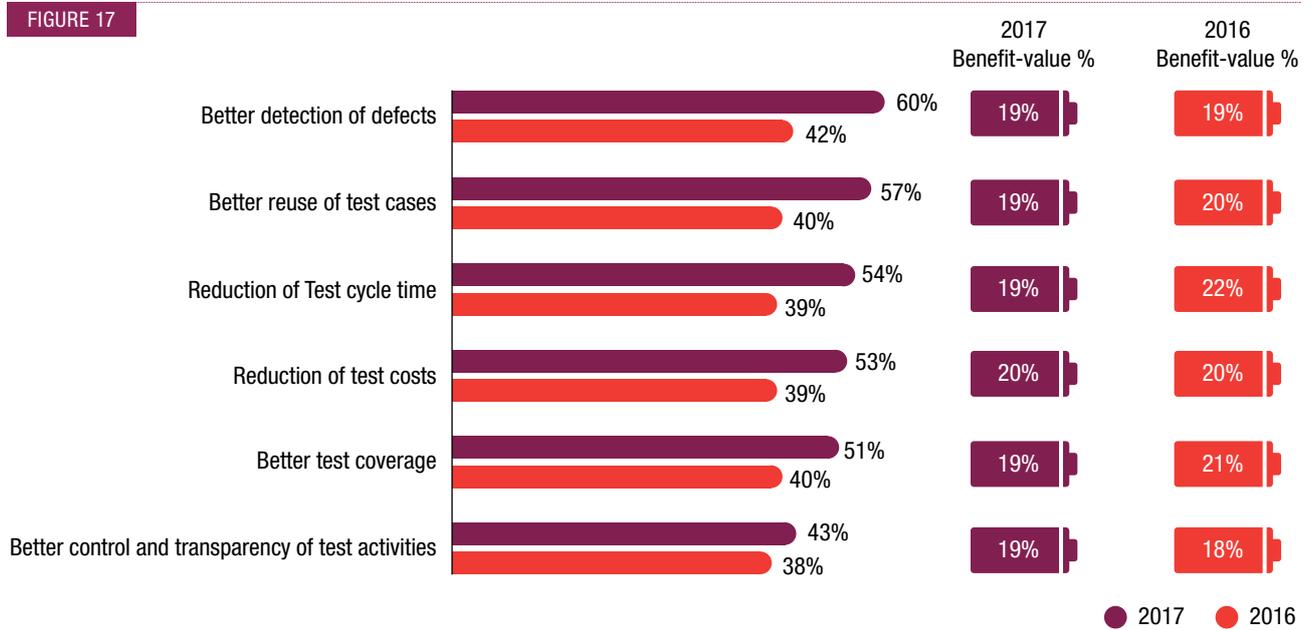
In this year's survey, there is a notable increase in the proportion of organizations benefitting from test automation. Up to 60% of respondents reported that test automation improves their ability to detect defects. This is because automation allows organizations to increase test coverage within the same timeframes. At the same time, 57% of respondents see an increase in the reuse of test cases through applying automation and 54% see a reduction of test cycle-time from automation.

A common pitfall in introducing automation is the big bang approach, an enterprise-wide initiative to introduce automation throughout the test-cycles. In many cases the return on investment is not at the expected level, which leads to skepticism about automation initiatives. Organizations introducing automation in discrete chunks achieve better

results than those taking the big bang approach. With the adoption of agile and self-empowered teams, this approach should progress with test automation. However, to track success, overall governance and transparent feedback of results must still be in place. Successful application of automation can depend on the skill-set and knowledge of the tester. We still see a big skills gap in this area.

In this year's survey, organizations have reported benefits across a range of automation techniques. The result is broadly in line with increasing rates of adoption. However, the benefit achieved from each technique has not shifted. The question is how to get the optimal value and service maturity by improving the Automation Index mentioned earlier.

Benefits of test automation



Challenges for integrated tooling

There is evidence in our findings to indicate that test automation is maturing in its own, individual phases. The use of advanced tooling and strategy for design automation or execution automation makes for a fine use case. Equally, there are challenges for the customers and opportunities for the service industry to help integrate these advanced and mature phases. Mature technologies will present a challenge as they have little flexibility to change or customize to allow integration of other tools in different phases. Tool vendors experience a similar challenge in trying to change their tools to integrate with other phases. They will try to address it by buying dominant suppliers in an adjacent phase to provide an end-to-end flow for the customers. Other tool vendors are

trying to start from scratch, gain expertise in one phase, such as test design, and proceed to build organically integrated tools in other phases such as test data or virtualization. This also bodes well for the industry.

However, organizations now face two choices: limit their tooling partnership to a few vendors who have gained significant expertise in two or three test lifecycle phases and build service layers to integrate them, or leave the individual lines of business to build their own tools in different phases without any centralized guidance. We believe that the clients the former strategy and approach will have the greater chance of success.

Summary

Automation is currently under exploited in QA and testing. While we see a rise in the number of organizations benefiting from automation, the value they generate is largely unchanged. Automation should not only replicate existing manual test processes; organizations should see it as an opportunity to support new ways of working in DevOps, mobile, and IoT. They will see a greater return on investment in automation by generating value in reaching business objectives, such as time-to-market, rather than

achieving incremental benefits in cost and efficiency.

Test automation must be employed in digital transformation to ensure future success. Adopting smart automation solutions is essential given the emergence of smarter applications and products that demand an integrated, intelligent, and automated approach for testing of continuously changing products in their rapidly changing business environments.

Industrialization

How Test Centers of Excellence adapt to the digital era

Dhiraj Sinha Vice President, Financial Services, Capgemini

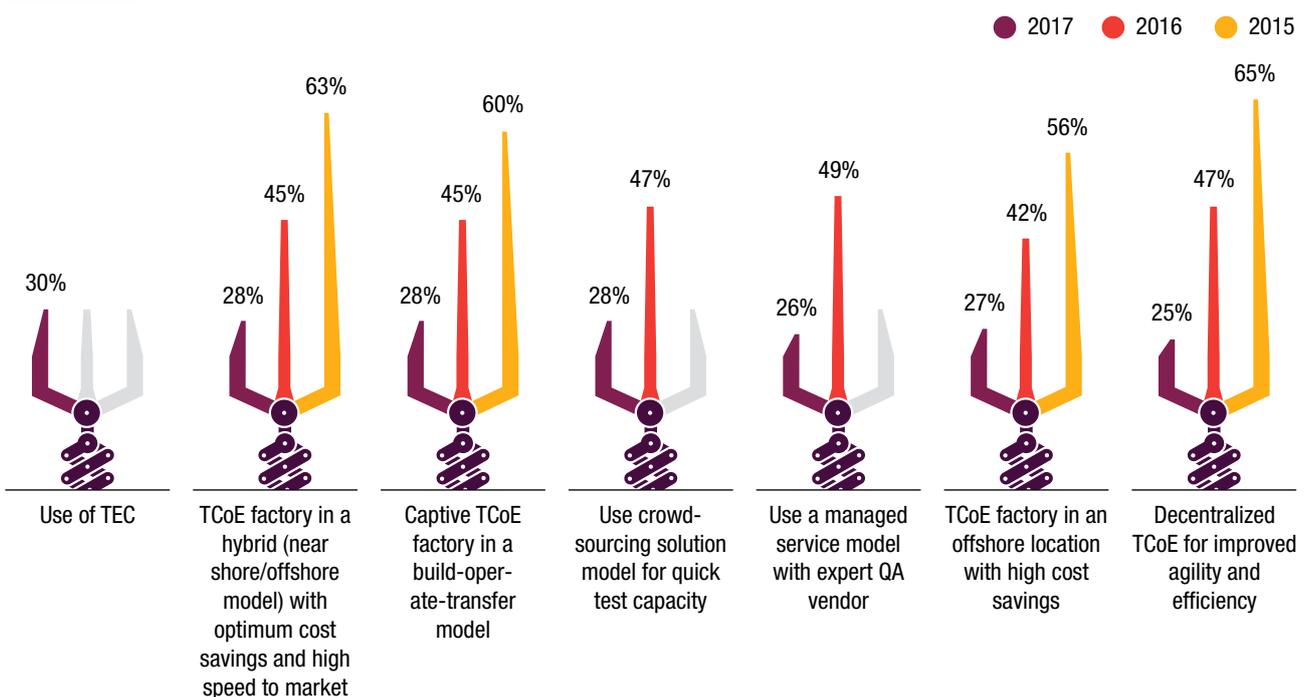
Peter Betting Director, European Software Test & DevOps Cloud Centers, Sogeti France

Over the years, organizations have moved to industrialize software testing by establishing centralized testing centers of excellence (TCoEs), either in-house or via service providers. This approach has offered economies of scale, the opportunity to develop appropriate skills and expertise, and helped standardize test environments, tools, and processes. However, with the onset of digitalization and the increasing adoption of Agile and DevOps, organizations must ask themselves whether these centers are fit for purpose and how best to adapt them to meet current and future requirements. In fact, more and more organizations have already realized that they need to re-think the centralization or decentralization of the QA and testing function from the ground up and there is a fundamental shift underway in

the manner in which testing activities are organized. The centralized test organization of the past was designed to be a factory, where testing of the software developed by multiple programs, domains, and lines of business was undertaken. Such test execution is becoming more and more decentralized today as responsibility for testing is undertaken within the line of business. Increasingly, what remains at the central level is a thin layer we call Test Excellence Center (TEC). It is a central organization responsible for selecting and managing enterprise test technology including test tools and test platforms. Moreover, it is common for the function to provide proof of concepts to assess emerging QA and test solutions in order to validate their value to the whole enterprise.

Approaches to Test Centers of Excellence

FIGURE 18



While such decentralization is an emerging trend, our survey reveals that the centralization of test activities continues to be extremely important for most organizations. For instance, when asked about the setup of their testing

activities, respondents gave the highest weighting to the aforementioned TECs. This was followed by “hybrid TCoEs (near shore/offshore model)” and “captive TCoE factory in a build-operate-transfer model.”

Digitalization and the adoption of Agile and DevOps sets the scene for a new era in Test Centers of Excellence

If testing is integral to the Agile way of thinking, what role does that leave for a TCoE? Organizations which cannot answer this question risk the center of excellence becoming a bottle neck, creating a backlog of testing and validation, and holding back the performance advances that Agile was supposed to create in the first place.

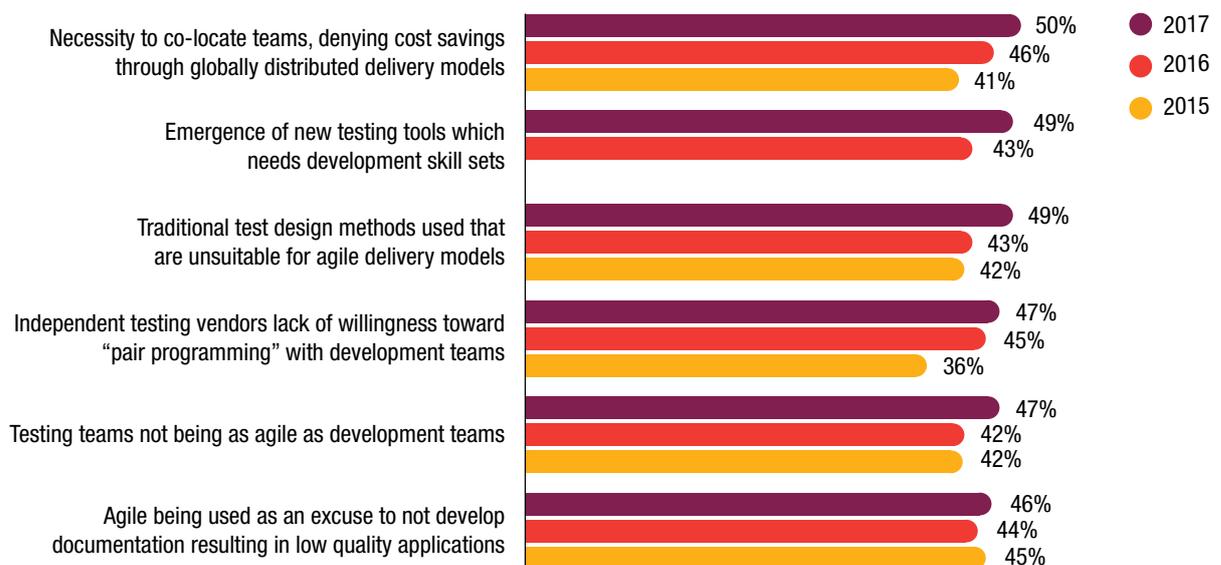
To successfully accommodate the tension between agile development and TECs or TCoEs, organizations need to understand which skills, resources and technologies they need to retain in the TCoE or TEC to support agile programs in the business. For example, the agile Scrum can employ multi-disciplinary teams of developers and testers producing a shippable product at the end of each sprint. Meanwhile, the TEC can bring in a common set of tools and processes, create the plumbing that will enable comprehensive test

automation, and provide and manage test environments and data. It can also offer specialized testing services such as performance and security testing, end-to-end testing and user centric testing. In the case of external TCoE providers, these can also be consumed on a pay-per-use basis.

Today, thanks to the emergence of digital technologies, increased market demands for speed and agility as well as the adoption of new frameworks such as Agile and DevOps, the traditional TCoE is under threat. In its place, a more nimble and adaptive TCoE is on the rise. Of course, different organizations are at different stages of this journey, something that also shows up in our survey results, which reveal an almost even split, between businesses placing test skills within an individual Scrum team or in TCoEs shared across Scrum teams.

Challenges in setting up an agile TCoE

FIGURE 19



QA workforce needs to adapt as TCoEs transform into TECs

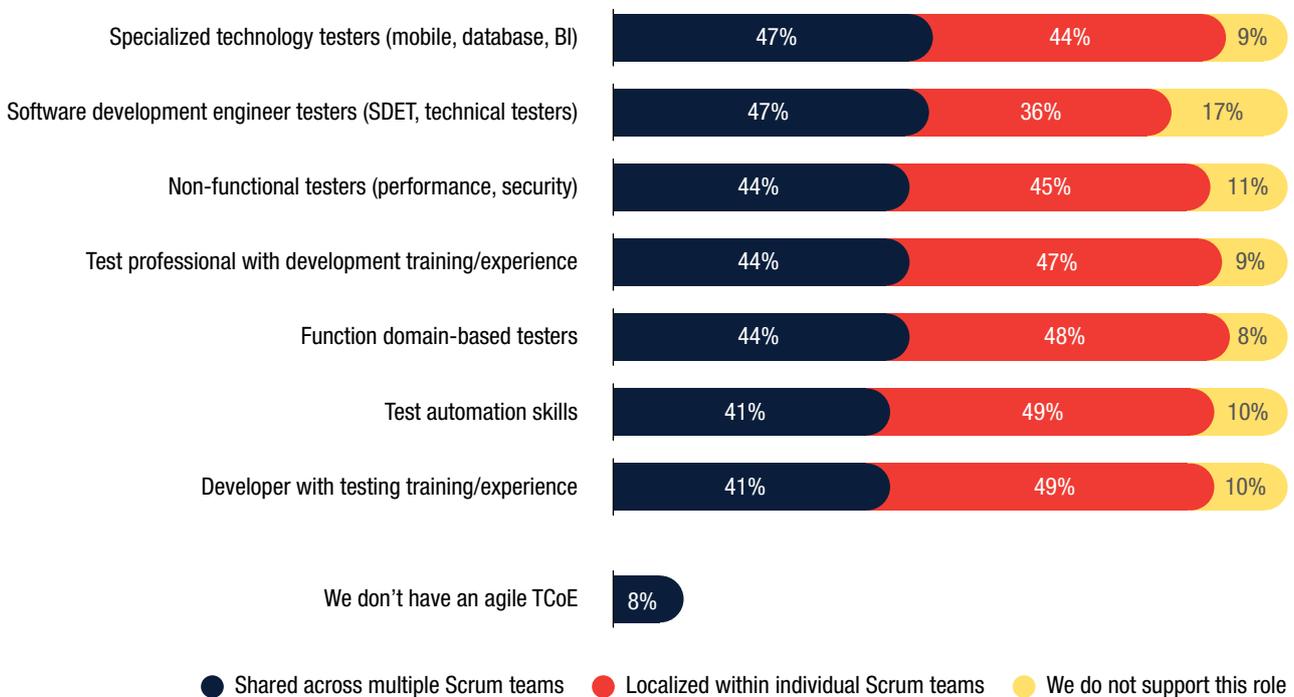
Before decentralizing their TCoEs, IT management might want to consider how mature agile development has become in the organization, in terms of how much it contributes to day-to-day development. In the chapter on Agile and DevOps of this report, we analyze and describe how organizations are adapting to Agile. We see an increased adoption of the agile development approach and a growing adoption of DevOps. But it is also clear that most organizations are using a mix of agile projects and traditional waterfall-style development projects. So, the needs and requirements in terms of resources, management, and governance also shows this mixed picture.

The result plays out in the location of certain skills. For example, in the case of software development engineer

testers (SDETs), we see 36% within the Scrum and 47% within TCoEs. So, are the SDETs developers who know testing, or testers who understand development? While the point may seem trivial, the ambiguity can result in uncertainty when trying to determine the roles and resources required for the optimum balance between centers of excellence and Scrum teams. Even if the roles are clearly defined, many organizations create the same roles in both centers of excellence and Scrum teams; a roughly equal split in the case of non-functional testers (44% shared across teams; 45% in Scrum teams). There is no clear point of view emerging in the industry with respect to how the organization should be designed and how different roles should be allocated. We are still a few years away from achieving such clarity.

Testing roles in agile TCoE set-up

FIGURE 20



The test professional of the future

In terms of developing skills to support industrialized centers of excellence, organizations will need to support both agile and waterfall models of development for the foreseeable future. When developing their a training program, HR strategy, skills roadmap, or training programs, organizations should bear in mind that the tester of the future needs to be able to switch between the two models with ease. In traditional development, the QA or test professional can easily work independently; whereas in Agile they need to work well in a team, communicate effectively with others and possess a variety of skills in addition to their expertise in testing. If organizations do not re-skill accordingly, they will find it difficult to meet the requirements of speed, efficiency and coverage of testing for the full spectrum of projects that come their way.

Next to a thorough knowledge of test methods, the tester of the future should be familiar with the latest tools used in the

market. He or she also needs the necessary technical skills to understand and work within a multi-disciplinary team.

It is clear that propelled by compelling economies of scale and the need to build expertise, the industrialization of quality assurance in centers of excellence continues to be a popular model. However, in order to continue to accrue benefits, organizations must define which roles, resources, and processes remain in the centers and which are devolved to the business units. They must equip TECs and TCoEs with the skills, technology, and infrastructure to serve both agile and traditional software development, without creating bottlenecks in delivery which could threaten competitive advantage in the digital arms race.

“ Test Automation developers are a part of Agile teams as testing is becoming more iterative and progressive. TCoE usage has decreased at my organization as we are constantly migrating towards the best testing practices in the market. **”**

CMO,
High Tech, India

Summary

Organizations have several options when building an industrialized test center of the future. The challenge is to combine flexibility and agility with efficiency and reuse. It can be overcome with transforming the massive centralized test factories or TCoEs into decentralized test operations in the domains and line of business or vice versa. But this must be guided and supported by a unified TEC.

For most enterprises the traditional world for core systems and the nimble agile world for digital applications will coexist. Each of these areas demand their own industrialized approach to QA and testing. But across these worlds the TEC will provide unified guidance and coherent choices on technologies.

Organizations must avoid the temptation to change their current working model in favor of a prospective model without thorough analysis and assessment of all needs and demands that coexist in the bimodal world of IT. Those considering a model change for their QA operations should look at their own maturity in terms of organization design, skills of key in-house personnel, and processes. We recommend that organizations run a thorough assessment of their organizational needs to maximize the benefits of either a TEC or a TCoE. This assessment can address all the aspects related to technology roadmaps, Agile/DevOps adoption, test lifecycle decisions, and workforce transformation in order to recommend the right road-map.

Test Data Management & Test Environment Management

Test environments and test data continue to be the Achilles heel for QA and testing

Shiva Balasubramaniam Vice President, Financial Services, Capgemini

The practice of Test Environment Management (TEM) has evolved significantly over the last few years. Yet, certain challenges remain. In particular, the insufficient integration of environments and poor management of data are two key problem areas in which a lack of skills and technology continue to hamper progress.

The industry currently uses both permanent and temporary environments for QA and testing, some of which are on-premise while others are in the cloud. As per last year's survey, the industry was predominantly using non-permanent environments (whether on-premise or cloud-based). This trend seems to have strengthened very slightly this year, with an average 73% (up by 1 percentage point since last year) of all test environments being non-permanent. Interestingly, the percentage of testing carried out in both cloud-based as well as non-cloud-based temporary test environments has fallen since last year. Instead, there is an increased use of developments like containerization which indicate an interest in creating and using temporary environments. According to

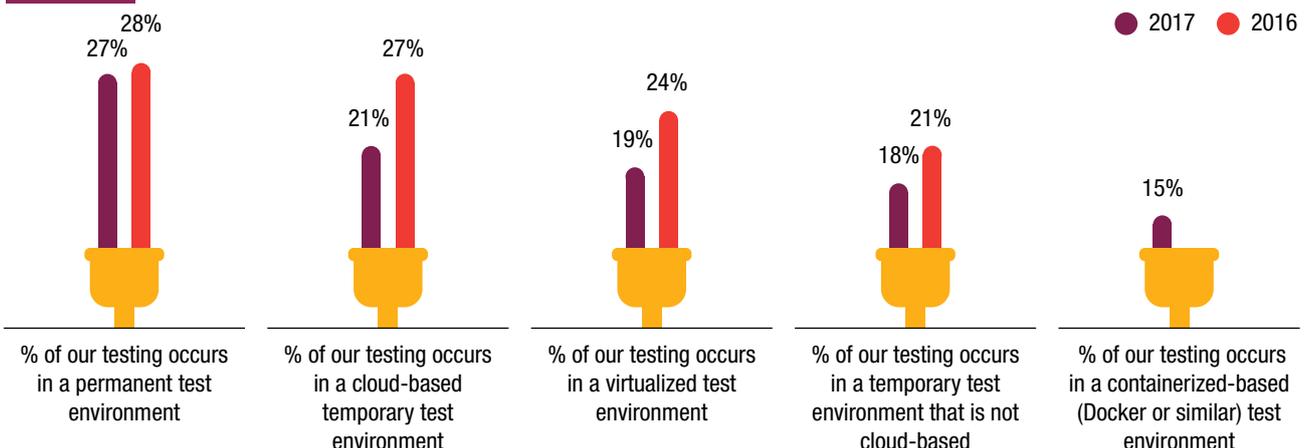
respondents, an average 15% of all test environments were containerized-based test environments.

This pattern follows the trend for virtualization that was seen last year and taken together, these trends demonstrate that while the QA function is slower in cloud adoption, it does focus on supporting Agile and DevOps by facilitating both continuous testing and rapid creation and archiving (snapshots) of environments. This augurs well for the industry and points to a greater adoption of cloud in the coming years. Thus, it is likely to lead to huge opportunities for both cloud and virtualization tool vendors to fulfil the test function's need for end-to-end test enablement and speed in environment readiness.

Another new trend seen in this year's survey is the verification of infrastructure and environment after migrating to cloud-based testing. This is the result of organizations learning from past failures and from the interruptions to end-to-end agile testing caused by cloud migration.

Proportion of testing in different types of environments

FIGURE 21



Cloud containers to speed up Test Environment Management

The QA and testing function is still grappling with the fundamentals of test data and test environment management in the cloud. This year’s survey shows that the “inability to manage excess needs for test environments” has increased to become the most significant challenge for test teams, rising to 48% of survey respondents, compared to 45% in 2016. This was followed by “a lack of visibility to test environment availability” (47% of respondents) and “a lack of availability of the right tools for testing”(47% of respondents). Interestingly, “having to maintain multiple versions of test environments” which was the most cited response in 2016 at 48%, fell eight points to 40% in this year’s survey.

A point to be noted is that the top two concerns highlighted by this year’s survey results are related to environments: one deals with demand management and the other with supply management of test environments. On the demand side, many of the environment-related challenges have to do with the configuration of test environments. Such challenges are invariably the product of the fragmented nature of

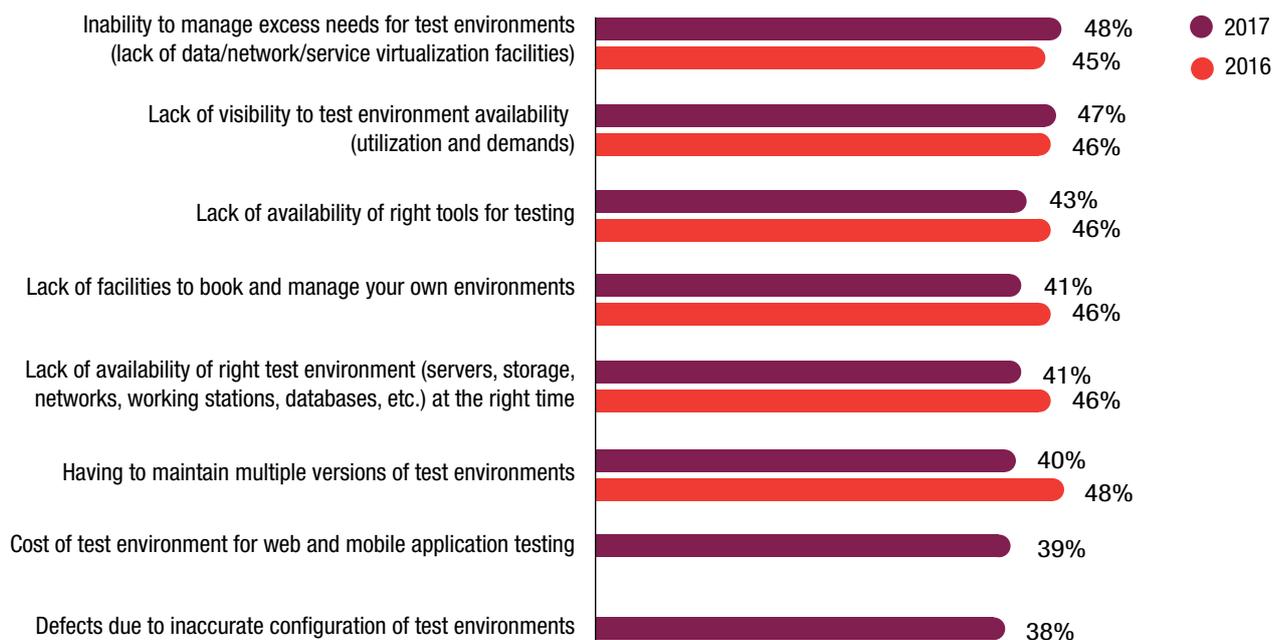
environment management activities: activities which may be managed by any one of the teams responsible for testing, infrastructure, development, or a combination of all three. These teams do not always communicate as well as they should. In some places, we see good processes but overall, we see a lack of best practice as well as automation.

On the supply side, the major challenge is the utilization of available environments. We see some ineffective environment management capabilities and as a result, organizations can miss the opportunity to re-purpose some of those environments for other users. However, we have also seen some improvement in this area over the last two years.

The third most important concern has to do with tools. Such challenges are not related to conventional test tools but instead concern tools for newer methodologies such as Agile and DevOps and their ability to sit in complex heterogeneous environments. This clearly points to challenges in bimodal IT as we saw in last year’s survey results.

Challenges with test environment management

FIGURE 22



Focus on test data compliance

Concerns related to test data management fall under two broad categories. First, big data, such as digital business, relies heavily on analytical applications that exploit unstructured data, such as video, social media text, and photos. It also means dealing with high-volume, high-velocity data, such as click-stream or geo-location data. Such big data sets are hard to replicate synthetically, which makes it difficult to create test data for these applications.

The second set of challenges relates to data compliance. This is because simply copying real-world data, either for big data or relational-type structures, risks contravening increasingly onerous data protection laws. For example, the EU's General Data Protection Regulation (GDPR) is set come into force in May 2018 for all companies operating in the EU, whether they are based there or not. It also applies to off-shore centers of excellence that carry out testing for organizations operating in Europe. Fines for non-compliance can be €10–€20 million or 4% of global annual turnover, whichever is greater. As these are not insignificant amounts,

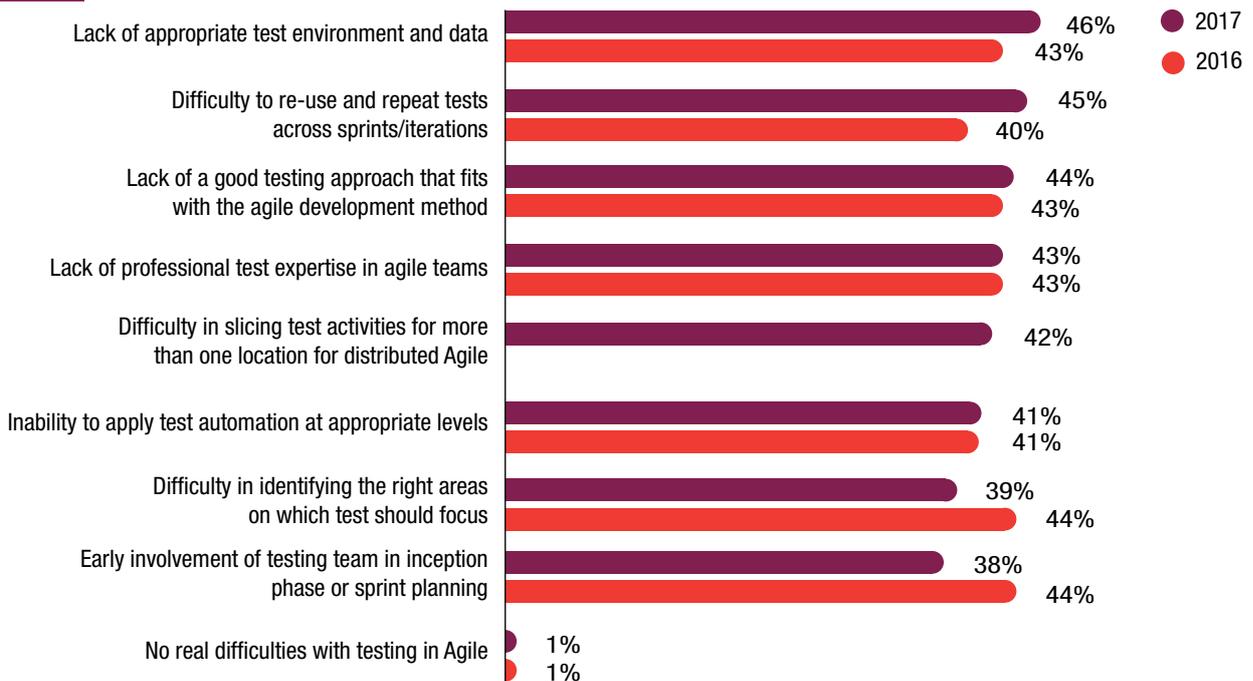
it's no surprise that concerns related to data compliance are prominent for most IT departments today.

The GDPR will undoubtedly create major challenges for test data management in the coming year, an area already perceived as challenging with regard to the adoption of Agile and DevOps. For instance, 46% of respondents say a lack of appropriate data and test environments is their greatest challenge when applying testing to agile development. To tackle such concerns, an increasing number of organizations will appoint chief data protection officers who will be held responsible for compliance and regulatory issues.

Data protection and privacy laws also raise concerns about the security of test environments. If an environment contains personal test data and suffers a security breach, businesses need to notify the authorities of the breach immediately. Do test environments have the capacity to detect data breaches? This is a question test managers need to ask themselves.

Challenges faced in applying testing to agile development

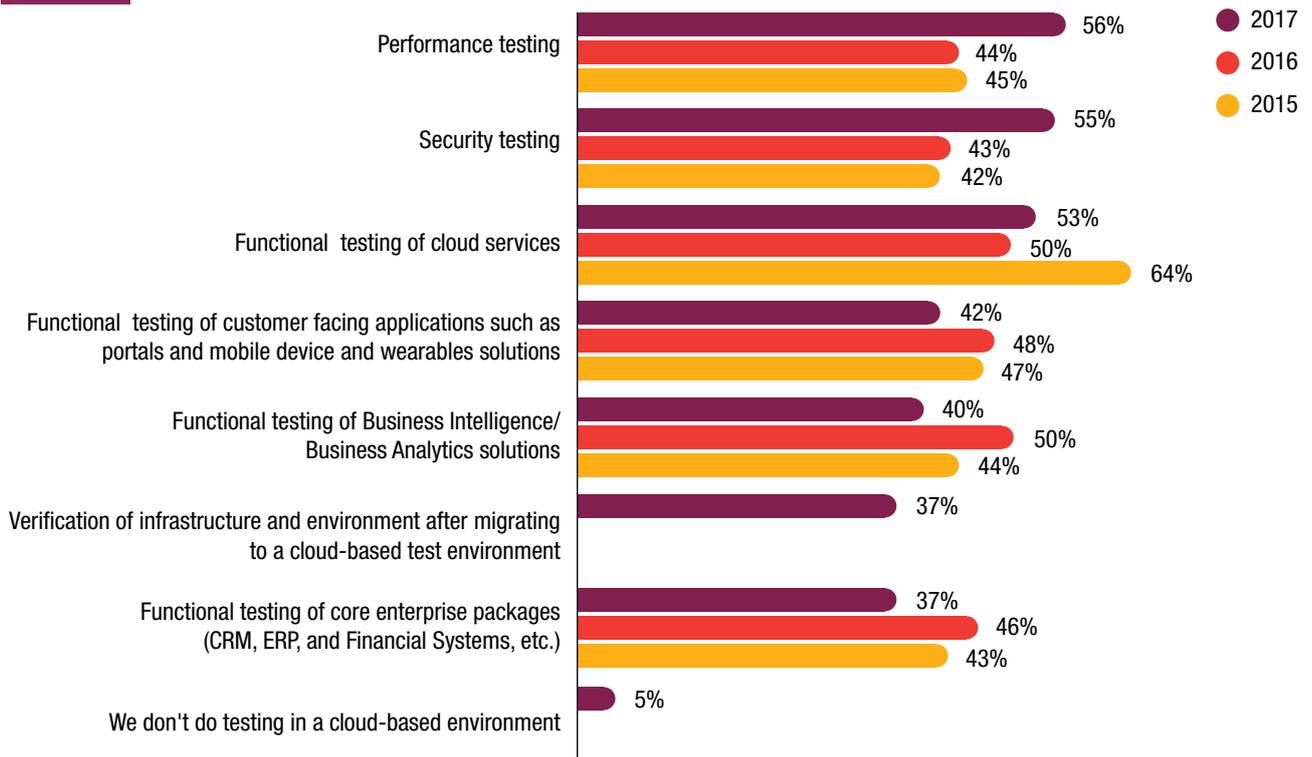
FIGURE 23



Test data struggles with the omni-channel challenge

Types of tests performed in cloud-based test environments

FIGURE 24



This year's survey shows that performance and security are becoming the most popular forms of testing performed in cloud environments, at 56% and 55% respectively. They both grew by 12 points over the last year and overtook "functional testing of business intelligence and analytics solutions" and "functional testing of cloud services", which were joint leaders with a 50% score in 2016. In 2015, functional testing was the dominant form of testing in the cloud with a 64% score, 17 points ahead of the next category.

For test environments and test data, we also see great challenges with regard to the testing of omnichannel systems. According to the survey, when asked about the challenges in testing mobile and multi-channel applications, as many as 41% of the respondents said they did not have in-house testing environments. This is an area that needs to improve in the coming years.

“ Test environment stability and test data are the main challenges in QA and testing today. ”

IT Director,
Germany



Summary

We see promising signs of improving efficiency in Test Environment Management as organizations adopt containerization. With the container approach to provisioning environments, organizations can create an executable version of the environment from which developers and testers can both work. It is the trend in environments that most promises to reduce the testing lifecycles.

Test environments and data already present serious challenges for organizations as the demands of ecommerce applications and big data analytics coincide with regulatory compliance. While poor communication between teams can hinder ambition to improve cycle times, the container approach to provisioning environments presents an opportunity to improve performance in the way digital business continues to demand.

We propose that the integration of environments is a prerequisite to dealing with their complexity in the modern age. We also propose that intelligent integration will provide smarter exchanges between test environment management systems, test data management systems, and the underlying test function to manage the test data and environments spanning heterogeneous technologies. Finally, in order to enable organizations to control the proliferating environments, we suggest automating the complex and run-time decision-making process so test teams can go beyond automation, integration, and intelligence to automated decisioning. On the horizon is the holy grail of the test ecosystem: a truly intelligent platform that is self-aware and self-adaptive. But it remains some way off.

QA and Testing Budgets

Budgets in flux as changes sweep through testing

Shiva Jayaraman

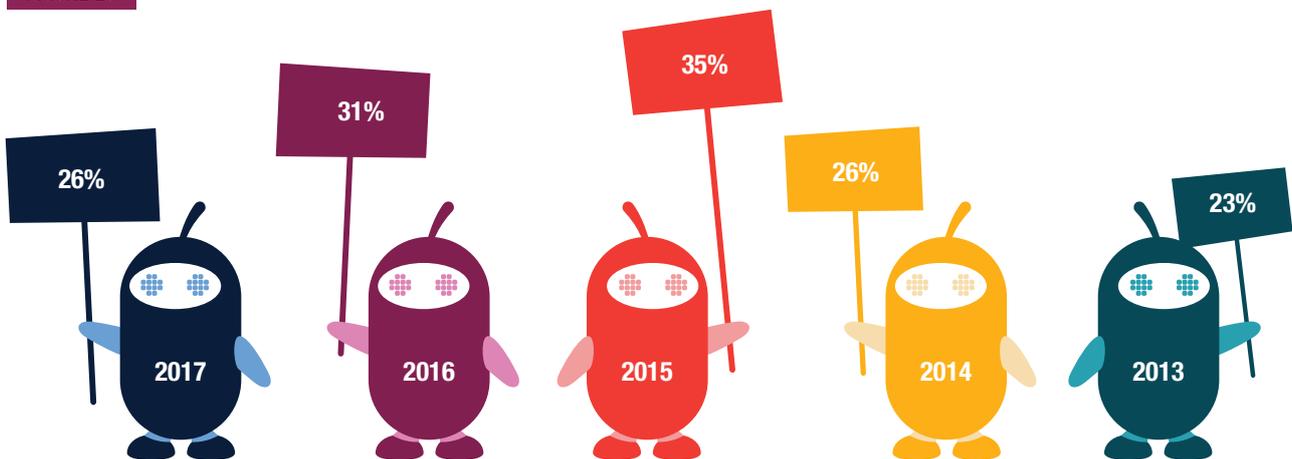
Vice President, Large Deals, Digital Assurance & Testing, Sogeti, Capgemini Group

Julian Clarke

Senior Director, Financial Services, Capgemini

Proportion of total IT budget allocated to QA and testing

FIGURE 25



Budgets tell a story. They show where the priorities are: what the business wants to do more of and less of. They tell us which activities are getting easier and which are dragging the business backward.

It is reassuring to see that budgets for quality assurance and testing continue to benefit from improved efficiency. The proportion of total IT spending on quality is 26%, down from 31% in 2016 and 35% in 2015. This is a sign that spending is falling back to the reasonable level of 25%, one that marks a good balance between feature creation and feature validation activities. However, when asked about historical spending,

68% of survey participants say they have seen an increase in the proportion of IT budgets spent on QA and testing over the last four years, up from 63% in 2016.

Finally, the organizations' projections regarding future costs is a concern. Survey respondents continue to be pessimistic about their ability to control spending. For example, in this year's survey, the respondents project that in 2020 they expect to spend 32% of their IT budget on testing, six percentage points more than their current level.

DevOps adoption is reducing clarity in measures of test budgets

Overall though, the drop in test budgets may point to organizations achieving greater efficiency in testing. However, there are other effects. While it was easy to measure test budgets in the centralized shared-service model, with the introduction of Agile and DevOps, where teams are

devolved to the business units, it becomes it harder to account for all test activities in an overall project budget. Similarly, organizations are still unsure whether Software Development Engineers in Test (SDETs) should draw from the test or development budget.

The story takes another twist when we look at expectations of future spending. On average, respondents expect their quality assurance and testing budgets to increase to 32% of IT spending by 2020. If increasing efficiency explains the

fall in budgets this year, then why do the same respondents expect to become less efficient in the future? Other factors are clearly at play.

Digital businesses plan to invest more in testing to protect brand

One explanation is that businesses are becoming more cautious in their digital offer. In the past few years, time-to-market advantage for new products and services was paramount and with the introduction of DevOps and agile methodologies, there was a sense that quality systems could be produced in ever-decreasing cycle times. But more recently, businesses are becoming aware of the high-profile nature of any customer-facing failures or data breaches, news of which can spread like wildfire on social media and

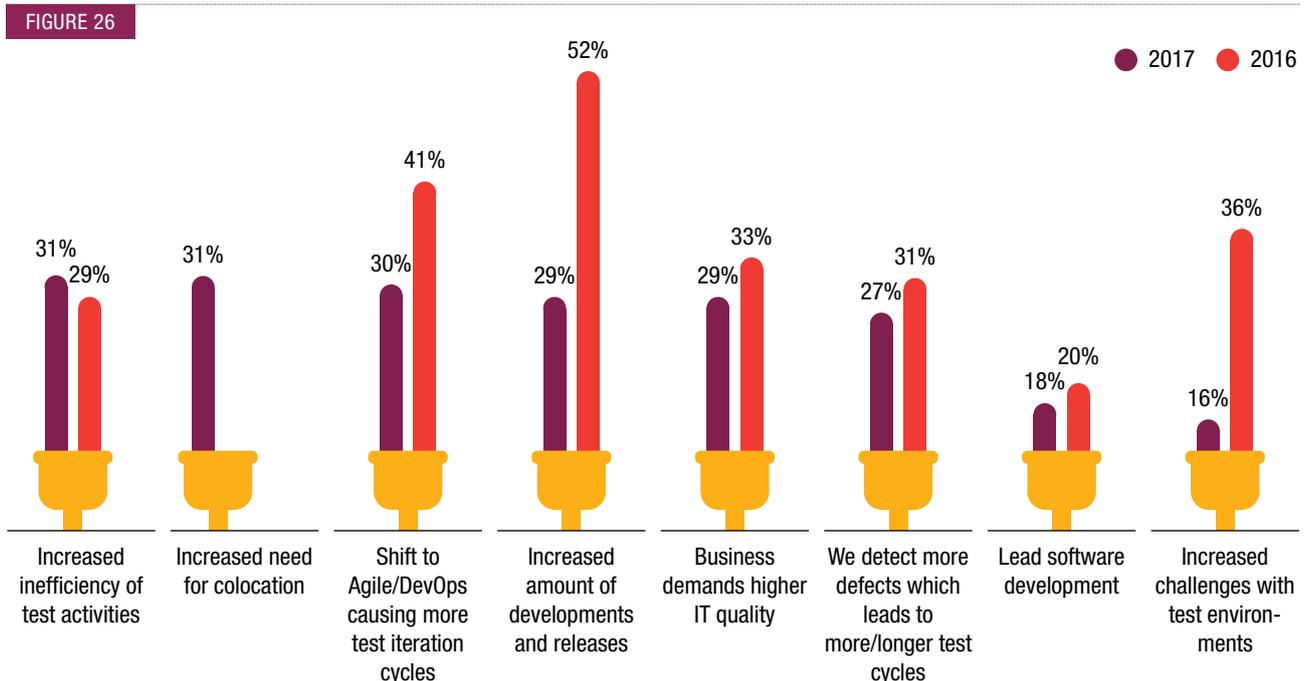
can cause significant financial consequences. Organizations are aware of the impact of any outage or security breach on brand reputation and are desperate to spend to mitigate these risks. A small error in security, for instance, can be so damaging for brands that it takes years for them to recover from the mishap. Speed is still important but there is a sense that organizations are re-calibrating to assure quality, which may explain why respondents expect to see spending rise.

Inefficient test processes and colocation initiatives drive increases in testing costs

The respondents attribute the increase of their spending on QA and testing to several causes: 31% of respondents say increased inefficiency of test activities is a major culprit for their increase in budget spending on QA and testing over the last four years. The inefficiency of test activities has several

root causes. First, while automated testing tools exist, our survey shows organizations do not always use them. For example, only 16% of end-to-end business scenarios are executed with test tools. Second, organizations do not reuse test cases as much as they could. Finally, an insufficient

Factors impacting the spike in QA and testing budgets



ability to define the right test coverage and test depth is affecting the efficiency of test activities.

The increased need for colocation is also having a major impact on testing costs, with 31% of respondents citing this cause.

Two other factors that are still viewed as significant causes of increasing the test budget are “shift to Agile and DevOps causing more test iteration cycles,” cited by 30% of the respondents and “increased amount of development and releases,” cited by 29%. However, it is important to note that these causes have come down significantly in the last year: in 2016, 41% and 52%, were attributed respectively. This declining trend shows that the QA and test organization is better equipped to deal with the increased flow of more, but smaller, software feature developments that are part of the Agile and DevOps transformation.

To understand the drivers for QA and test budgets, it also helps look at the proportion allocated to categories of hardware and infrastructure costs, tools and license costs, and human resources.

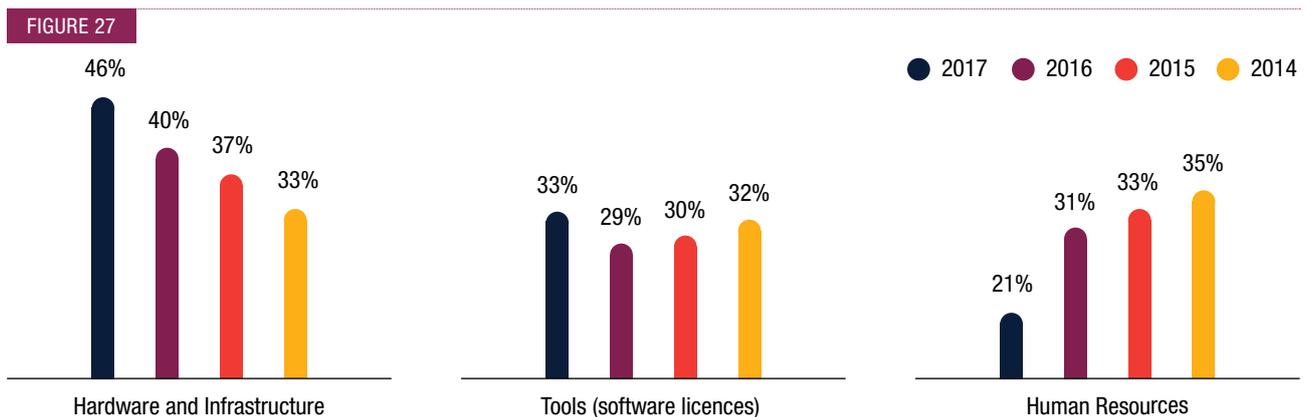
The increased use of QA and test tools is reflected in the survey results where we see the proportion of the test budget spent on them climb from 29% in 2016 to 33%

in 2017 which correlates with the increased level of test automation throughout the test process. The cost of traditional automation tools has fallen year-on-year. The rise in proportion of budget spent on QA tooling is down to increased automation in other areas, such as service virtualization, data and network virtualization needed to make Agile and DevOps testing more efficient. Tooling in these areas is yet to mature to the levels of traditional automation tools.

While demand for colocation and a shift to Agile and DevOps have increased costs, the proportion of budget spent on human resources has fallen from 31% last year to 21% this year. The QA and test function is generally in control of costs despite upward pressures from the move to insource or move work back onshore. This is a remarkable achievement. But on closer analysis, the pressure on the human resources budget does not fully explain why respondents continue to be concerned about raising costs of future QA and test budget.

Fears over future costs mostly result from the shift in the proportion of spending on hardware and infrastructure in QA and test budgets. It continued to rise from 37% in 2015, to 40% in 2016, to 46% this year. We see this as an additional argument to focus on smarter test platforms.

Proportion of QA & testing budget allocated to hardware, infrastructure, tools, and HR



Summary

While it is reassuring to note that the continued spending in QA and test budgets over the last few years has been restrained and reduced, respondents continue to be concerned about rising costs in the future. Even with very good control over budgets for human resources in the face of increasing demand for insourcing and onshoring, it is the

tools, hardware, and software infrastructure that contribute the greatest pressure on QA and test budgets. This is due to the constant demand for heterogeneous tools and technologies as organizations embrace agile and DevOps methodologies.



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Automotive

Software assurance vital as Automotive sector shifts to mobility services



Kai Grambow Corporate Vice President, Global Sector Lead - Automotive, Capgemini Group

The Automotive manufacturing sector is marked by the need for huge capital outlays, long development cycles and high barriers to entry. These factors make it extremely tough for new players to enter this space. On top of this, the industry has passed through a phase of consolidation which has resulted in a handful of giant companies dominating this industry. Thus, in terms of competition, there has been little disruption by new manufacturers so far. However, automobile related technologies today are at an inflection point. These technologies promise things such as driverless vehicles, ubiquitous connectivity and vehicle electrification. Thus market disruptions are being caused by technological developments and it is technology based start-ups like Uber and Tesla which pose a serious threat to the established order. Such start-ups combined with a rising environmental consciousness among consumers are expected to bring down car ownership numbers in the future.

Manufacturers are responding to these changes by putting digital engagement and customer experience at the center of their strategies. The result is a greater focus on digital markets and websites to get their brand value across to consumers at every possible opportunity. Manufacturers are also offering customers the ability to customize models to a greater degree, creating challenges for inventory management and supply chains. Lastly, in-car technology including navigation, online connectivity, comfort, control, safety and entertainment are all designed to enhance connection with the brand by presenting consumers with a home-away-from-home or a working environment. There is also a transformation taking place focused on the automation of production and supply chains, through the use of IoT, Big Data and artificial intelligence. All of these trends are having a profound influence on QA and Testing

Increased product quality an objective for testing

When we look at the motivations for investing in software testing, the automotive sector rated nearly all objectives higher than most industries. Half of the respondents in the automotive sector rated an increase in the quality of software or product as a very important objective, compared with 41% of all sectors. The only objective it rated lower than all industries was the desire to protect the corporate image and branding, at 25% versus an average of 27% across all industries.

When asked about the objectives for IT overall, the Automotive sector shows a preference for enhancing customer experience, at 51% compared with an average

of 38% across all sectors. Increased output, by implementing more requirements from the business, was lower than all sectors, at 27% compared with 32%.

Gigantic leap in assurance of autonomous vehicles

The focus on quality is not only important for products available now, but also for those soon to arrive. From the beginning of the next decade, we expect to see self-driving, autonomous vehicles being launched in the market. Their development presents a severe challenge for software testing. Public acceptance of these vehicles will depend on their safety record, which will, in turn, depend on the quality of the software which controls them.

The software controlling autonomous vehicles will need to be reliable as well as secure. In particular, communication with surrounding vehicles and central management is potentially a vulnerable area which hackers will attempt to exploit. Part of the role of software assurance will be to ensure they do not succeed. In essence, assurance teams will need to move from testing software to testing algorithms. Considering current capabilities, this is a gigantic leap for QA and Testing, one for which the industry needs to begin preparing.

Maturity in IoT testing

As can be expected from a manufacturing industry, the Automotive sector is more likely to have a test strategy for IoT than other sectors. Forty percent in the sector rate their IoT strategy as fairly mature, compared with 32% in all other sectors. Even so, testing non-functional aspects of IoT, including portability, interoperability, and reliability is rated as the greatest challenge by 35% of respondents in the sector, compared with 27% in all sectors. Testing interactions between the different layers, including device, hardware, gateway, storage, user or application interface is named as the greatest challenge by 37% in the automotive industry as compared to an average of 26% across all sectors.

Automation of software testing is seen as vital by IT leaders in the Automotive sector. As the roll-out of IoT creates an explosion of data generated by enterprise and operational applications, so the proliferation of devices, operating systems and infrastructure exponentially increase the number of test scenarios required. Keeping control would be impossible with manual testing alone.

Challenges in test automation

Fortunately, adoption of automation in the sector is relatively strong. When asked about the technical challenges in developing applications, only 38% of respondents name too much reliance on manual testing, compared with 48% for all sectors. The result is mirrored in the automotive sector's view of the challenges in introducing test automation. Overall,

it sees automation as less of a challenge than other sectors. For example, the challenge of creating a higher emphasis on end-to-end lifecycle automation for better return on investment was cited by 41% in the sector compared with 52% for all industries.

There are, however, two challenges with test automation that autos experience in measures more than the overall average. Up to 43% of the Automotive respondents cited a lack of skilled test automation resources, against the sector-wide average of 40%. Likewise, 44% from Automotive firms cited the arduous need for tech-orientation, multi-skilling, and frequent up-skilling, as a barrier to implementing test automation—the overall average is 41%.

We are seeing a gradual introduction of agile and DevOps methodologies in the Automotive IT department. As elsewhere, it has an impact on software assurance and testing. While this is particularly true of consumer and dealership facing applications, many back-office applications are also employing agile development. However, where safety is a factor – in engine management software, for example – agile methodologies are often rejected in favor of taking the testing out of the development cycle. This is placing limits on the extent of agile roll-out compared with internet-native organizations.

But Automotive manufacturers do need agility in another sense. It once took an average of six years to introduce a new model, and the industry knows this is not fast enough. IT application strategy will need to support a faster pace of product development.

For those organizations using agile development, the ones in the automotive sector were less likely to use the Scaled Agile Framework (SAFe) approach to testing (50%) when compared with all industries (58%). Although it is generally less popular than SAFe, the distributed agile model is used more often in the Automotive sector (45%) than all sectors (41%).

Agile development means challenges in applying test automation at appropriate levels for Automotive firms (53%) more than all sectors (41%). However, skills seem to be less of a problem. Forty three percent of all sectors find the lack of professional test expertise a challenge in agile development, while only 29% in the automotive sector find the same.

Testing Centers of Excellence popular in automotive

We see a strong trend towards the industrialization of software quality assurance and testing in the automotive sector, through Test Centers of Excellence (TCoE), where resources and skills are gathered in a central unit. The



industry is given to off-shoring software development and so it exhibits a strong bias towards outsourcing TCoEs compared with other sectors. The use of a managed service model with expert QA vendor, is very important according to 38% of respondents in the sector, compared with 26% of respondents in all sectors.

At the same time, there is also a preference for the Test Excellence Center (TEC) model, where testing is devolved to development teams, but environments, tools, data and technical expertise are managed under a central umbrella. Use of TECs is very important to 41% of respondents in the Automotive sector, compared with 30% in all sectors.

Industrialization takes on another dimension in the Automotive sector, as development and testing of vehicle components are often outsourced to small specialists. As more components become digitally controlled, these providers are moving into software testing.

Environments and data an issue in development

Test environments and test data are a challenge for the Automotive sector. Rating the technical challenges they experience in developing applications, 64% in the sector name lack of sufficient development and test environments compared with 56% for all sectors. The greatest challenge in environments comes from the inability to manage excess needs for test environments, such as a lack of data, network or service virtualization facilities, according to 62% of respondents in the automotive sector compared with 48% in all sectors. The issues with environments and data are contributing to difficulties in rolling out agile development in the sector. Lack of appropriate test environment and data is

a top challenge when applying testing to agile development according to 55% in the automotive sector compared with 46% in all sectors.

The automotive sector spends slightly more than all sectors on software quality assurance and testing than all sectors. It spends 29% of IT budgets, compared with 26% in all sectors. However, the pressures on budgets show a more marked difference with other sectors. Business demands for higher IT quality are named by 60% of respondents in the sector as having a big impact on test budgets, twice the figure of 29% for all sectors. Increased complexity of IT applications is also a big challenge for 40% in the sector compared with 18% in all sectors. However, test inefficiency is less likely to be a problem when compared with other industries: it is only cited by 27% in the automotive sector compared with 31% for all industries.

Summary

The Automotive industry is driving rapid digitalization in response to the threat of mobility services to its business model. As cars become more digitally controlled, and the driver and passenger environments more digitally enhanced, software testing will become increasingly critical for both safety, as well as an enhanced customer experience. The industry is mature in its approach to IoT testing, as we expect in the shift towards Industry 4.0 and flexible, efficient supply chain. It also shows a greater adoption of automation than most other sectors. The sector will need to maintain focus on automation and smart test solutions in order to assure the level of product quality and customer experience transformation in tomorrow's world where mobility services are becoming more dominant.

Consumer Products, Retail and Distribution

Consumer Product, Retail and Distribution firms open a new chapter in digitalization



Theodore Levine

Executive Vice President, Application Services, Capgemini

Tim Bridges

Executive Vice President, Global Sector Lead-CPRD, Capgemini

The Consumer Product, Retail and Distribution (CPRD) sector was at the forefront of the big bang of Digital Transformation. In the dotcom boom, it was the retail sector which first witnessed, suffered from, and ultimately exploited the transformative power of the worldwide web and related internet technologies. As they try to keep up with on-going trends in social media and mobile technology, firms in this sector need to see off threats to their brand value on all fronts. In this era, mobile, e-commerce, supply chain management, product identification and customer intelligence will provide a critical competitive advantage in consumer industries. Quality Assurance and Testing can demonstrate its value by ensuring these systems are fit-for-purpose, reliable, usable, secure, and are delivered on a timely basis.

As a proxy for Digital Transformation, the survey results show the CPRD sector is more likely to appoint a chief digital officer (CDO) than other sectors (43% versus 40%). Over time we have seen digital strategies develop in the CPRD sector and patterns emerge. In the early stages of transformation, there was a trend towards appointing a CDO to drive initiatives. However, the strategy risks compartmentalizing digital transformation: it is easy for people to see engagement with the digital agenda as someone else's job. More recently, we see digital strategy subsumed into operational strategy. After all, Amazon does not have a CDO.

Consumer expectations force digitalization though the supply chain

The CPRD sector should embed their digital strategy in operations because Digital Transformation is far-reaching and enables them to take on more than just multi-channel engagement. Although digital interaction with consumers is the 'front-end' of the business, everything the businesses do, should ideally respond to information gathered from the analysis of consumer and customer data, whether that is e-commerce click-streams, social media sentiment or sales records. To bring new product and special offers to market in response to intelligence gathered from consumer analytics will require the digitalization of supply chains and operations, employing Internet of Things (IoT) as applicable. Meanwhile, consumers want to know about products' authenticity, as well as their environmental and social impact. Providing this information demands traceability through the supply chain, e.g., food provenance from "farm-to-fork" and initiatives to avoid child labor in supply chains. We expect to see IoT and block chain technologies employed to address these challenges.

Reducing cycle time ranked over product quality

As consumers rely on social media references and mobile commerce channels, traditional media and physical stores play a declining role in buying decisions. Brands need to be relevant to this world, to interact with it and keep up with the pace of change. We see this in our survey results. For instance, ensuring end-user satisfaction is the most important objective when it comes to quality assurance and testing, cited by 35% of the CPRD.

We see many priorities for QA and testing play out as consumer industries try to accelerate their mobile interaction with customers. For example, a mobile app may offer customers of a fast food chain the ability to order a meal from a nearby restaurant and to pick it up a few minutes later. Providing such a service requires the integration of many technologies, including electronic point-of-sale systems as well as mobile platforms. It is not a trivial feat. Also, customers expect new features and offers regularly. In their desire for such new services, consumers are often prepared to tolerate some loss in service quality. Losing an order for the sandwich is not the same as losing a sizable banking transaction. However, if any issues hit the end-user, companies need to be prepared to triage solutions rapidly. Consumers may tolerate the occasional outage, but only if they are fixed quickly.

Maturing in mobile testing, but challenges remain

According to our survey, consumer industries appear to be more mature than other sectors across a broad set of challenges in mobile testing. While 52% of all respondents say there is not enough time to test mobile applications, only 46% of those in CPRD sectors agree. Similarly, 46% of the whole sample say they do not have the tools for mobile testing as against 41% in consumer industries who say the same. We see investment and development of technology and processes in mobile testing in the CPRD sector. However, perhaps because of the volume of mobile testing in consumer sectors, they are more likely to struggle to find mobile testing experts and in-house testing environments than other sectors.

Companies within the CPRD sector are trying to bridge two worlds with their QA and testing. They use agile techniques and DevOps, for customer-facing technologies, including social, web, and mobile interactions. Meanwhile, in-house technology for managing stores, products and the enterprise tend to rely on more traditional waterfall-style development. Since each model implies a different approach to testing, CPRD companies will need to account for both development models as they centralize and industrialize their testing capabilities. Overall, we see fewer companies within the sector employ agile methodologies in development as compared to other industries. For example, 48% of CPRD

firms employ the SAFe agile testing methodology, compared with 58% in all industries. 15% percent of consumer companies have no specific approach to testing in agile, compared with 5% of all industries. A similar picture emerges with the application of DevOps methodologies.

Use of third-party service providers in both development and testing can help explain the slower introduction of agile and DevOps in the sector. Companies within the CPRD sector are more likely to use a TCoE (Test Centers of Excellence) than other sectors (35% compared with 31%). At the same time, 36% of CPRD Companies, are likely to outsource in a managed service model with expert QA vendors compared with 26% of all organizations. We have seen consumer companies outsource development and testing of enterprise applications, to off-shore locations, in large-scale, long-term deals, largely to reduce costs. This leads us to question whether these relationships are flexible enough to cope with the changing needs of the sector as it moves further towards agile development. The contracts and performance metrics created for waterfall development can be difficult to adapt to the agile world. At stake is the time-to-market in the digital offer. There may be cause to re-think these arrangements.

Containerization growing in test environments

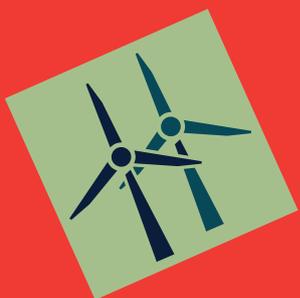
The CPRD sector shows a slight preference towards cloud computing models, both for running applications and testing. For instance, companies within the sector are more likely to have a greater proportion of their applications running in the private cloud: 49% says they are running 21–30% of their applications in the private cloud, compared with 44% of all industries. We see similar trends for innovation in test environments. While the trend for cloud-based testing mirrors all industries, consumer industries lead in the containerization of environments. 17% are likely to carry-out 20–30% of their testing in containerized environments, compared with 11% of all industries.

Summary

We are already seeing leaders in the CPRD industry eyeing the next transformation in digital commerce, which may well come in the form of voice-activated commerce and automated replenishment. The popularity of Amazon's Echo voice systems, which promises to incentivize the ordering of goods from Amazon, is prompting the industry to consider what voice-activated commerce means for retail and brand identity. Similarly, automated replenishment is creating new threats – and opportunities – along with a new flood of data to analyze. CPRD firms will need to apply everything they have learned about quality assurance and testing during the rapid development of mobile applications, to keep pace with these waves of innovation. Whilst the sector may have been at the forefront of the digital transformation, they are certainly not yet near the end.

Energy and Utilities

The Internet of Things (IoT) shows testing maturity in Energy and Utilities



Perry Stoneman Executive Vice President, Global Sector Lead-Energy & Utilities, Capgemini

Digital transformation is sweeping across all areas of the economy. But in the Energy and Utilities sector, it's not the only change organizations have to contend with. They will also have to manage the transition to renewable and low-carbon energy, radically altering the way the sector sources energy and distributes it to customers.

Solar power will soon become the cheapest source of electricity and will be accompanied by a shift to more intelligent, responsive distribution grids, as consumers and businesses produce and store electricity on their own premises. At the same time, consumers are becoming more fickle and new market entrants are increasing competition. Energy producers see an end date to their reliance on oil and coal and are increasing the pace at which they switch to renewable and nuclear sources of energy. The transition to digital business will be essential to underpin these changes, as organizations strive to become more agile and efficient.

Our survey results reveal that 47% of Energy and Utility organizations have appointed a Chief Digital Officer (CDO), compared with a 40% average across all industries. The result suggests the sector's maturity in Digital Transformation, since, like all sectors, about a quarter of organizations say the business leadership (C-suite) leads Digital Transformation. However, 9% of utilities and energy organizations say they do not have a CDO as Digital Transformation is not part of their strategy, compared with 6% of all organizations.

Product quality paramount

When we look at drivers for Quality Assurance and software testing, one of the two most important objectives is increasing the quality of software or product which is cited by 48% of utilities and energy organizations. This is higher than the average for all sectors, which is 41%. Detecting software defects before go-live is the lowest ranked at 22%, and lower than the average of 28% for all sectors. Rating for end-user satisfaction as a driver has fallen. In 2016 it was 45% for the sector, making it one of the highest among all sectors; in 2017 it fell to 30% and was among the lowest. The result could be a concern for the utilities sector, which is seeking to become more customer-focused by developing a digital engagement strategy similar to the CPRD sector that uses both web-based and mobile channels.

In utilities, we see market trends driving testing. The market is being altered by the arrival of the so-called utility-in-a-box, which promises to create a full digital retail utility at half the running cost of a conventional utility. Brick-and-mortar utilities say they need to lower costs to this level within four

to five years, a short time-frame for firms used to running assets for 30 years. This is slashing software development and testing cycles.

However, we also see a classic bi-modal IT split, as utilities companies are forced to retain long-standing assets – both physical infrastructure as well as of software applications such as SAP and Oracle. In these legacy applications, third-party testing is growing. Outsourcing deals are being renewed and increasing in their scope, both in testing and application hosting.

Mobile solutions for field engineers

In the Energy and Utilities sector, adoption of mobile solutions covers internal processes, as well as customer-facing applications and services. There is an increasing desire to serve field engineers through mobile channels, both to create efficiencies in processes and to ensure organizations can recruit a younger, digital native workforce. In areas of the field where data quality can have an impact on health and safety, there is a demand on QA and Testing to be able to verify the validity of the data collected on mobile devices as part of the testing process. As new devices, such as Google Glass style eyewear, become more common in the field, testers can expect to make them part of their scenarios.

In our study, we see the internal focus of Energy and Utilities sector in relation to mobile testing. Asked about the greatest challenge in testing mobile and multi-channel applications only 30% in the sector say they don't have the devices readily available, compared with 40% across all industries. Hence portability of mobile applications is less important to the sector: only 30% see it as a challenge compared with 38% overall. However, some aspects of mobile testing remain a challenge. Fifty-six percent in the sector say they do not have the right testing process or method compared with 47% in all industries.

As companies progress with Digital Transformation and incorporate mobile channels in their strategies, we see a shortage of testing skills in the sector. This is also true of the move to embrace agile development, which we see in customer-facing applications rather than legacy applications such as ERP. Perhaps, it is as a result of this, that the SAFe (Scaled agile framework) methodology is used by only 40%, compared with 58% in all sectors. A similar trend arises in the set-up of agile Test Centers of Excellence (TCoE) when addressing which testing roles are shared across multiple scrum teams. Software Development Engineer Testers (SDET or technical testers) are cited as an example by 33% in the Energy and Utilities sector, compared with 47% in all sectors.

Because the industry faces challenges both in digital and physical transformation, we see a growing trend to reach for external testing services and cloud testing, as a model for outsourcing IT. Linked to this, we see a move to cloud-hosted

applications and cloud-based testing; the so-called Testing-As-A-Service model.

IoT booms in homes, engineering and infrastructure

While the transition to Internet of Things services, with its implications for testing, is on the agenda across all sectors, in Energy and Utilities it is all the more pressing. In the utilities sector alone, there are around 300 million smart-meters in use worldwide; a figure which is growing rapidly. With the explosion in the roll-out of these devices, we expect utilities to focus on the cost-to-serve each unit, including end-to-end testing, as utilities look to manage them remotely. We expect around 60% of homes will have smart meters at some point between 2020 to 2025, with a prevalence of third party management of these devices. We expect utilities to learn lessons from the early roll-outs, including how they test meters in the laboratory before implementation.

Meanwhile, we see both Energy and Utilities organizations among the leaders in the implementation of IoT devices for measuring and collecting data from engineering hardware such as pipelines, drilling machinery, and power transformers. In such an asset-intensive industry, competitive advantage can come through maximizing return on capital by reducing downtime and lowering cost of maintenance. Both will come via data collected by IoT devices, processed by an IoT platform that feeds into analytics software. Furthermore, we see IoT management going straight to a cloud platform, either internally or from a third party, in 80% of use-cases. In some cases, testing will be bundled with these services.

In line with this picture, the survey results show relative maturity in IoT testing in the sector. The number of Energy and Utilities organizations saying they have a specific strategy for testing products in an IoT environment, went from 25% in 2016 to 38% in 2017. The average for all sectors is 32%.

With the kind of strategy employed for smart grids and predictive maintenance, testing will be extremely important. The potential volume of data will be such that even today's 'Big Data' technologies will struggle to cope. The more intelligence embedded at the edge of the network, nearer devices themselves, the better. But this requires thorough, end-to-end testing to offer benefits in practice.

Summary

The Energy and Utilities sector is responding to two transformations at the same time. Firstly, it must digitize its operations and the way it engages customers and consumers and secondly it must move towards renewable and low-carbon energy. By leveraging the benefits of IoT, one transition can aid the other. Smart grids, intelligent energy usage, and predictive maintenance, can help organizations become more efficient and make better use of their assets. But testing skills and operations will need to keep pace.

Financial Services

Financial services sector requires a cultural shift to advance along its digital journey



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Tattoos and piercings are not the norm for employees in the Financial Services industry, but these are not normal times. A leading investment bank was so keen to speed up its shift to agile development and DevOps, it hired software engineers directly from one of the world's largest social networks. The result was a change in the appearance – and average age – of the IT department. The lesson for others in the sector, is that improving how efficiently they build and test software is not just about adopting new technology and processes. Style and culture need to change too.

Across a broad spectrum of retail banking and insurance, as well as commercial and investment banking, we see an overwhelming drive toward digitalization of services. More and more discretionary IT spending is now dedicated to the mission.

Our survey shows 45% of Financial Services organizations with a dedicated Chief Digital Officer (CDO), slightly more than the 40% average for all sectors. However, fewer organizations in the sector are likely to see the business leadership drive Digital Transformation (20%) when compared with all sectors (25%).

The priorities for testing also throw into question the way the Financial Services sector puts its desire for Digital Transformation into action. When we look at the objectives for testing and quality assurance, we find those citing end-user satisfaction fell to 24% in the sector in 2017, down from 36% in 2016. The average for all sectors is 34% in 2017. The only priority higher than average is the desire to protect the corporate image and branding, which 29% of Financial Services respondents cited, compared with 27% in all sectors.

Maturity in multi-channel services

In the roll out of multi-channel services, we see some maturity in mobile testing. Across the board, the Financial Services sector found it less of a challenge testing customer experience for multi-channel applications, compared with other sectors. For example, the challenge of “getting the right coverage of end-user expectations and requirements in the test set” scored 26% in the sector compared with 32% for all sectors.

The desire to digitize services at speed, while constantly refreshing the offer, is driving wide spread adoption of both agile methodologies and DevOps in Financial Services. For example, a large payment card firm was working on 40 agile projects five years ago. In 2017, it was running 800 agile projects. To do so, they are recruiting candidates who are steeped in the agile way of working from the internet software sector, and using them to build the transformational momentum.

Agile and DevOps create new testing challenges

In larger organizations, we see a change in the management of testing as teams are broken out of Test Centers of Excellence (TCoEs) and embedded in agile sprint teams. However, mid-tier and smaller financial services organizations are finding it hard to make the transition, and hire the skills necessary to make the jump to agile development. For example, a bank in the US mid-west wondered how it would attract the right candidates to its location outside the country's main cities.

Insurers in general have been slower to adopt agile methodologies and struggle to bring development of back-end legacy systems in line with the new way of thinking.

In our survey, we see that those adopting agile development in the Financial Services sector are more likely to opt for the Scaled Agile Framework (SAFe) methodology (64%) than the average across all sectors (58%). The difference is greater with DSDM, which was preferred by 62% in the sector, compared with 50% across all sectors.

Financial Services organizations report less challenges with testing in agile developments, compared to the average for all industries. They do not have the same difficulty in the re-using and repeating of tests across sprints/iterations, which were cited by 36% in the sectors. It is lower than the 45% average for all industries. However the financial sector reports more challenges with environments and data (53%) when compared with all industries (46%), this may be down to the volume of testing they undertake.

Opportunities lie in greater automation

Alongside agile and DevOps, Financial Services organizations are striving to make testing faster and more efficient with automation. While we hear a lot of discussion about the potential for automation focusing on the application of advanced analytics and predictive testing, for example, we find organizations can miss opportunities to automate the more basic tasks such as building test environments and creating test cases.

A more structured and pragmatic approach to automation can help accelerate test cycles, and we see an opportunity in

the Financial Services sector for test automation to be more broadly applied. In insurance, for example, companies face frequent rate and form changes. Automation has the potential to speed up testing of how these changes are implemented across legacy applications. Here, automation may be a challenge, since the solution can bridge across multiple technologies, such as Java middleware and mainframe environments. However, test automation in this context it is not impossible, and investment in this area will offer rewards.

Industrialization reflects the move to agile development

The move to agile and DevOps is also reflected in the industrialization of testing in TCoEs. While these have been popular in the Financial Services sector, organizations interpret the model in a number of ways. Overall we see a pull to place more testing expertise in agile development teams. When asked to rate the importance of elements in the setup of test operations, respondents in the Financial Services sector offer a lower score for all categories but one. The move to decentralize TCoEs for improved agility and efficiency was higher in the Financial Services sector, at 28%, when compared with all sectors, at 25%.

In banking, we see that industrialization of testing and agile development are not always opposing forces. We see industrialization of tools and environments, but that does not mean they necessarily co-locate test teams. Instead, they work in distributed delivery teams. At the same time, TCoEs have to support traditional waterfall style development. In supporting both approaches, we see best practices evolving, with few claiming they have perfected their model.

Test environments begin to support a new development model

We see a mixed picture in test data and environments. In insurance, test leaders have begun to discuss virtualized environments in response to agile development. However, it is more conversation than action. They have a strong understanding of what agile development can do for them, but the test infrastructure and data has yet to support it.

In banking, test teams are a little more advanced regarding environments and are already using containers to support their DevOps pipeline. But there is also a sense they are just getting started, and provisioning of environments has much more to offer testing efficiency.

Our survey shows the focus of Financial Services organizations on test data. When asked about the challenges in managing test data, respondents in the industry more or less mirror all sectors, aside from when complying with data security and data privacy regulations for test data, where they nudged higher than the 50% average at 53%.



Test budgets unlikely to see growth in line with Digital Transformation

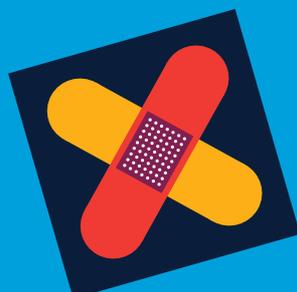
Test budgets are under the same pressures as all of IT spending. Everybody is trying to do more with less. Despite the risk to reputation and compliance, budgets receive no special treatment. In our survey, we see the concerns that the industry has with containment of the spend on testing, and this is real for the financial industry too. When asked to rate which trends have had an impact on the increase of QA and Test budgets, 34% in the Financial Services sector cite agile and DevOps causing more test iteration cycles, compared with 30% across all sectors. Remarkably complexity of IT applications is only cited by 9% of respondents in the sector as a factor increasing budgets, compared with 18% in all industries.

Summary

The Financial Services sector is caught between conflicting forces. Competition from outside the sector is forcing a rapid pace of disruptive digitalization, which impacts its approach to testing. TCoEs are moving towards playing a supporting role to help increase test activities in devolved scrum teams. At the same time, the legacy technology of their core banking applications, organizational inertia, and compliance with regulation can slow the pace of change. Yet, the industry misses opportunities to improve test automation and exploit virtualized test environments. Better application of these resources could help the Financial Services sector accelerate the difficult transition to digital services.

Healthcare and Life Sciences

Healthcare and Life
Sciences feel the
pressure on test
budgets



Timothy Moore

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Pharmaceutical firms have seen diminishing returns from their investments in traditional clinical research and development, and are turning to the promise of digital technology – from sensor-enabled pills that help measure patient adherence, to connected medical devices that measure patient vitals and deliver medicine automatically.

Underpinning all these developments is safety. Its influence on software testing cannot be underestimated. Not only is software assurance vital to safety in the digital control of drug manufacturing processes, it can also be a factor in the publishing of supporting information that comes with drugs. Any software errors which affect patient safety, either directly or indirectly, can have a huge impact on the organization in question.

The pressure to safely digitize the sector comes in the context of a new period in industry finances. Historically, pharmaceuticals companies have enjoyed high margins. That situation is now under threat from generic drug producers and global competition. Meanwhile, in healthcare, spending is always under tight control, particularly in publicly funded services.

Software quality top driver for testing

Overall, the Healthcare and Life Sciences sector, in general, rated the objectives for QA and Testing as more important than other sectors. This is particularly true of the objective of increasing the quality of software or product, the highest rated at 44% compared with 41% across all sectors. The lowest rated objective was to protect the corporate image and branding at 23% compared with 27% for all sectors.

When the survey looked at technical challenges organizations experience in developing applications we saw an inability to test integrations at an early stage because of test environment limitations rated highly among participants from the Healthcare and Life Sciences sector, at 56% compared with 51% from all sectors. Only a lack of sufficient development and test environments, at 52%, is lower than all sectors at 56%.

Innovation in R&D rather than development

We see the Healthcare and Life Sciences as a slow follower in Digital Transformation. At the moment, it is just beginning to understand the opportunities integrated digital technologies present and are scratching the surface of their application.

Experimental technologies, such as digital delivery of drugs, are on the industry's research radar. Also at the cutting edge, is the control and transfer of medication through the skin, using electric charge. Software controlling these technologies is often tested by a specialist research and development team, rather than the enterprise software development and testing function.

The overall trend in the adoption of digitization is on par with the average across all industries.

Automation struggles with virtualization

We see the widespread adoption of predictive analytics as one of the automation technologies adopted by the sector. The technique is not only applied to software testing; we see it applied to R&D, Supply Chain Management and marketing too.

When we look at the main challenges organizations face in achieving their desired level of test automation, 56% of the health and life science sector rates service virtualization highly, compared with only 38% of respondents in all sectors.

SAFe popular among agile adopters

Agile development and the DevOps organizational model have been slow to take off in the Healthcare and Life Sciences sector. They are now beginning to take advantage of these approaches, giving the sector the opportunity to learn lessons from early adopters from other industries. The use of an agile methodology is being driven by a desire to improve quality, while at the same time containing costs and maintaining profitability as the digitization spreads through the industry.

Of those organizations using agile development, the Scaled Agile Framework (SAFe) is popular: 78% in the Healthcare and Life Sciences use it compared with 58% in all sectors. Similarly, 64% in the sector employing agile use Insert Dynamic Systems Development Method (DSDM) after companies test principles compared with 50% in all sectors.

When we look at the challenges organizations currently face in applying testing to agile development, difficulty in re-using and repeating tests across sprints and iterations is named by 57% of organizations in the Healthcare and Life Sciences sector compared with 45% in all sectors.

However, other survey results suggest a slow adoption of DevOps. When we look at the challenges in introducing automation to testing, we find difficulties with integrating test

automation into a DevOps process scores low, at 18%, with organizations in the Healthcare and Life Sciences sector compared with 38% in all sectors. This may be down to lack of progress with DevOps, rather than specific efficiency in applying testing to the organizational model.

Hybrid offshoring popular in industrialization

Industrialization of testing is a little more advanced in the Healthcare and Life Sciences sector than the adoption of agile and DevOps. Building Test Centers of Excellence (TCoEs) to centralize resources, technology and expertise is becoming more popular mainly because of the cost pressure on IT. We see off-shoring of software development, including testing, to India and Eastern Europe.

The survey shows the relative popularity of TCoE factory in a hybrid near shore-offshore model, trying to optimize cost savings while also maintaining a high speed to market. In the Healthcare and Life Sciences sector, 31% employed this model, compared with 28% in all industries. At the same time, the sector is adopting the Test Excellence Center (TEC) model, which sees testing devolved to business units or sprint teams, supported by centrally managed environments, tools, and expertise. Use of this model is cited by 30% of respondents, the same proportion as all sectors.

Data regulations present a challenge for testing

Use of virtual and cloud test environments is also slow to take off in the Healthcare and Life Sciences sector, barring a few of the largest pharmaceuticals companies, where they have been using these techniques for around five years.

Test data can cause difficulties for both Healthcare and Life Sciences companies as many of their applications process data relating to patient medical history. This can introduce complexity when using this type of data to test applications, especially offshore. Different jurisdictions around the world have different rules for the processing of medical and personal data. Among the most onerous will be the EU's General Data Protection Directive set to come into force in May 2018.

When we look at the survey results for environments and data, we see 47% of organizations in the Healthcare and Life Sciences sector say defects due to the inaccurate configuration of test environments is a challenge compared with 38% in all sectors. Meanwhile, lack of visibility to test environment availability is less of a challenge for the sector, experienced by 42% of organizations compared with 47% of all sectors.



Test budgets under pressure along with IT spending

Anecdotally we see pressure on test budgets in the Healthcare and Life Sciences sector. In the pharmaceuticals sector, in particular, we see corporate leadership scrutinizing and cutting IT spending to a greater degree than other industries. Despite the drive towards digitization, CEOs sometimes fail to understand the value of IT. Therefore IT leaders can find it difficult to protect software development and test spending.

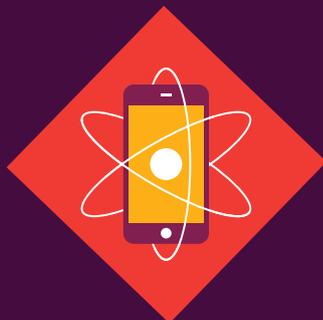
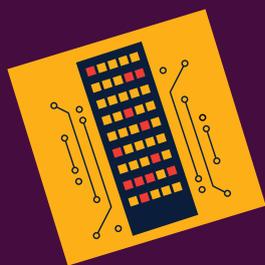
Healthcare and Life Sciences sector respondents' rated the increased inefficiency of test activities as having less of an impact on the increase of QA and Test budgets, at 21%, compared with all industries (31%). However, we see from

the survey data the pressure on test spending as digitization spreads through the industry. Increased complexity of IT applications has an impact on budgets, from 29% of respondents in the sector compared with 18% in all sectors.

The Healthcare and Life Sciences sector lags behind other sectors in its adoption of the most modern software development and test techniques. Although it is adopting innovative digitization of health and medical technologies, testing and IT budgets, have yet to achieve investment in line with these developments. As the leaders in digitization begin to see a competitive advantage from their strategy, we may see more attention to test techniques and budgets in the industry.

High Tech

High Tech sector struggles to meet testing demands with resources



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The High Tech sector includes a large number of industries such as Aerospace, Automotive, Biotechnology, Electronics, Information Technology (IT), Automation and Controls, Nanotechnology and Robotics solutions to name a few. All of these industries are at the cutting edge of technology and as such, are seeing massive changes due to the impact of emerging technological trends such as Digital Transformation, Smarter Devices, Big Data, the Internet of Things and predictive analytics. Many high tech companies are in the middle of the so-called industry 4.0 transformation, where adoption of cyber-physical systems, IoT leverage, cloud computing and cognitive computing is transforming the industry from the “automated product factories” into “smart factories”. These emerging technologies are radically transforming what these industries can deliver and this is having a direct impact on the QA and Testing function as well.

The QA departments in the High Tech industry are critical to validate and ensure that industry products meet increasingly higher standards of quality. Typically high test coverage is demanded and at the same time the industry also demands a higher speed to market. These imperatives also came through in our survey responses. When High Tech companies were asked about the objectives of their QA and Testing function, on average they gave higher weightings to objectives across the board. Among all the objectives, the biggest difference was seen in ‘detecting software defects before go-live’: as many as 39% in the High Tech sector rated the objective as very important, compared with 28% across all industries. Survey results also demonstrated the importance given to quality as an objective of the overall IT strategy. This is understandable as the impact of a product defect can have immense and sometimes even life threatening implications. As a consequence there are many regulations in this industry which drives quality and its criticality in this industry. The need to be compliant against these regulations also leads to compliancy validation, which has become an important role and service for many High Tech industry products and operations. As many as 46% of those in the High Tech sector rated quality as very important, compared with an average of 41% across all sectors. Another important objective included ‘enhance security’ (cited by 38% of respondents) which is due to the increased connectivity of High Tech products, where concerns about the safety of data has led

to an increased level of security testing to minimize the risk of data breaches. The higher weighting given to QA and Testing objectives is an indication that testing departments in these companies are held to a higher standard than those in other sectors.

As one might expect, the High Tech sector is ahead of all industries in Digital Transformation. The High Tech industry is riding a digital wave and the industry 4.0 transformation is a key driver for this. Our survey shows 45% of organizations in the High Tech sector have appointed a dedicated Chief Digital Officer (CDO) compared with 41% in all industries. However, expert opinion shows a greater usage of a number of digital technologies, such as the Internet of Things (IoT) and virtualization. For instance, as many as 39% of High Tech respondents said they had a fairly mature IoT strategy as opposed to an average of 32% for all sectors. Increased usage of connected devices, virtualization and augmented reality are also impacting QA and Testing practices in the High Tech sector.

IoT testing is maturing in the High Tech sector. Fewer organizations in the sector find IoT testing challenging in comparison to all industries. The greatest difference lies in creating test environments with virtualized end-products, devices or test data, where 42% in the High Tech sector find it a challenge compared with 53% in all sectors.

Lack of agile test expertise a challenge

The advent of agile is leading to a re-organization of workflows and restructuring of processes in the High Tech sector. Organizations are implementing agile and DevOps to speed up delivery. Continuous feedback and continuous testing are important activities in DevOps. The industry has a high demand for DevOps engineers having skills in continuous integration and automated, unattended build and functional testing. There are severe challenges to meet these needs: 55% of respondents in the high tech sector say a lack of professional test expertise in agile teams is a challenge compared with 43% in all sectors. And a lack of a good testing approach that fits with the agile development method, is a challenge for 29% in the High Tech sector.

Expert opinion suggests that the adoption of DevOps still lags behind that of agile in the High Tech sector. According to our survey, only 32% use continuous monitoring with predictive analysis in the High Tech sector, compared to 41% in all sectors. However, 40% in the sector treat infrastructure as a code, compared with 32% in all sectors.

The High Tech sector also shows some interesting trends with regard to the organization of testing. Many High Tech

organizations follow a multi-vendor strategy and their products consists of many complex sub-components. Therefore, system integration testing by a dedicated independent test organization plays a critical role. A TCoE factory in a hybrid near-shore / offshore model with optimum cost savings and high speed-to-market, is among the top two priorities of 34% of the High Tech organizations. In addition, the use of a crowd-sourcing solution model for quick test capacity, is very important to 36% of the high tech organizations. This is much higher than the cross-industry average of 28%. The High Tech industry embraces crowd testing, typically as an additional validation approach for mass-production products. A controlled beta-group can try out products after initial internal validation but before a complete launch to the market.

The High Tech sector seems to be more in line with others when it comes to the cloud. One area of divergence is in the functional testing of core enterprise packages (CRM, ERP, financial systems and so on): 25% in the sector name it as a type of testing they perform in a cloud-based test environment, compared with 37% in all sectors. Lack of facilities to book and manage environments, is a challenge to 47% in the High Tech sector compared with 41% in all sectors. However, lack of visibility of test environment availability is only a challenge to 40% of respondents in the High Tech sector compared with 47% in all sectors.

Environments inhibit test integration

One of the biggest challenges being faced by QA and Testing departments in the High Tech sector relates to Test Environment Management (TEM). According to our survey, an inability to test integrations at an early stage because of test environment limitations is a challenge for 57% in the sector, compared with 51% in all sectors. The fact that this percentage is higher than the cross-industry average, is directly related to the fact that test environments for High Tech products are highly complex and typically have to be engineered from early stage hardware components. In addition to this, there is a heavy reliance on engineering simulators for various components. It is not uncommon that the hardware components and simulators for test environment are not fully ready at the moment of test.

Summary

More than any other sector, it is High Tech, which is faced with the need to test digitally enhanced and increasingly complex products and software. Greater demands are being put on QA and Testing teams, compared to other industries, without a commensurate increase in test budgets. This year's survey, shows that respondents within the High Tech sector are increasing the test budget at a greater rate than other



sectors. Fifty-eight percent of the respondents say they experienced an increase in the proportional effort and cost spending on QA and Test activities over the last 4 to 5 years compared with 50% in other sectors.

Experts predict that it will become progressively difficult to meet the expectations of quality, speed and cost of product validation without a transformation to smart analytics,

predictive QA rules and cognitive robotic test automation. The engineering expertise and attitude of testers in the High Tech sector today is enabling the industry to move faster in the creation of intelligent test solutions, like self-aware robotic arms that can perform physical test actions, automatic image recognition comparison tools, and smart analytical solutions for automatic optimization of test scenarios.

Government and Public Sector

Public Sector keeps pace with innovation



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Unlike other sectors of the economy, funding of the Government and Public Sector depends directly on political decisions, which vary according to time and place. Inevitably, budgets are always under pressure as politicians are aware, public money should be well spent. In this context, demands to do more with less can benefit from investments in technology, which is sometimes seen as a means of lowering the cost of serving and interacting with citizens. It is the job of Quality Assurance and Testing to ensure these digital services are reliable, fit-for-purpose, and deliver the value they promise.

Appointment of a Chief Digital Officer (CDO) can act as a measure for the extent of Digital Transformation in an organization. In the Public Sector it is low. Our study found that 21% of the Public Sector organizations appointed a CDO compared with 41% of all organizations. However, the Public Sector is more likely to state it drives Digital Transformation from the Chief Executive Officer (CEO) or similar (31%) than all industries (25%).

Whether justified or not, there is a perception that Government and Public Sector organizations have struggled to get value from IT outsourcing. While large contracts in the hundreds of millions of dollars, promised to deliver skills and economies of scale, some have struggled to cope with changes in policy, as the Public Sector can lack the in-house skills to manage service providers of this size. For this reason, we have seen Public Sector organizations move towards smaller outsourcing and service deals, including engagement of relatively small suppliers. Public Sector organizations hope these arrangements will provide the flexibility and speed necessary to help support Digital Transformation. However, local legislation governing security requirements can prevent outsourcing in this way.

As well as offering current services via digital media, Government and Public Sector agencies are thinking of how to restructure organizations and re-engineer services

to take advantages of modern cloud-based software and services. At the same time, parliamentary constraints can delay transformation.

While the Public Sector does not have the same focus on omni-channel communication as we see in consumer-facing organizations, we are beginning to see more of a focus on the “customer journey”, and an application of analytical technologies necessary to predict when citizens will leave public service websites and start contacting call centers.

A mixed picture in testing budgets

Objectives for software testing in Public Sector reflect the sector’s priorities. The desire to detect software defects before go-live was higher than average at 37%, as a top-two priority whereas the industry average is 28%. Although the Public Sector does not have to compete for customers in the same way as consumer-facing services, end-user satisfaction is still a priority in software testing objectives: 38% cite it as a priority compared with 34% across all industries. The figure has also risen sharply: in 2016 it was 31%.

Our research reveals a mixed picture in QA and Test budgets. Compared with all sectors, more Public Sector organizations spend a relatively smaller proportion on testing: 27% spend between 1–10% of the IT budget on testing, well above the average of 20% for all sectors. Only 6% of Public Sector organizations spend the recommended range of 21–30% of IT budget on testing, the lowest of all sectors and well below the average of 17%. But when it comes to higher spending, 19% of Public Sector organizations, spend between 51–60% of IT budgets on testing, higher than the average for all sectors of 17%.

The range may reflect the complexity of the Public Sector and the variety of organizations it can include, from large Central Government departments, to regulatory bodies and small Local Government units.

We have seen IT spending, and spending on software testing, hold up during a difficult financial period, in the Public Sector. While Governments may see investment in IT as a vehicle for greater efficiency, and therefore helping ease budget pressure in other areas they are also expecting greater results without increasing investments. IT departments must support digitization of services without additional budget, while they are aware management are applying return-on-investment calculations with greater rigor.

Framework deals aid access to testing services

Outsourcing includes services for provision of testing, where the Public Sector score slightly higher than private sector

organizations in our research. Thirty one percent of Public Sector bodies, are likely to place a contract for testing off-shore, with high cost savings in mind, compared with 27% of all sectors.

We see the mechanism for contracting testing services easing in some areas. For example, in the UK, a central government body released eight framework contracts for QA software testing, giving its departments a choice of a total of 42 suppliers across the frameworks, who have been vetted as part of a move to make compliance with Public Sector procurement regulation more efficient.

As the Public Sector strives to provide more information and access to services online than ever before, partly to engage the public, and partly to reduce costs, we are seeing the adoption of agile development and DevOps methodologies, with a resulting impact on software testing.

Gradual move to Public Sector agile development

The research highlights that public sector organizations are increasingly looking for “T-shaped” testers, or those with a broad set of technical skills as well expertise in testing. In the context of agile, business process owners or scrum masters are more likely to drive Quality Assurance, rather than traditional test managers. It is a massive change for the management of testing. The QA and Testing function has to create processes with faster release cycles, rather than a release every two years, as some have become accustomed to. However, in some jurisdictions legal restraints and employee regulation can hinder these changes.

Our results demonstrate that the introduction of agile methodologies is not more challenging in the Public Sector, where IT salaries can be lower than, any other sector of the economy. All organizations are facing challenges. For example, 46% of all sectors find lack of appropriate test environments and data a challenge, compared with 41% in the Public Sector. However, 45% of Public Sector organizations find it difficult to identify the right areas on which tests should focused, compared with 39% of all sectors.

Although changing processes is reputed to be difficult in the Public Sector, it appears to be managing the transition to agile style development as well as any other sector. This relative strength may be down to recruitment of more private sector IT leaders and test professionals during the economic down-turn, as well as IT moving up the agenda in the Public Sector. The move to digital services has been a culture shock to some Public Sector organizations and the budget cuts, have made efficiency through digitization an imperative. Also, there tends to be a spirit of co-operation between IT



organizations in the Public Sector so peer-to-peer learning may be a factor. In some cases, we even see a merger and centralization of technology teams to support digitization.

Mobile and IoT present testing challenges

The move to mobile services is part of the Public Sector digitization agenda. Policy leans towards giving, as much of the population as possible, access to services using mobile devices to make it easy for citizens and to lower costs for organizations. We have found Public Sector organizations building their own labs to test mobile services on real, as opposed to virtual, devices. Cloud-based emulators have yet to take off in the Public Sector.

Our research shows something of the struggle. Asked about the challenges in mobile testing, 49% of organizations in the public sector say they do not have the devices readily available. This is compared with 40% in all industry sectors. At the same time, 51% of Public Sector organizations say they do not have the right tools to test mobile devices; in all sectors the figure is 40%. While mobiles services are a priority for the Public Sector, it is challenged by the testing processes and technologies to keep pace with the rate of change.

Another developing area in the Public Sector is the Internet of Things (IoT). While we have seen the technology sector focusing on industrial applications for these technologies, the government sector will also see benefits. Potential applications include traffic management, predictive parking and optimal refuse collections.

In IoT we remain concerned about the Public Sector's approach to testing. When asked about their specific test strategy for testing products in an IoT environment, 37% of Public Sector organizations said they are working with IoT but currently did not have a specific test strategy. This figure is higher than that of any other sector. The average across all industries is 25%. The Public Sector also scores lowest on maturity in IoT test strategy: 20% say they have a mature IoT test strategy while 32% of all sectors say they do. This does not mean the Public Sector is less likely to roll out IoT. Only 14% of Public Sector organizations say they have no IoT strategy compared with 18% of all organizations.

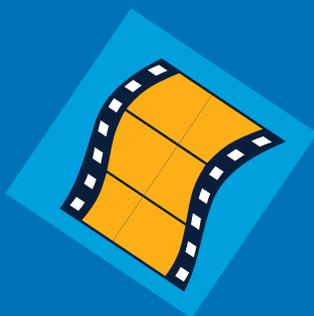
We see a growing interest in IoT in the Public Sector, particularly around road infrastructure and public transport. However, test operations lack expertise and tools in this areas.

Summary

Much of the work Government and Public Sector organizations carry out comes down to information and services, which are ideally suited to Digital Transformation. Considering the budgetary restraints in the public sector, IT departments have proved effective in laying the foundations for these changes. However, they must improve their approach to testing of mobile services and the Internet of Things, if they are to continue to provide value in return for the public spending. Legislators also need to ensure that regulations governing outsourcing and use of cloud services keep pace with speed of Digital Transformation.

Telecom, Media and Entertainment

Diverse Telecom, Media and Entertainment sector faces technology divide



Darren Coupland

Executive Vice President and COO,
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The Telecommunications, Media and Entertainment (TME) sector consist of companies which provide either digital services and traditional media content, or the infrastructure (cables, radio or electromagnetic systems) over which such content is shared. There are two divergent trends at play in this sector, driven by two radically different types of organizations which dominate this space. On the one hand, are the larger, more traditional enterprises, which are struggling to bridge the divide between legacy applications and the latest technologies. On the other hand, an increasing number of start-ups and internet-based media firms such as Netflix, Amazon, and Google are redefining business models and work processes using big ideas based on cutting edge technologies. Both of these types of companies have different capabilities and challenges as well as ways of working and they are both playing in an intensely competitive marketplace marked by low margins. In addition, this is a market in which time-to-market (with new deals, broadband/handset offers etc.) is extremely important, as is the ability to retain existing customers with newer, more customized and innovative packages. It is these overarching trends which underlie some of the most important QA and Testing trends in this sector.

Given this market, the main drivers for testing come down to speed and appeal over quality. When asked to rate their objectives, implementing quality checks early in the lifecycle was low for the Telecom, Media and Entertainment sector at 19% compared with 30% for all sectors. However, given the extremely competitive nature of the market, the sector also gave a higher rating to the objective of end-user satisfaction at 38%, compared with 34% for all industries.

Legacy technology holds back Digital Transformation

Some of the most important technological trends of recent times such as mobile content, Internet of Things (IoT) and streaming media services are directly related to the products and services provided by the TME sector. In fact, one might argue that Digital Transformation literally defines this sector. This is also backed up by our survey according to which organizations in this sector are more likely to appoint a Chief Digital Officer (at 46%) as compared to the average across all sectors (at 40%). Additionally, 3% of organizations in the TME sector say Digital Transformation is not part of their strategy compared with an average 6% for all sectors.

However, as already mentioned, a significant proportion of the market consists of older and more traditional conglomerates which are hampered by the presence of

legacy systems. This exacerbates the challenges associated with Digital Transformation. For instance, creating price plans can mean changes across Billing Support Systems (BSS) and Operations Support Systems (OSS) which may pre-date the internet era. Although the changes may not be complex, in terms of lines of code, applying them across numerous environments can be an onerous task, and so is testing once the code is in place. Some systems are so old, that engineers struggle to get spare components. Often the engineers are reticent to install upgrades for fear of introducing catastrophic instability. Many of the larger players in the sector support several billing systems as a result of the history of mergers and acquisitions in the industry. The risk of making incorrect changes cannot be underestimated in any way, as market regulators often have powers to impose fines.

This has a direct impact on QA and Testing for many of the TME companies. For instance, when asked about the technical challenges they experience in developing applications, 57% of the TME sector cited too much reliance on manual testing compared with 48% across all sectors. But there is evidence of a more structured approach to go-live decisions. Only 36% say they suffered from a lack of effective quality information to make go-live decisions for releases and features; as against 43% across all sectors who say the same.

Agile and DevOps struggle to be accepted

The two different kind of organizations which dominate this sector also have an impact on the adoption of agile and DevOps methodologies. While internet-based media services have been built on rapid release cycles, telecom organizations struggle to introduce these approaches outside e-commerce and customer-facing software. In fact, introducing these methodologies is virtually impossible for workflows which incorporate legacy billing systems. Where agile is in use, we find a preference for the Scaled Agile Framework (SAFe) testing methodology (52%) although it is less pronounced when compared to the average across all sectors (58%). However, we also see a preference for increased functional test automation combined with agile lifecycle management tools (48%), much more than in other industries (34%).

Telecom companies can also face challenges in introducing agile development and testing across their software estate as they may have signed service contracts for legacy applications for five to ten years. The suppliers tend to specify a waterfall-style development model and are often reluctant to change based on client request.

The struggle to introduce DevOps is even more challenging, a fact that is reflected in the adoption of test automation.

When we asked about the main challenges in achieving the desired level of test automation, 44% in the Telecom, Media and Entertainment sector (as opposed to 38% across all sectors) said they were facing difficulties with integrating test automation into a DevOps process.

Opportunities for automation

We see an opportunity for companies in the TME sector to improve their use of automation. There is often a lot of noise in the development cycle, with many requests for changes. As a result, early stages of the cycle slip and testing gets squeezed, which is a problem if manual testing is in place. There is a tendency to pay for additional manual testing at the end of the development cycle, rather than apply automation and improve the process. Many organizations thus stand to improve efficiency and reduce costs with scriptless automation and automated frameworks.

Mobile applications should be at home in the Telecom, Media and Entertainment sector, and to some extent, this is borne out in the results of our survey. When we asked about where organizations focus their efforts when testing mobile applications, we found 61% in the sector chose efficiency and performance, including network related efficiencies, compared with 53% in all sectors. One part of this can perhaps be explained by the presence of media companies who are interested in the efficiency of content streaming to mobile devices across networks.

It is common for the sector to set up physical device hubs as well as cloud emulators, to test the performance of mobile devices running apps and rendering media. In the process, they are learning how to deal with complexity. Currently, there is a remarkable proliferation of devices, code, and conditions across the sector. This is leading to the increased usage of predictive analytics techniques in testing, as it is simply impossible to cover all possible permutations of apps, operating systems and hardware given the time pressure faced by an organization. A test strategy built around predictive analytics and automated tooling is the best way to tackle such challenges and we expect these trends to gain strength over the next couple of years.

Test Excellence Centers fail to take off

Over the past couple of years we have seen the rise of Test Excellence Centers (TECs) which support testing activities as a part of integrated teams supported by environments, tools and expertise. This model has not taken off in the TME sector in the same way it has in others. When the survey asked about test operations, 23% in the TME sector say they use a Test Excellence Center compared with 30% across all sectors. The Test Center of Excellence (TCoE) factory, which carries out the majority of testing, in a build-operate-transfer



model was named by 22% in the sector against 28% of respondents in all sectors. Only placing the TCoE factory in an offshore location with high-cost savings was more common for TME when compared with all sectors at 30% versus 27%.

IoT presents a huge opportunity for the telecom sector as it strives to provide the infrastructure and add-on services to support intelligent connected devices, especially in expanding revenue in the business-to-business market. Therefore it is a concern that only 27% of respondents in the sector say they have an IoT testing strategy compared with a 32% average across all sectors.

Summary

In summary, the approaches to testing in the Telecom, Media and Entertainment sector are varied. While some

internet-based media firms are ahead in terms of digitalization, automation, agile and DevOps, older telecom organizations are held back by legacy billing systems, which are slowing down their progress towards agile. Moving forward, we see greater opportunities for test automation in the sector as well as virtual test environments and Test Excellence Centers. It is also likely that in the future consumers will demand a single provider to offer value and simplicity through a bundled set of voice, mobile, data and TV services. Telecom companies need to unite these services under a consistent brand experience while grappling with an underlying complex array of legacy and modern IT stacks and technologies. This is a key issue that needs to be addressed and supported by the quality and test function too, if TME companies are to take advantage of the opportunities offered by emerging technologies.



About the **Study**

The World Quality Report 2017-18 is based on research findings from 1,660 interviews carried out during April and May 2017 using CATI (Computer Aided Telephone Interviews). 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.

This interviews this year were based on a questionnaire of 43 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.

Survey Sample

For this year's research, we selected only organizations with more than 1,000 employees (in the respondent's national market) – an approach used for the last two years to provide us with valid trending data.

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

With the inclusion of product heads/CTO for the second time, we are able to bring in their views and insights in the space of Product and Engineering Services (P&ES) for Automotive, HealthCare and Lifesciences and HighTech Sector.

The research sample consists mainly of senior-level IT executives as shown in Figure 31.

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 2017-18 is based on a sample of 1,660 interviews from enterprises with more than 1,000 employees (25%), organizations with more than 5000 employees (3%) and companies with more than 10000 employees (41%) . 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. In order to derive better insights and to ensure effective analysis of the survey results, two new questions were added this year and a couple of constructive changes were also made to the answer options.

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 1,660 sample size.

Questionnaire and Methodology

The survey questionnaire was devised by QA and Testing experts in Capgemini, Sogeti and Micro Focus (sponsors of the research study), in consultation with Coleman Parkes Research. The 43 question survey covered a range of QA

and Testing subjects, enriched by qualitative data obtained from the additional in-depth interviews. The quotations shown in the report are taken from these in-depth interviews.

Total
1660

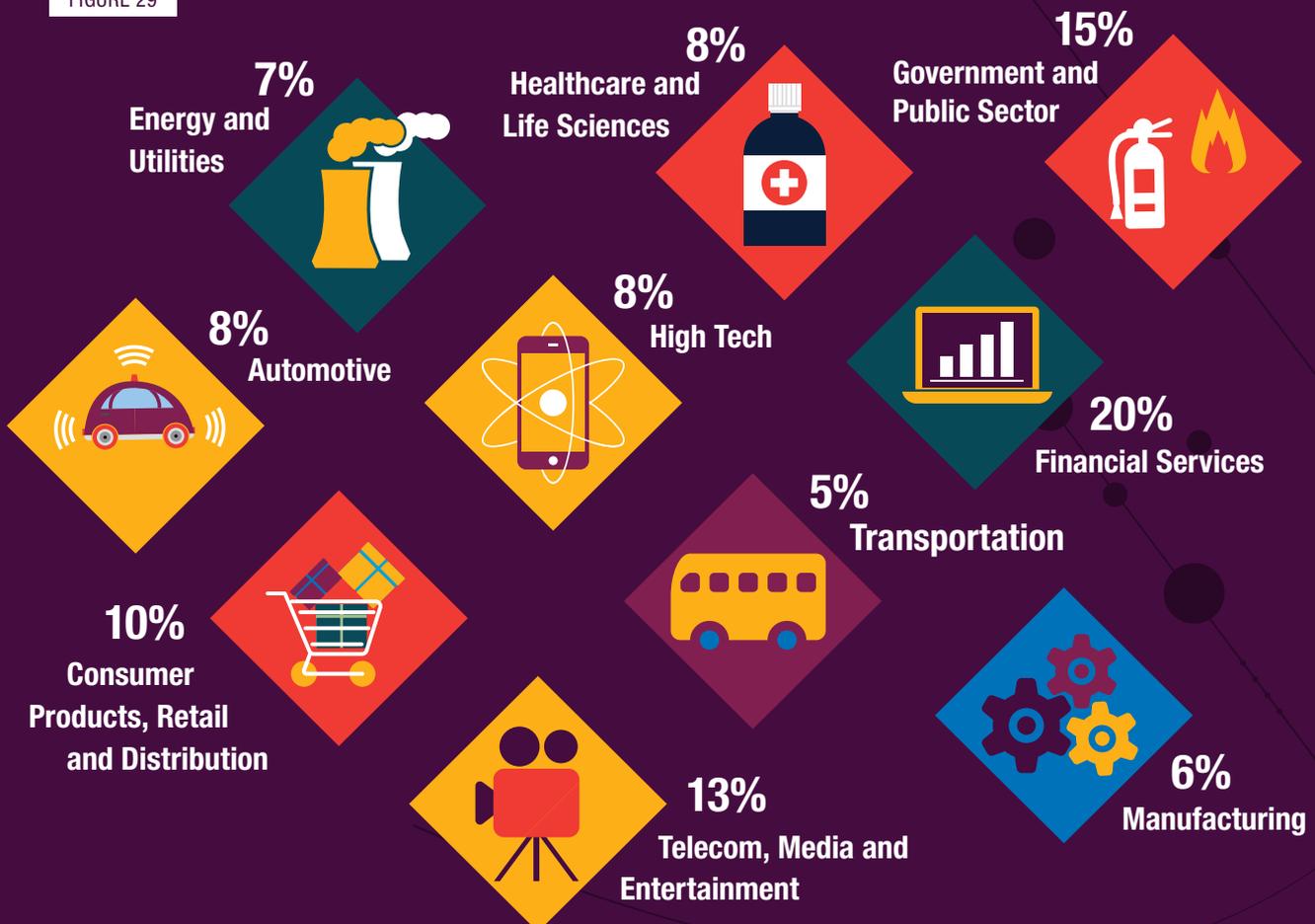
Interviews by Country

FIGURE 28

Country	Number of respondents	Country	Number of respondents	Country	Number of respondents
Abu Dhabi	10	Germany	125	Portugal	35
Australia	80	Hong Kong	20	Qatar	10
Belgium and Luxembourg	30	Hungary	30	Saudi Arabia	10
Brazil	80	Ireland	25	Singapore	20
Canada	65	Italy	50	Spain	35
China	60	Japan	35	Sweden	85
Czech Republic	30	Jordan & Bahrain	5	Switzerland	20
Denmark	25	Netherlands	100	UAE (excluding Dubai, Abu Dhabi)	15
Dubai	10	New Zealand	10	UK	125
Finland	25	Norway	30	USA	280
France	150	Poland	30		

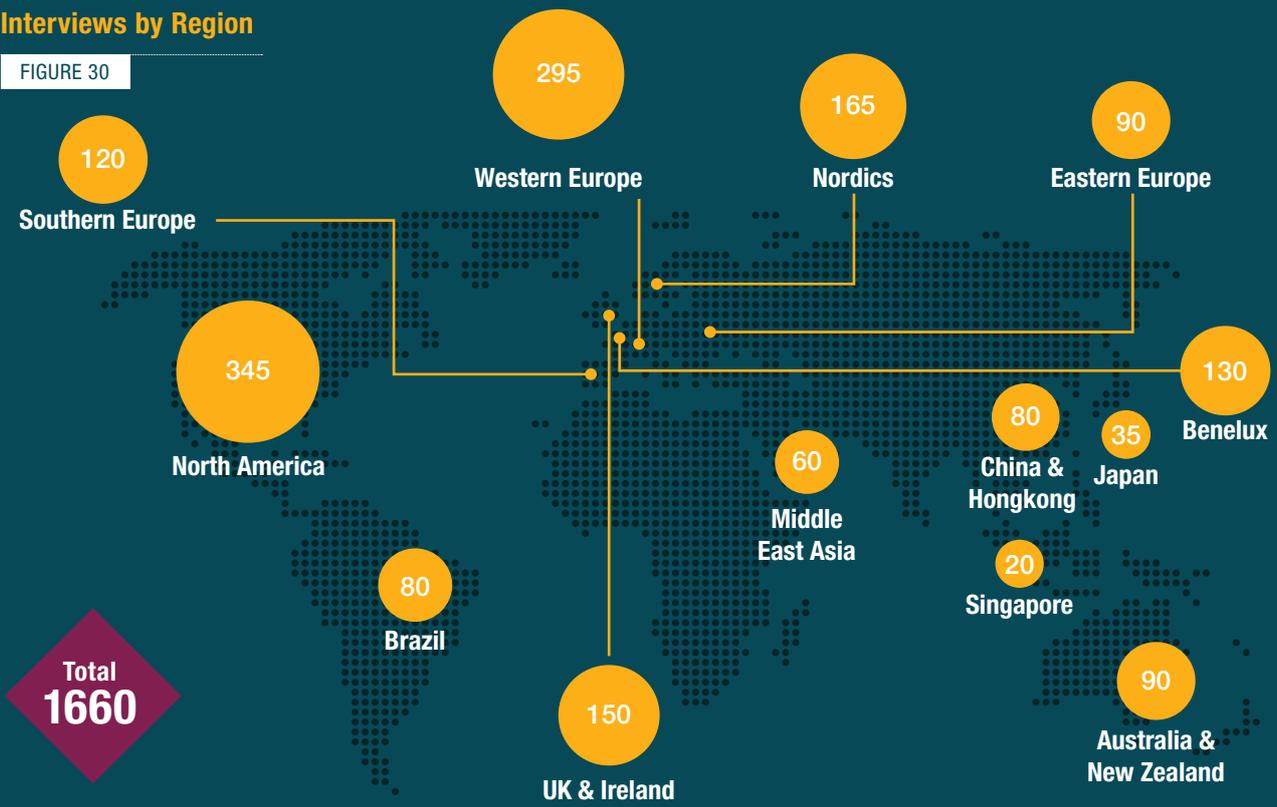
Interviews by Sector

FIGURE 29



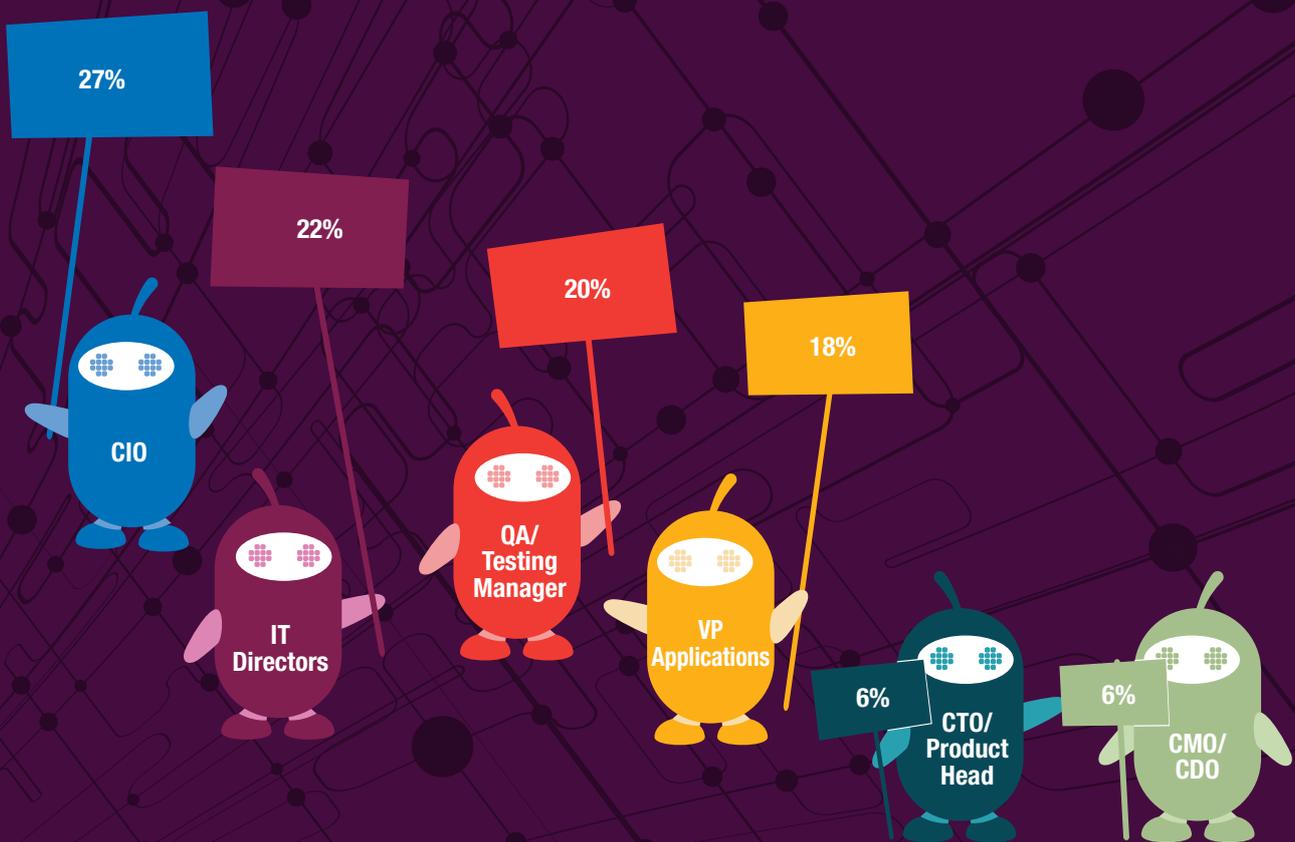
Interviews by Region

FIGURE 30



Interviews by Job Title

FIGURE 31





About the Sponsors

About Capgemini and Sogeti

With more than 190,000 people, Capgemini is present in over 40 countries and celebrates its 50th anniversary year in 2017. A global leader in consulting, technology and outsourcing services, the Group reported 2016 global revenues of EUR 12.5 billion. Together with its clients, Capgemini creates and delivers business, technology and digital solutions that fit their needs, enabling them to achieve innovation and competitiveness. A deeply multicultural organization, Capgemini has developed its own way of working, the Collaborative Business Experience™, and draws on Rightshore®, its worldwide delivery model.

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Thank you

Cappgemini, Sogeti and Micro Focus would like to thank

The 1,660 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 Cappgemini, Sogeti and Micro Focus.

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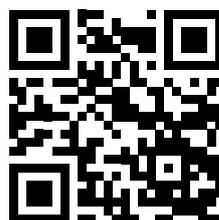
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