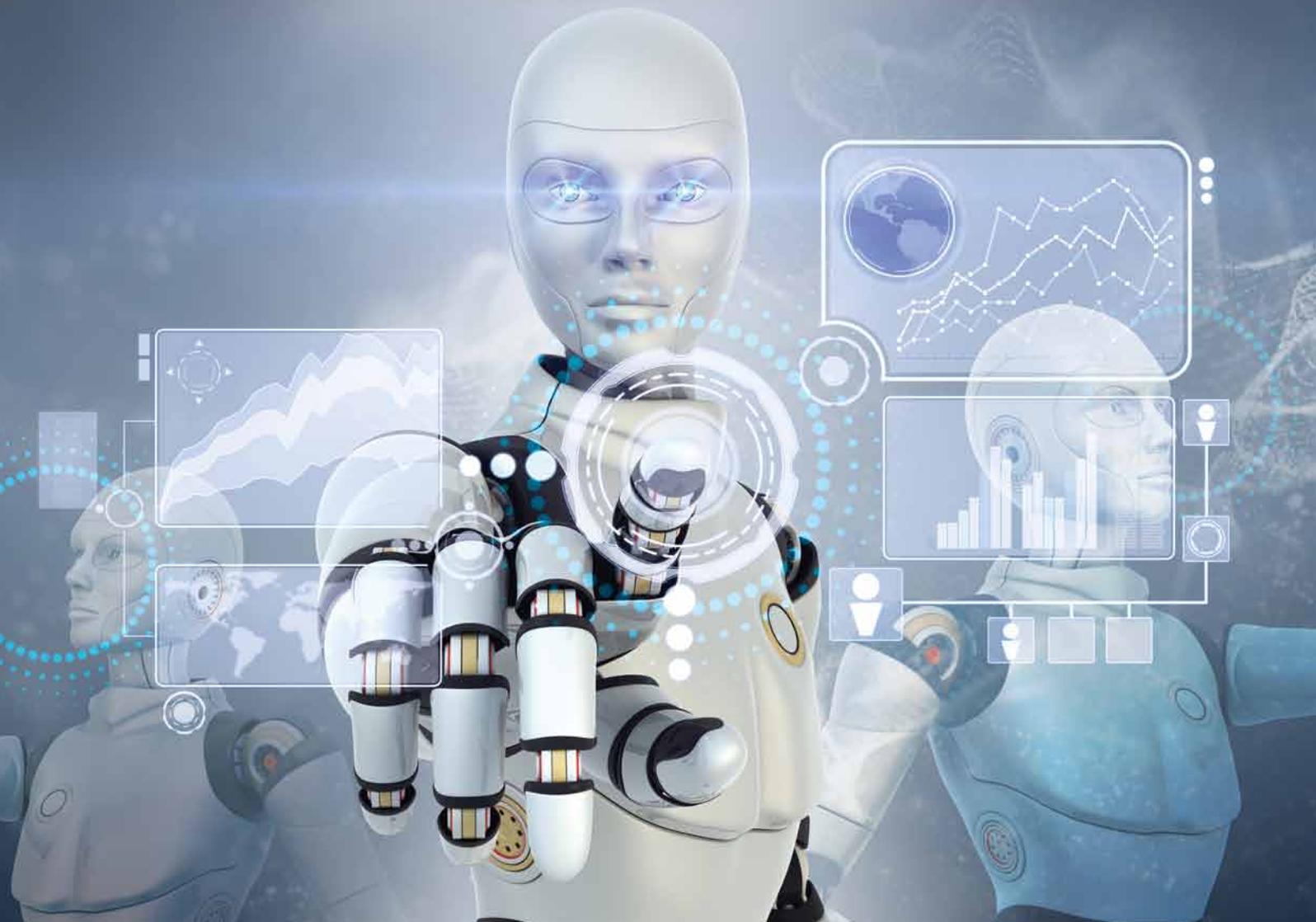


# WORLD QUALITY REPORT

2016-17

EIGHTH EDITION





# World Quality Report 2016-17

## Eighth Edition

Regional and country reports are available online from [www.worldqualityreport.com](http://www.worldqualityreport.com) or from Capgemini, Sogeti and HPE 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, Middle East and the Nordic Region

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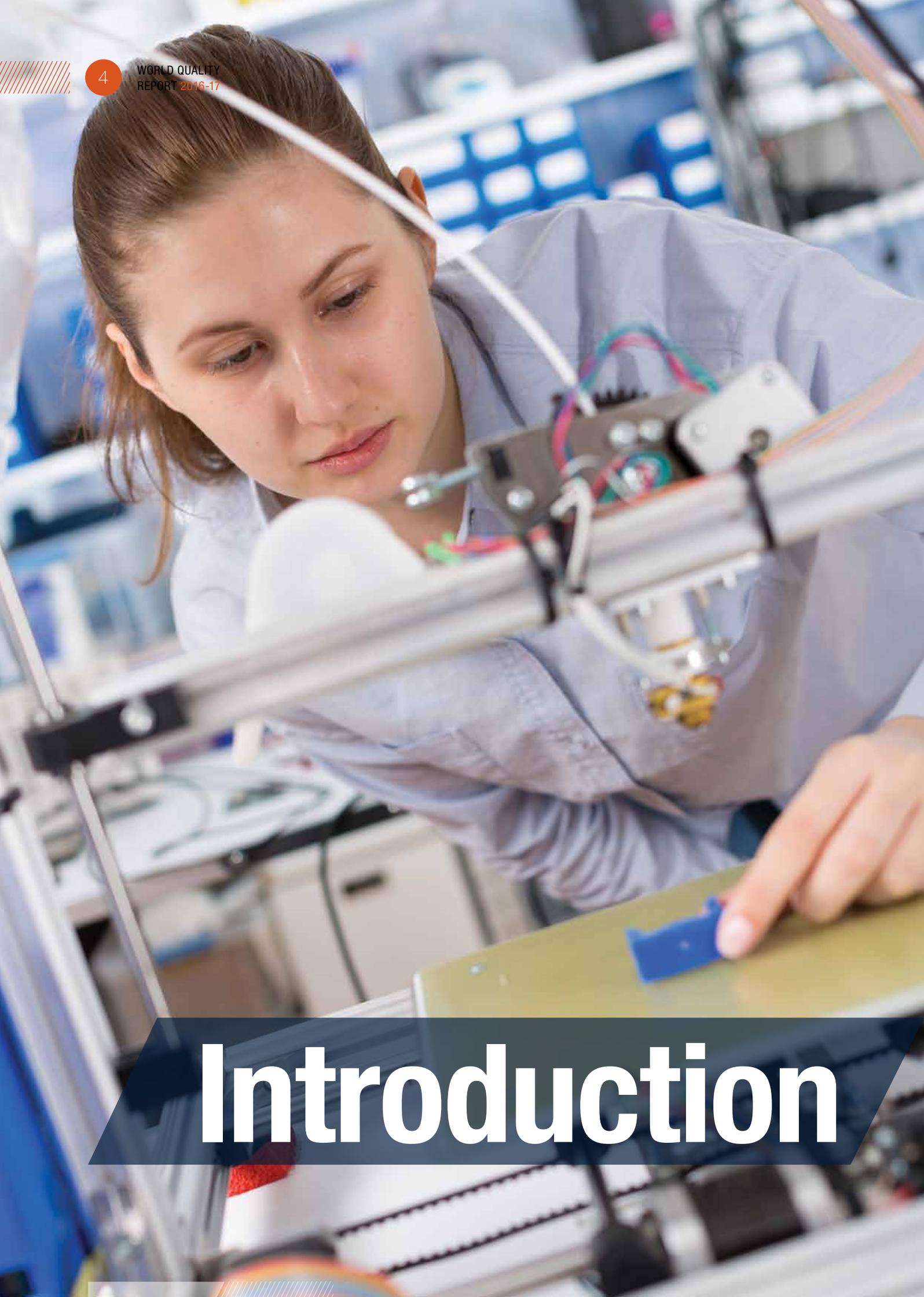
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A woman with brown hair tied back, wearing a light blue lab coat, is focused on working on a complex electronic assembly. She is using a tool to adjust a component on a green printed circuit board (PCB). The assembly is mounted on a metal frame and includes various electronic components like capacitors and resistors. The background shows a factory setting with blue shelving units and other equipment.

# Introduction



**Hans van Waayenburg**  
Leader, Testing Global Service Line  
Capgemini Group



**Raffi Margaliot**  
SVP and GM, ADM,  
HPE Software

Welcome to the eighth edition of the World Quality Report by Capgemini, Sogeti and HPE - a comprehensive and balanced overview of the key trends driving Quality Assurance (QA) and Testing.

If you are one of the 1600 executives across 32 countries who participated in the research, we thank you for your time and contribution. We would also like to thank our subject matter experts, for their insights and analysis as well as the team that worked on bringing out this edition of the World Quality Report.

As Digital Transformation sweeps the world, more and more of an organization's services are exposed to direct customer interaction. This is one of the biggest factors driving IT (as well as QA and Testing) towards business goals such as decreasing time-to-market, increasing security, performance and customer satisfaction.

In order to deliver towards such objectives, the QA and Testing function is rapidly re-inventing itself. It is for this reason that we see trends such as the increased adoption of agile and DevOps, the use of predictive analytics and increasing automation of QA and Testing practices, the move towards hybridization of TCOEs as well as a change in the skills required from quality professionals. To a certain extent, these objectives are also driving the adoption of cloud technologies. This report tracks all of these changes, and outlines the directions in which the QA and Testing function is evolving.

The report also contains an analysis of quality practices across different sectors as well as countries and as you go through the report you will notice certain overarching trends that dominate the world of QA and Testing today. I would encourage you to get in touch with your Capgemini or Sogeti account manager to discuss how this research might shape your future plans.

Finally, I hope that the information contained in this report will provide tangible benefits and food for thought. Happy reading!

I am very happy to sponsor and share the results from the 2016/17 World Quality Report. Each year we explore the major trends and issues that are the forefront of IT and QA leader's minds. We share the results, to give you the insight you need to address the challenges that are most critical to your business success.

Software drives our interactions and relationships, creating what is defined as the idea economy, and it is this idea economy - where innovation, new ideas and creative ways of doing business happen. Software is the canvas and paint that enables the idea economy.

To compete requires businesses embrace digital and software in a new paradigm. Users expect an exceptional experience and responsive services. Many businesses must evolve and transform to adopt this digital mindset. As the digital transformation continues to accelerate into more industries, there is an increase in the adoption of agile and DevOps principles to ensure organizations can achieve the speed, quality and scale needed to succeed.

We see the focus of testing changing as a pure technical validation of functionality, performance and security to validate the value of IT from the point of view of the customer. Testing should validate the optimal user experience.

In this maelstrom of change, it is clear that for our respondents, security, customer experience and quality are more important than ever.

HPE partners with and helps IT leaders like you to increase velocity and deliver amazing apps so you can confidently meet the needs of your consumers. Accelerating software delivery through agile and DevOps, enabling continuous testing and high fidelity feedback, our solutions are designed to help delivery teams accelerate and succeed. We're innovating with predictive analytics to help software teams tap into historical data to learn and anticipate the future, further streamlining their software delivery. We help you accelerate app delivery and to ensure that the apps you build can perform, scale and are secure. If you would like to learn more go to: [hpe.com/software/adm](http://hpe.com/software/adm)

I want to acknowledge everyone – especially the team at Capgemini and Sogeti – who contributed in the research and creation of this eighth edition of the World Quality Report.

**Mark Buenen**

Vice President  
Global Leader, QA and Testing Practice  
Sogeti

**Govind Muthukrishnan**

Senior Vice President  
Testing Leader, Financial Services  
Capgemini

# Executive Summary

The past year has seen an unrelenting uptake of new technologies, including the Internet of Things, as organizations seek to disrupt with digital at an ever faster pace. This eighth edition of the World Quality Report illustrates the impact of these trends on the Quality Assurance (QA) and Testing function, which is increasingly required to transform into a business enabler and secure client value from Digital Transformation programs.

This year's research was conducted among 1,600 CIOs and IT and testing leaders from 32 countries across the globe. It reveals a shifting set of primary objectives for the QA and Testing function compared with last year. It's a change that reflects a desire to stay close to the essential objective of testing, which is to prevent serious defects from reaching production, but always related to the higher objectives of customer value and business outcomes.

What clearly emerges in this year's survey is that organizations continue to evolve their QA and Testing function in their

traditional Core Enterprise IT (systems of record), as well as in their nimbler digital Business IT (systems of interaction). This QA evolution in these parallel, but different, worlds often sees a duality of processes, technologies, skills and testing organizations co-existing. Our study findings thus reveal various multiple approaches and trends, sometimes partially shared, but at other times running in tandem.

There has been a shift towards a focus on how QA and Testing can improve business outcomes, such as customer experience, revenue growth, and uninterrupted business operations. It is no longer simply about getting a product or service to market quickly and with as few defects as possible. Instead it is about transparent business risk profiling and the shifting left of quality responsibilities, along with upgrading critical QA enablement components, such as test data, test environments and test network. Together, these will drive effective decision making and deliver business results.



When combined with the relentless push for speed through rapid release cycles enabled by agile and DevOps, digital is resulting in an escalating volume of new developments, technologies and interconnected systems. We see organizations increasingly struggling to find the right approach to quality validation and testing for these systems and technologies. So while there is clarity on the part of this year's study participants in terms of their understanding of the challenges in the Core QA (a term we coined to support the Core Enterprise IT), newer challenges and contrasting priorities seem to emerge as they seek to understand what we refer to as Business QA.

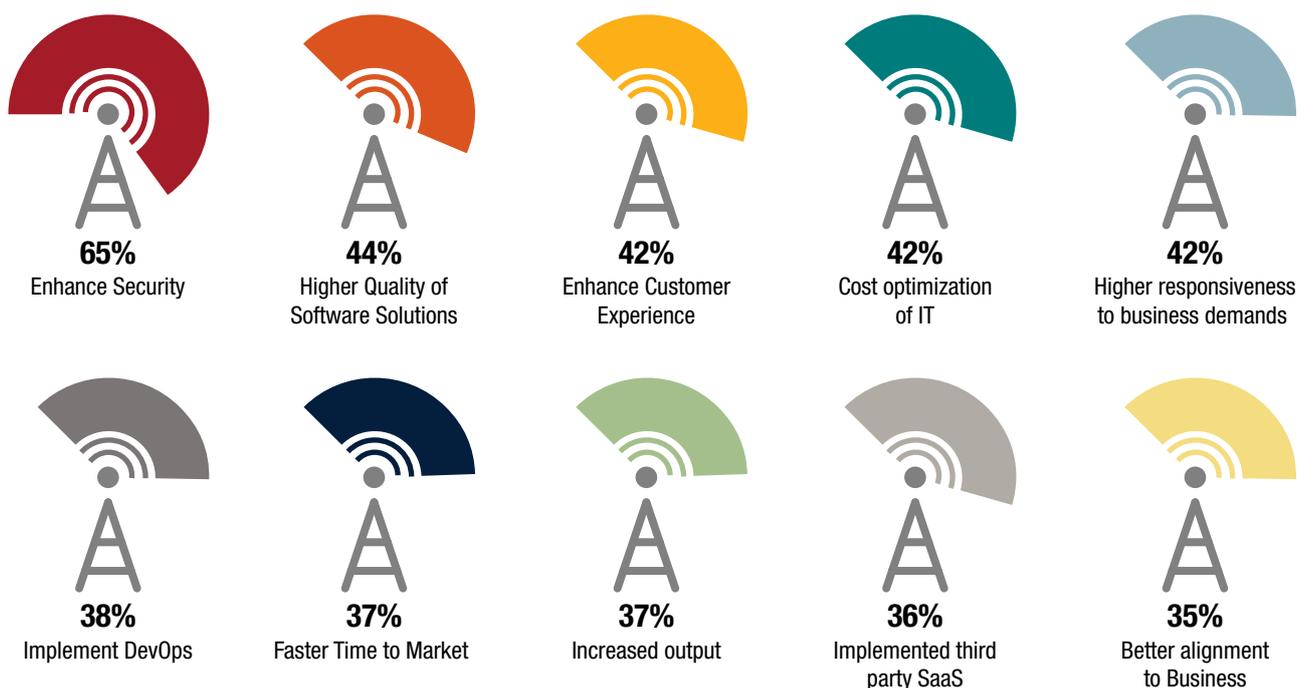
Organizations must adopt a fit-for-purpose test strategy to manage these differing challenges in their bi-modal IT, in both their legacy and agile development approaches. Our research clearly shows that despite the continued adoption of agile methodologies, challenges with quality and testing in agile projects are increasing. The most notable difficulties are in identifying the right areas on which to test, the availability of flexible and reliable test environments and test data, and the realization of benefits from automation. In the world of traditional Core Enterprise IT systems, the centralized Testing Center of Excellence (TCOE) has played an enormous part in bringing efficiency and higher maturity of testing. In the de-centralized and agile world this is apparently much more difficult to achieve.

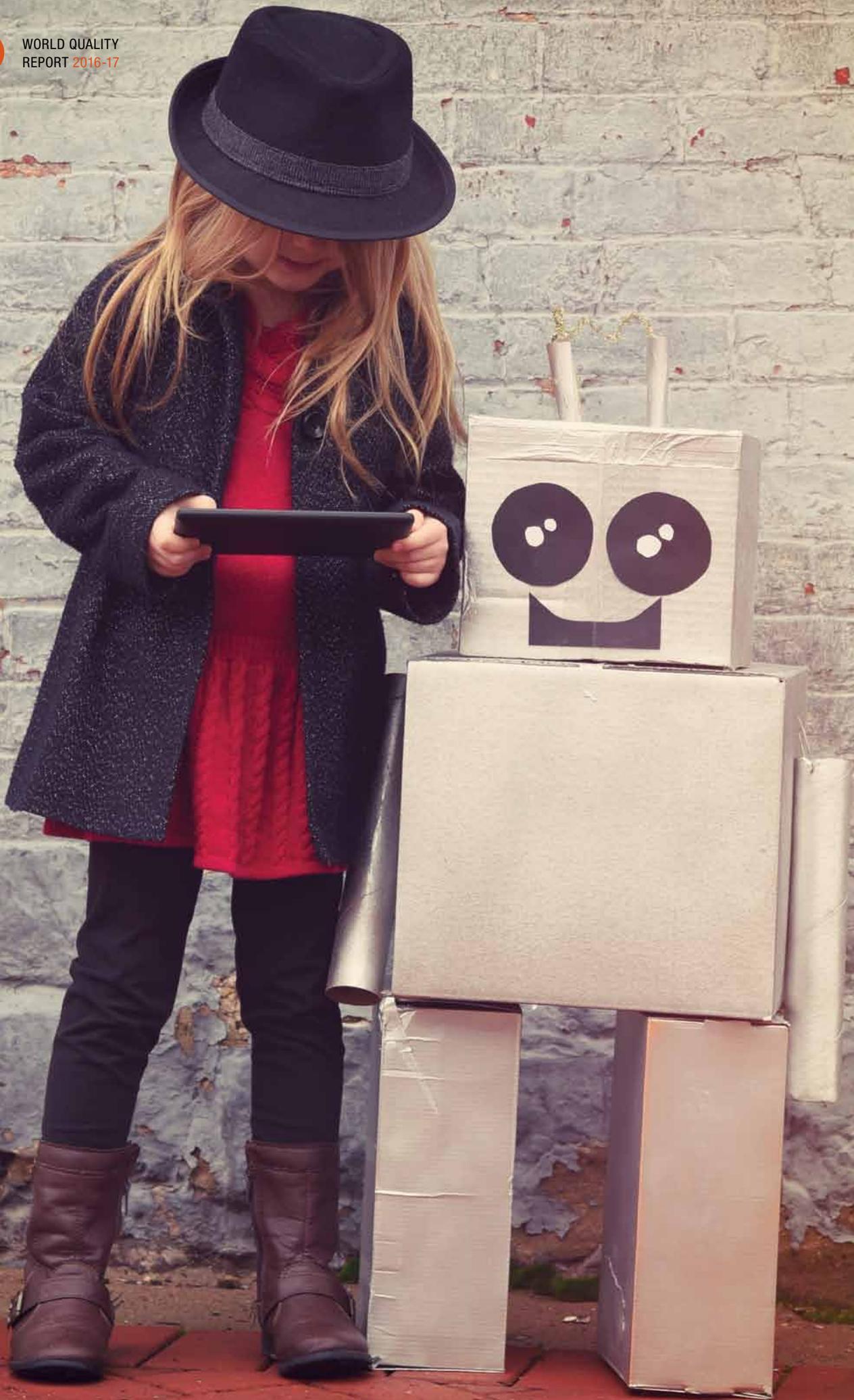
When asked for their opinions concerning the objectives of QA and Testing, our senior management survey participants revealed very distinct, yet equally high scoring, expectations. On the one hand, they have a basic and essential expectation of testing, which is to prevent defects from production. On the other hand, there are expectations at a very different abstraction level: to contribute to business growth and business objectives, as well as to ensure end-user satisfaction. The QA team must be aware that these expectations are of equally high importance, but to comply with them will require a very different level of reporting on QA and Testing results.

We believe that the most important solution to overcome increasing QA and Testing challenges will be the emerging introduction of machine-based intelligence. This will be the next big wave of change after the introduction of risk-based test strategies and test automation technologies. An intelligence-led QA approach enables QA activities to be automatically defined and adjusted to reflect the realities of past projects and releases as well as day-to-day data points from production. It will radically change the QA and Testing approach, which currently relies too heavily on largely subjective manual decision making, preparation and execution.

FIGURE 1

### Executive Management Objective with QA & Testing

 2016




# World Quality Report Findings

## 1. Digital Transformation continues to drive IT strategy and make itself felt in the QA and Testing function.

Organizations in all sectors continue to use new digital technologies to accelerate change and connect in new ways with their customers. For the QA and Testing function tasked with assuring customer value and business performance, Digital Transformation brings both challenges and opportunities.

The challenges include the need to manage escalating test volumes at increased speeds, while specific skillsets in multiple areas are still relatively immature or scarce. The most notable lack of skill is in the areas of: intelligence-driven QA and Testing strategies; newer test automation skills; optimizing test environments; test data management; and enabling QA activities in agile and DevOps settings. Keeping tight control of budgets is also a challenge, with a large and growing percentage of the QA and Testing budget for new developments now consumed by digital technology solutions (mobile, cloud, business intelligence and business analytics, and the Internet of Things).

There is also a growing opportunity to use the host of new tools in the mobile and digital testing space to measure, quantify and better understand the user experience. This gives QA and Testing professionals a bigger role to play in the strategic imperative to embed customer experience at the heart of Digital Transformation programs. We also observe a levelling in the digital maturity across sectors this year, with previously immature sectors catching up, or even overtaking, last year's digital leaders.

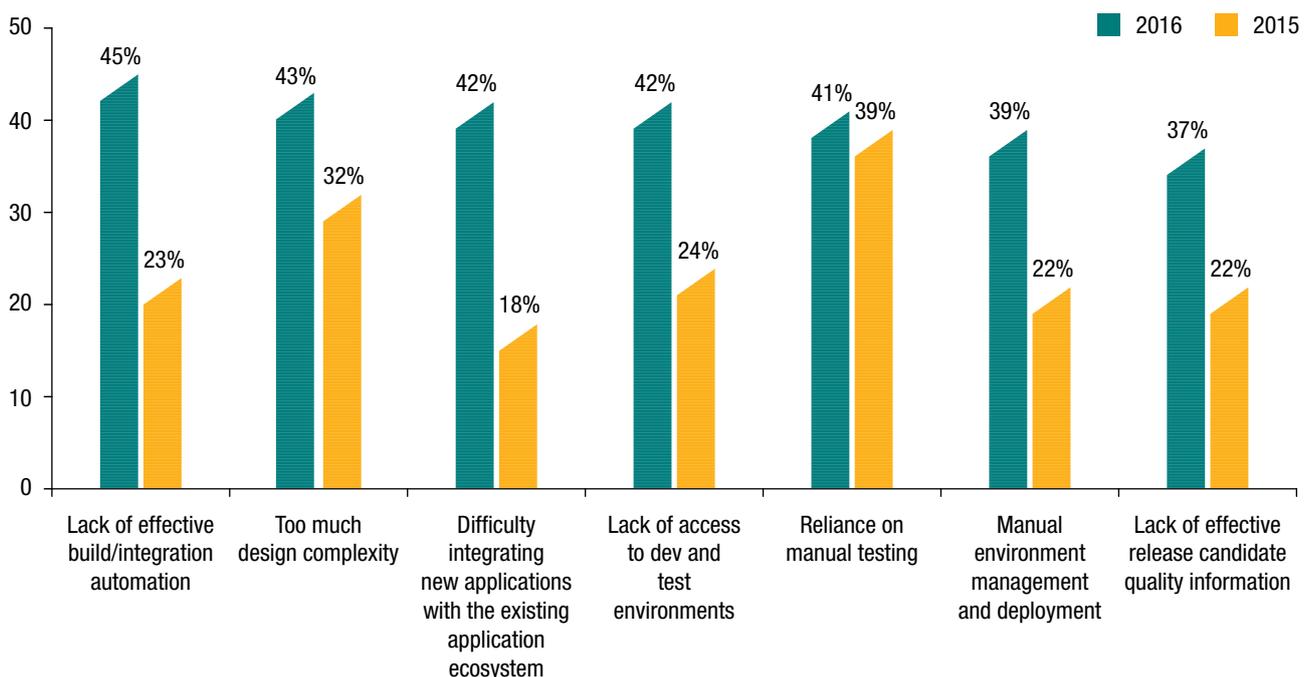
## 2. Agile and DevOps continue to grow in adoption, with QA making a corresponding move.

The ability to bring new products and services to market ahead of the competition is a crucial differentiator for today's digital enterprise. It is no wonder, therefore, that the agile methodology is firmly embedded in development lifecycles, and now DevOps principles are growing in use, albeit still as an emerging practice. This trend looks set to continue and grow in the future.

While both agile and DevOps offer significant opportunity to drive faster release cycles, it is evident that the issues around

FIGURE 2

### Top 7 challenges in Application Development



managing and implementing the quality and test measures are an increasing challenge. Organizations are struggling to find the answer to the question of how to achieve speed (or velocity) with the right level of quality. By removing boundaries between the disciplines, quality validation and testing activities are being more fully integrated in the agile development lifecycle, although there is still a long way to go. For example, while agile implies a shift left in QA and Testing to earlier in the lifecycle, 44% of this year's survey participants using agile claim involving the testing team in the inception and sprint planning phases is a challenge.

This year we have also identified a need for agile testing expertise to become more strategic, with a focus on transformation, rather than purely on execution. Organizations report a lack of specific QA and Testing skills to be a challenge, so in addition to the key skills such as test strategists, test environment specialists and test data specialists mentioned earlier, we see an emerging need for data scientists to implement a data-led predictive QA approach. Overall, the key themes for testing in agile this year are to establish distributed agile and test approaches, and to focus on business outcomes and customer value, rather than on tools.

The study findings pertaining to DevOps show an increasing maturity with a better appreciation of the true purpose and application of DevOps. A striking development in the approach to QA is the uptake of continuous monitoring with predictive analysis, along with the increased adoption of more cloud-based test environments, both reported by 42% of this year's study respondents.

Despite the growing maturity, it is clear that DevOps implementation challenges go far beyond just issues with QA. After an initial focus on delivery pipeline automation and tool implementation, it is evident that breaking down the silos of business, development, quality and operations requires a culture change. There is a risk that the implementation of Quality Assurance in the development cycle will be buried among other generic and potentially more pressing DevOps implementation challenges. However, this would be a serious mistake because a QA guideline and toolkit for DevOps can be the enabling glue that keeps teams focused on customer value and business relevance.

### **3. The emergence of Internet of Things functionality is a disrupting force with the potential to increase the impact of failure.**

With 85% of participants in the World Quality Report 2016 study saying Internet of Things products are part of their business operations, it is clear that there's a whole new world of connectivity and functionality that must be validated and verified.

It is very worrying that 68% of the organizations in which Internet of Things products or solutions play a role do not currently have a test strategy for this specific aspect of their IT. Apparently many of them are relying on the quality validations performed by the device manufacturers. This situation must change and it appears that 30% are planning an Internet of Things test strategy in the near future.

Assuring the quality of Internet of Things functionality will become an increasingly bigger part of the QA and Testing function's remit as more and more things are connected and able to share data across networks. This will see the emergence of new test tools and approaches designed to deal with the exponential increase in test requirements and data. For example, a form of artificial intelligence and machine learning is viewed as valuable functionality for achieving and maintaining good test coverage, leading to a high level of product quality.

### **4. The challenges around managing and driving down the cost of test environment management are growing.**

The key challenges in test environment management (TEM) revealed this year are:

- Having to maintain multiple versions of test environments, claimed by 48% of survey respondents
- Lack of facilities to book and manage their own environments, cited by 46% of respondents
- Lack of visibility to test environment availability and demand, cited by 46% of respondents
- Lack of the right tools for testing has jumped again, with 46% of respondents citing it as a challenge.

While there is an increasing trend for investing in test environment management, the rising cost of test environments is turning the spotlight on how to drive TEM efficiency. Investment in test environments is aimed at removing the testing bottlenecks in the development cycle that are a barrier to rapid releases.

The relative lack of TEM maturity gives rise to inefficiency and this has an ensuing impact on the budget. Indeed, increased challenges with test environments are cited as having the third biggest impact on QA and Testing budgets.

Despite the growing challenges, TEM is slowly maturing. Previously scarce skillsets are increasing, although it will be a while before TEM is fully professionalized. Core systems built to support testing are becoming increasingly smart, using analytics and self-managing capability for testing environments and data. As the needs of agile and DevOps cycles escalate, test environments and test data management will become ever more automated and virtualized.



### 5. The continued requirement to find efficiencies at every level in QA and Testing remains evident despite this year's success in containing costs.

This year's share of the IT budget devoted to QA and Testing has dropped to 31% after a significant and worrying increase from 18% to 35% during the preceding four years. There is no room for complacency, however. Despite this year's reduction, there is an overall prediction that spending will increase to 40% in 2019. This far exceeds reasonable levels of up to 25% and points to a continued urgent need to find efficiencies.

This need is brought into sharp focus by the knowledge that the growing adoption of digital innovation will lead to an increase of test cycles and require further investment in test platforms and test tools. This will potentially drive up costs still further if not sufficiently controlled. Traditional measures for driving efficiency have been: low-cost offshoring, centralizing test functions and increasing automation levels. However, agile and DevOps adoption limits the possibility of low cost offshoring, and automation is still only delivering a partial return on investment (ROI). So other and new measures are required in addition to these traditional ones to ensure that the containment of QA costs can improve.

Transformation to intelligence-led QA and Testing will be the next disruptive change. All the previous findings highlight

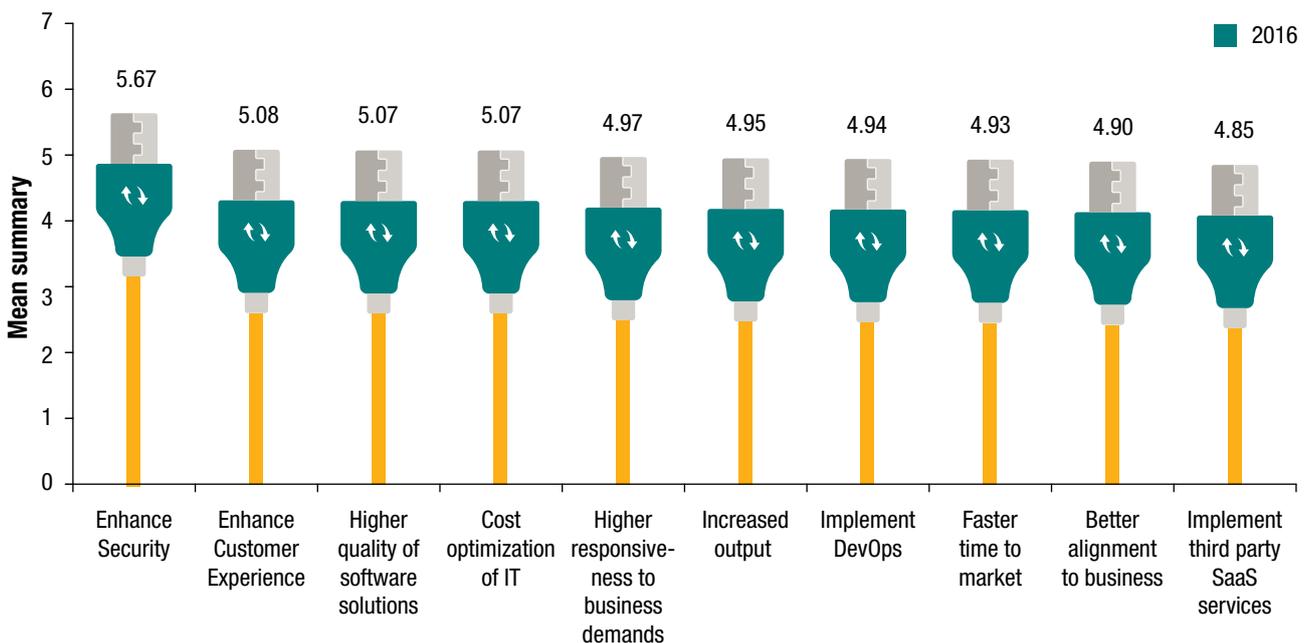
the need for a next level of change in the QA and Testing operations of all organizations. While the advent of new digital technologies and the Internet of Things is creating an increasingly heavy workload for the QA and Testing function, it also offers the potential to take an intelligence-led approach to validation and verification activities. From gaining a better understanding of the end user, to addressing challenges of what to test and improving environment availability, new approaches and tools are available, with more emerging.

These can inform and drive more efficient test cycles with predictive analytics and the ability to leverage Big Data, including production and user data.

This year's study findings reveal that 40% of participants foresee using predictive analysis as one of their automation techniques in the coming year. This will enable organizations to use automatic and self-learning analysis and decision making technologies on all QA aspects: from strategy decisions (what should be tested and to what depth), to test set generation and adjustment, test environment preparation, test execution and production quality decisions. This will be extended across the development and operations phase of the application in a continuous mode, with minimal human-led decisions in true zero-touch testing or test environment and data provisioning.

FIGURE 3

### Top 10 most important aspects of your IT strategy



# Key recommendations in order of importance

## 1. Invest in intelligent self-learning QA and Testing platforms for all areas of the application landscape.

Intelligent, self-learning technology will drive analytics and artificial intelligence, processing and interpreting the huge volumes of data that it is not humanly possible to analyze. It will become far easier to identify what to test and where more testing is required to bring down costs with more efficient, data-led testing. Leveraging predictive analytics from various sources to bring speed efficiencies in all areas of quality decisions is one of the major emerging opportunities. This intelligent data analysis will facilitate the strategic identification of what to test and predict quality issues before they occur in production.

The key on the journey toward intelligence-driven QA is to invest in and experiment with tools that enable the user to: analyze the root cause of defects; analyze coverage and efficiency of test sets; analyze utilization of resources and environments; predict test estimation based on requirements; predict risk areas and risk levels of projects; and plan the priority of test cases.

## 2. Adopt a QA approach for DevOps, agile and traditional – powered by enablement teams that help to truly shift left quality.

The core idea behind DevOps is to remove the boundaries between the traditional silos of business, IT development, QA and IT operations, and to extend the agile and Lean principles from software development to the software deployment phase. It is our view that this process can only be successful if the Quality Assurance aspect is integrated and maximum automation is achieved in each step of the DevOps lifecycle. To begin to realize the benefits promised by the DevOps philosophy, we believe automation of QA activities is not only required but is the core enabler of increasing throughput and velocity. In other words, testing activities, done traditionally, will become the constraining factor. Or the alternative is that testing will not be done adequately, therefore putting your organization's reputation at risk. We recommend beginning your agile and DevOps journey by first shifting testing left to involve the test team right from inception. Then shift testing right over time once you achieve scale, and build continuous testing, environment virtualization capabilities, cloud-based environments, and predictive analytics capabilities for DevOps.

The right skillsets for the agile test organization should include test strategists and environment and data specialists, as opposed to pure play automation specialists. From an automation standpoint, test driven development (TDD), behavior driven development (BDD), white box testing skills and services virtualization should take on greater importance than functional automation skills. A way to resolve both strategy and competency challenges is to use a centralized Quality Management Office (QMO), which ensures the right degree of automation coverage and tools defined for the various levers, such as TDD, BDD, service virtualization, environment virtualization, continuous monitoring, test data automation, and functional and non-functional automation. In this way the QMO acts as an enabler for driving velocity in agile and DevOps initiatives, as well as the continuous improvement in the traditional development projects.

## 3. Invest in as-a-service solutions for test environment management, test data management, and test execution.

The TEM and TDM challenges differ from a Core QA and a Business QA perspective. The challenges in Core QA are one of seeking a test-focused ecosystem, for example data or environment provisioning with a view to unlocking resource idling. Whereas the challenges in Business QA are more likely to be the simple and basic need of what to test and how to test. Given the different needs, we recommend organizations make use of mature solutions that handle environment and data provisioning more as a service that can remain as a shared service to serve the needs of a highly efficient and offshored Core QA and an increasingly agile Business QA.

The increasing challenges with TEM and TDM are not only resulting in cost inefficiencies in traditional Core IT systems, but are also interfering with the velocity targets of digital Business IT applications. We believe that a few steps are critical to address this:

- Assign the responsibility of optimizing Core IT test environments to a TEM team
- Invest in virtualized and cloud-based environments for the digital Business IT
- Invest in intelligent test data generation and TDM solutions
- Establish service-based solutions for test environment provision and test data provisioning for projects.



#### 4. Develop Internet of Things-specific test strategies

Internet of Things developments are changing the value chains of enterprises by expanding the machine-to-machine and machine-to-human communication and data exchange. New devices, developments and content exchange between these devices are happening at a faster and faster pace. And as we increasingly rely on connected, self-steering and self-learning devices, the key quality aspects that should be considered are: security, operational reliability, ease of use, and performance. On top of this there is a series of technical level quality attributes: compatibility, installability, interoperability, and resource utilization.

The test approach and test depth will differ depending on whether you are a manufacturer of an Internet of Things device, an integrator of the device, or an end-user of the device. But as the Internet of Things is playing a more important role, each and every enterprise must have a specific risk-based test strategy for it, as well as availability of a test environment set up in which the device can be tested safely. Clearly this validation requires higher levels of engineering skills because it means dealing with: validation of the operation of the device itself; the validation of the connection of the device in its environment; the storage and processing of data; and validation of the potentially multiple applications by which humans can control and interact with the device.

#### 5. Manage quality with simple balanced scorecards per Line of Business and per application or process.

With the transformation to more agile and DevOps-based development, organizations are relying more on self-empowered and self-steering teams. This obviously leads to more flexibility and speed, which is a good thing. However, the flip-side of this is that organizations now lack insight into the quality at an overarching enterprise level. The solution to this challenge is to balance the conflicting needs within the context of resource constraint.

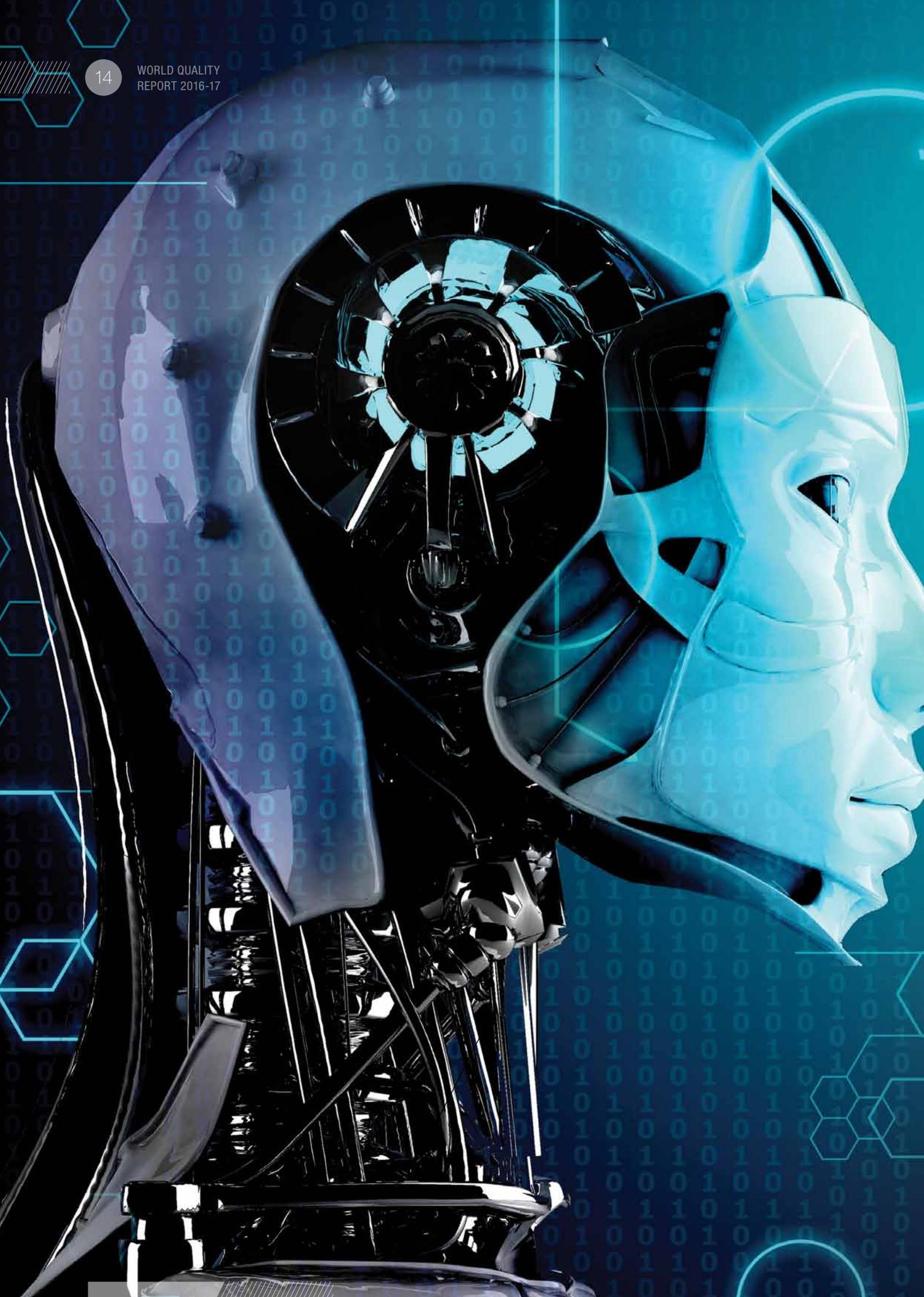
One way to establish the balance and take the right decisions is to keep a real-time dashboard that tracks the enterprise-quality balanced scorecard with metrics that are critical to both velocity and quality. This dynamic dashboard should represent a handy set of critical quality indicators on a platform and application level, together with a few managerial performance indicators. The minimum recommended managerial performance indicators are: release quality; test productivity; and test velocity. The minimum recommended quality indicators per application are: status of production incidents; release defect status; percentage features that have passed exit criteria; and total number of features delivered.



Automation plays a major role in transition to DevOps. Use of different automated tools is key to success of a DevOps program.

**CIO,**  
Retail, Sweden





# Current Trends in Quality Assurance & Testing

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# Digital Transformation

## Disrupting business models for a better customer experience

**John Jeremiah**, Digital Research Team Leader, HPE

**Renu Rajani**, Vice President, Capgemini

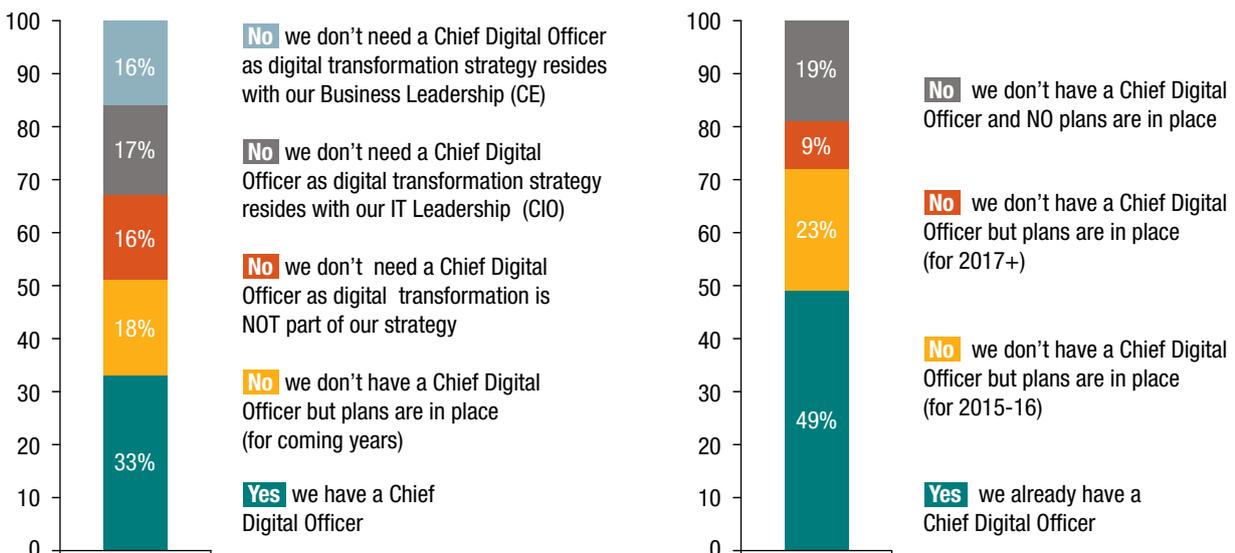
**Sathish Natarajan**, Service Delivery Director, Capgemini

While Digital Transformation continues at pace, it is safe to say that digital is no longer viewed as something new. Instead, it is an everyday means by which organizations are accelerating change, rethinking their business models and operations, and reacting to emerging external market forces. The end customer is a lot closer to the business than ever before, with profound implications for the Quality Assurance and Testing functions.

Social media, mobility, business analytics and cloud solutions have equipped the digital enterprise with the tools it needs to get closer to customers, empower employees, and transform internal business processes for the past five years. But technology changes rapidly and there is a marked growth in the need for Internet of Things integration, whereby every device is becoming a smart device that's connected to the internet, continuously sharing and providing customer-relevant data.

FIGURE 4

### Percentage of Organization with a dedicated Chief Digital Officer





## Digital maturity measures reveal steady growth

As part of our survey into the impact of Digital Transformation on QA and Testing, we investigated in more detail the extent to which organizations are making digital a senior-level priority, either with the appointment of a dedicated Chief Digital Officer (CDO), or with existing executive positions assuming responsibility for digital. This acknowledges that as digital is increasingly embedded in day-to-day activities, so potentially is the management of digital.

Last year, our research showed that 48% of the organizations interviewed had a CDO and 23% were planning to establish the role over the coming months. This year's findings reveal that 66% now either have a dedicated CDO or have assigned the role of CDO to the newly defined categories of the IT leadership (17%) or the business leadership (16%) as part of their Digital Transformation. One measure of digital progress in light of our new categorization is in the 3% drop in those organizations with no plan for this role, down from 19% in 2015 to 16% in 2016. Additionally, 18% of those currently without a CDO, have plans in place for the coming years.

A number of last year's digital laggards have caught up with the digital leaders. 76% of respondents in the Automotive

sector state they have either a dedicated CDO or assigned CDO role, followed by the Public Sector (73%) and Telecoms & Media (69%) at the top of the leader board. This year's Public Sector survey participants have gone down the route of appointing a dedicated CDO far more enthusiastically than most other sectors with 51% compared to Consumer Products, Retail and Distribution (CPRD), and Manufacturing, where only 25% have a dedicated CDO. Higher digital maturity in the Public Sector aligns with the increased move to a digitally inclusive model for the provision of citizen services and stretched efficiency targets set by governments across the world.

We can clearly see a jump in maturity by the CPRD sector (68%) from the bottom of the maturity curve to a mid-way position. Transportation too has moved from its laggard position in 2015 to join CPRD and Financial Services on 68%. This year's laggards are Healthcare (61%), High Tech (57%) and Energy & Utilities (54%), with the latter showing little change.

## Renewed focus on efficiency and effectiveness

The World Quality Report 2016 survey findings show that the key strategic IT drivers to securing the quality of Digital Transformation are still relevant: security, customer experience and corporate image remain among the important objectives. However, there is also renewed focus on efficiency and effectiveness as important QA and Testing objectives.

Drilling down into the figures, there is a slight correlation between the absence of a digital test strategy and a relatively higher proportion of IT budget spent on QA and Testing, as shown in Figure 5. This demonstrates that a higher level of digital focus does not automatically lead to an increase in QA and Testing spend. Thus digital is not a primary driver of QA and Testing costs. Nonetheless, in a rush to meet the objective of improved time to market, organizations adopt DevOps and continuous integration methods, which do affect the QA process.

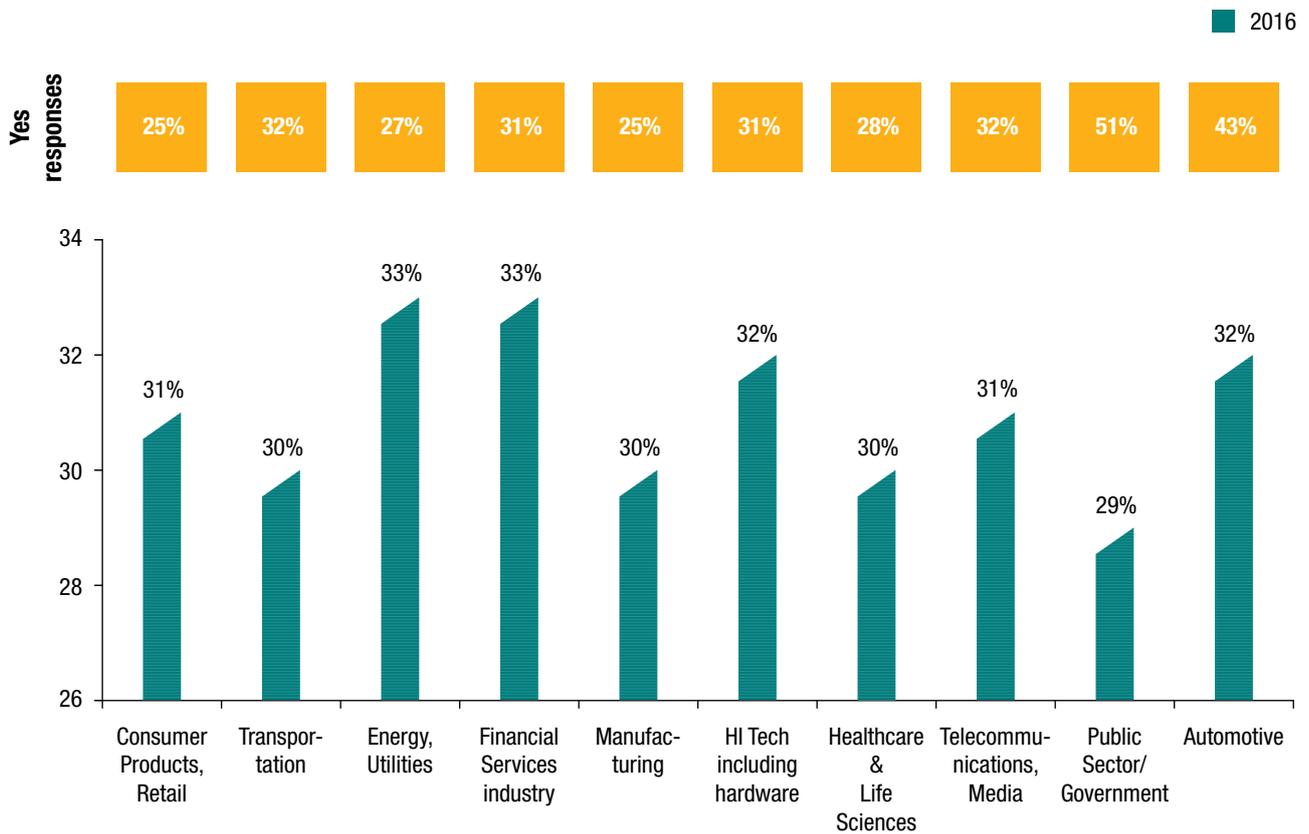
Overall, of the QA and Testing budget for new developments, 60% is consumed by new digital technology solutions (mobile, cloud, BI/BA, Internet of Things). This is a big increase from last year's 53%. Spending on front office solutions dipped a little to 14%, down from 17% last year, while ERP and legacy back office solutions is 4% down on last year at 27%. For the first time this year, we also specifically measured the percentage of the QA and Testing budget spent on Internet of Things solutions, which stands at a solid 13%.

Clearly, customer-facing applications and digital innovation solutions around mobile, cloud and BI/BA, and Internet of Things continue to consume a major share of the QA and Testing budgets for new developments. This is an ongoing Digital Transformation trend recorded by the World Quality Report over the past three years: 30% to 53% to 65%.



FIGURE 5

### Percentage of organizations with a Chief Digital Officer and the IT budget allocated to the Testing and Quality Function



### Level of cloud-based applications predicted to increase over the coming three years

There has been a significant drop in the level of public and hybrid cloud-based applications over the past twelve months. This year, we have also recorded the level of on-premise cloud applications for the first time, as opposed to bundling it with the private cloud metric. When combined, private cloud (30%) and on-premise cloud (15%) applications as a percentage are little changed from last year's private-only measure, up just 1% to 45%. Clearly on-premise cloud solutions are a significant component of the overall private cloud options. It's likely that the high figure for private cloud when compared to public cloud (down to 23% from 29% last year) and hybrid cloud applications (down to 18% from 28%) is due to concerns about both security and control of data.

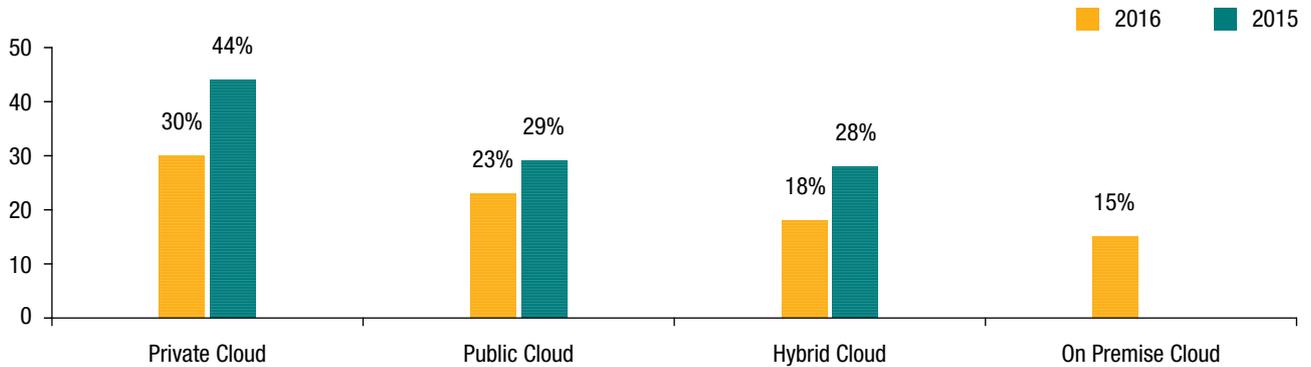
There is a shift at a sector level compared with last year where the highest percentage users of private cloud were the

Public Sector and Healthcare organizations. This year, that honor goes to CPRD (36%) and Manufacturing (33%), with Public Sector (29%) and Healthcare and Life Sciences (28%) among the lowest users. When combined with the volume of on-premise cloud applications, CPRD is still using the most, with a combined total of 49%, followed by the Energy & Utilities, Automotive, and Manufacturing sectors, all at 48%, and Financial Services at 47%. Again, Public Sector (45%) and Healthcare (43%) are at the lower end of the spectrum, although at 39% it is the Transportation sector that uses the least private and on-premise cloud applications.

Regionally, there are significant differences between the biggest users of private cloud-based and on-premise cloud applications as a combined total. The Middle East is the most prolific user at 52%, while Central Europe records a 20% lower

FIGURE 6

Percentage split of cloud based application



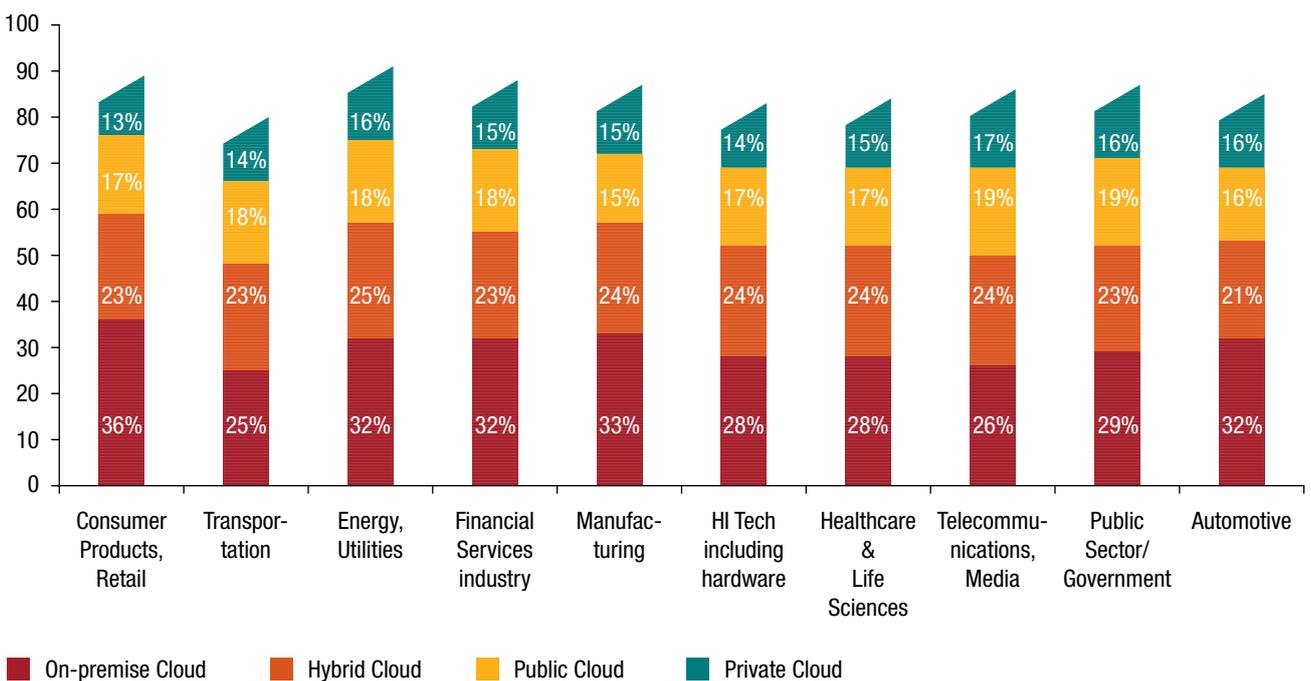
usage at 32%. In between these polarities, North America records a 49% usage, and Asia Pacific stands at 46%.

This year's respondents to the question of cloud-based applications usage believe that it will grow. Based on a three-year horizon, they predict strongest growth in a combination of private cloud applications and on-premise cloud applications, from 45% to 55%, followed by public cloud, from 23% to 28%. Hybrid shows a moderate growth

expectation, from 18% to 21%. The strongest growth in private cloud proves that the concerns around data and privacy extend beyond the traditionally data sensitive sectors like Financial Services to other sectors, such as CPRD and Energy & Utilities. The moderate growth in public cloud-based applications is a signal that organizations are also expecting open cloud solutions to be beneficial from cost, maintenance, and scalability perspectives.

FIGURE 7

Percentage split of cloud based application



## Higher focus on performance testing while functional validation on cloud is ignored

More and more organizations are transforming ways of working to become cloud-first enterprises. Understandably this has a direct impact on the testing approach used, with cloud-based and/or third party software-as-a-service (SaaS) solutions having a specific risk profile. This is demonstrated in a number of striking changes to the specialist approach of testing these applications.

In particular, we see a significant increase from last year in the percentage of study respondents saying they pay special attention to peak load testing. This is up from 38% to 54% and brings peak load testing in line with the other two areas covered in this aspect of QA and Testing, security and performance. Both of these are up just 1% to 53% this year. The increase in focus on peak load testing can be attributed to the fact that organizations are using more

cloud-based services for day-to-day business operations and customer engagement, for which scalability and responsiveness to peak loads are increasingly important. This finding also suggests our study participants may not yet be using true cloud native applications services. If they were, peak loading would not require special attention in a more mature cloud environment.

Our study findings also reveal that many organizations are currently ignoring the need to validate their move to cloud. The percentage of respondents that do not follow a specific test approach for testing cloud-based applications is increasing, up from 24% in 2015 to 49% this year. This is a sign that organizations have not yet realized the need to specifically test for cloud migration.

FIGURE 8

### Approach towards testing of cloud based and third party SAAS (Software as a Services)





## Challenges increase for mobile and Multi-channel applications testing

There has been a surprising increase in the number of respondents reporting challenges with testing mobile and multi-channel (mobile, wearables, social, and traditional) applications this year. Having reduced in volume across the board in 2015, all the issues in this area covered by the World Quality Report 2016 survey have seen marked increases. A lack of the right testing process or method has seen the biggest jump at 20% more than 2015. It is also the greatest challenge this year, cited by 48% of respondents. This leapfrogs the challenge above last year's top three challenges: lack of an in-house test environment, up this year from 38% to 46%; not enough time to test, up from 36% to 44%, and a lack of mobile test experts, up from 29% to 46%.

There is a core high level sequence of activity that can help to address this challenge. The first is to understand user-base usage patterns and device demographics. Then prioritize the

features being developed, and test and deliver based on this usage and adoption to avoid wasting time and energy on low value use cases. The next activity is to prioritize and create a sufficiently representative development and test ecosystem of devices, Operating System, and carriers, while minimizing variation in the testing pool. Finally, delivery of features should be accelerated through continuous integration and continuous delivery (DevOps), with feedback leveraged to shape each iteration.

Clearly, there is an overall sharp deterioration in the management and operations required for mobile testing. It is possible, that given the increasing complexity of the mobile landscape, organizations are struggling to cope with the variation in tools, devices, and methodologies. With growing integration, testing becomes more complex and new areas must be validated. For example, what is

FIGURE 9

### Challenges in testing mobile and Multi-channel (Mobile, Wearables, Social, and Traditional) application

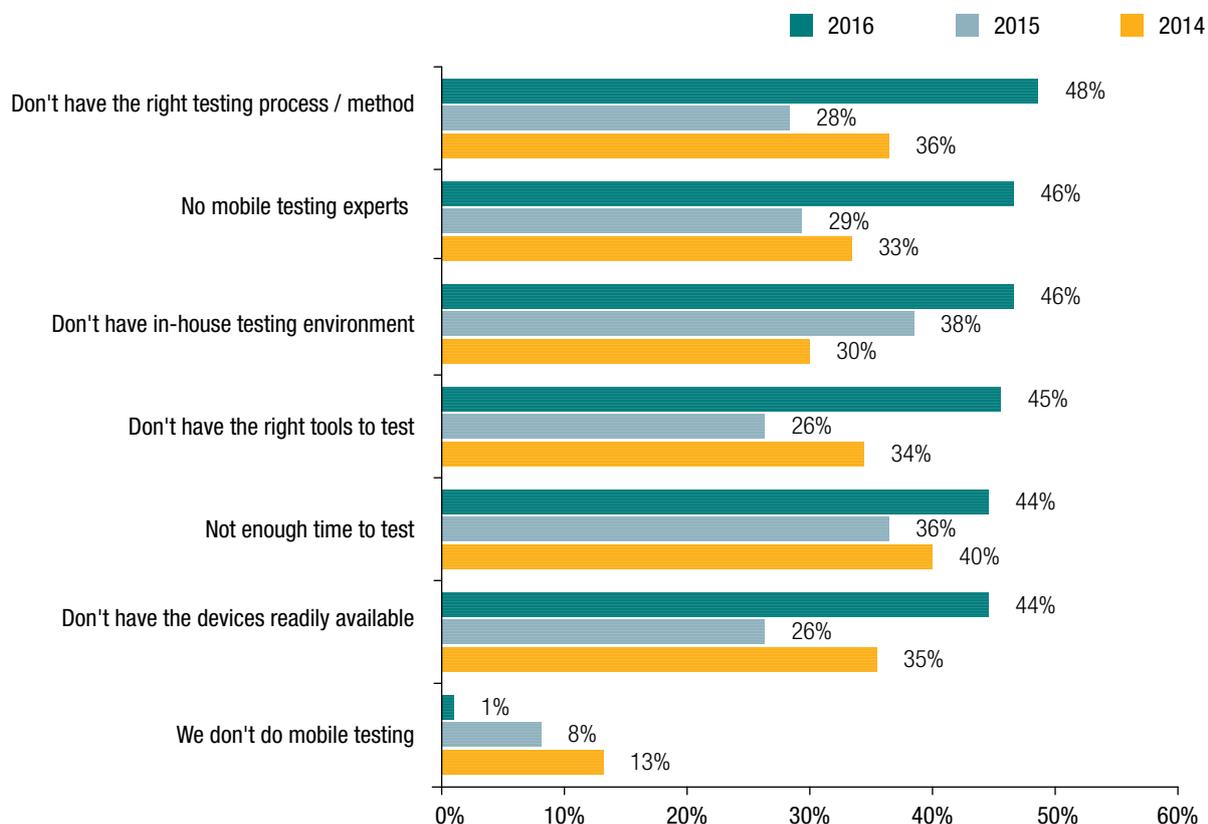
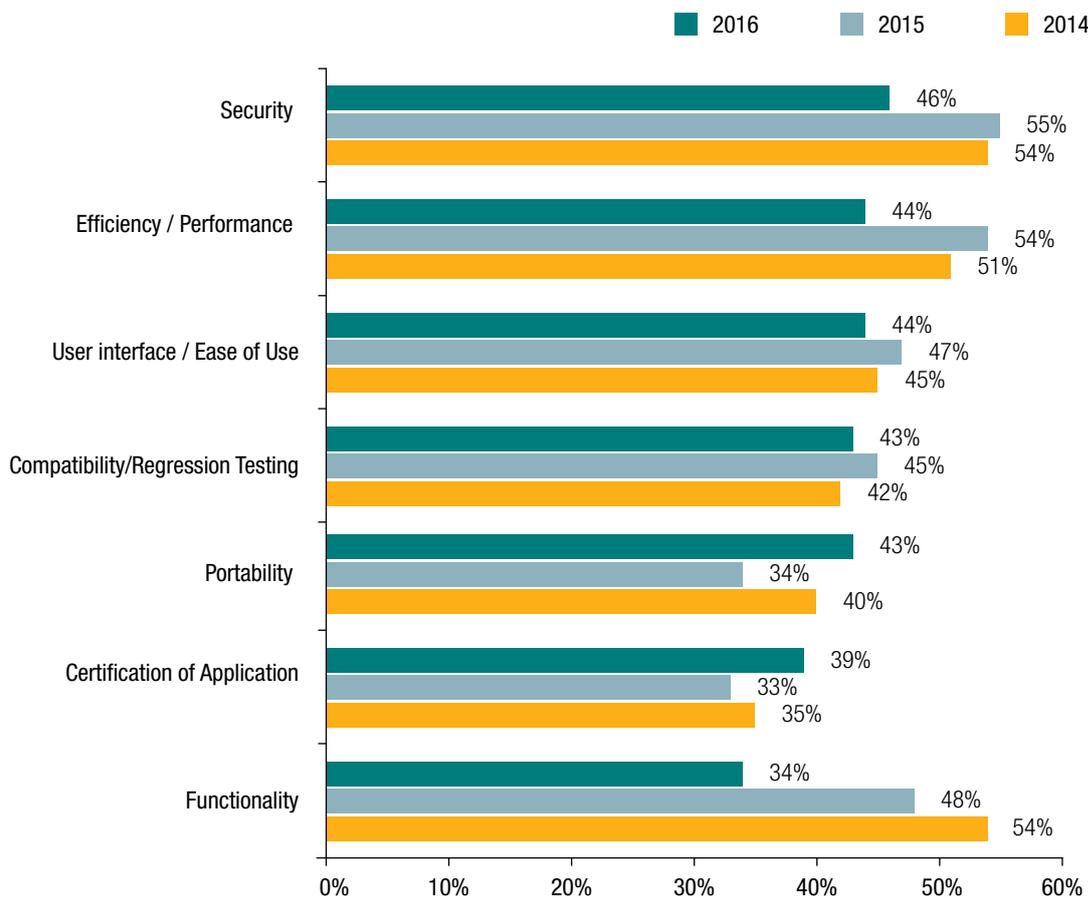


FIGURE 10

Focus area for testing mobile applications



the overall integrated user experience? How secure is data exchange and storage – is the analytic engine correct? In addition, although many more organizations are making use of mobile solutions, mobile testing is still viewed as a relatively new skill in the development lifecycle.

While the challenges with testing mobile applications have increased and changed in priority over the last year, the focus areas for testing mobile solutions are fairly consistent with 2015. The top three remain security (46%), efficiency and performance (44%) and user interface/ease of use (44%). All three, however, are down in terms of the focus effort. This is surprising, not least with regards security, which is the number one IT strategy priority by a long measure. One

possible reason for the drop in percentage effort afforded to security is the strong desire to move away from public cloud to private and on-premise environments, which offer greater control over security.

With just 34% of respondents focusing on functionality, this is the least tested area of mobile applications and is down from 48% last year. This can be explained by the fact that, for many mobile solutions, functionality validation can be moved to field testing by real (subset) users. Additionally, with a reduction in large releases of complex upgrades in favor of smaller DevOps style releases, testing is becoming more granular and minimal, with limited complexity of functionality to test.



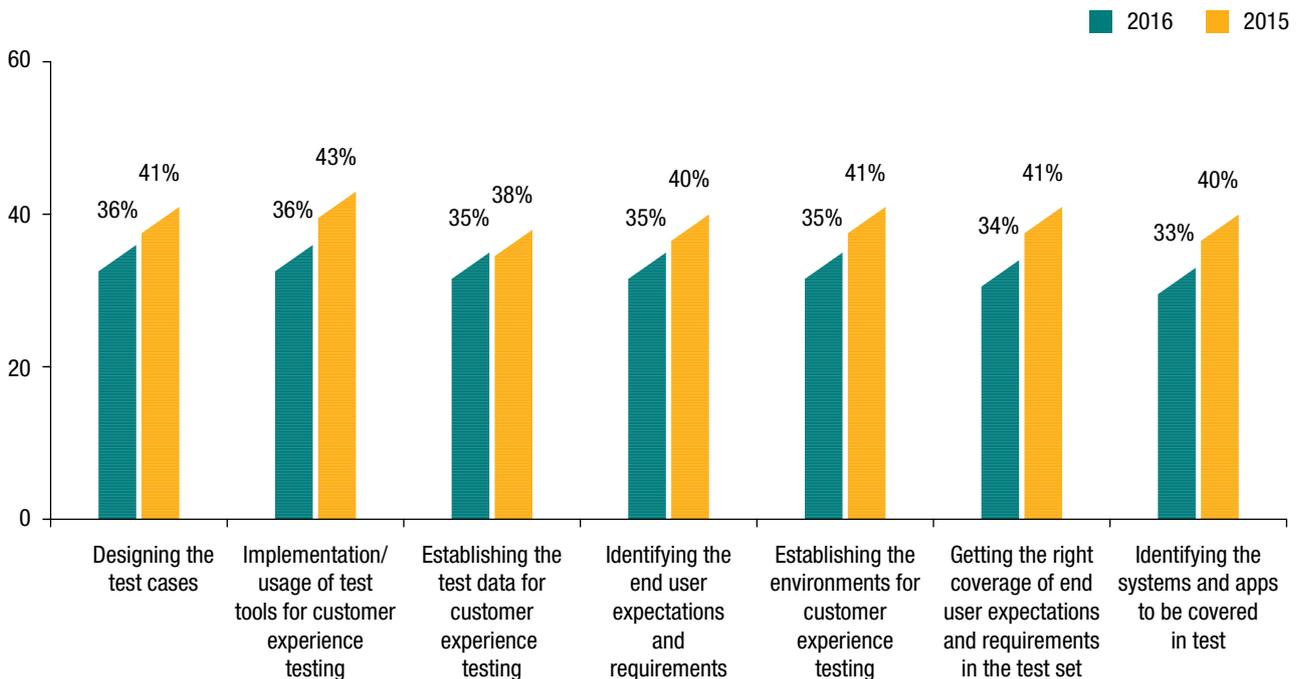
## Customer experience testing challenges reduce

This year has seen a reduction in all challenges with testing the customer experience of multi-channel applications. The two most challenging aspects, both ranked by 36% of study participants, are designing the test case (down from 41% in 2015) and implementation and use of test tools for customer experience testing (down from 43%). It can be a real challenge to understand how customers use an application and, while these two challenges are being experienced to a lesser extent this year, it is clear that the QA and Testing challenge of creating scenarios to genuinely reflect the flow of what users do remains.

The challenge of identifying end user expectations and requirements has dropped from 30% to 35% compared with last year's study findings. This could be reduced still further through the wider adoption of behavior-driven-development techniques. Overall, the reduction in challenges is an indication that organizations are better able to manage their customer experience testing and have improved their understanding of the user experience. With a host of new tools in the mobile and digital testing space, it has become easier to measure, quantify, and better understand the user experience. This will characterize QA and Testing in the coming years.

FIGURE 11

### Challenges for Testing Customer Experience for Multi-channel applications

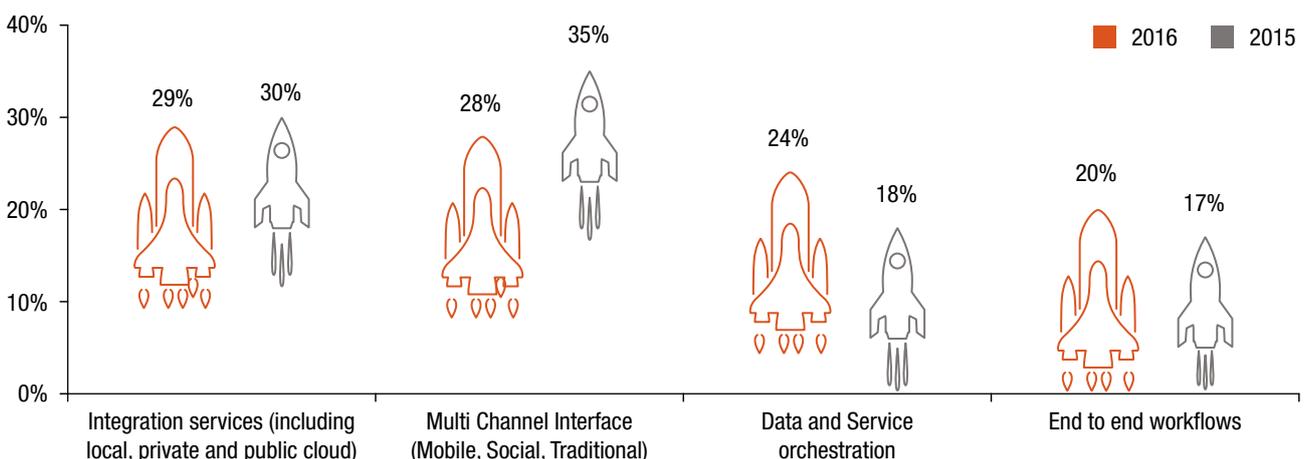


Digital continues to disrupt and the World Quality Report 2016 study findings reveal that testing new digital implementations is causing specific test challenges. At 29% of respondents, the challenge with integration services is the most cited. The speed of ongoing Digital Transformation is seeing the rapid integration of different IT architecture components (front office systems vs back office systems), direct access to data lakes, and new off-the-shelf services with back office and legacy systems. This speed is causing a major challenge and the focus of QA and Testing should be targeted at securing the quality across all system layers.

Testing the multi-channel interface appears to have become less of a challenge this year, dropping from 35% to 28%. One possible explanation for this could be the level of maturity achieved by some of the respondent organizations in their understanding of how to test the omni-channel experience, with the result that they must have developed more robust testing strategies. Other challenges, however, are more pronounced this year, such those associated with data and service orchestration, and end-to-end workflows. This is possibly due to the adoption of digital implementation into mainstream IT strategy as digital comes of age.

FIGURE 12

### Most challenging aspects of testing digital implementation



## A digital future cannot come at the cost of quality

The consumer appetite to engage via digital channels is matched only by intolerance for any defects that might have an impact on their user experience and business outcomes. Digital Transformation is also fundamentally changing the way in which business and IT interact. Historically, business demand drove IT, but with greater digital capability, this situation has reversed. Today we see IT driving business as digital enables new ways of working, engaging with end users, and turning data into strategic insights.

While digital has also created an expectation of speed-to-market, it is essential that this speed doesn't come at a cost to quality. Digital Transformation is still evolving, with many organizations struggling to make the shift to adopt cloud native applications. QA and Testing has to continue

its transformation and work in new ways adapted to this digital world.

With the proliferation of application releases and demand for speed, it is impossible to test 100% of all releases. Instead, the key will be to test the right things, at the right time. The use of intelligence-led testing and predictive analysis will enable this, although there is clearly still a long way to go to achieve it: 35% of respondents say that establishing the data for testing customer experience for multi-channel applications is an important or very important challenge. Nonetheless, it is our belief that only by truly knowing the customer can QA and Testing activities be effectively prioritized to meet the needs of the digital enterprise and its customers.



# Internet of Things and Security Testing

## Stretching the need for quality and security

**Yves Le Floch**, Vice President, Cybersecurity Services, Sogeti

**Tom van de Ven**, Senior Test Consultant, High Tech, Sogeti

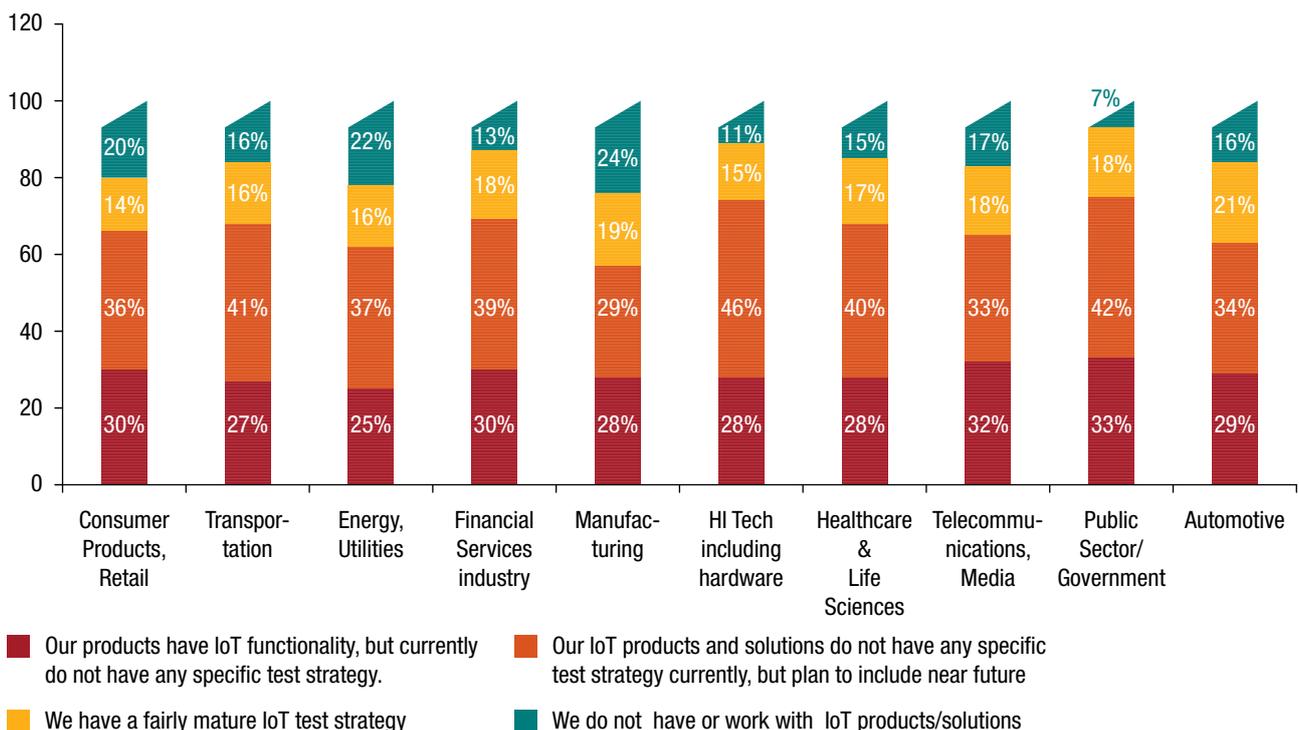
**Vivek Jaykrishnan**, Director Technology – V&V, Capgemini

The Internet of Things is revolutionizing the way we work and how we live. The amount of devices and level of data exchanged in our connected landscape is growing to epic proportions. This is demonstrated by the 85% of participants in the World Quality Report 2016 study that say Internet of Things products are part of their business operations.

However, 68% of respondents with Internet of Things functionality do not have a specific test strategy for it. This is perhaps because most do not manufacture the Internet of Things device themselves, relying instead on the device manufacturer to plan and execute tests. But we believe an Internet of Things test strategy is needed, even though it

FIGURE 13

Organization with specific test strategy for testing products in an Internet-of-Things (IoT) environment



will require the introduction of new skills and extension of the test environment. This is because testing these smart, connected solutions demands a broader and more complex scope than traditional software testing. Organizations must also pay attention to defining a strategy for system integration testing and/or real-life testing.

There are a number of techniques coming to the fore as building blocks for Internet of Things testing. One of these is the use of crowdtesting, although this has security implications around whether security is adequately guaranteed and if the IP is sufficiently protected. Interoperability testing is another technique that we are seeing more and more of to meet the end user expectation of being able to switch seamlessly between device operating systems and different application versions. Other building blocks include structural IT system

tests in virtualized environments, validation of communication protocols, integration testing with test devices, scenario-based testing, exploratory testing, and quality monitoring in production.

While 68% without a test strategy for their Internet of Things functionality is high, in fact 38% concede that they have plans for one in the near future. It is a concern that 30% of respondents with functionality claim to have no specific test strategy and no plans for one. It's possible that these companies are confident their existing testing is adequate. Alternatively, they might simply be content to rely on the device manufacturer. Worryingly, they may not realize the huge potential for risk if they don't have a comprehensive Internet of Things test strategy.

## Security presents a challenge in the Internet of Things

When asked about the key challenges with testing products in this Internet of Things environment, our World Quality Report 2016 study participants give an equally high score of 4.70 (on a scale of 1-7 with 7 being most challenging) to security testing and creating a test environment with virtualized end products, devices, or test data. The security challenge is no surprise due to the difficulty in testing between each Internet of Things layer, made up of the application, data and business intelligence, communications bridge, and the thing itself. The challenge of testing this interaction between layers receives an average 4.67 score, putting it above those of testing the integration with third party solutions/products (4.66), and testing non-functional aspects (4.57). To overcome this challenge, new ways of working must be introduced, with domain, test craftsmanship and project management experts all talking and collaborating.

The challenge with creating test environments for virtualized products is largely due to the need to switch from a physical

environment to a virtual one and how best to connect all aspects for the first time. Testing the end-to-end user experience, including performance, follows closely behind these two leading challenges with a score of 4.69. Internet of Things functionality is typically centered around the end user, and the aim is for the product or application deployed to simply just work. The challenge lies in defining the right metrics to ascertain what the user feels about the product.

Looking more closely at the security challenge, another factor to consider is that, although the secure by design approach is the right one to adopt, it is currently rarely applied in the Internet of Things development process. This is due to a number of reasons, including a lack of expertise, rush to market, and low security maturity compared to traditional IT. However, if security is not taken into account in the design planning and process, there is little chance it can really be taken into account in the testing process.

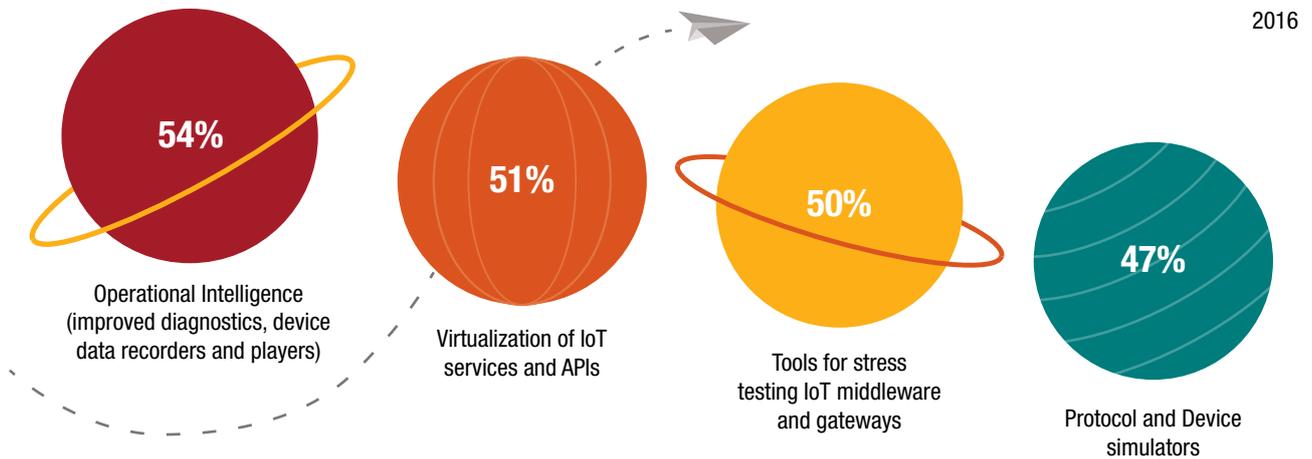
## Opportunities for further testing identified

This year's study participants were also asked about the possible opportunities for solution development for Internet of Things testing. At the top of the leader board, rated by 54% of respondents, is the opportunity for Operational Intelligence, with improved diagnostics, device data

recorders and players providing real-time monitoring and analytics of Internet of Things devices. This is followed by: virtualization of Internet of Things services and APIs (51%); tools for stress testing middleware and gateways (50%); and protocol and device simulators (47%).

FIGURE 14

### Opportunities for solutions for IoT testing



The popularity of Operational Intelligence aligns with the start-up mentality in Internet of Things product development. There are two potential testing opportunities for Operational Intelligence in testing: the use of real-time data collection to analyze and predict potential failures before they occur; and the ability to allow for early real-life validation checks by launching beta-versions.

The high ranking given to the opportunity to develop testing solutions for the virtualization of Internet of Things services and APIs lies in the potential for moving testing much earlier in the development cycle. By virtualizing device test-beds

or the testing of the end-product in which the device will be integrated, it is possible to more easily test scenarios in early stage development.

It is also interesting to note the relatively low score given to protocol and device simulators (47%) in terms of the opportunities for testing solutions. There is currently no generic Internet of Things protocol as one standard, and this lack of standardization means there is insufficient breadth and depth for customization purposes, thus a low solution opportunity score.

## Artificial intelligence will be part of future Internet of Things testing

It is evident that the adoption of artificial intelligence and machine learning will increase for testing and validation of Internet of Things developments. This is borne out by the 46% of our survey participants agreeing with the idea that “Internet of Things solutions have an unlimited amount of situations to test, requiring a form of artificial intelligence and machine learning to test to the best extent”.

There is an even 42% average across the remaining three statements regarding their ideas on Internet of Things testing. Firstly, the difficulty with Internet of Things testing lies in the things part. One of the key challenge here lies in the different speeds at which a product (the thing) and its associated software are developed. Software development

is much faster, so there is a need to bring the two together at testing stage.

Secondly, in response to the idea that less functional testing and more Internet of Things experience testing characterizes testing in this area, both Energy & Utilities and Financial Services come in above average, at 53% and 52% respectively. These two high scoring sectors place a big value on their customer satisfaction scores, which is possibly why they believe testing the experience should be a priority.

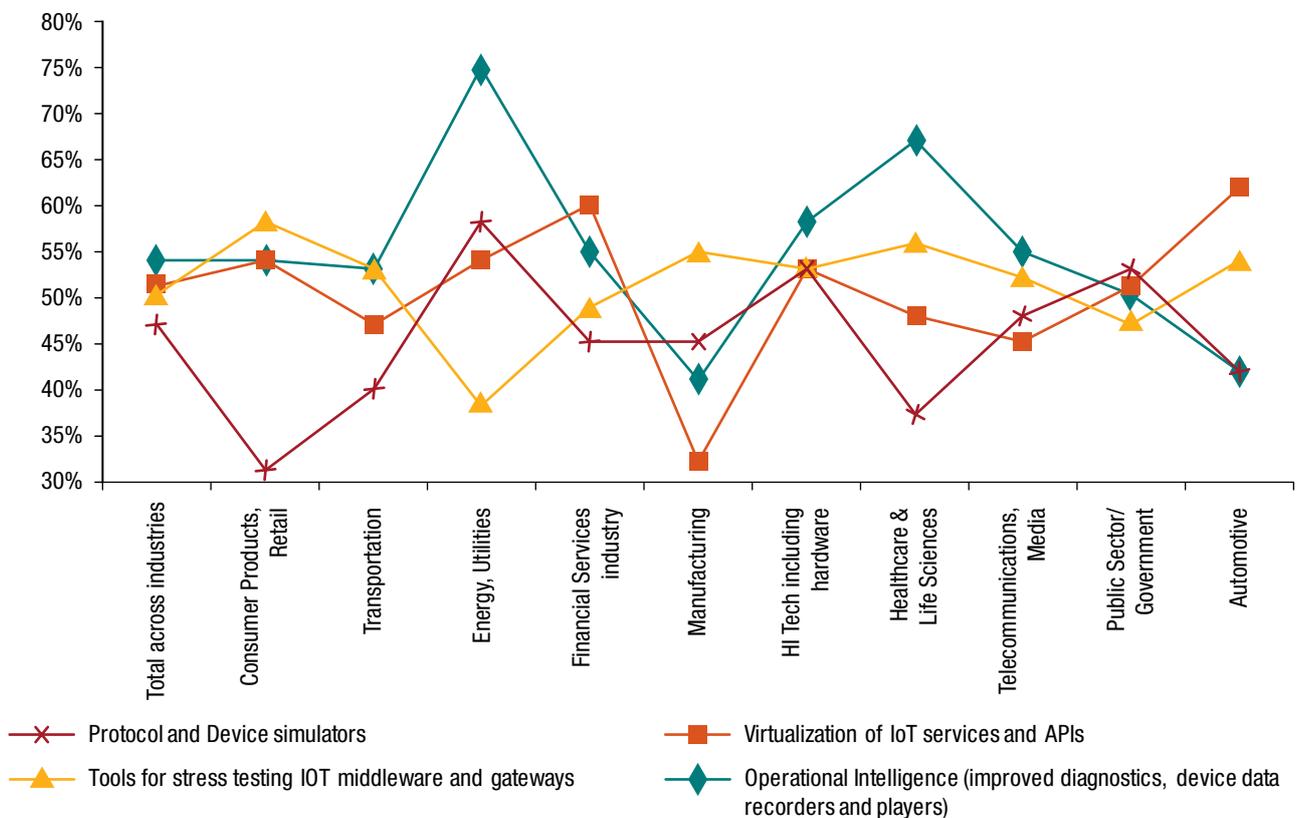
Thirdly, a shift from testing with domain knowledge to testing with test craftsmanship also receives an average of 42% in this topic area, although there is a marked difference in

the Energy & Utilities industry's score (19%). Historically, companies in this sector tend to be more conservative and work from domain knowledge as a base, thus this is not an unexpected result. For the rest, while there is still a bias towards companies relying on their product domain experts,

there is clearly a move towards test craftsmanship. This is likely to be because domain expertise is no longer sufficient for testing Internet of Things functionality, which requires a more theoretical and broader knowledge of testing.

FIGURE 15

### Opportunities for IoT testing across industries



### Security stands out more clearly as the number one IT priority

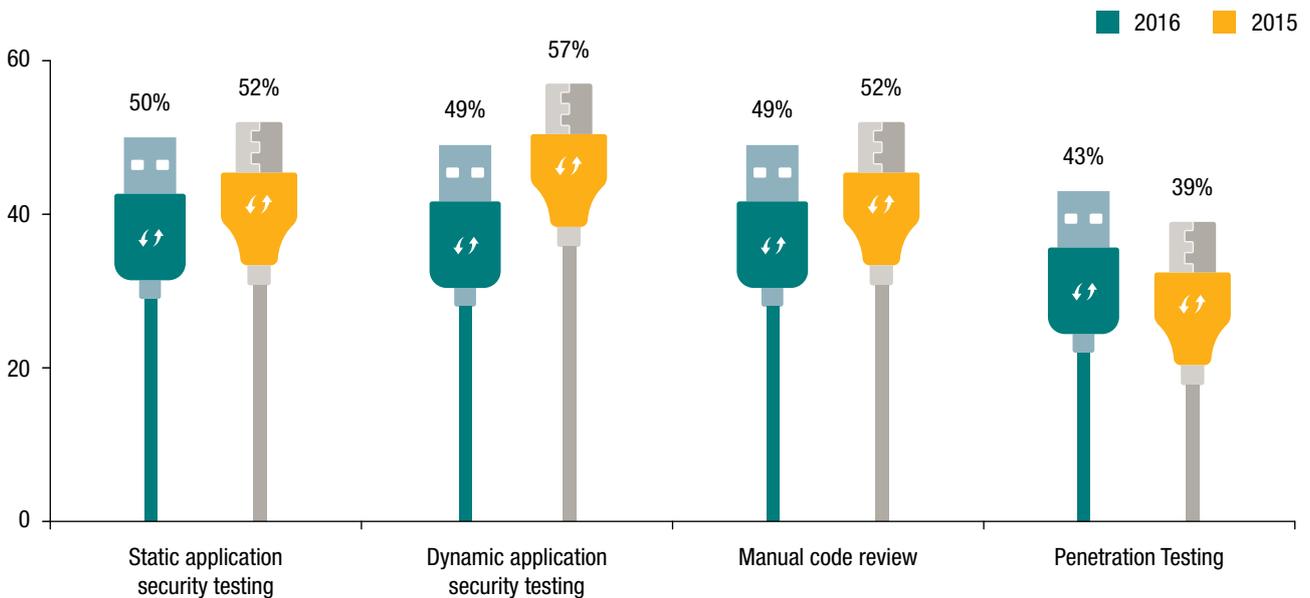
This year's World Quality Report study reveals that enhancing security overall is the most important aspect of IT strategy by a long measure. It scores 5.67 on a scale of 1 to 7 (with 7 being the most important). Indeed, 65% of respondents rate security as important or very important, with the next closest priority of higher quality software solutions coming in at more than 20% lower (44%). This comes as no surprise. Industry reports suggest that 84% of breaches occur in

the applications layer and, with the escalating adoption of cloud services, mobile applications and Internet of Things capabilities, today's digital enterprise is potentially more vulnerable than ever.

There have been a number of changes in the most commonly performed security testing activities over the past twelve months. Dynamic application security testing (DAST) testing,

FIGURE 16

### Commonly performed security testing activities



where code running on the server is checked, has dropped from 57% to 49%, while penetration testing is up from 39% to 43%.

The logical conclusion for the drop in DAST testing is that some companies are buying in more expertise rather than relying too heavily on automation; penetration testing meets this requirement. Both DAST and static application security testing (SAST), which is performed by 50% of respondents, are very much automated, yet hackers are human and look for increasingly smart ways to attack applications and gain access to enterprise assets. Thus expert reviews and penetration testing in combination with automated SAST and DAST affords a greater level of security.

Manual code review is also slightly down, from 52% in 2015 to 49% in 2016. We view this as likely to be the result of the increasing uptake of agile, DevOps, and continuous integration methodologies. These promote rapid development, which potentially leaves less time for manual code review. As penetration testing comes towards the end of the development cycle, it seems likely that time is being kept back for this, preferably before the application is in production, although occasionally afterwards. In last year's report we suggested that penetration testing still had room to grow and it is clear that this growth is underway.

### Increase in contributors to security testing

The type of contributors to security testing has also seen big changes this year, with significant increases in all but one area. Just 1% of participants claim to carry out no application security testing, compared with 17% last year, which demonstrates that security testing is no longer viewed as an option, but is part of strategic intent.

The level at which managed application security testing services are performed has increased from just 35% in 2015 to 51% this year. Similarly, internal security testing teams using pay-per-use tools has increased as an approach from 32% last year to 51% this year. Close behind, at 50% of respondents (up from 34% in 2015) is the use of an external

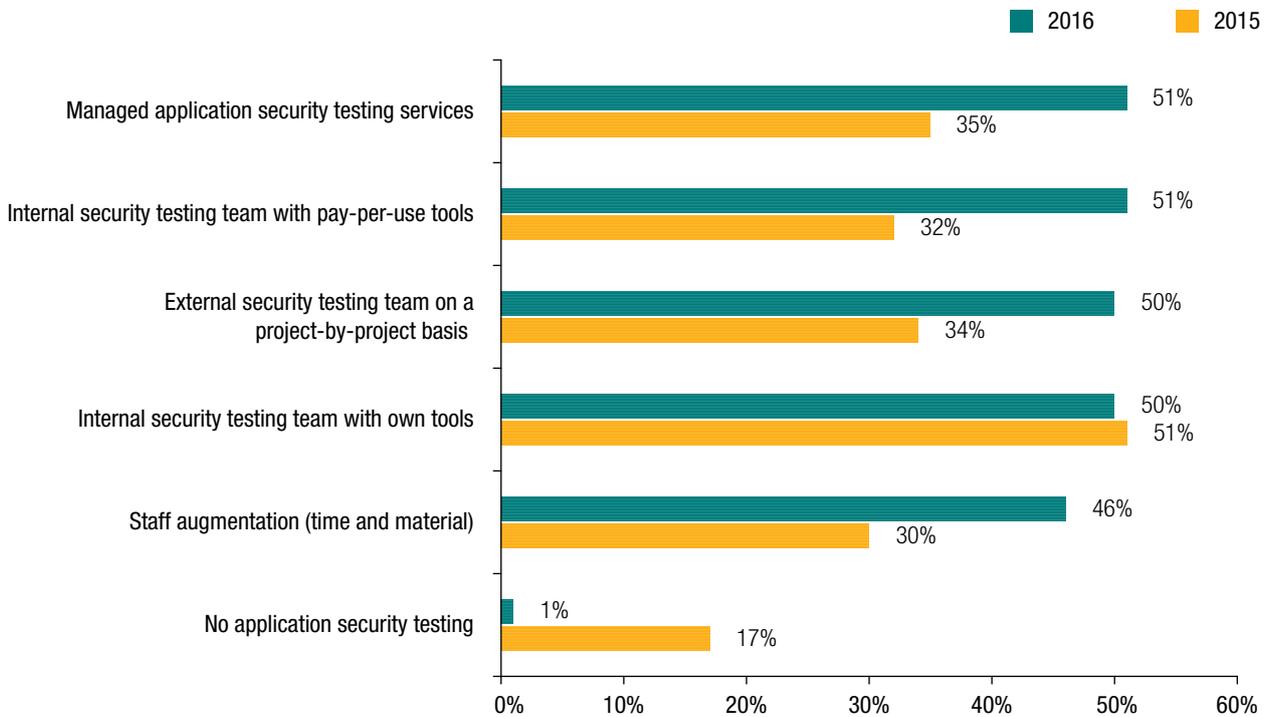
security testing team on a project-by-project basis. Even staff augmentation (time and material), although not the most favored approach (46%), has nonetheless significantly grown in use from 30% in 2015. The use of an internal security testing team with its own tools is the one area that remains almost static this year at 50%.

support in one form or another a growing requirement as internal security teams become overwhelmed with testing volumes. In addition, many organizations find it extremely difficult to hire and keep properly qualified resources to provide application security testing; more and more of them prefer to rely on specialized external teams.

It is clear from these findings that the increasing workload as a result of spiraling application development has made external

FIGURE 17

**Contributors performing security testing**



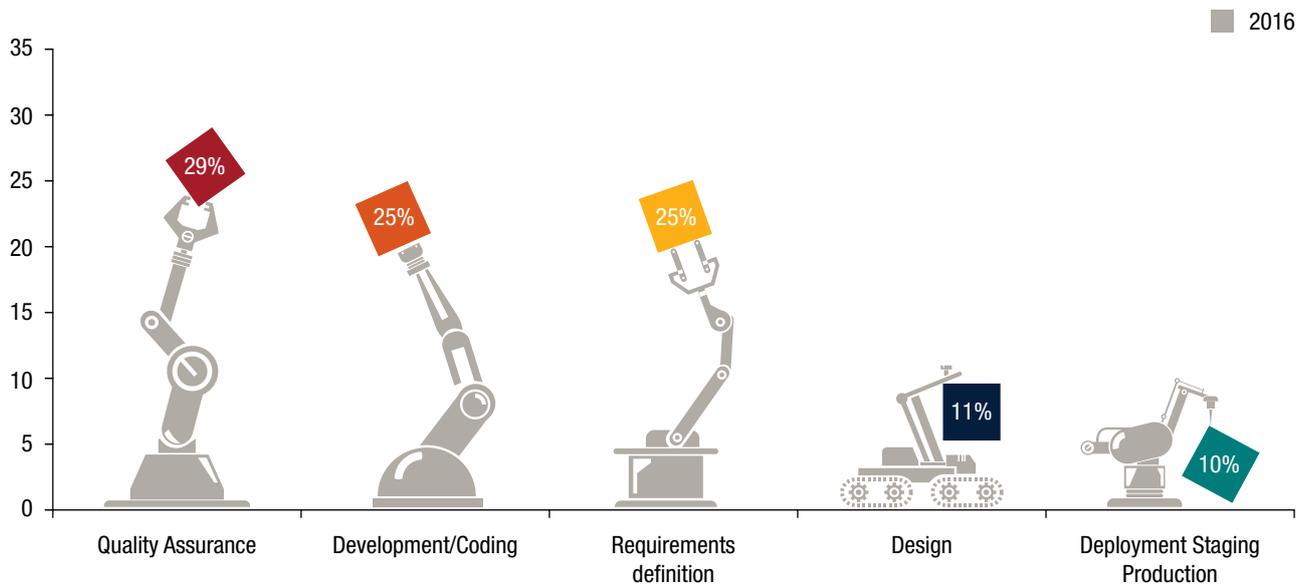
**Late stage testing continues to dominate**

While security assurance activities are undertaken at all stages in the application lifecycle, once again there is a preference for late-stage testing. More respondents actively participate in it on average during the QA phase (29%) than at any other time in the lifecycle. This takes QA above the development and coding phase (25%), and above the requirements definition phase (25%).

stage because this moves it up in priority from the least used phase (alongside design) in the 2015 study. This shows that security is increasingly being viewed as an important aspect of an application, not just an afterthought. Indeed, we know that security by design is the only way to ensure that protection is robust against most threats, while security after design is likely to result in additional costs, delays and poor security.

It is positive to see the percentage of security assurance activities carried out at the earlier requirements definition

FIGURE 18

**Application security assurance activities****Bringing mainstream security and Internet of Things together in future QA and Testing activity**

Overall, this year's study findings are strong confirmation that enhancing security is by far the most important aspect of IT strategies, in all sectors and all geographies. There are clear trends: a steady increase in systematic testing of all applications/releases; an increasing call to security testing specialists to support and augment in-house testing capabilities; and more security in the requirements stage of the development lifecycle.

The proliferation of interconnected devices and the collection, analysis, and sharing of personal data and images have driven security to the top of the CXO agenda. Nonetheless, the approaches used for validation and security checks are not yet mature and require closer scrutiny. With the growing adoption of agile and DevOps, we also believe that security awareness and the responsibility for assuring security will now be assumed by all team members. This will move security testing from the end of the development lifecycle to security engineering in all stages.

Connected products and the Internet of Things impact the physical world, as would a security breach associated with them. In the quest to improve Internet of Things security, security by design assumes that security is tested as early as possible, for example in the requirement phase, even if end-user experience or time-to-market are bigger drivers for the projects. But the impact of the Internet of Things on testing is far broader than security alone. Different types of test focus areas are needed for the end-to-end validation of an Internet of Things solution. For example, interoperability, usability, efficiency, performance, and compatibility, to name just a few, must be taken into account. As this exciting technology development grows exponentially, testing must keep up.

# Agile and DevOps

## More intelligence-led testing will meet speed, quality and cost imperatives

**Deepika Mamnani**, Principal, Financial Services SBU, Capgemini

This year's World Quality Report marks a new impetus for testing in agile projects. The increased demands for what appear to be opposing objectives of speed, quality and cost require organizations to rethink their quality validation and testing activities. Standard automation of test cases is no longer enough. Instead, Quality Assurance and Testing professionals must adopt integrated quality engagement models, a business outcome focus, and the use of intelligent data analysis to form test strategies and create automated optimized validation checks and test sets.

It is clear from our survey findings that organizations are increasingly struggling to match the right level of quality with the demand for speed. To address this, QA and Testing experts should be fully integrated with the agile teams. They must take a business-centric approach to choosing the

right test focus areas and creating nimble processes, such as such as behavior driven development (BDD) to define acceptance criteria that can be automated. They should also leverage techniques such as mind maps and model-based tests, and make use of intelligent tools as vital enablers. All of this requires skills, not just in testing, but in business understanding, development and new tool technologies as well.

With this change comes the need for agile testing expertise to move away from execution to transformation, and from a focus on test execution tools to strategy capabilities. We are seeing a similar maturing of DevOps practices with organizations becoming more informed about various DevOps levers.

## Multiple hybrid agile frameworks shape the agile testing future

Just 1% of this year's study participants say they do not adopt agile development methods. There are three clear preferences in terms of the percentage of projects adopting agile methods: Scrum and Scaled Agile framework (SAFe) are both used in 24% of projects, while Dynamic Systems Development Method (DSDM) is used in 22%. SAFe has gained popularity in all sectors, due to the fact that it

addresses large-scale portfolio management, program management, release management, budgeting and multiple practices. Other agile development methods in use are: XP, used in 17% of projects, Lean Software Development (16%), and Kanban (15%). With a total in excess of 100%, these figures demonstrate a mix of multiple methods within different projects.

## Distributed agile model increases in use

The key themes for testing in agile this year are to establish distributed agile and test approaches, and to focus on business outcomes and customer value, rather than on tools. Those study participants using agile adopt a range of testing approaches and, once again, it is clear that

multiple guidelines and frameworks are combined within single projects. The most used of these is to work in a distributed agile model, adopted by 42% of those using agile, up significantly from last year's 24%. Looking ahead, a distributed agile model will be critical to successful agile



development projects due to the ability to include low cost, same time zone, near shore options. To this end, agile program, portfolio management, budgeting, governance and demand management will be required to balance core and flexible teams and drive economies of scale.

In setting up an agile Testing Center of Excellence (TCOE), the need to co-locate teams is viewed as the biggest

challenge. 46% of respondents whose organizations use agile cite this as a challenge due to its potential to deny cost savings through globally distributed delivery models. In agile development, close and immediate collaboration of disciplines is needed and this can conflict with the objective to optimize testing costs. The agile TCOE, therefore, needs to offer a more optimum mix of onshore, offshore, and near shore teams to balance both cost and flexibility.

## Familiar challenges in higher proportion

The increasing adoption of agile development has been met with an increase in the challenges encountered with testing in agile. Last year, 18% of respondents to this question said they had no real difficulties, contrasting with just 1% this year. We can see that as agile becomes enterprise wide, environment and data challenges for testing exponentially increase.

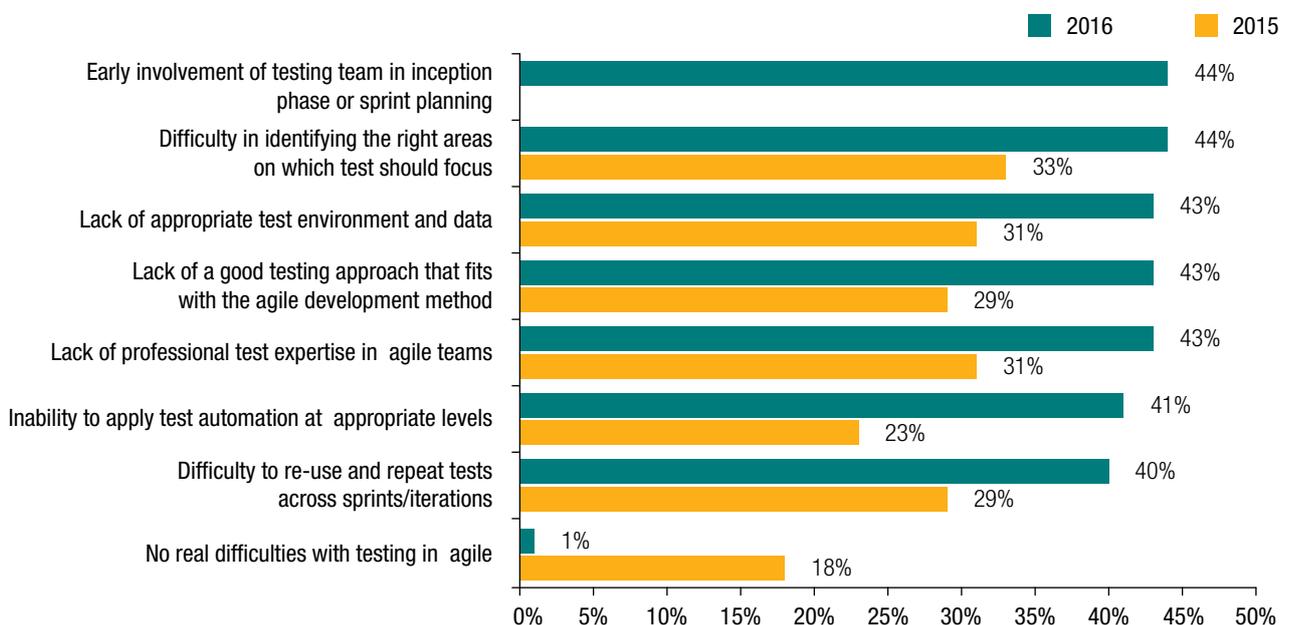
With quality demands now taking on a more strategic character, these challenges are heightened. The top two challenges in applying testing to agile development, both cited by 44% of the 2016 study respondents, are: identifying the right focus areas for testing, up from 33% in 2015; and early involvement of the testing team in inception and sprint planning phases. The late involvement of testing teams has ramifications, with less time for the in-depth analysis on which

test strategy decisions are made. This creates difficulties with allocating the appropriate level of test types and test depth. As a consequence, the selection of automation technologies, preparation of test data, and set up of the test environment do not receive the consideration needed, leading to quality issues in software, insufficient throughput of new functionality, and poor containment of overall IT costs.

Lack of a good testing approach that fits with the agile development method is cited by 43% of respondents this year, up from 29% in 2015. This reflects a shift in behavior where testing is being viewed as the biggest bottleneck in the delivery of agile projects. Also cited by 43% of participants as a challenge is a lack of professional expertise in agile teams, up from 31% last year.

FIGURE 19

### Challenges faced in applying testing to agile development



## Skills shortage must be addressed to avoid bottlenecks

The shortage of testing skills in all stages of agile projects has to be addressed to avoid testing being a bottleneck in development. An average 22% of respondents state that they need to build test strategy and design skills. This is followed by a lack of: non-functional skills (21%), test environment virtualization skills (21%), understanding of business process (20%), Test Driven Development (TDD) or Behavior Driven Development (BDD) (20%), test data setup skills (20%), and predictive analytics skills (20%). This latter skillset will be needed in a future intelligence-led QA and Testing landscape to predict the quality impacts of new functionality plans, agile backlogs, open defects, and production incidents based on data facts.

QA transformation and strategy consulting capabilities are also needed to define the appropriate speed-to-test

levers for agile initiatives. Our study participants also noted other skills gaps, as follows: TDD or BDD (20%), software development engineer testing (SDET) and development and coding skills (both 19%), production quality monitoring skills, and functional test automation expertise (both 18%).

One other challenge should be noted as testing shifts left to an earlier stage in the development process. Bottlenecks around both environment and data arise as a result of the adoption of agile in the enterprise, with an average project containing at least 15-20 Scrum teams at a minimum becoming the new norm. This requires test environment, test data, and virtualization skills to keep up with delivering shippable increments at an ever faster pace.

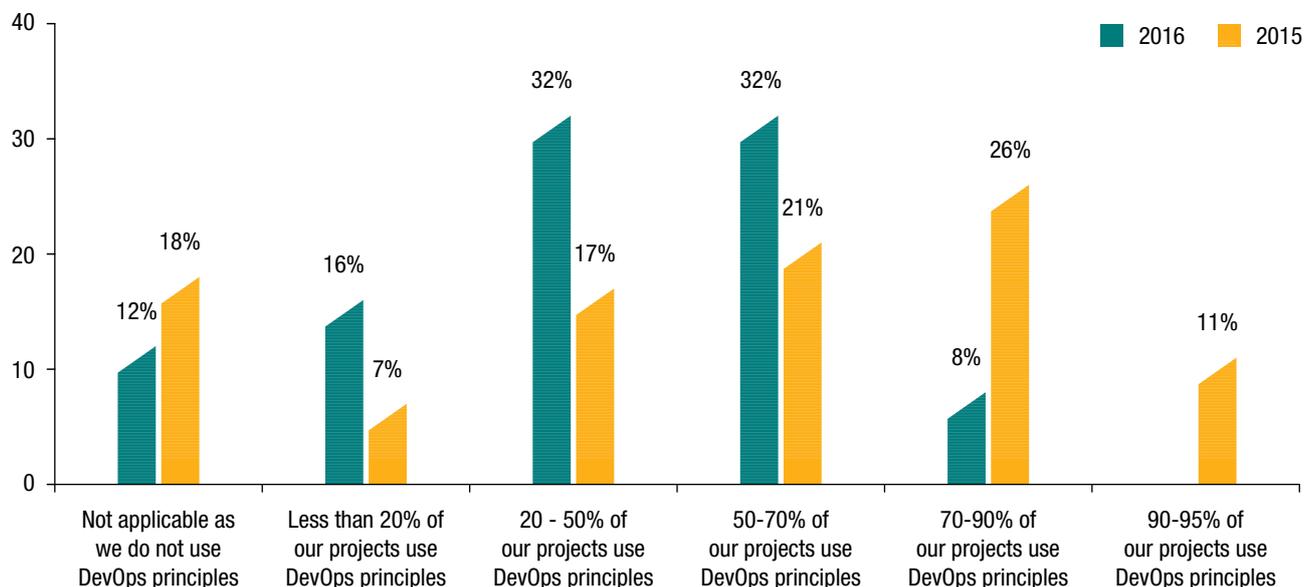
## DevOps matures with a new appreciation of its purpose

The use of DevOps principles has continued to grow, although it is still very much in an emerging stage. Just 12% of CIO respondents this year say they are not using DevOps, compared with 18% in 2015.

DevOps principles are, on average, being applied in 38% of projects, with 40% of respondents saying they use them in more than 50% of their projects. In last year's study some 26% of respondents said they used DevOps principles in a

FIGURE 20

### Projects using DevOps principles





high 70-90% of their projects. That number has dropped in 2016, down to just 8%. There is no usage in the extremely high 90-95% category this year, compared with 11% of projects last year.

We interpret this significant drop to be proof of realism and a better understanding of what DevOps is. Last year

organizations were eagerly jumping on the hype of DevOps but without fully understanding its real impact and application. Today there is better recognition that adopting DevOps implies a complete change of culture with the breakdown of barriers between disciplines. As a result, the averages are now shifting to the center, with 64% of respondents claiming they use DevOps in 20-70% of their projects.

## Multiple approaches are used to achieve quality in DevOps

Almost all organizations embarking on DevOps initiatives use some flavor of agile. There is a shift in the various DevOps practices used this year. Last year's most used practice was to break down large development efforts into smaller batches of work, used by 51% of respondents. This has dropped to 38% and been overtaken by several other practices. This demonstrates recognition that DevOps is about more than just cutting up large releases in smaller batches.

Speed-to-market is particularly critical for the development of digital platforms. Among the success factors are the ability to decide on the right things to test in the shortest time possible. Leveraging predictive analytics to bring speed efficiencies in all areas of quality decisions is one of the major emerging opportunities.

The drive to increase speed of testing in agile and DevOps further mandates the ability to spin up multiple environments early on in the lifecycle. This is made possible by increasing the use of cloud-based test environments with virtualization. This is confirmed by the fact that 42% of respondents claim to use both continuous monitoring with predictive analytics and more cloud-based test environments. That the use

of these levers will grow is evident from the study finding showing that those already using and those planning to use cloud-based test environments rise to 86% and 84% respectively when combined as datapoints.

Use of loosely coupled architecture and microservices has increased this year to 41%, up from 31% in 2015. When combined with the figure for those planning to use it, this leaps to 88%. This is not surprising in light of the fact that adopting flexible and service-based architecture reduces the need for big up-front design and enables the release of the software early and continuously. Continuous testing has gone down this year from 50% in 2015 to 41%, but we believe this is due to a better understanding of true continuous testing, which is zero-touch testing in a true integration of build and integration of code with unit testing, BDD, functional and non-functional tests. Again, of more relevance is the combined current and planned use, which stands at 86%. This is also high for the practice of automating the delivery pipeline (83%), and treating infrastructure as a code (81%). These shifting patterns are a sign of more strategic thinking and approaches to DevOps.

## Shifting testing left and right in combination is the way ahead

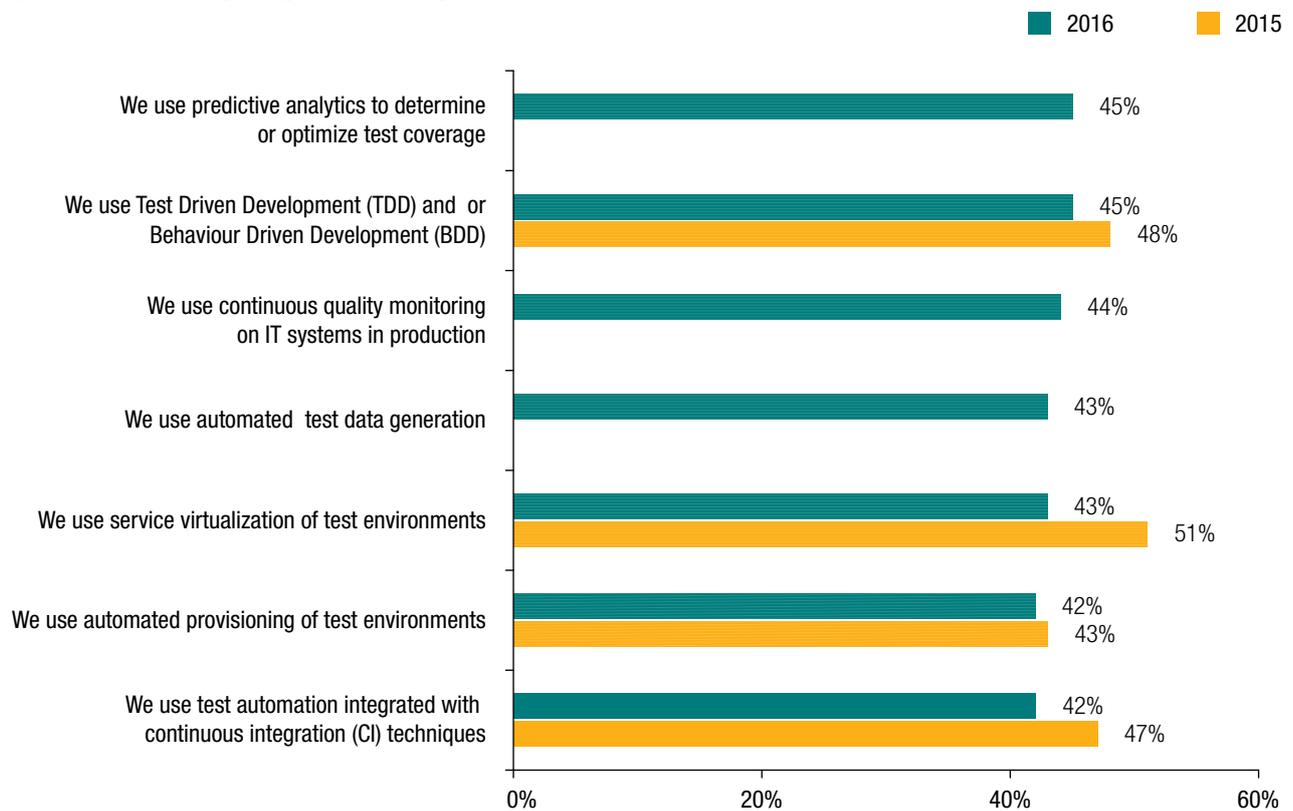
It is apparent that a combination of test approaches is used in a DevOps environment. The use of predictive analytics to determine or optimize test coverage emerges alongside TDD and/or BDD as the two most used approaches (45%). This is a promising sign of testing maturing as it shifts left in the DevOps process with service virtualization, TDD, BDD and continuous integration techniques.

Testing is also moving right towards later stages, with production monitoring and the provision of predictive analytics feedback into development and testing gaining popularity, along with automated test data generation. This is again indicative of the growth in intelligence-led testing that we believe will characterize the future testing landscape.



FIGURE 21

## Approaches to testing in agile in your organization



The biggest change in QA and Testing in the transition to DevOps is the human mind-set change.

**QA/Test Manager,**  
Consumer Products, Germany



## Changing skillsets catering to a new world

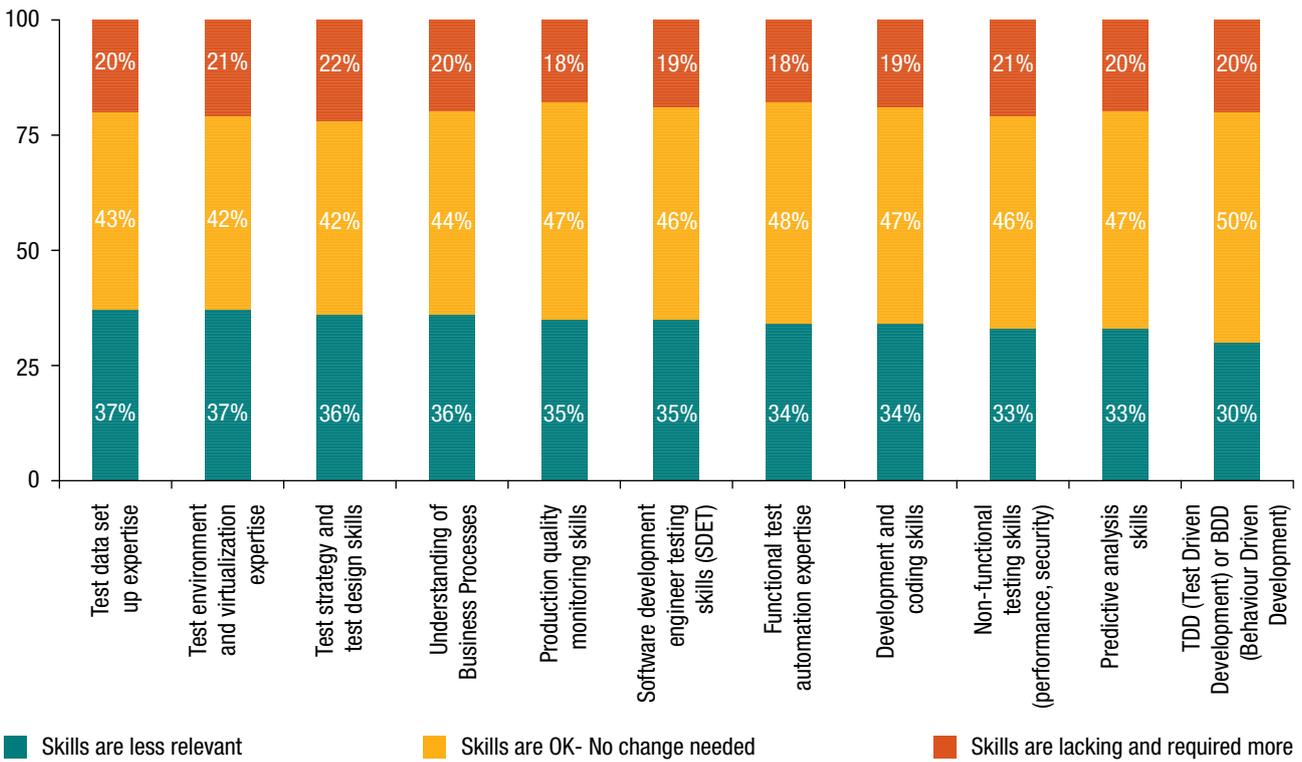
This year's study participants were asked to comment on the extent to which agile and DevOps changed the skills they needed from QA and Testing professionals. We have already commented on the very real skills gap, but overall, there is a fairly consistent level of satisfaction (42%-50%) where skills are deemed to need no change. However, it is clear that some are considered less relevant than others, although there is a marked difference in this across our respondent base. Both test data setup expertise and test environment and virtualization expertise are seen as less relevant today than any other skillset (average 37% of respondents). The low average score for these two skillsets is questionable, however. Agile and DevOps are highly demanding, as proven

by the fact that the environment and data issue scores among the top challenges with testing in agile. Thus we would argue that these two areas should be in higher demand.

Focusing on enhancing the mix of expertise in agile-DevOps teams will be a critical success factor in future, for example with the inclusion of more predictive analytics to help turn data-led insights into a better customer experience and improved business outcomes. Understandably, this intelligence-led environment will be heavily tool- and historic data-enabled, but asking the right questions to guide the right decisions will become more important than ever.

FIGURE 22

**Skills needed from QA and Test professional for agile and DevOps**



**Steps to take agile and DevOps deeper into the enterprise**

The survey clearly demonstrates that the primary focus on speed in agile and DevOps is causing increasing challenges with quality. The way forward is to find a better balance between this speed and quality. One option is to create a centralized Quality Management Office to drive transformation and enable all testing phases by providing the right set of nimble processes, tools, and, of course, test competencies for all projects.

The basic skills mismatch discussed earlier also stands in the way of achieving a balance between velocity and quality. The solution here is to build multi-skilled agile testing expertise comprising transformation experts, domain experts, strategy consultants, SDETs, environment virtualization, test data

experts, specialized test experts and data scientists. These skills should be balanced in a combination of core and flexible teams to drive economies of scale.

Finally, we infer that for an ideal agile and DevOps engagement, organizations need test environments that are flexible (loosely coupled) and cloud-based, which support continuous testing and continuous quality monitoring. Given the complexity of all of this working together in an agile environment, we recommend that organizations invest in smart ecosystems capable of using predictive analytics and automated decision making to achieve the two objectives of speed and quality.

# Industrialization and Testing Centers of Excellence

## Reflecting the shift to an intelligence-led test approach

**Prabakaran Karuppiah**, Vice President, Financial Services SBU, Capgemini

The adoption of digital transformation, agile and DevOps is forcing a change in Testing Centers of Excellence (TCOEs), which were originally set up to industrialize all test operations with cost efficiency as the primary focus. Now, more than ever, the TCOE has to adapt to facilitate the changing QA demands.

The response to this year's World Quality Report survey shows increased maturity and balance in fulfilling the differing QA needs between the worlds of core IT and the business IT landscape of flexible customer-facing applications. While centralized QA and Testing operations still remain a predominant theme, either in-house or through outsourcing to an independent third party, there is enough data to

acknowledge the emerging needs of a decentralized model. This typically comes from large Lines of Business (LoBs) in enterprises and from the adoption of agile/digital practices.

Evidence shows that preference for a full centralized TCOE with its incumbent overhead is trailing behind other delivery options, although the difference is not significant. This is consistent with last year's three-year trend away from central to decentralized delivery, which was pushed further with the growing adoption of agile and DevOps. This decentralization does not negate the need for a core central function. In fact, the hybrid TCOE has a thin central enablement layer providing QA standardization and governance across units.

### Traditional and agile work alongside each other in bi-modal development

We observe an increase in the impact of the bi-modal world of core IT and business IT on the modern TCOE. Here, the traditional engagement model of staged disciplines that work sequentially (business analysis, design, build, QA and Testing, production) co-exist in the TCOE with the agile development model that sees these divisions merging, with the testing activity carried out by multiple disciplines, rather than just testers. With increased digital and DevOps adoption, there is a reduction in traditional back-end system

development and testing methods, or at least an increase in bi-modal. Indeed, we predict that at least 90% of enterprises will adopt bi-modal development by 2018.

Interestingly we assumed that the cost of QA and Testing would be lower in a centralized TCOE compared to a decentralized TCOE. However, correlation analysis on the survey data does not give any evidence for this.

### Setting up test operations leans towards flexible solutions

The key conclusion to infer from Figure 23 is that the primary focus on achieving maximum cost efficiency in the form of operational test factory models and captive TCOEs is giving way to the demand for more flexible, nimble and easily

accessible TCOE models, such as crowdsourcing options. It is interesting to note that, amid this shift, organizations still seek managed service models from expert QA vendors.

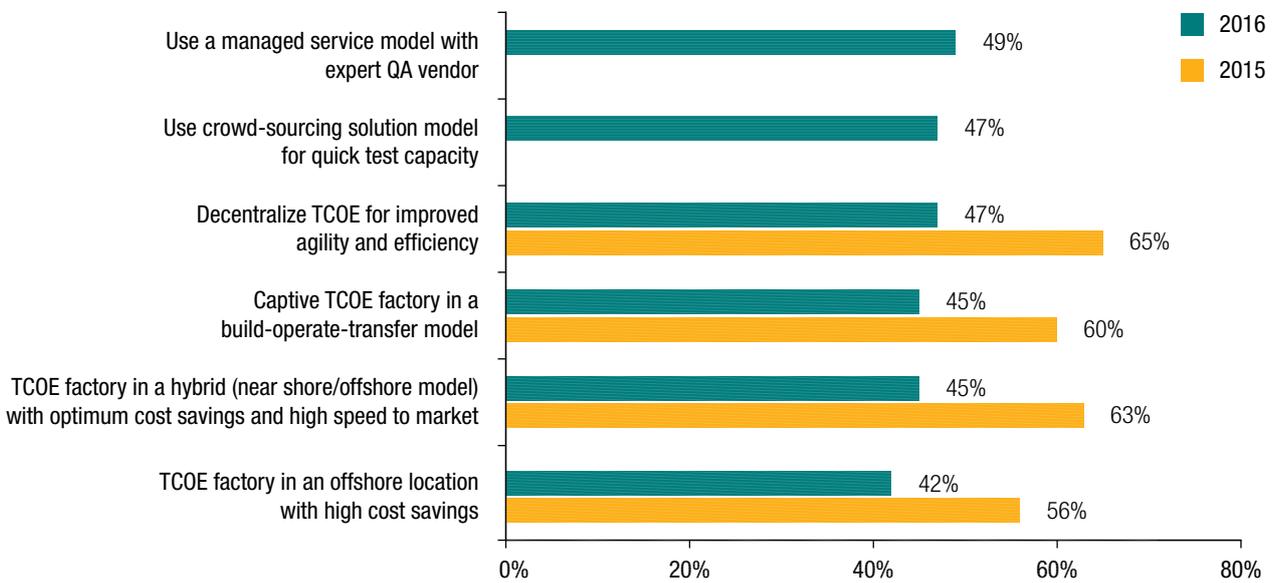


In the setup of test operations, this year’s survey findings reveal a significant interest in crowdsourcing. While a managed service model provided by an expert QA vendor ranks the highest in importance (49% of respondents), the use of a crowdsourcing solution model for quick

test capacity is used by 47% of respondents, alongside a decentralized TCOE for improved agility and efficiency. This puts crowdsourcing ahead of a captive TCOE factory (45%), a hybrid TCOE factory model (45%) and a TCOE in an offshore location (42%)

FIGURE 23

**Important elements in setting up your test operations**



The most important opportunity for using intelligent data analysis in testing is to decide on our strategy based on the data analysis, with tools that help to visualize the data.

**IT Director,**  
Financial Services, South Korea



**Changing skills and new challenges for agile TCOE setup**

The make-up of an agile TCOE in terms of skillsets shows a number of changes in the roles shared across multiple Scrum teams and those that are localized within individual Scrum teams. The key change concerns specialist technology testers which, from being the least shared role across multiple Scrum teams (38%) in 2015, is now the most shared (41%). This moves the specialist tester above last year’s most shared role across multiple Scrum teams, software development engineer tester (SDET), which drops from 43% to 40% in the 2016 survey responses.

This changing make-up is in line with greater use of the hybrid model and a decentralized TCOE where a wider range of skillsets are localized in Scrum teams as and when they’re needed. This is especially so where a Line of Business needs to get critical features to market quickly. Skills are directly accessible and available within the teams and there is limited overhead in getting tasks executed. The need for flexibility is driving the transition to clusters of smaller TCOEs, rather than a single large TCOE that doesn’t have this flexibility. The reverse of this, of course, is that with



the breaking up of the central TCOE there is a risk of skills redundancy and inconsistency of methods and tools when we look across LoBs. As such, some organizations are retaining a central corporate TCOE layer that is responsible for standards, test guidelines and test platforms, and for leveraging best practices.

This year's survey data leads us to conclude that there is a whole new set of special skills expected from the test

experts of today and tomorrow. It is not only about deep test automation skills and specialized non-functional test skills, or domain and technical tester skills, but also demands hands-on expertise with various modern and DevOps enabling development platforms, including digital, analytics and cloud.



The number one challenge is finding the skilled people.

IT Director,  
Pharmaceuticals, Ireland



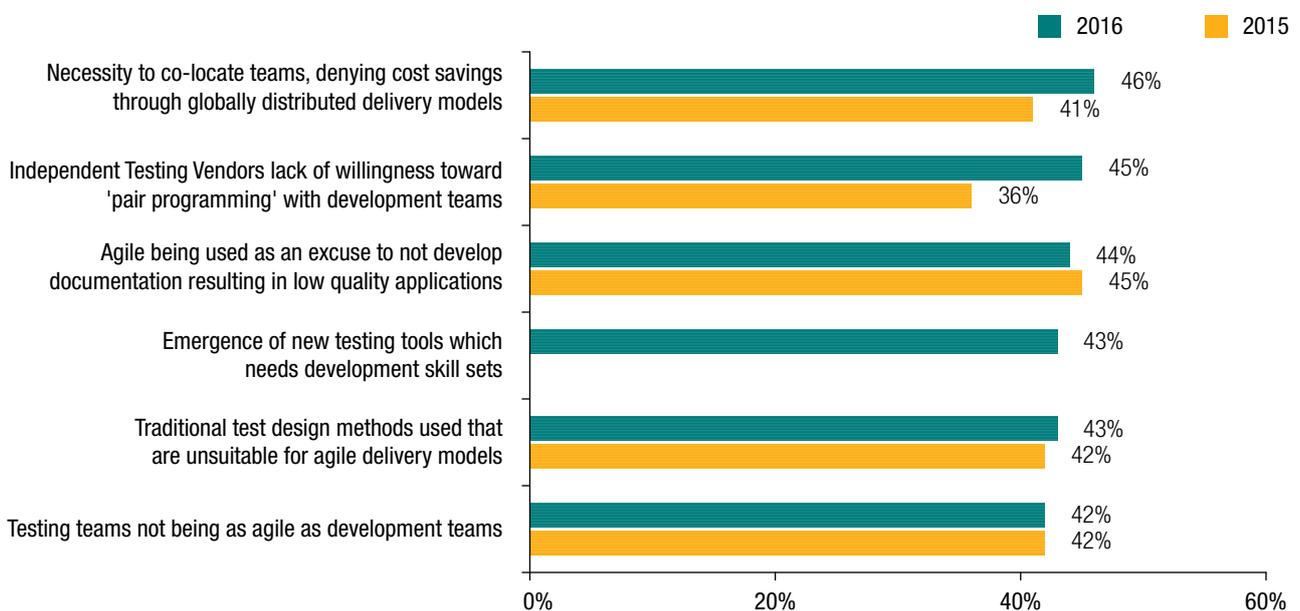
## Challenges in setting up an agile TCOE

Setting up an agile TCOE brings a number of challenges. When compared with the 2015 survey findings, the World Quality Report 2016 results for the type of challenge encountered are relatively unchanged, with the exception of the top two challenges. The most encountered (or expected) challenge when setting up an agile TCOE is the necessity to co-locate teams, which denies cost savings through globally

distributed delivery models. This has grown as a challenge from 41% in 2015 to 46% this year, largely because agile and DevOps approaches demand multi-skilled teams working together, simultaneously in a highly collaborative mode. Co-location is a major enabler of this, yet brings with it the issues of sub-optimal costs and the potential challenge that skills are not always locally available.

FIGURE 24

### Challenges in setting up the Agile TCOE





The second most perceived challenge, that of the lack of willingness by independent testing vendors to participate in pair programming with development teams, is up even more, from 36% last year to 45%. Pair programming typically brings together two developers in one place, one to write and one to review code. However, reliance on independent QA partners can create difficulties with co-locating the validation and verification team with development teams. This is especially the case in heavily low-cost driven contracts where there is no clear agreed co-location demand upfront.

The third most important challenge in setting up an agile TCOE is that of agile being used as an excuse to avoid developing documentation. At 44%, this means that organizations are not necessarily taking into account the true essence of agile at all times, which is the fragile balance of speed, quality and cost. It is all too easy to place quality at the bottom of the priorities pile and our recommendation is to embrace a clear standard methodology enterprise wide, that puts quality alongside the pursuit of speed and low costs. To enable this, quality can be managed with greater visibility through the use of transparent QA and value dashboarding.

## Significant drop in test automation after last year's increase

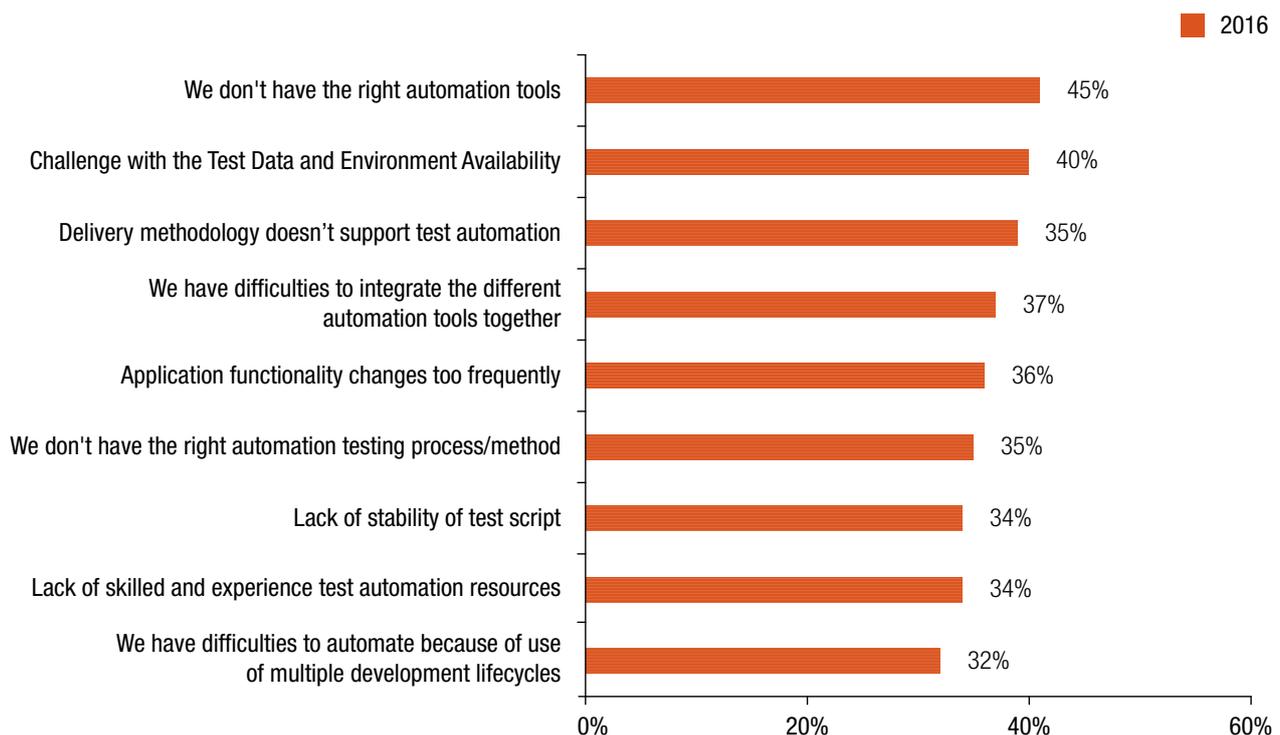
Test automation is a vital contributor to testing efficiency, yet this year's study participants claim just 29% of testing activities are automated. Further, a high percentage of automation projects fail or don't result in the anticipated Return on Investment. There are a number of reasons for this, beginning with a lack of central coordination and guidelines on tools and their usage. Another cause is a short-term focus

on automating what is required to meet current project and/or release needs, rather than long-term strategic planning and maintenance.

We also see other challenges standing in the way of increased automation, such as: brittle scripts with high maintenance, low automation ROI; tight time constraints;

FIGURE 25

### Test Automation Challenges



heterogeneous tools and frameworks across the testing cycle; and high license costs with low utilization and ROI. A need for multi-skilling also presents a challenge, with the industry seeking engineers capable of moving beyond single competencies to be able to carry out manual testing, service test and automation testing, and writing some code or tool to compare data and results.

Getting to grips with all of these challenges demands the selection of a basic tool strategy and guidelines as part of the test process, along with the means to measure the level

and effects of increased automation. Putting a central team in place will ensure best test automation practices and new technology developments can be leveraged. Other changes to bring on board are the use of continuous integration and execution in the development cycle, as well as new strategies and solutions, such as progressive automation, scriptless automation, and life cycle automation for vastly improved outcomes. Zero touch testing and execution, and automation as a utility service, have the potential to deliver 20-30% reduction in cost of quality, with significant cycle time reduction.

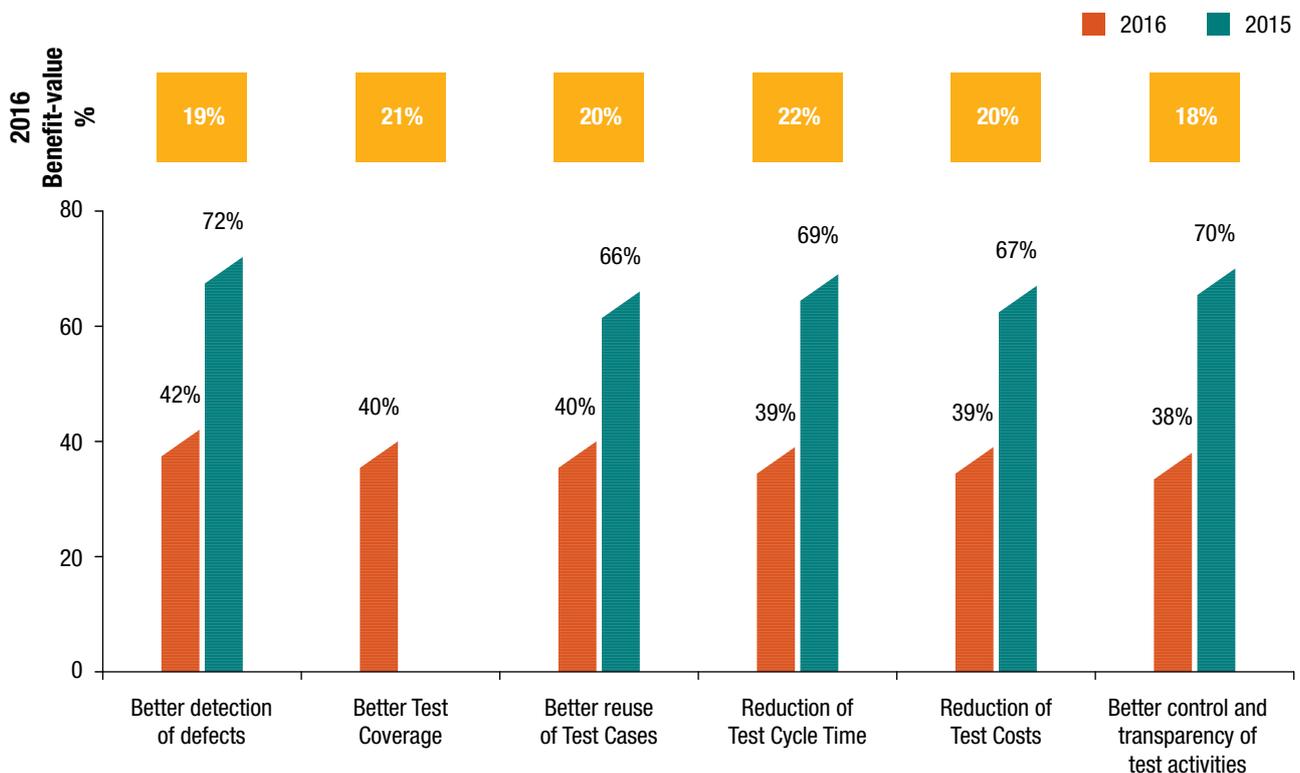
## Benefits of test automation re-inforce desired outcomes of QA and Testing

The most realized benefit of test automation is better detection of defects, cited by 42% of the study respondents. This is followed by better reuse of test cases (40%), and better control and transparency of test activities (38%). Those respondents claiming to have benefited from test automation

were additionally asked to estimate the percentage of improvement experienced. A reduction of test cycle time (22% level of benefit) scored most highly, which again ties in with the overarching QA and Testing objectives, including contributing to business growth and outcomes.

FIGURE 26

### Test Automation Benefits





## Robotics and machine-based learning indicate a shift to intelligence-led QA and Testing

As Digital Transformation initiatives continue to roll out across all sectors, the World Quality Report 2016 survey asked participants which emerging automation techniques they foresaw using in the coming year. At 42% of responses, both robotics automation and test design automation were the top two techniques.

Robotic automation has wide-scale applicability in the process intensive QA world, going beyond regression testing to user acceptance testing and even progression testing. It makes sense for the world of core QA striving to reach the next frontier of automation: a software defined self-learning test organization that is even less dependent on human effort. At the same time, the modern IT landscape with its business focused QA also demands higher levels of self-aware test automation solutions. So it is not surprising that cognitive automation is equally on the uptake.

Robotics automation sees configurable software being set up to perform the tasks a human assigns and controls. Essentially, once they've been shown what to do, the robots ('bots') can be left to get on with the work. They can interact with the system or application the same way a human does.

Intelligent and smart bots can be self-aware, self-monitored, cognitive, and application agnostic, helping to significantly lower operating costs with increased business agility.

The high percentage for robotics automation is, in reality, more a reflection that this technique is so promising that it will be explored in the coming year, rather than already fully utilized. Nonetheless, it marks an unmistakable movement across QA and Testing to the next stage beyond mere industrialization towards an intelligence-led approach with predictive analytics. Robotics will bring the head count down in the QA and Testing function as these machines take on the more repetitive analysis and execution tasks and routine jobs currently undertaken by humans. Figure 27 also illustrates the potential uptake of other emerging techniques that will critically change test automation over the coming years. Intelligent, self-learning technology will drive analytics and artificial intelligence, processing and interpreting the huge volumes of data that it is not humanly possible to analyze. It will become far easier to identify what to test and where more testing is required to bring down costs with more efficient, data-led testing.

FIGURE 27

### Emerging Automation Techniques

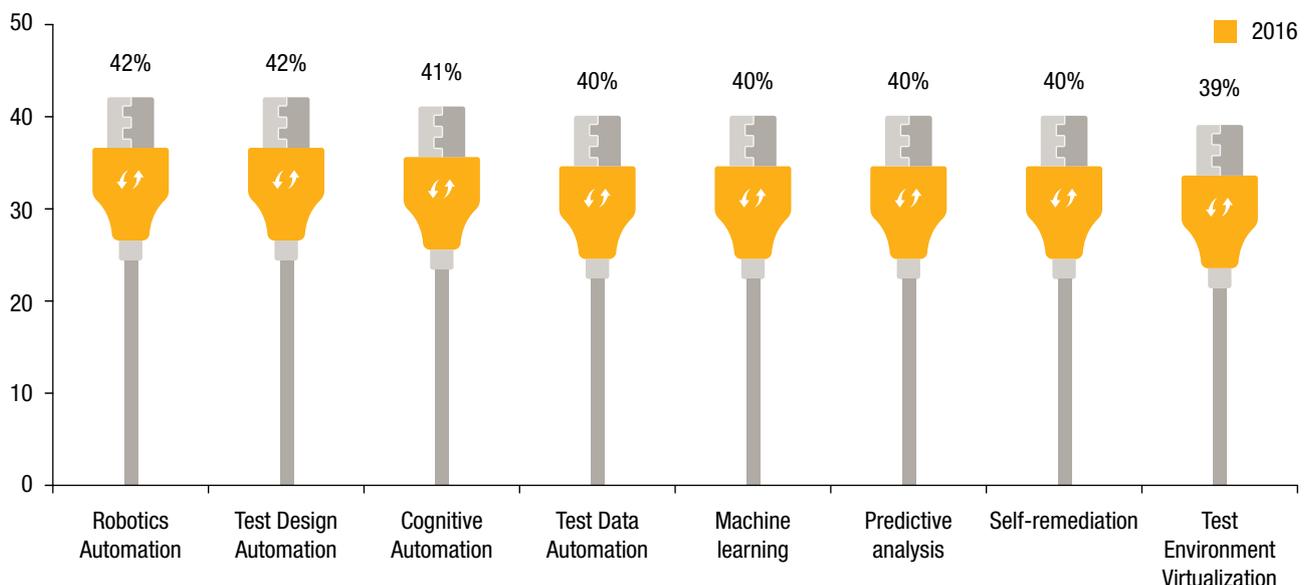
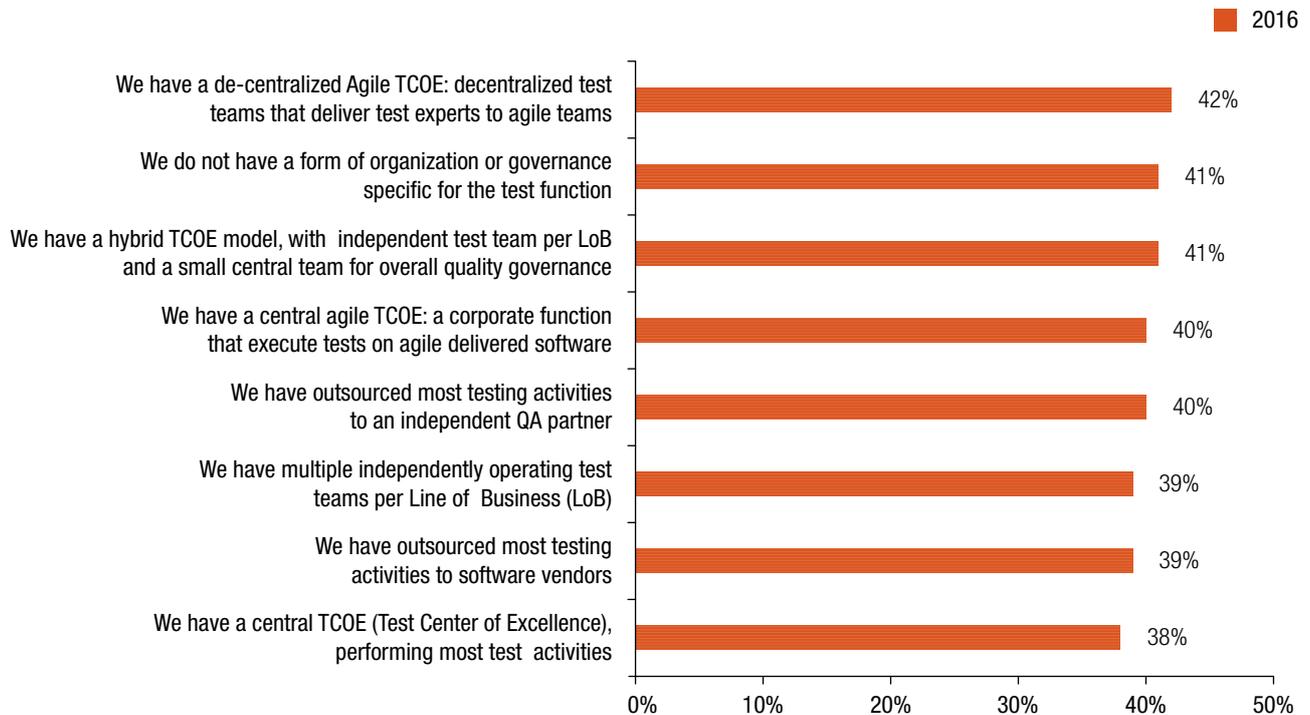


FIGURE 28

**Statement best reflecting your company's testing activities****An intelligence-led future characterized by agile and DevOps**

We can see that testing is embarking on a new era of industrialization at two different levels. First, there is a wave of existing outsourced and offshored traditional QA supported by automation that is moving to higher levels of automation via robotics, with a view to do more for less. Second, there is a newer need from agile QA for initial outsourcing, offshoring and automation.

Automation as a science is also evolving, moving from a basic script automation to scriptless automation and on to robotic automation in the legacy world. There is an evolving trend to higher levels of intelligent automation, largely driven by data-rich digital applications. All of these trends open up an exciting and intriguing world of self-aware, self-remediating, analytics-driven automation. This is the future of testing, and it is beginning right now.



The biggest challenge in testing is identifying the right risks and identifying the measures to take for testing to cover those risks.

**QA & Test Manager,**  
Banking, Netherlands





# Test Environments and Test Data Management

## Key-enablers for quality in agile and DevOps

**AJay S Walgude**, Vice President, Financial Services SBU, Capgemini

Test environment management (TEM) and test data management (TDM) need to evolve as DevOps drives further virtualization and Digital Transformation makes itself felt. Overall there is an increasing trend for enhancing and increasing the flexibility of test environments across all areas of testing. There is, however, still a lack of skillsets in TEM at a broader IT industry level and, although there are signs of increasing maturity in this skills area, it will be another year or two before it takes on the mantle of a fully-fledged profession. Those organizations that invest in enhancing their test environments, for example by adopting cloud, are better equipped and able to adopt agile and DevOps practices at the level needed to secure business outcomes and drive customer value.

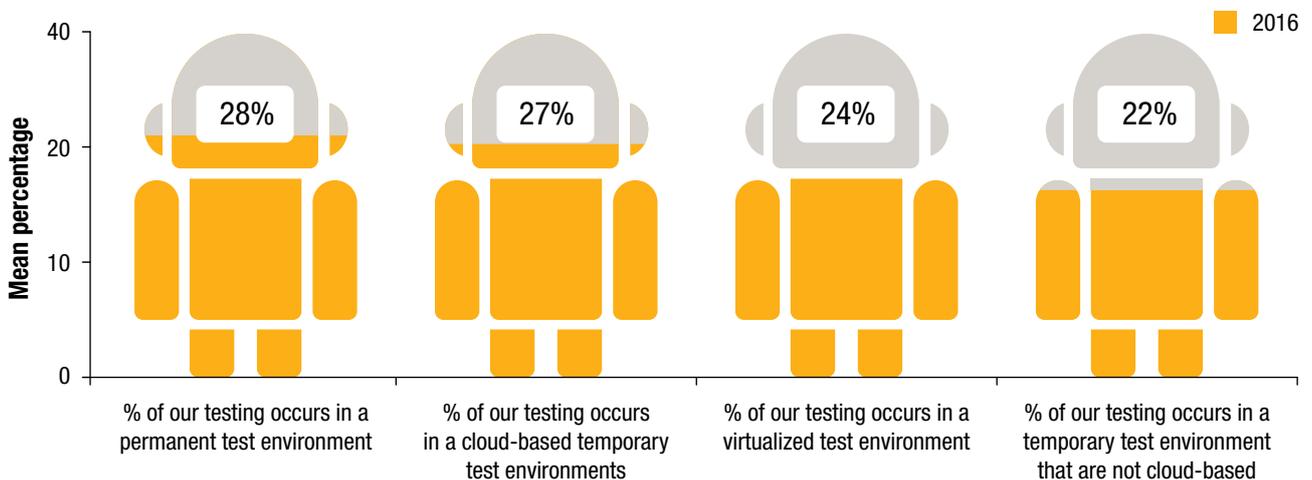
The World Quality Report 2016 study participants record a relatively even spread of testing in different types of environments. This is a reflection of the variety of systems in operation across IT landscapes today, all of which demand different types of test environment that have the potential for

enhancement in one way or another. Some 28% of testing overall occurs in a permanent test environment, closely followed by 27% in a cloud-based temporary environment. Just a few percentage points behind are: testing in a virtualized test environment (24%); and testing in a temporary test environment that is not cloud based (22%).

So despite the relentless move to cloud, a major part (28%) of testing still relies on a permanent test environment. This is typical of the systems-of-record that form the backbone of large enterprises, for which testing is commonly confined to this environment. Positively, we see that the use of cloud and virtualized test environments in combination cover 50% of all test activities. This is re-assuring because cloud enables test environments to be spun up or deleted at an individual level, while virtualization enables easier and faster set-up of integrated system test environments. This is one of the major pre-requisites for an efficient test solution with a high level of speed and flexibility.

FIGURE 29

### Test Environment Types



## Cloud-based testing used across all applications

Our key prediction is for greater use of cloud-based test environments in the coming years. Of the testing that is currently performed in a cloud-based environment, 50% of respondents carry out functional testing of Business Intelligence (BI) and Business Analytics (BA) solutions, up from 44% in 2015. Last year's most performed testing type in the cloud was functional testing of cloud services, but this is down from 64% in 2015 to 50% this year. The least performed in the cloud are performance testing (44%) and security testing (43%).

We are also seeing an increase in cloud adoption for testing core enterprise packages, such as CRM, ERP and financial systems, up from 43% in 2015 to 46% in 2016. However, the legacy and custom software development (CSD) applications show a dip from their initial enthusiasm for cloud adoption. We expected this trend to be more pronounced in the North America region and in Financial Services because of their initial enthusiasm and dependency on CSD applications.

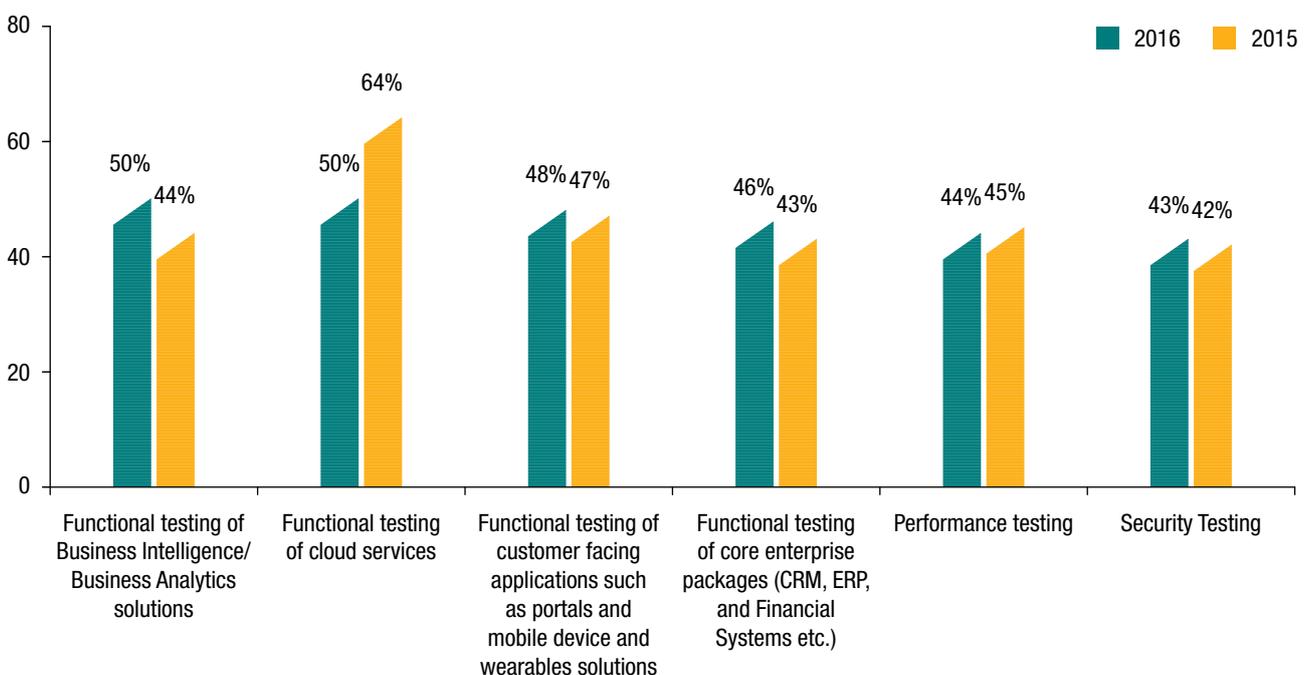
However, we note that the dip in cloud adoption is almost uniform (50%) across all sectors and all geographies.

The high level for functional testing of BI/BA solutions is a reflection of the increased use of cloud-based analytics solutions. As these systems run in the cloud, the testing takes place on the cloud too. The high proportion of functional testing of portals and environments is also understandable. Typically, organizations want to test these applications across multiple browsers and devices, for which maintaining physical environments and providing continuous upgrades would be costly.

Surprisingly, the percentage of performance tests on cloud-based test environments is relatively low. We believe that this percentage could be higher because cloud-based environment solutions would be ideal for this type of testing in order to quickly generate an environment that is a close copy of production.

FIGURE 30

### Percentage of testing performed in a Cloud-based test environments





## Challenges increase as need for visibility grows

This year's World Quality Report study records an overall increase in the level of challenges with provisioning test environments to test teams compared with 2015, along with some interesting new candidates. The problems are, in fact, fairly basic and reflect the relative immaturity of test environment management overall. In most cases the underlying challenge is a lack of ownership and clearly assigned responsibilities. This is worsened by the fact that increased adoption of agile and DevOps leads to more multiple parallel testing activities, each of which requires its share of test environments and tools.

It is interesting to note a growing awareness and understanding of the environment challenges, with all issues being more pronounced this year. No one challenge stands out, however. Instead there is a fairly even range of 45% to

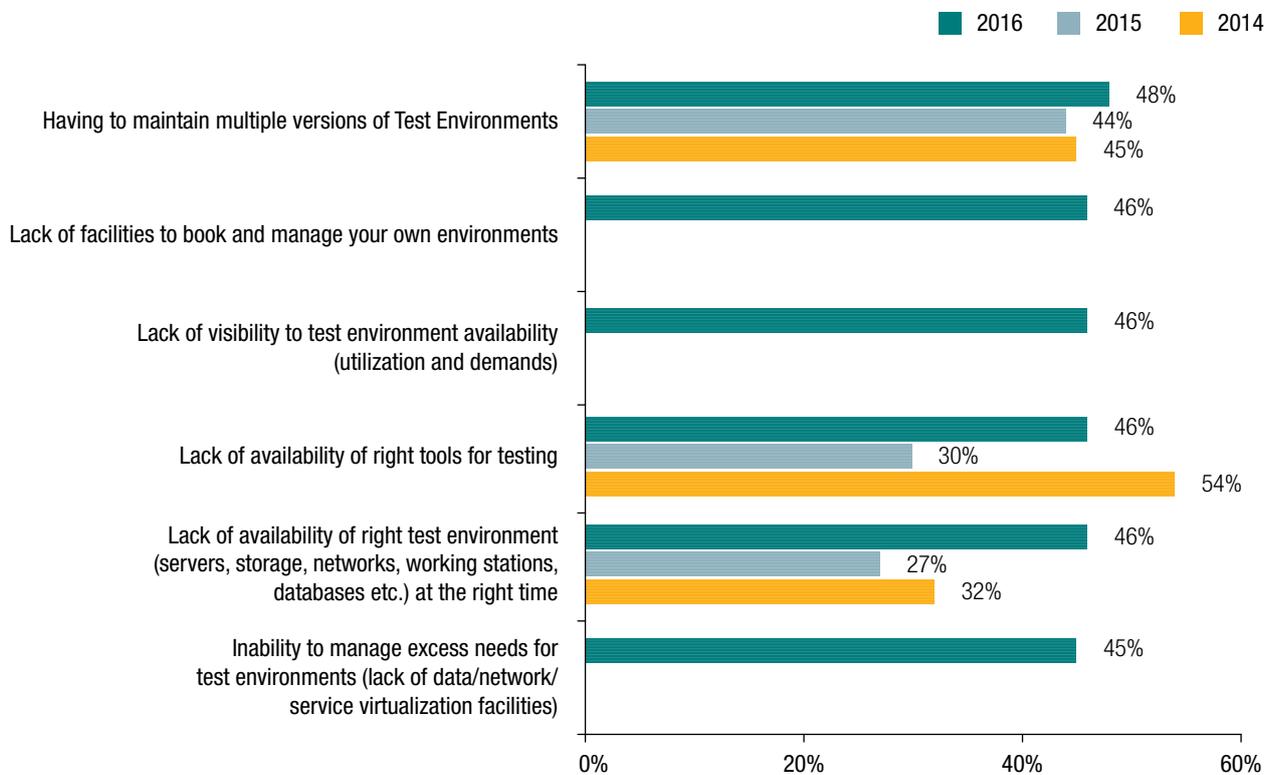
48% of organizations saying each challenge is an issue. The most cited of these is the difficulty with having to maintain multiple versions of test environments, claimed by 48% of study participants, and up from 44% last year.

In this complex landscape, organizations are looking for greater visibility and automation across test environments in terms of their provisioning. This is highlighted by the second most encountered challenge, the lack of facilities to book and manage their own environments, cited by 46% of respondents. In the future, we expect to see an increase in cloud-based environments that can be provisioned on a one-to-one basis for each individual wanting to run a test.

A lack of visibility to test environment availability in terms of utilization and demand is also cited by 46% of respondents.

FIGURE 31

### Challenges with Test Environment Provisioning



This reflects the increased difficulty with controlling and optimizing the growing number of environments being used to meet the escalating needs of agile and DevOps cycles. It also indicates a better appreciation of the potential cost saving opportunity, but this requires a clear picture of the utilization level so that organizations can make intelligent

decisions about environment optimization. A lack of the right tools for testing appeared to be reducing last year, but it has jumped again in the 2016 study findings with 46% of respondents citing it as a challenge. This is strange given the abundance of tools for testing and the proliferation of cloud-based access to these tools.

## Test data management challenges increase as data grows exponentially

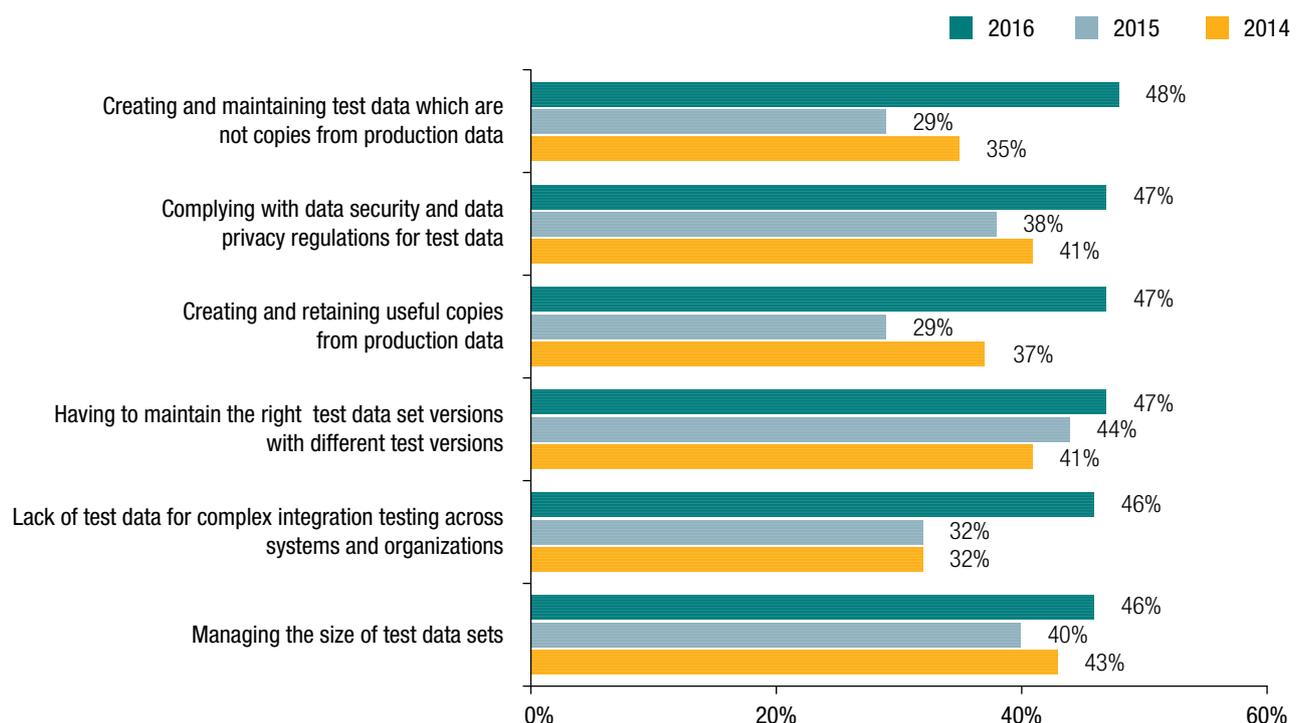
The challenges with environments extend to the management of test data, with an increase in the level of challenges reported across the board. Two data management concerns in particular stand out for the size of the increase over the past year. The most cited challenge of creating and maintaining test data that are not copies from production data has risen to 48% from 29% last year. Similarly, one of several challenges cited by 47% of respondents is that of creating and retaining useful copies from production data, also up from 29% last year.

These two big increases are indicative of a lot more focus being given to creating and maintaining data for test

purposes. As test sets proliferate across the enterprise, the issue of test data has come of age and organizations have a much better understanding of the challenges. We see, for example, that complying with data security and data privacy regulations for test data is a leading challenge, alongside the need to maintain the right test dataset versions with different test versions, both cited by 47% of respondents. The data security challenge is up 9% on last year, providing a clear a sign of more awareness and scrutiny of privacy and data security regulations, which limit the use of production data for test purposes.

FIGURE 32

### Challenges in managed test data





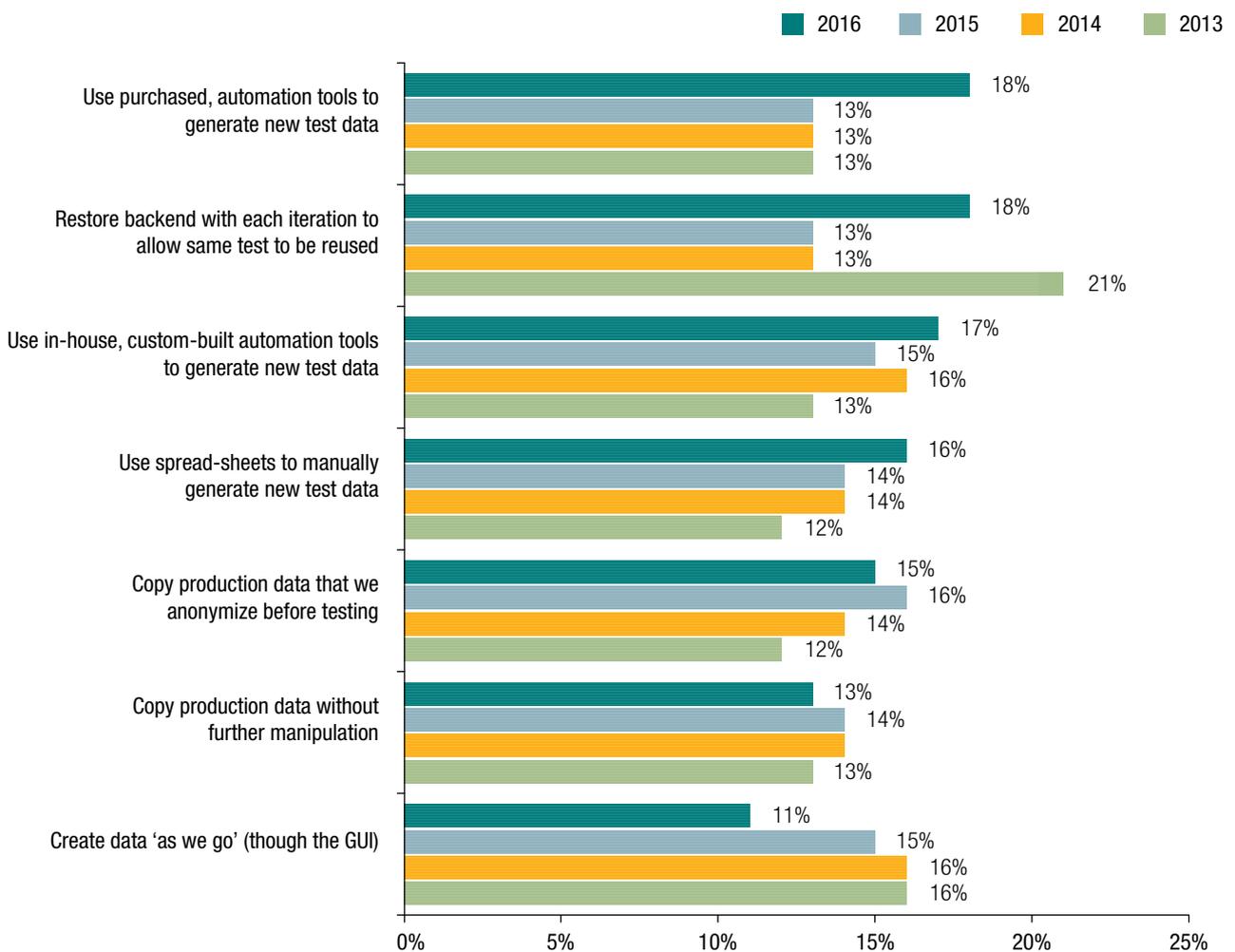
46% of respondents say that the difficulty in managing the size of test datasets is a challenge, which is not surprising in light of the increase in test data. On the other hand, while a lack of test data for complex integration testing across systems and organizations (46%) is not the highest encountered data challenge, it is nonetheless up 14% on last year. This significant rise reflects the heightened need for far reaching integration testing. One example of this is the need for increased customer journey testing to secure customer value before go-live. This end-to-end testing stretches across larger groups of systems, which are often located/owned by different Lines of Business and developed and maintained by completely different teams.

The increased reporting of test data challenges across the board is a clear sign that organizations today better appreciate and acknowledge the importance of test data provisioning and TDM in general. This increased awareness comes after an initial period during which the focus was on optimized human resource capacity provisioning through managed service contracts. From the continuous drive to further optimization, it is evident to many respondents that challenges with the test data provisioning, as well as the environment provisioning, are serious bottlenecks for increasing the productivity of their test teams.

## Test data generation tools are on the rise

FIGURE 33

### Test Data Generation technique



Only one third of this year's respondents resort to data generation techniques, which leads us to conclude that this is still not a prevailing method. Instead, many organizations continue to rely on copies of production data.

There is a clear trend towards using more tools for generating test data for multiple iterations of testing. All four of the most used approaches show an increase over last year. The first of the leading two is to purchase automated tools to generate new test data. At an average of 18% of all the methods used, this is up from the 13% recorded every year since 2013. Also at 18% is the approach to restore the backend with each iteration to allow the same test to be reused. This is up from 13% in 2014 and 2015, but is not at the 2013 level of 21%.

There have also been increases in the use of in-house, custom-built automation tools to generate new test data, up 2% to 17% in 2016, and in the use of spreadsheets to

manually generate new test data, which has surprisingly increased from 14% in 2015 to 16% this year. As Figure 33 shows, there are several other approaches to generating test data, largely unchanged in terms of use, although "creating data as we go" has dropped from 15% to 11%. This is a welcome drop because it is the most primitive way of managing test data needs.

Looking more closely at the highest used approaches in this category, one reason lies in the increasing maturity of the tools on the market. Solution providers and tool vendors are bringing unique data management solutions to the market and these are being snapped up by today's enterprise IT. We also see that organizations have a much better understanding of how to create and manage their own test data sets, using automation and virtualization as test environment systems evolve.

## A need for better test ecosystem management in future

As TEM and TDM mature, it is positive to note that the reliance on production data, those masked and especially those unmasked, is going down, while the reliance on data generation is on the rise. These are welcome trends.

While solutions that integrate the testing function with test data provisioning systems and test environment provisioning systems are available to drive efficiencies, they are not yet widely used. IT organizations have a thorough knowledge of how to manage their test infrastructure, yet are not on top of the proliferating test environments and test data. A gradually maturing profession is getting to grips with challenges around tools and resourcing, often in partnership with external help, but there is a long way to go to get the most out of test ecosystems.

Looking ahead, we believe that the core systems built to support testing will become smarter, using analytics and self-managing capability for testing environments and data. We see this as the future of QA and Testing. TEM and TDM will become ever more automated and virtualized, going beyond integration to intelligent interactions and automated decisioning. QA and Testing will tap into many of the analytics-driven decision making tools and work with niche analytics companies to integrate testing logs with test data and environment, enabling automated intelligence-driven decision making in the coming years.



**Teams without access to live-like test environments cannot test efficiently and comprehensively to ensure production-ready performance. Low-quality applications turn off customers, risk damaging your brand and require significant development/testing.**

**Senior Test Engineer,**  
Avionics & Aerospace Systems Manufacturing, China



# QA and Testing budgets

## Getting a grip on test spending

**Brian E F Shea**, CEO, Sogeti UK

The steady year-on-year growth of Quality Assurance and Testing budgets observed since 2012 has come to a halt. Where last year we were talking about IT spend on QA and Testing outstripping predictions, this year has seen a decline in spending. On average the industry is now spending 31% of its IT budget on QA and Testing, compared with 35% in 2015, 26% in 2014, 23% in 2013, and 18% in 2012.

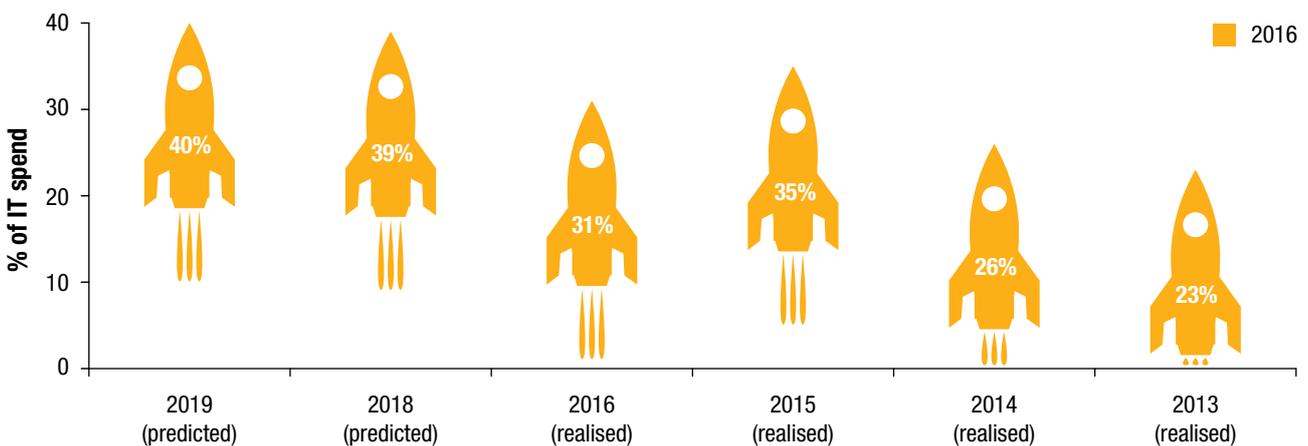
Better containment of QA and Testing costs was one of our key recommendations last year, so the stabilization is an encouraging development. However, while this is a positive trend, it is clear that organizations are not yet confident that

they are in full control. Indeed, this year's World Quality Report study participants predict an upward move to 40% by 2019. This is slightly above the 2015 expectation of 39% by 2018, despite this year's stabilization.

At well above a reasonable 25% of the IT budget, even this year's average is still too high and an indication that QA and Testing is not as efficient as it should be. So while the reduction in budget is encouraging, the journey towards more efficiency should still be an important objective of the QA and Testing functions in almost every organization.

FIGURE 34

### Budget allocation as percentage of IT spend



### Uncertainty about budget needs as digital continues to disrupt

One reason for the lack of confidence in the ability to stop costs increasing is that more and more organizations are looking at agile, DevOps and Digital Transformation. This is leading to uncertainties about the options for controlling and containing the QA and Testing budget due to the increased

pace of deliveries and continuous stream of updates with agile and DevOps. The growing role of QA and Testing within design and development activities will add further cost pressures, while ongoing technology advancements, such as Internet of Things, increase the risk of failures.

QA and Testing must aim to mitigate the impact of these failures. Organizations also recognize a need to invest in next generation automation tools. While this could add initially to the QA and Testing spend, with sufficient return on investment control this should actually lead to a decrease in budgets thereafter.

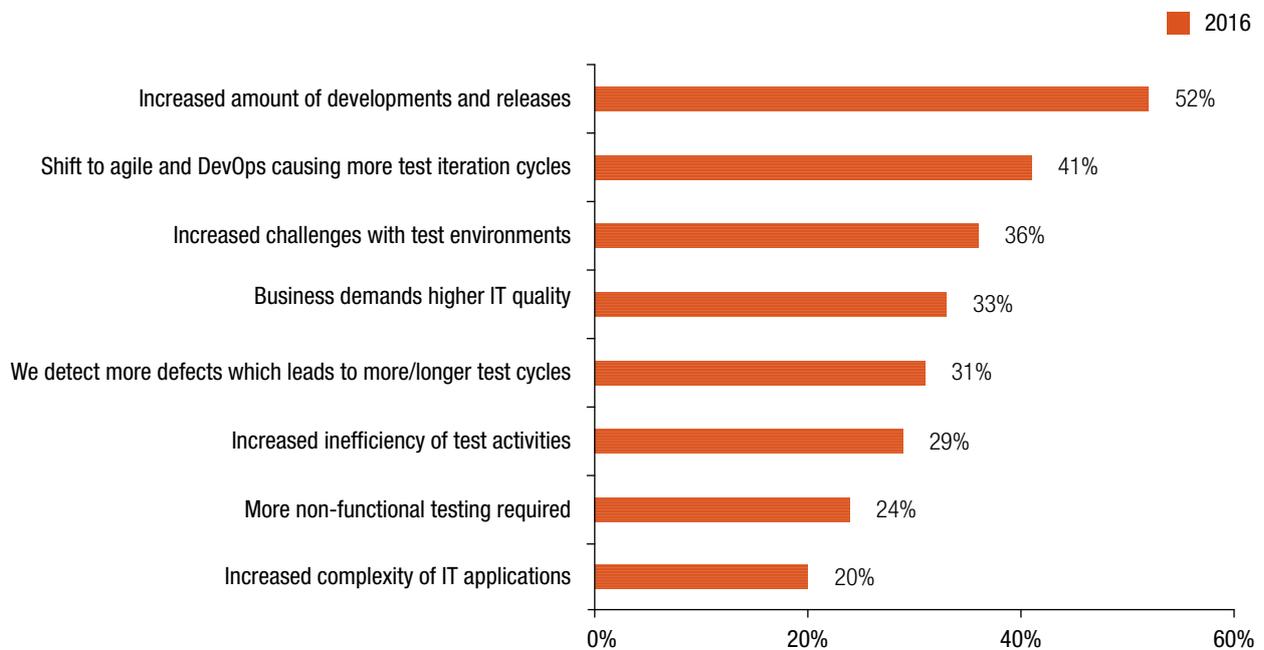
This year's study findings reveal that the increased level of development and releases is deemed to have had the biggest impact on QA and Testing budgets, ranked 5.3 on a scale of 1-7 (with 7 being the biggest impact). This is followed by increased challenges with test environments at 5.1, and the shift to agile and DevOps causing more test iteration cycles at 4.9. Respondents clearly feel that the shorter and faster development cycles as a result of the shift to agile and DevOps, and the corresponding need to test more, are major contributors to the predicted increased IT spend on QA and Testing. Shorter development cycles leave teams with less time for appropriate quality checks, leading to more test cycles than anticipated.

In many cases, due to the rapid adoption rate for DevOps and the escalating volume of releases, the right frameworks to manage this landscape have not yet been put in place. Organizations have had around 10 years to adopt agile, but the rate of DevOps adoption is clearly much faster, with just 12% of respondents to this year's World Quality Report survey saying they are not using DevOps. As such, we should not be surprised that this change comes with quality issues. Investment in the frameworks to continue this journey, with governance checks, certifications, and adherence to regulation, will have to be put in place over the coming years.

It is also interesting to note that, despite the ongoing investment in digital and Internet of Things technologies, the survey participants feel that an increase in the complexity of IT applications is having the least impact on their budgets at present. Just 20% of respondents cited it as having a big impact. Clearly, the need for speed is perceived as making a bigger impact on quality than having to work with more complex and integrated technologies.

FIGURE 35

### Aspects impacting the increase of QA and Testing budgets





## More efficient focus on human resourcing helps to reduce budget

The distribution of test budget between human resources, hardware and infrastructure, and tools (software and licenses) is shifting. Spending on hardware and infrastructure has increased from 37% in 2015 to 40% in 2016, and it remains the biggest area of budget allocation. It had appeared to stabilize in 2014 when it dropped back from the previous year's 40% to 33%. However, it has since begun to climb in tandem with a proliferation of test environments.

Many organizations still have challenges with mastering their test environments. Although we predict that these challenges will stabilize in the next few years, it is likely that the proportion of the QA and Testing budget allocated to hardware and infrastructure will continue its climb and reach 42% before that stabilization. In this landscape, increased focus on test hardware and infrastructure remains a major opportunity for organizations to save cost on their QA and Testing spend. Options for this include test infrastructure rationalization programs, central management and consolidation of best test practices, pay-per-use service models, and the adoption of cloud-based test environments.

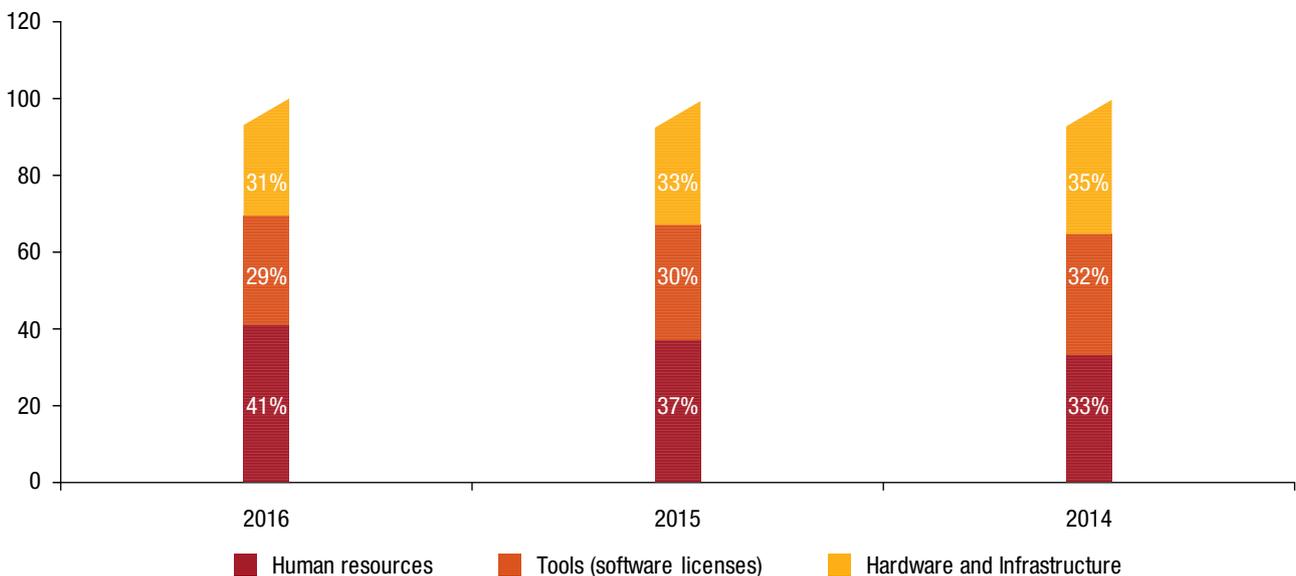
While it is often difficult to find and rationalize the right hardware and infrastructure, it is a different picture when it comes to spending on human resources and tools. These aspects are easier to control and this year's study findings

reveal that costs as a proportion of the budget are falling. Spending on human resources has dropped from 33% to 31% over the past year, despite the need for new skillsets, for example in the testing of Internet of Things technology. This has been achieved with increased automation, by leveraging offshore resources, and by making use of flexible service contracts. Furthermore, it continues the downward trend that began in 2014.

At 29% of the QA and Testing budget, spending on tools is almost stable this year, down just 1% from 30% in 2015. This follows a spike in spending activity in 2014, largely due to the need for investment in digital tools. The reduction over the past two years reflects the growing maturity in the market and a greater adoption of open source test tools. It is possible that spending in this area will go down still further in the coming years. One reason for this is a continued shift from perpetual licenses to software-as-a-service. Additionally, niche vendors offer alternative solutions at relatively lower cost and this too brings down spending. There is also a continued provisioning of open source solutions that have become better, are more complete, and offer very good value for money. So even on a corporate scale, this type of tool is accepted as being part of the development and testing team's toolbox

FIGURE 36

### Split of QA and Testing Budgets



## Sector spending reflects emergence of Internet of Things

The highest sector spenders overall are in Financial Services and Energy & Utilities, both spending 33% of their IT budget on QA and Testing. They are followed by High Tech (31%) and Automotive (31%), with the least amount being spent by Public Sector and Government (29%). The high percentage in Energy and Utilities is surprising in an industry that is seeing significant cutbacks at present. This year's spending percentage range of just 4%, compares with last year's 8% range from 38% at the top end and 30% at the bottom end.

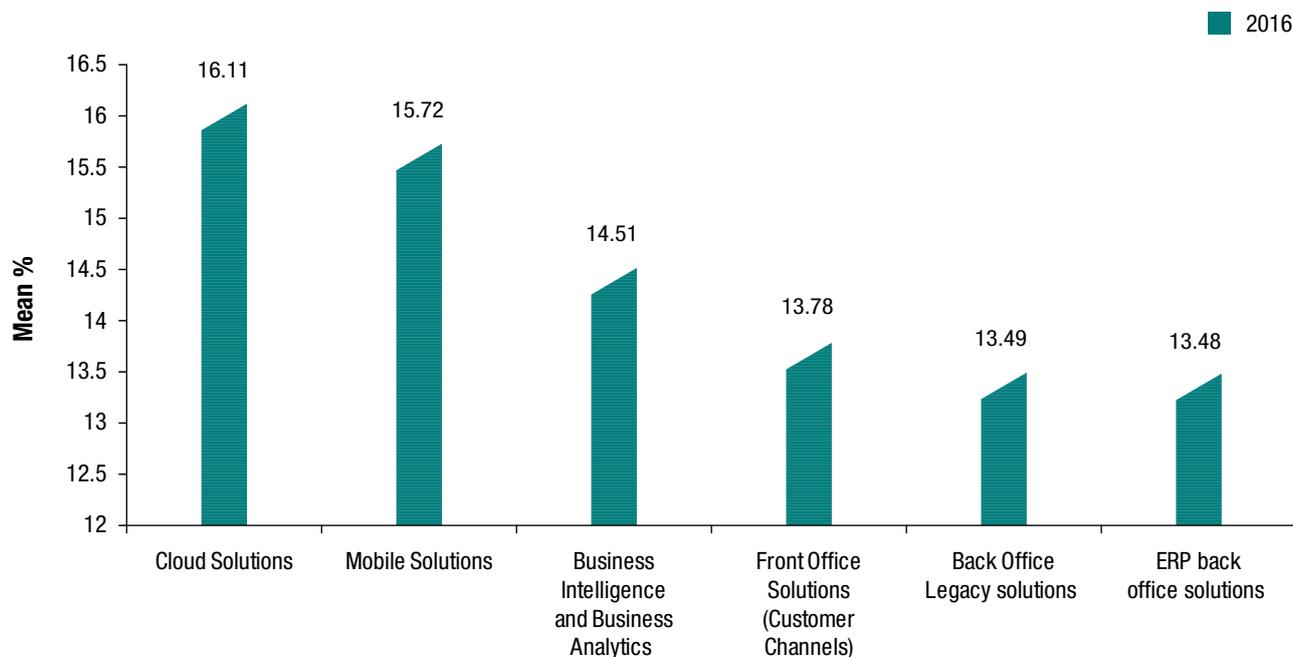
As discussed in the chapter on Digital Transformation, the impact of the Internet of Things is being felt across different aspects of QA and Testing, including the budget. This wasn't measured in 2015, so we cannot make a direct comparison this year. However, we can see that the budget distribution between different types of applications is slightly shifting to take account of the 13% average budget allocation to the Internet of Things.

Front office and mobile solutions together make up 30% (down from last year's 35%). Likewise, cloud is slightly down to 16% (from 18%). The slight decrease in these areas is unsurprising with the growing adoption of Internet of Things, cloud and mobile. The percentage of the budget given over to Business Intelligence and Business Analytics is down slightly compared with last year to 15% (from 17%), while back office legacy is also slightly down to 13% (from 16%). The budget allocated to ERP back office solutions has remained static at 13%.

Regionally, we observe a similar range of spending on testing mobile solutions with the Asia Pacific region investing the most at 17% of the IT budget and Latin America the least, at 14%. Similarly, the budget allocated to Internet of Things testing is fairly even, from Central Europe at the top end (14% of its IT budget) and Western Europe at the bottom end (12%).

FIGURE 37

### Testing Budget Split 2016





## Good DevOps practise can be a lever for cost optimization

The uptake of Internet of Things technologies in tandem with the rapid move to DevOps is changing the shape of QA and Testing. Certain work previously carried out by testers is now being performed by more generalist members of the DevOps team. This move to DevOps could easily result in a lack of transparency and therefore control over QA and Testing budgets. However, if the move to more DevOps practices is done well, the QA and Testing budget will go down as testing shifts left (the fail forward principle) enabling organizations to find defects earlier. On the other hand, if done poorly, it will increase the budget as a result of many more QA issues and test cycles being needed to reach the right level of quality. Another key opportunity to optimize costs is a centralized focus and governance of the test environments in use in the enterprise. This will not always be an easy task due to test environments in many enterprises being neglected for too long. But, as explained in the chapter on test environments, there are huge opportunities to move faster to cloud-based and virtualized environments. Potential saving will easily be in the region of 10%-20% of the total spend on QA and Testing.

Nonetheless, while there is some control over spending on environments, the predictions of escalating costs show that confidence is not high. Thus there is still a need for tight focus on containing the cost of quality and it will be interesting to track the topic of QA and Testing budgets in the coming

years. For traditional waterfall-based development, it makes more sense to centralize and consolidate all three key cost drivers of testing, environment and tools within a test factory. However, with more and more agile and DevOps adoption, we will need a lot more data analytics to drive decision making within such an integrated test factory.

While some effort is being seen in further improving quality and costs within the testing function, for example with vertical analytics, such as predictive test management tools, more effort is also needed in horizontal analytics. This is the collection of test data relating to test requirements and test cases, test environments, test data, and resources. It uses highly intelligent analytics software to drive decision making inside the test factory. We predict that those organizations best able to rise to the challenge of escalating QA and Testing costs and budgets will be the ones investing in both horizontal and vertical analytics.

Overall, this year's prediction of an increase in spending over the coming years demonstrates an understanding of the implications of the changes in development cycles and adoption of new technologies for the QA and Testing budget. The rationalization programs, best practice measures, new service delivery models, and cloud-based testing options recommended in this chapter, along with the use of intelligent test tools, will help to counter potential budget increases.



The biggest change in testing as a result of the transition to DevOps is Automation, as it is the core of the successful DevOps cycle.

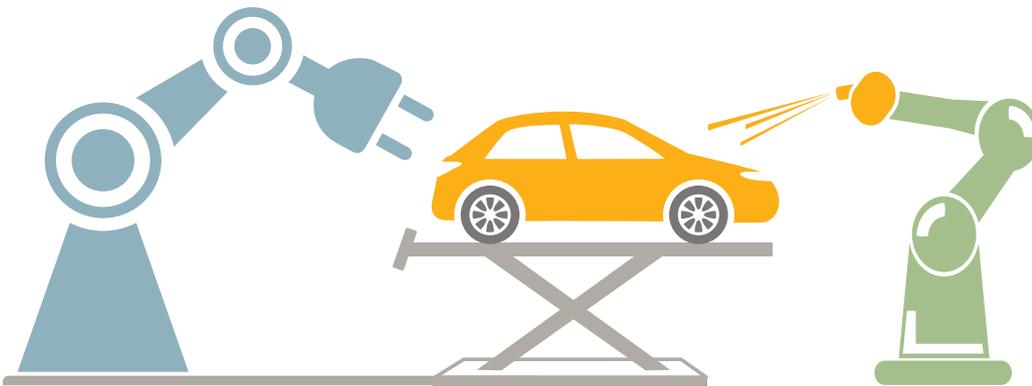
**VP of Applications,**  
Logistics Provider, Italy





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# Automotive

## Digital capabilities continue to change the character of development and testing

**Kai Grambow**, Global Leader, Automotive Sector, Capgemini

Digital is having a big impact on the Automotive sector where companies are looking to get close to the end customer via digital means. The uneven growth observed at a regional level last year continues, with North America achieving record sales at the top end of the spectrum and Latin America in heavy decline at the bottom. Europe currently remains relatively strong with improved sales, while Asian market growth has slowed, although certainly not flat-lined. For instance, with the highest volume of unit sales globally, China's automotive sales continue to grow, but just not at the same year-on-year rate as seen previously. It is clear that all organizations, no matter the country, are adapting ways of operating and seeking to engage with the end customer in a more personalized manner.

The World Quality Report 2016 study findings bear out the increasing digitalization of this sector. Some 43% of Automotive participants say they have a dedicated Chief Digital Officer, second only to Government and Public Sector (51%). Further, with heavy investment in digital capabilities underway, the sector is clearly ramping up a gear, but nonetheless still has some way to go.

The gradual uptake of digital technologies is making itself felt both on the shop floor and in the vehicles themselves. Digital Transformation projects are up and running across

all areas of the Automotive sector: original equipment manufacturers (OEMs), assembly, supplier plants, etc. Thus, digital manufacturing is now becoming a reality as operations and information technology converge. In this landscape the Internet of Things is increasingly a disruptive force on the shop floor. Equipment and systems are becoming smart and connected, and embedded software, robotics and digital communication capabilities are driving an exponential growth in data.

Beyond digital manufacturing, the other key digital trend in this sector is the advances being made in autonomous driving. Almost all manufacturers are now investing heavily in this, making it no longer the preserve of tech companies such as Apple and Google. This development has come earlier than many people anticipated although, in reality, it is likely that full-scale industrialization of autonomous cars could take up to ten or more years. Changes such as clear lanes and smart technology to guide vehicles will have to be incorporated in our roads and highways before full-scale industrialization can take place. Nonetheless, we are seeing established manufacturers already testing certain advanced features, but mainly in their premium segments.

The more connected the manufacturing plant becomes, the greater the requirement for QA and Testing services. This



is not restricted to the Automotive sector, but is typical of today's digital manufacturer. One aspect of digitalization, however, that is more prevalent in the Automotive sector than in many others is the need for heightened cybersecurity. The development of connected car features, such as vehicle management, driver behavior analysis and safety monitoring, has become a main theme for OEMs, who must respond to consumer concerns about data security and privacy. It is no surprise, therefore, that enhancing security is ranked as an important or very important aspect of IT strategy by 67% of study participants in this sector, significantly more than any other objectives.

There is a prevailing nervousness in the industry regarding hacking. Currently, while there are many connected car features, these are not as well protected as they should be and this has increased the interest in the specialist area of cybersecurity QA and Testing. As with previous years' study findings, the Automotive sector performs a range of security testing activities. The most used approach is static application security testing, employed by 53% of respondents in this sector, which is just 1% down from last year. There has been a marked drop in the use of dynamic application security testing, down from 64% in 2015 to 44% this year. Manual code review is also down, from 59% last year to 43% this year. More respondents are using penetration testing (ethical hacking), up to 50% from 39% last year.

Major testing initiatives have continued over the past twelve months and testing as a discipline is becoming more industrialized. OEMs are responding to cost pressure with both industrialization and offshoring featuring in their QA and Testing strategies. This is a shift for OEMs who have typically offshored their application management, but not their testing. Today, however, the cost and quality outcomes of handing testing to a Systems Integrator able to industrialize the process for a whole domain, rather than for just for single applications, are being sought. Some 44% of Automotive participants in the World Quality Report 2016 study say they have outsourced most testing activities to an independent QA partner.

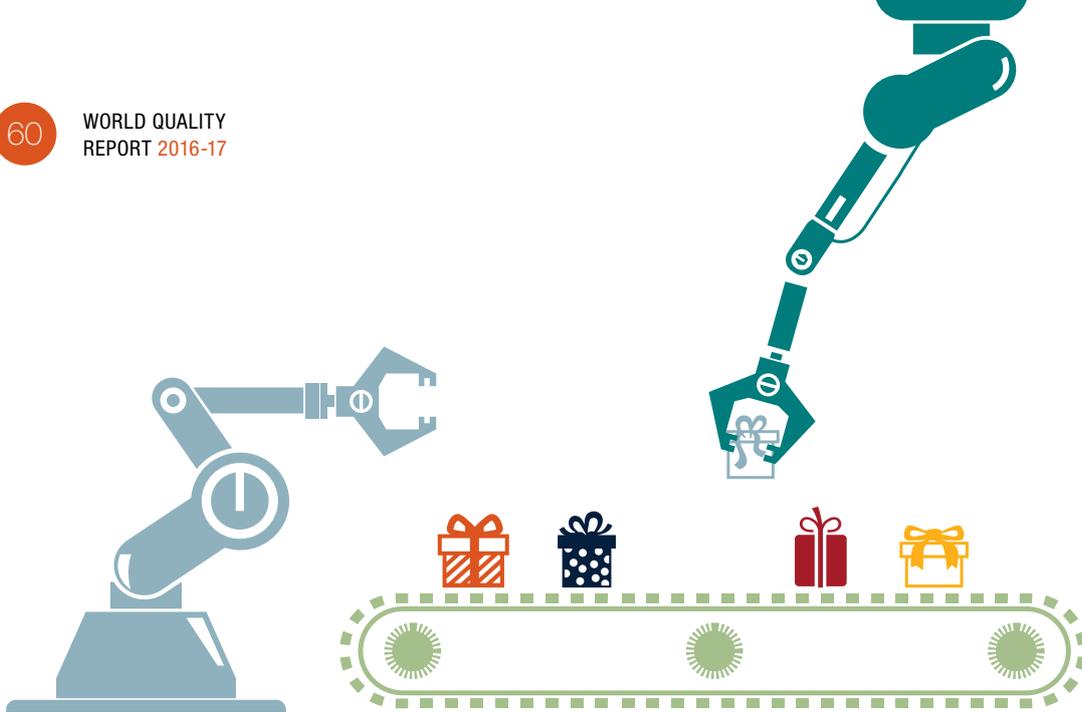
One aspect of QA and Testing operations that has emerged is the move away from centralized HQ-induced system development, whereby one system is rolled out all over

the world. Instead, we are seeing a more market-specific approach. The Automotive sector powerhouses of America and China are now setting the scene for de-centralized system development, with systems and applications brought to market and tested in an agile DevOps model. This reverses the HQ-centric model of a few years ago, which took too long to get innovations to the different global markets. It shifts QA and Testing to these markets to support development activity, and requires deeper levels of engagement with local partners. This is reflected in our 2016 study findings relating to the set-up of test operations. Automotive companies give an equally high importance ranking to the setting up of a Testing Center of Excellence (TCOE) in a hybrid (nearshore/offshore) model and to a decentralized TCOE for improved agility and efficiency. These are cited as important or very important by 52% of Automotive respondents respectively.

Looking ahead, we believe that the use of automation and industrialization, not just in testing but in the wider IT function, will change the landscape over the coming decade. Its potential to cut the cost of testing and development activity raises the possibility of bringing QA and Testing functions closer to the main markets. Offshore locations, such as India, currently provide labor arbitrage benefits, but increasing automation will reduce this and could create a negative offshoring trend.

In line with the all-sector average, the percentage of the overall IT budget spent on QA and Testing this year has dropped. It is down from 35% in 2015, to 32% in 2016. Still the Automotive sector study participants predict QA and Testing spending to rise to 40% of the overall IT budget by 2019. While this predicted upward trajectory has to stop at some time, it is perhaps indicative of the industry's enthusiasm for emerging technologies and automation techniques. For example, 48% of survey respondents in this sector foresee using cognitive automation in the coming year; 43% expect to use robotics automation; and 40% foresee the use of predictive analysis (automated identification of risk areas). Elements of these developments are already evident, with 47% of Automotive sector respondents saying they use predictive analytics to determine or optimize test coverage in a DevOps environment. This corresponds with findings from across all sectors of an increasingly intelligence-led approach to test data and test environment management.





# Consumer Products, Retail and Distribution

## Achieving customer intimacy across multiple channels is a growing challenge

**Sreenivasrao Baru**, Corporate Vice President, Global Head CPR Sector, Capgemini

**Theodore Levine**, Leader, CPRD Sector, Capgemini

The trend for greater customer intimacy reported in 2015 has become even more pronounced over the last year. Digital Transformation is part and parcel of this trend as it enables organizations to better understand their customers through intelligence-led insight into their buying behaviors. Clearly this is especially true for enterprises in the Consumer Products, Retail and Distribution (CPRD) sector.

QA and Testing is a key enabler in enhancing customer experience in this sector. This is reflected in the leading QA and Testing objective amongst the CPRD companies taking part in the World Quality Report 2016 survey. Against an all-sector average of 39%, ensuring end-user satisfaction is the most cited CPRD objective, with 48% saying it is either important or very important.

As customers continue to share their personal information with CPRD companies, they are asking in turn what the CPRD companies can do for them. They insist on security of their personal information and they expect a consistent user experience across all devices. They are increasingly browsing on one platform, selecting on another, and paying on yet another. Thus the interoperability of devices will be

a challenge going forward, encompassing different screen sizes (laptops, tablets, mobile phones) and operating systems. 44% of CPRD companies in this year's survey say they focus their mobile applications testing efforts on the user interface and ease of use, second only to security and efficiency/performance, both cited by 46% of respondents.

The task for CPRD companies is to provide a seamless interface between all platforms, enabling the customer interaction of browsing and buying. In this landscape, difficulties in managing test data across the end-to-end transaction will increase as multiple identities, technologies, tools and platforms proliferate in the coming years. Indeed, 46% of the CPRD participants in the 2016 study say a lack of test data for complex integration testing across systems and organizations is a challenge.

Digital Transformation and the move to cloud platforms are also giving rise to growing concerns around the security of transactions and customer data. Unsurprisingly, enhancing security remains the number one strategic IT priority. On a scale of 1 to 7, with 7 being the most important, this year's CPRD survey participants rank enhancing security as 5.85.



Security mechanisms in retail have evolved ahead of other sectors, driven by customer demand for digital shopping and the need to safeguard multiple points of interaction across a consumer's life. Furthermore, the level of information shoppers share with retailers is more personal than in most other sectors, embracing lifestyles, family and more, and this gives a different perspective to the focus on security.

Another key trend characterizing the CPRD sector is the steady progress of new multi-channel business models, with the likes of Uber setting the pace, and a corresponding focus on how to make the last mile pay while meeting customers' expectations.

With the shift away from large scale, traditional development projects, there is less demand for big, centralized testing teams in the CPRD sector. Instead, we see a growing demand for testing associated with platform migration projects, especially dealing with cloud. This is reflected in the 2016 survey findings, with 41% of those CPRD respondents using agile development saying they work in a distributed agile model. Further, in the general organization of test activities, this sector records the lowest usage of a central Testing Center of Excellence performing most test activities, with just 32% of respondents saying they use this approach, against a 38% all sector average.

While traditional testing issues with the likes of SAP and Java remain the same, three distinct focus areas are emerging in the agile and DevOps era for the QA and Testing function: the digital customer experience, as noted above, Big Data, and cloud. In one sense, making the move to cloud is similar to the transition from mainframe to client servers of a few decades ago. It is important to identify and test existing interfaces to ensure they are protected and will work well in the cloud environment.

The continuing investment in cloud platforms as a means to reduce CapEx is placing further demands on the QA and Testing function. Also driven by customer demand, more and more CPRD companies are moving to the cloud but their migrations, particularly amongst retailers, are governed by the timing of big seasonal events, such as Christmas, Easter, Thanksgiving, and Black Friday, which demand minimal disruptions and quiet times for production releases. Nonetheless, this year's World Quality Report study findings reveal that CPRD organizations are the highest percentage users of private cloud. They claim that on average 36% of their applications are currently cloud based. When combined with on-premise cloud platforms, this figure rises to 49%, again the highest across all sectors.

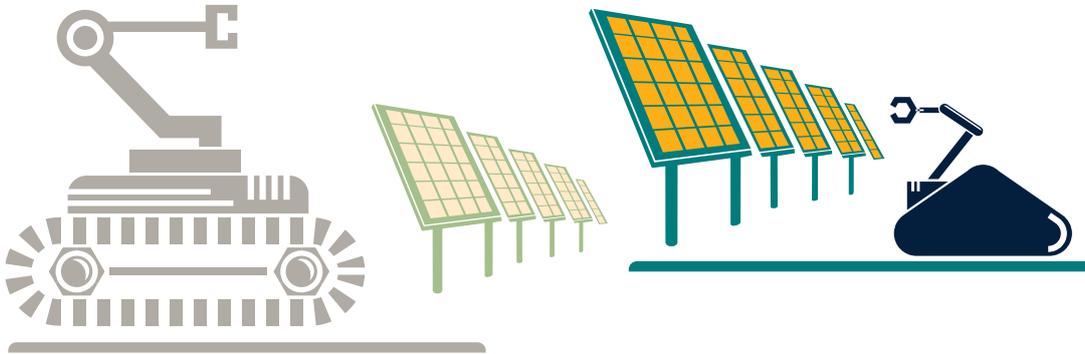
In contrast to this, CPRD survey participants record a big drop in the percentage of hybrid cloud applications being used, down from 26% last year to 17% this year. Despite this recorded drop, we believe that businesses are continuing to look for hybrid solutions. They are evaluating third party software-as-a-service solutions in tandem with private cloud for certain aspects, such as production environments, along with hybrid for some of their development testing.

Agile development and the application of DevOps practices continue to be a factor in the CPRD development lifecycle. As companies in this sector investigate as-a-service cloud-based delivery and digital enablement, they are seeking to leverage DevOps methods to help them on this journey. The frequency of releases, however, presents a challenge in terms of ensuring intimacy with customer needs. CPRD companies employ a number of different approaches for testing in the DevOps environment to help them achieve this, the most used of which is automated test data generation, cited by 47% of CPRD respondents using DevOps. The specialist knowledge of testing teams remains important in this respect too as they build deep customer knowledge of the way in which an application is used in order to create relevant releases.

This year's chapter on industrialization and automation discusses the rise of crowdsourcing as a model for providing rapid test capacity. An average 47% of all respondents to the 2016 survey state that crowdsourcing in this way is important or very important, but the CPRD sector comes in higher at 55%.

Looking ahead, we believe that spending on QA and Testing will increase in the coming years, despite a slight drop over the past year. This is due to the escalating development of native cloud applications and a focus on customer experience. While development costs look set to come down due to agile and a further uptake of DevOps practices, the need for complex systems integration testing will push testing costs higher. Solutions being offered to organizations in this sector will move to full-service end-to-end business transaction QA and Testing support, embracing the full technology stack, infrastructure, data across all layers, applications and the customer experience. For retailers in particular, developments with the convergence of digital and in-store channels, and corresponding changes to smart in-store formats, will drive an increased need for QA and Testing.





# Energy and Utilities

## Exciting transformation journey gathers pace

**Perry Stoneman**, Global Head of Sectors & Utilities, Capgemini

The most significant trend shaping the IT landscape for Energy and Utilities (E&U) companies this year is a move towards Digital Transformation. There has been a big increase in the number of organizations starting to embrace digital with long-term digital strategies. However, there is no clear consensus in terms of which key Digital Transformation objectives are driving this, from the desire to embed customer experience at the heart of business strategy, to the need to deliver operational improvements.

This year's World Quality Report study looked at the roles taking responsibility for these transformation strategies. 27% of the study participants from the E&U sector say they have a Chief Digital Officer (CDO). Other leaders also have a remit for digital, with 19% in this sector saying they don't need a CDO because Digital Transformation is in the hands of their IT leadership (CIO), and 8% saying it resides with the business leadership. While other sectors have been quick to adopt digital technologies, we can see that this industry is still slightly behind the curve, as evidenced by the proportion of companies saying they don't have a CDO because Digital Transformation is not part of their strategy. At 25% of this sector's study participants, this is the highest across all sectors, and there is clearly a big difference when compared with the likes of the Transportation (9%) and Automotive (10%) industry study respondents.

Protecting the corporate image is cited by Energy and Utilities companies as the leading objective of QA and Testing, with

a much higher rating than any of the other sectors. This aligns with an interesting trend, whereby a number of well-known companies have created secondary brands to better appeal to the market. The legacy names are tied to legacy business models and don't reflect the more digital operating environment. The new sub-brands, on the other hand, clearly convey a more modern corporate image, which the QA and Testing function has a role in protecting.

Introducing digital capabilities into the business demands a new QA and Testing skillset. Greater API development, for example, requires a different type of test tool, while the move to more agile development demands new testing services. While there is no clear ramp-up of these today due to the relative digital immaturity of this sector, there is no doubt that both automation and industrialization of QA and Testing will become increasingly important.

One aspect of Digital Transformation that has taken off is the use of mobile applications. While a very high proportion of companies in this sector have launched a mobile app, the number of customers giving these apps a high satisfaction rating is reportedly fairly low. Companies need to reengineer their processes and move away from viewing their digital apps as they did their old technologies. They must take on board the attributes that make a digital app user friendly. What is it that the consumer is looking for? How can we better engage with our workforce using digital apps in order to retain the best talent? Interestingly, 43% of this year's



World Quality Report survey participants in the E&U sector are already testing the user interface and ease of use of mobile applications, and 17% of the QA and Testing budget is spent on mobile solutions. There are challenges, however. 48% of respondents in this sector say that they don't have the right testing process or method for mobile and multi-channel. The new skillsets required are also lacking, with 43% saying they don't have mobile testing experts.

Another technology change associated with digital strategies is cloud adoption. Last year we reported that there was recognition amongst the industry's CIOs of the need for cloud strategies. This has moved forward in the past year, with many IT leaders no longer simply planning to implement a strategy, but now actively defining a timeline for migrating non-SCADA (supervisory control and data acquisition) systems to the cloud. With cloud offering potential cost reductions of 30-40% in the provision of infrastructure, it is no wonder that 17% of QA and Testing budgets is currently spent on testing cloud solutions. This is the same as last year but, when combined with the 13% spent on testing Internet of Things solutions, it paints a picture of an industry undergoing massive QA and Testing change.

With a strong track record of physical and perimeter security, for example in the protection and access control of nuclear plants, the E&U sector has also turned its attention to cybersecurity. Cyber attacks on energy grids have ensured that security is not just a senior-level responsibility, but goes to the very top of the organization. With CEOs assuming this responsibility, it is no surprise that once again security is the leading IT strategy priority this year. Manual code review and static application security testing are the most performed security testing activities overall. When testing mobile applications, including devices and wearables, 52% of survey participants in this sector say that security of sensitive data on the device or over the air is an area of focus, more than any other aspect of mobile testing. This assurance of security is critical to giving a field-based workforce remote access to customer and enterprise data and aligns with the operational performance objective of Digital Transformation.

Smart meter programs are being rolled out at pace in this industry. Around 300 million smart meters have been

deployed so far, with 1 billion predicted to be in place between 2020 and 2025. These are nodes on the system that didn't exist before. While this might present a security threat from hackers, in reality the meters themselves don't yield that much sensitive information. Instead, the testing for these is more likely to be around efficacy. Customers simply want their smart meters to work. Looking to the future, the next step will be to enable customers to access data from their smart meters in real time. Developments such as smart home technology are emerging, but as yet no one sector is winning the prize amongst the broadcasters, home security firms and utility companies building up their capabilities in this area. It is nonetheless an evolving area for which QA and Testing will become increasingly relevant.

The somewhat conservative approach to agile and DevOps adoption has remained consistent this year. In fact, 15% of this year's study participants say they do not use DevOps principles, against an all industry average of 12%. This conservatism isn't preventing the industry investigating and predicting the use of new and emerging capabilities. For example, 49% anticipate using cognitive automation (automated capture, recovery and distribution of specific knowledge and operation instructions) in the coming year, while 32% say they expect to use predictive analysis as an automation technique.

This type of new capability will forge a more intelligent-led approach to future test activities, but it will also make an impact on spending. While the percentage of the total IT budget spent on QA and Testing this year remained static at 33%, companies in this sector predict a rise to 41% in three years' time. This aligns with the strategic decision to move ahead with Digital Transformation, for which QA and Testing is an important facilitator of end-user satisfaction, whether that user is a customer or an employee. There is a long transformation journey underway and while the industry is protected by a strict regulatory regime, it can't protect itself against customer expectations for a seamless digital interface to the services they consume. That's the role of QA and Testing and it will be an increasingly important role as the pace of Digital Transformation escalates.





## Financial Services

### A new approach to QA and Testing is needed for rapid development cycles

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**Krithika Kumar**, Vice President, Financial Services SBU, Capgemini

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In an industry beset by tough competition from new market entrants, low interest rates, and limited growth, organizations across the Financial Services sector are seizing the opportunity to disrupt with digital and use their data to differentiate the customer experience.

Increasingly, Financial Services institutions are co-innovating with the financial technology companies (FinTechs). These firms are already part of many innovative market-facing experiments and they are becoming further embedded in transformational programs, which have ambitious time-to-market goals. Given these trends, QA today has to deliver results in a shorter timeframe and in a more complex technology environment. Co-developed with the FinTechs, we see Blockchain and digital payments as a hotbed of innovation in customer experience and transaction processing. Many Financial Services institutions are evaluating smart contracts with their industry peers and implementation of these standardized contracts will need a common validation approach across the industry.

As insurance companies, banks and capital markets firms continue to embrace Digital Transformation, they are seizing the opportunities it brings for better customer engagement and new business models, as well as for

pushing workforce enablement. The ongoing trend to develop front-end solutions for tablets and smartphones is shifting to the development of more functional applications to work on these different devices.

True agile delivery moves developers and QA and Testing teams in Financial Services beyond purely the tools and processes needed to get a new product to market, to a new mindset that embraces a deeper understanding of the new delivery paradigm. Shorter release cycles with an increase in the use of agile and DevOps in banking requires rapid QA and Testing. While the uptake of DevOps is slower in insurance, there is a feeling that from 2017 onwards it will take off. In banking the move of DevOps into mainstream development is resulting in a push for more test automation to assure quality across the shrinking development timeframe.

As the focus on customer experience is embedded further into digital strategies, companies are building more and more application programming interfaces (APIs). For example, banks are converting internal assets into APIs for tasks such as fraud management. These APIs require a new approach to QA and Testing, with a lot more service virtualization. QA and Testing professionals are required to possess developer skills along with functional testing skills.



There is a need to understand the new architectures on which to test these APIs. Further, a lot of customer experience API development will involve several different providers, making the process highly complex. The challenge will be to make this API testing, as well as the management and build of the functionality, a seamless process.

Data is increasingly being used across this sector at a number of levels. For example, insurers are analyzing customer data to tailor customized services, better understand policy risks, and take an intelligence-led approach to claims.

In banking and capital markets, data analytics is now part of mainstream processing. For example, customer value analytics is used to create richer profiles of customers using particular services, such as a credit card. This profiling is not new, but the extent of it is. Geo-presence capability now enables the location of a transaction to be identified, while metadata concerning family members is used to embellish the customer profile. All of this demands a deep understanding of the underlying technology.

In this data-rich landscape, data strategies must incorporate integration testing, stability testing and compatibility testing across multiple technology browsers and within concurrently running development programs. Integration is complex and testing has to be carried out quickly to meet development demands. This presents testers with a challenge. In the World Quality Report 2016 study findings, 42% of Financial Services respondents say a lack of test data for complex integration testing across systems and organizations is a challenge. Complying with data security and data privacy regulations for test data is another challenge, cited by 45% in this sector.

Enhancing security is the number one IT strategy objective, with 67% of Financial Services survey respondents saying it is either important or very important. There's a sound reason for this. Security in this sector is incredibly complex. The entire security architecture is more multi-faceted than ever before and it is not uncommon to see 100+ security products utilized in it. Thus, there is a significant amount of work for the QA and Testing function.

As the security threats evolve, the available products evolve in tandem and specific security testing experience with these technologies can be hard to find. Instead, we see a lot of QA being carried out by developers. In addition, many firms make use of the product vendors, demanding that they do much of the security testing. We are also seeing companies aggregating security products and taking over the management of the service. This is borne out by the 57% of companies in this sector who say they use managed application security testing services.

Security is also a priority test activity for the cloud-based and third party software-as-a-service aspects of the IT landscape. 56% of the Financial Services participants in our study say they pay special attention to security requirements and risk, more than the level of attention paid to performance requirements and risk and to peak load requirements and risk, both 53%.

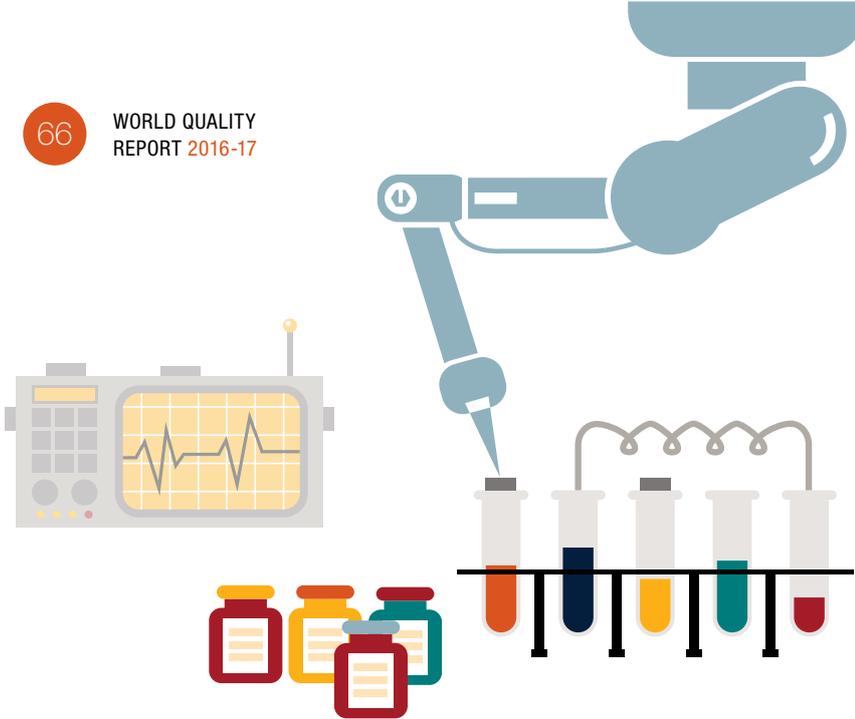
The rapidly increasing cloud adoption in Financial Services is being driven in part by cloud providers bringing improved products to the market. Continuity, capacity management and cost optimization largely define the agenda for cloud adoption. Quality of service and service assurance for both production and non-production platforms are fundamental in this.

The Internet of Things is another element of Digital Transformation, sitting alongside cloud, mobile and cybersecurity. While currently there appears to be no established strategy for this, it looks set to be one of the next big waves of technology focus. For example, fitness trackers offer health insurers the potential to analyze fitness data and offer rewards to customers with a healthy lifestyle. As yet, this type of solution does not exist and will require non-traditional ways of testing with a big focus on automation.

Telematics in cars is already a reality and driver behavior profiling is being used in some car insurance instances. Home automation solutions, whereby homeowners can manage their home security remotely, will also make an impact on home insurance policies in the future. In banking too, credit card issuers are developing and piloting solutions connecting physical stores and customers' digital ID to understand their shopping patterns. Again, this is an emerging, rather than a mainstream technology.

Investment in future innovations such as this will have an impact on QA and Testing budgets going forward. The QA organization will need more developer-testers and system integration testing orchestrators, and they come at a cost. To meet these expectations, yet contain costs, test automation and the use of new approaches, such as predictive analytics to identify what needs to be tested (and what doesn't) and an integrated tooling approach, will be vital. As a highly package-driven business, Financial Services is amenable to end-to-end and lifecycle automation. When coupled with the fact that the sector has a mature QA approach to embracing predictive analytics, this can drive down cost significantly to neutralise the escalating cost challenges posed by digital disruption. Further, test environment and test data management will see a push to more open source solutions and tools, which will reduce license costs.





# Healthcare and Life Sciences

## Smart technologies and connected data streams help to push a patient-centric agenda

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**Malavika Athavale**, Associate Vice President and Head Product V&V practice, Product and Engineering Services, Sogeti

Digital technologies are changing the face of the medical device industry and broader healthcare sector. The Internet of Things, cloud and transformation programs characterize this evolving digital world. Where previously there were concerns about sharing data across networks, there is now increasing confidence in cloud platforms for sharing and storing data, such as electronic medical records. We are also seeing more and more large hospital systems being implemented in a cloud-based model, with software-as-a-service subscription-based delivery. Indeed, Healthcare and Life Sciences respondents to the World Quality Report 2016 study claim that 84% of their applications are currently cloud based. Some 28% are private cloud-based, with predictions that this will increase to 35% in the coming years, while a further 24% are public cloud-based.

This is having an impact on spending, with the QA and Testing function reporting that 17% of the testing budget is spent on cloud solutions. Cloud adoption demands new QA approaches, with quality firmly embedded in the process of designing, building and procuring for the cloud. QA activities must cover not just validation, but also integration, regression and performance testing for all the different layers of these new cloud platforms.

One outcome of increasing digitalization is the ability to truly put the patient at the heart of healthcare provision. For the first time ever, the entire industry is coming together with a focus wholly on the patient, from healthcare providers and hospitals, to public health bodies and equipment and medical device manufacturers. There is a push toward proactive, rather than reactive healthcare, with enabling technologies driving connected health provision. For example, we see an increase in wearable devices, such as fitness trackers and elderly care monitors, along with health portals connecting patients to their clinicians, and home-based medical monitoring whereby clinicians can receive patient data via a phone line. These connected data streams are enabling the delivery of increasingly individualized patient-centric care. A growing interest in telemedicine is also evident, for example with major healthcare providers implementing tele-intensive care units, enabling care providers to monitor the sickest of patients remotely.

All of these developments make a big impact on the QA and Testing profession, which is tasked with validating and verifying a massively growing product set and proliferating data channels. It is an increasingly strategic role. The core purpose of this sector is to improve the quality of life and



healthcare for patients, and that includes the efficacy and safety of equipment and devices, along with patient data security. Indeed, the most highly rated QA and Testing objective amongst this year's Healthcare and Life Sciences study respondents is 'to assure minimal disruption to business operations by mitigating risks'. Cited as important or very important by 49% of respondents in this sector, it is significantly higher than the all-industry average of 39% for this objective.

In this increasingly digital landscape, device manufacturers have had to transform not only ways of working, but also the products they're bringing to the market. Medical device applications previously built on proprietary hardware are now being built on digital technologies and mobile apps. For example, patient data that was previously stored in workstations is being overtaken by centralized data that is accessible from anywhere. Manufacturers are developing smart apps to enable clinicians to tap into this data remotely. In addition, as Internet of Things functionality becomes widespread, manufacturers are investigating smart device management and using remote capabilities to optimize service costs for their health sector customers and their own support teams. To this end, Healthcare and Life Sciences respondents to the World Quality Report 2016 survey claim to spend 16% of their testing budget on Internet of Things solutions, with a further 17% being spent on mobile solutions.

In common with Digital Transformation programs across all sectors, a focus on user experience, rather than purely on features, is driving further change. For example, it is no longer just a case of providing an app enabling remote access, but is about making that app as user friendly as possible so that the clinician can see more patients and use his or her time more effectively. Testing the customer experience is a challenge, however. On a scale of 1-7, where 7 is most challenging, the Healthcare and Life Sciences study participants rank identifying the end user expectations and requirements as the top challenge at 4.86, equal only to the challenge of designing test cases. This is closely followed with a 4.85 ranking for implementing and using test tools for customer experience testing, and by establishing the test data for customer experience testing with a ranking of 4.80.

Data analytics has come into its own in this sector as more and more information is captured from connected devices, systems and wearables in the Internet of Things. This is driving a data-led approach to improving disease management. Partnerships are being forged between healthcare providers and vendors to build more analytical platforms and create new business models embracing ecosystems of solution vendors, niche product developers and tool vendors. The

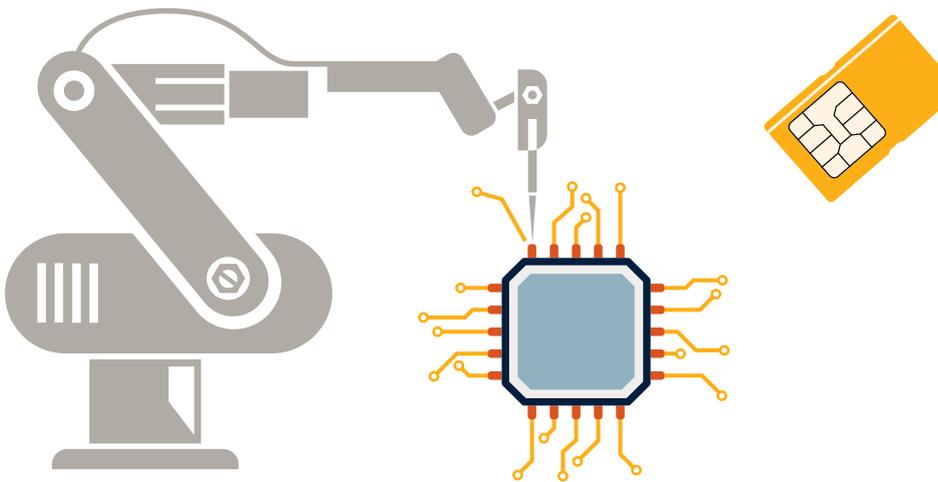
resulting mix of processes and tools all brought together on a common platform is keeping the QA and Testing function busy. It is perhaps why 34% of this sector's World Quality Report 2016 respondents rank integration services, including local, private and public cloud, as the most challenging aspect of digital implementation. This is more than any other challenge, and higher than the all-sector average of 29%. Analytics are also shaping test approaches, with 41% of Healthcare and Life Sciences study participants saying they use predictive analytics to determine or optimize test coverage when testing in a DevOps environment.

The demand for ever faster releases of new products and enabling technologies has seen a high level of adoption for agile development methods. The medical device sector was a pioneer of behavior-driven-development (BDD), which is understandable for a product-centric industry. 41% of those organizations in Healthcare and Life Sciences that use agile say they utilize test-driven and BDD approaches. The most used approach to testing in agile for this sector is that of increased functional test automation combined with agile lifecycle management tools at 44%. DevOps too, and testing in the DevOps lifecycle, is a noticeable trend that looks set to increase. For example, while 39% of Healthcare and Life Sciences respondents say they use continuous testing, a further 54% currently not using it say they plan to in future.

Of course, test automation is also an enabler of speed-to-market and there is increasing maturity as the QA and Testing in this sector moves beyond simply standard automation of manual tests. The Healthcare and Life Sciences study participants claim that 27% of their test cases are automated. However, this is not without its challenges and 41% in this sector claim they don't have the right automated process/method. Despite this, 50% say test automation helps to reduce costs, while 47% say it results in better detection of defects.

Beyond simple automation, we are also seeing more use of autonomies, the first level of automation maturity, whereby proactive activities are created on top of the standard automated testing. Interestingly, 42% of those surveyed in this sector say that in the coming year they foresee using robotics automation, the second stage of maturity in automation, whereby software robots replicate human interaction with applications. A third stage of maturity, that of cognitive testing techniques, is also emerging, with 34% of the Healthcare and Life Sciences study participants saying they foresee using cognitive automation in the year ahead.





## High Tech

### New technologies enable adoption of Digital Manufacturing

**Jean-Pascal Duniau**, Testing Leader, Sogeti High Tech

**Malavika Athavale**, Associate Vice President and Head Product V&V practice, Product and Engineering Services, Sogeti

The continuing uptake of Digital Manufacturing processes and approaches characterizes the High Tech sector this year. Also known as Industry 4.0 (the fourth industrial revolution), the journey to Digital Manufacturing has been triggered by the availability of enabling technologies and new capabilities, such as the Internet of Things, Big Data, predictive analytics and industrial systems security. These are at the forefront of the Digital Transformation programs making an impact on economic landscapes across the hardware and device manufacturers, aerospace firms, defense contractors and large-scale consumer electronics companies that make up the High Tech sector.

Digital Manufacturing is the convergence of operational technologies (industrial process automation, factory automation) with IT (business process automation). The outcome of this convergence is the ability to deliver new products faster and more often, and with a high level of customization. This speed, understandably, has an impact on the QA and Testing function throughout the specification, design, development and test lifecycle. A more scientific approach is being adopted, with testers extending their knowledge to the domains of business, data, robotics and mathematics. We have moved from the provision of purely QA services, to that of digital QA services.

In factories and complex systems, such as those in aircrafts, trains and power plants, there is now an expectation of zero latency; for consumer products, we are no longer talking about ease-of-use, but about pleasure-of-use. This explains why the two most important objectives of QA and Testing cited by the High Tech participants in this year's World Quality Report study are: to increase quality awareness among all disciplines, cited as important or very important by 44%; and to detect software defects before go-live (42%).

In this world of smart, connected products, assets and plants, technology solutions are becoming highly complex and operated in ever larger contexts. This has an impact on the user experience, with improved omni-channel information flow giving deeper insight into product behavior through analytics. As a result, the scope of QA and Testing services must be extended in terms of expertise, testing coverage and volume. In this context there are four trends emerging in QA and Testing: simulation (virtualized testing), robotics, Big Data, and cybersecurity.

Of course, simulation is not new in this environment. However, the huge scale and complexity of many industrial projects means simulation is even more vital today for controlling costs and preventing traditional QA and Testing efforts from



becoming a barrier to the rapid release of new developments. Instead, virtualization enables testing during specification, as well as in the system integration and validation stages. It makes it possible to simulate use cases without having to stop production. This shift left to early validation of specification and design and the ensuing early-stage identification of defects can make a significant contribution to faster time-to-market and cost reduction. In some instances, 80% of use cases can be simulated, making a massive impact on costs. Virtualization is also used in the verification of systems under test, such as an engine, or the environment around the system under test, for example a production line. This can save many system integration-bench hours and deliver further cost savings, with some simulators processing more than 100,000 different parameters.

Another lever for efficiency is robotics. In the High Tech sector, where the use of robotics is not new, there is an increased enthusiasm for robotized testing. Some 42% of High Tech participants in this year's study foresee using robotics automation in the coming year. This reflects an evolution in robotics, with robots able to operate in collaboration with a human operator on the same test bench. Robots are, in essence, co-workers, set up to handle repetitive commissioning testing, perform complex tests, and quickly learn to recognize defects. They are fast becoming an important asset for testing complex physical systems.

Big Data is proliferating within High Tech companies, where test activities can generate huge volumes of data spread over thousands of parameters. Traditionally, the focus in terms of this data has been on the results themselves; at its basic, a pass or fail. Now, however, with the ability to analyze data, and with input from data analysts and data scientists, the industry is starting to define test strategies based on previous testing results (predictive testing). This can detect tests that are irrelevant, while others may be extended to cover more parameters. Test data from bench, simulators, and real systems can also be correlated to improve test efficiency. Thus the growth in Big Data becomes a major lever of cost reduction and increased revenue, rather than a drain on resources.

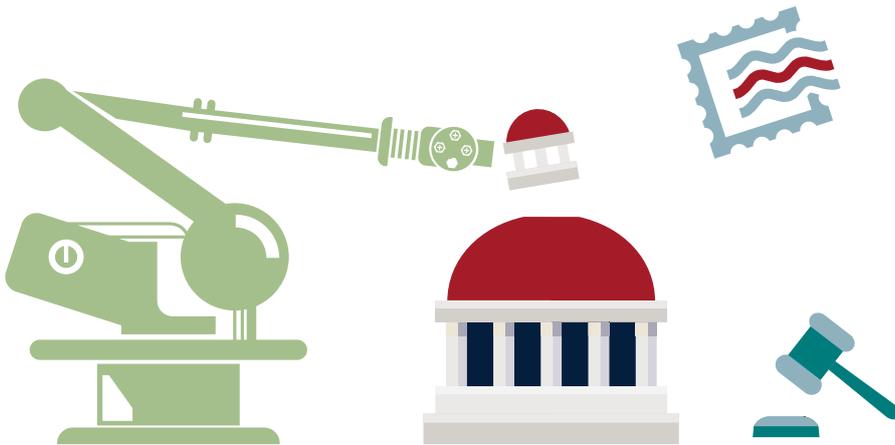
An acceleration of cybersecurity testing is another consequence of the move to Digital Manufacturing. Awareness of the need for cybersecurity to safeguard data and assets has been growing over recent years. With the convergence of IT and operational technology in the High Tech sector, there is heightened focus on product security, penetration testing and design security. Industrial networks that used to operate in isolation are more vulnerable in the Internet of Things as data from industrial control systems,

smart sensors, devices and machines is pushed out through different channels. More and more Internet of Things connectivity is appearing in omni-channel consumer solutions, such as smart metering, smart building, and home appliances. While the omni-channel information flow gives deeper insight into product behavior, it also opens a gate into IT infrastructure and systems. This is why security testing must be part of any Digital Transformation project. Indeed, there is a real concern about the security of data amongst High Tech companies, with security being cited as the most important objective of IT strategy across all sectors covered by the World Quality Report 2016 study. Some 65% of High Tech participants say it is important or very important. This is way ahead of the second most cited IT strategy priority in this sector, that of IT cost optimization (46%).

Test industrialization and automation are critical aids to meeting the escalating need for QA and Testing services. But there are challenges with automation. For example, 42% of the High Tech participants in this year's study say they struggle with test data and environment availability, and 42% say their delivery methodology doesn't support test automation. Thus more and more companies are turning to external, managed service provision. 57% of High Tech companies say they use managed application testing services and 49% use external security testing teams on a project-by-project basis. This gives companies cost effective access to the new skillsets now characterizing QA and Testing, such as scientists, mathematicians and robot programmers. The efficiency offered by industrialization comes in the form of Testing Centers of Excellence (TCOEs) and this sector adopts a number of approaches: on a scale of 1 to 7 (with 7 being most important) High Tech companies rank a captive TCOE factory in a build-operate-transfer model at 5.27, followed by a hybrid near shore/offshore TCOE factory (5.17), and an offshore TCOE factory (5.13). A managed service model with an expert QA vendor is rated 4.98.

Spending on test environment automation, new tools for creating real-time data, simulation, Internet of Things testing and security will push up QA and Testing costs over the near horizon. In fact, the study findings indicate that High Tech companies expect spending on QA and Testing to increase to 40% of the overall IT budget by 2019. However, we believe that this will start to reduce significantly thereafter as a result of greater efficiency in the verification and validation process made possible by the new digital tools and sophisticated approaches. These are already reducing test cycle times from three months-to-a-year down to just one week. With wider adoption, the implications for more cost efficient QA and Testing are clear.





# Government and Public Sector

## The pace of Digital Transformation activity increases

**Matt Howell**, Head of Public Sector, Capgemini

The focus in Government and the Public Sector is on engaging more closely with citizens, as well as on user-centric design; just as it was a year ago in our World Quality Report study. This focus is a key driver for the many digital projects underway across the world.

Government needs to deliver better services more cost effectively. At the same time, the majority of governments are still running legacy technology landscapes, in which they have invested billions over the years, creating the duality of digital and legacy that we noted last year. Those few governments not held back by large portfolios of legacy applications are ahead of the game, and have a chance to skip a generation of IT to move ahead rapidly with their digital engagement. They are investing in cloud-based and open source systems to build business services on digital technologies.

For the main, however, the duality of IT landscapes requires different types of testing activity split between the two. As an example, in a DevOps development environment more typical of greater digitalization, we see high usage of automation and emergence of predictive analytics to determine or optimize test coverage. On the other hand, testing in the legacy environment still operates using the traditional waterfall methods associated with complex systems on aging technologies. QA departments continue to implement improvements around automation levels,

risk-based testing and data creation tools in an attempt to keep pace with the level of change demanded due to the amount of digital front-end releases driven through DevOps.

While the citizen engagement focus remains unchanged as a driver, the pace is certainly ramping up. In general, there is a policy to get as much of government as is possible online, as fast as possible. The impact on QA and Testing in this fast-paced world is leading to a very different and entirely iterative lifecycle, with tooling and testing shifting left to earlier in the process. Offshore testing is often not possible because data cannot easily be moved offshore in its entirety, even though many data masking tools are available. Instead, smaller testing teams embedded in the development environment will increasingly be the norm. There will, of course, still be a requirement for traditional-style testing, but the way in which systems are tested is changing.

A key measure of digital intent and maturity is whether organizations have a Chief Digital Officer. 51% of Government and Public Sector respondents to this year's survey say they have a CDO, more than any other sector. A further 33% have assigned this role to other senior leaders. The CDO is now a core role to which business and IT look to deliver transformation. With the move to cloud platforms and an increase in agile development, the CDO often takes precedence over the Chief Information Officer (CIO), and in some instances replaces the CIO all together.



As the pace of Digital Transformation accelerates, there is a lack of internal resource in key areas. For example, in the testing of mobile and multi-channel applications, 52% of survey respondents in this sector say that one of their greatest challenges is the lack of an in-house testing environment. 51% cite a lack of internal mobile testing experts. The latter shortage is indicative of a wider resourcing challenge from the top down and a struggle to find people able to scope and manage the transformation of large elements of the IT environment. This presents a risk internally, but is also evident externally where the sheer volume of people required to run agile programs is lacking in the market. To keep up with demand, organizations in this sector, as well as external suppliers, must create the right culture to attract new, more digitally attuned talent. It is also important to recognize that QA and Testing skills are part of the digital agenda and need to be factored in to the hunt for digital talent.

Another matter for concern in testing mobile and multi-channel applications is that of security. It is cited by 49% of the Government and Public Sector study participants as an area of focus, more than any other area. Enhancing security is also the most important aspect of IT strategy by a long margin. 29% of respondents in this sector report that it is very important, a long way ahead of the second most cited area of strategic importance, that of IT cost optimization (14%). The importance of security is unsurprising as government does all it can to make it easier for citizens to engage and for services to be delivered online.

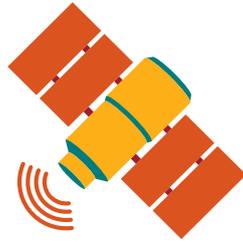
Government and Public Sector organizations have a duty to safeguard data, no matter how many routes are opened up into them to facilitate citizen engagement. This is leading to significant investments in cybersecurity and the securing of data assets. Specialized teams and agencies with responsibility for securing data on a policy basis are increasingly the norm. For the QA and Testing function, this has heightened the focus on testing applications for security. According to the World Quality Report 2016 study, this sector engages both internal and external teams for such security testing activities. 59% of Government and Public Sector respondents say they use an internal testing team with its own tools, while 57% utilize managed application security testing services. Alongside penetration testing techniques that have been in use for some time, organizations are looking at tools that can analyze code for weaknesses at the earliest stage in the development lifecycle.

The caution associated with a need to safeguard data slowed the adoption of cloud in this sector initially. However, with large cloud providers moving to operate “sovereign” data centers in many of the bigger countries, take-up will accelerate. Further, it is likely that we will see cloud’s evolution often embracing an enterprise hybrid cloud model, with some data on the public cloud and more highly sensitive data in a private cloud. The starting point should be to understand what data there is and then ascertain the level of security it needs.

Currently, 19% of the QA and Testing budget in Government and the Public Sector is spent on cloud solutions. This compares with 14% on Internet of Things solutions, which will ultimately play a massive part in IT. The opportunities for Internet of Things capabilities are huge, for example in the health sector and hospitals where high volumes of assets can be monitored and patient health tracked via wearable devices. At the moment, however, it is early days and these opportunities are still being identified and built into future IT plans.

This future QA and Testing landscape will also continue to feature automation and industrialization of test activities. This will be essential as digital programs roll out at pace. Indeed, 28% of test cases in this sector are already automated, while a range of Testing Center of Excellence (TCOE) options are used to drive industrialization. The most used TCOE model by Government and the Public Sector is a captive TCOE in a build-operate-transfer model (23% of respondents), followed by a TCOE factory in a hybrid (near shore/offshore) model (21%). The least used is an offshore TCOE (19%). The industrialization offered by a TCOE will be essential as this sector continues to transform. Government has to deliver services to the citizens in the way they want to consume them, and digital will be an enabler of this. It supports the rapid creation of citizen-centric business services, for which high volumes of QA and Testing activity is required. Furthermore, the implementation of new business models, such as a mobile workforce, that have the potential to cut the cost and resource effort of delivering services, will be a feature in the future, requiring further investment in test industrialization.





# Telecom, Media and Entertainment

## Testing the end-to-end customer experience enables market differentiation

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**Sanjeev Arya**, Vice President, Telecom, Media and Entertainment Sector Leader, Capgemini

Customer experience sits at the heart of business and IT strategy across the Telecom, Media and Entertainment (TME) sector. Testing the customer journey to ensure that every touchpoint is both seamless and customer centric is a key part of this as companies strive to differentiate themselves. This is a business necessity as growth in more developed markets flattens and more digitally aware customers demand services fit for their lifestyle. Preventing customer churn, whilst attracting customers from the competition, will drive revenue and profitability.

Telecom companies are also pushing ahead with quad-play strategies bringing together the four streams of fixed, mobile, television and internet. Big investment is being made in network innovation with a move towards intelligent and software defined networks. Smartphone penetration has grown faster than expected and with this growth comes an ever bigger volume of network data. Companies aim to use the data for generating better customer insights and making informed investment decisions.

In this landscape, the leading IT strategy priorities identified by the World Quality Report 2016 study are unchanged from last year. By far and away the top priority, cited as important or very important by 68% of TME survey participants, is

enhancing security. Enhancing customer experience (46%) and cost optimization of IT (44%) are the second and third most cited IT objectives. The huge expectation of telecom network security requires a continual process of QA and Testing. Companies must constantly test not just the network and infrastructure, but the service and apps as well. This calls for robust end-to-end QA across all planes of business.

At the network level, there are now many more vulnerabilities to be tested and fixed, with the application layer being a particular focus of cyber attack. A malicious hack on a customers' network, such as a credit card operator, has significant reputational and financial implications for both the telco operator and its enterprise customer. There is also an interesting security challenge in terms of how to ensure that customers only use the services they pay for. As an example, in the push to deliver television as part of a quad-play service, can the service be fully penetration tested for unauthorized access to prevent revenue leakage? There is an even distribution of the leading security testing activities this year amongst the TME study participants. Both manual code review and static application security testing are used by 53%, closely followed by dynamic application testing at 52%. Cited by just 40%, the least used activity is penetration testing (ethical hacking).



With a great customer service being essential for success in this sector, and heavily impacted by the adoption of digital, there is evidence of TME companies proactively working with partners to create delivery models aligned with the customer journey. This journey begins with a customer's very first contact, perhaps online or often in-store, and continues at every stage of the relationship. This calls for a tailored personal experience for each customer, whether retail or enterprise, ensuring accuracy in billing and promptness in issue resolution. A challenge emerges in this end-to-end process of how best to bring together the components of IT estates and multiple stakeholders to assure the quality of full service, underpinned by both software and network.

We are seeing much of the QA and Testing work being carried out by external parties, with TME operators taking on more of an orchestration role. One reason for this is limited internal capabilities as new digital channels and devices proliferate. Some 47% of TME sector companies in this year's study say that they don't have the right tools to test mobile and multi-channel applications, and 47% don't have an in-house testing environment. A lack of mobile testing experts is cited by 44% of TME participants.

It is thus clear why 42% of TME companies say they use outsourced testing activities from an independent QA partner, and 40% outsource to software vendors. A mix of both decentralized and central Testing Center of Excellence (TCOE) models exists as companies determine the optimum way to test and assure every touchpoint on the customer journey. However, with agile increasingly part of the development cycle, and now DevOps, albeit at an early stage, there is evidence of testing shifting back in-house as part of a continuous development cycle, leading to hybrid models at play.

The adoption of agile and use of continuous testing is not without its challenges. Some 48% of TME respondents say that early involvement of testers in the inception phase of sprint planning is difficult, followed in equal measure at 47% by challenges with identifying the right areas in which to test, an inability to apply test automation at appropriate levels, and a lack of appropriate test environments and data. Companies in this sector still struggle to combine their traditional waterfall development with the newer agile and DevOps, but a gradual shift to agile and short waterfall development projects is evident, particularly for digital projects. At such times test automation can be brought in to help support the more rapid release cycle, engaging both the systems and the processes around them.

This test automation and the industrialization offered in a TCOE model is evolving, becoming less about functionality and more about a complete service, including the business

processes that govern them. In this model, test pricing has the propensity to move away from daily and fixed-price contracts to managed service contracts. The high level of mergers and acquisitions activity noted in last year's World Quality Report continues to be a factor in this sector. The quad-play strategy is one of the reasons for this as traditional telcos join forces with cable and content providers to expand their offerings. Programs to leverage assets and integrate architectures, services and software in a transformed IT stack are thus ongoing. A big challenge is to enable visibility across all services, and across domains and markets, paving the way for cross-selling and value-selling. We expect to see a higher spend on the tools and systems that give this visibility.

Appropriate tools offer the potential for innovation around service effectiveness, for example, emotional analytics tools to detect a customer's disposition on a given day, while Big Data analytics can enable a more proactive service built on predicted customer behavior. Predictive analytics is emerging and 39% of TME survey participants say that they foresee using it as an automated test technique in the coming year. In a DevOps environment, 47% are already using predictive analysis to determine or optimize test coverage, while 24% say the use of agile and DevOps has created a need for more predictive analysis skills.

The TME sector was one of the first to pick up on the Internet of Things trend several years ago, providing the network backbone required to connect the millions of devices and apps. Nonetheless, there has been a struggle to define a robust business case for adopting and developing solutions to support the Internet of Things explosion, and to develop business models by which data traversing the network can be monetized. Currently 32% of study respondents in this sector say they do not have a specific test strategy for their products with Internet of Things capability. A number of companies have struck partnerships with firms in other sectors to develop new products and get ahead of the game, for example with connected cars in the Automotive sector. Agile development and continuous QA are ideal for this because they support the rapid release of new, game-changing products. We expect further growth in this respect.

The macro situation continues to impact IT strategies. The impact on IT of a fluid European eco-political landscape is expected to be massive. The QA and Testing function must step up as an enabler to help navigate ambiguity by testing and validating actual or what-if system and parameter changes. Companies in this sector need to prepare for the appropriate level of test coverage due to potentially changing data protection laws. This will have an impact on the location of IT infrastructure, policies, and flow of data, as well as on service bundles for enterprise and retail customers.



A young boy with goggles on his head is focused on working on a small mechanical device in a workshop. He is wearing a plaid shirt and overalls. To his right, a large, black, boxy robot with glowing eyes and a radio antenna stands on a workbench. The robot's arm is extended towards the boy. The workshop is filled with various tools, including wrenches, screwdrivers, and a tin can filled with tools. A blueprint with a drawing of a robot is visible on the workbench. The scene is lit with dramatic, low-key lighting, creating a sense of concentration and craftsmanship.

# About the Study



The World Quality Report 2016-17 is based on research findings from 1,600 interviews carried out during April and May 2016 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 44 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/CTOs for the first 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 Life Sciences and High Tech Sector.

The research sample consists mainly of senior-level IT executives as shown in Figure 41.

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 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 2016-17 is based on a sample of 1,600 interviews from enterprises with more than 1,000 employees (25%), organizations with more than 5,000 employees (34%) and companies with more than 10,000 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 1,600 sample size.

## Questionnaire and Methodology

The survey questionnaire was devised by QA and Testing experts in Capgemini, Sogeti and HPE (sponsors of the research study), in consultation with Coleman Parkes Research. The 44 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.



FIGURE 38

1600  
Total

## Interviews by Country

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

FIGURE 39

## Interviews by Region



FIGURE 40

Interviews by Sector

1600  
Total

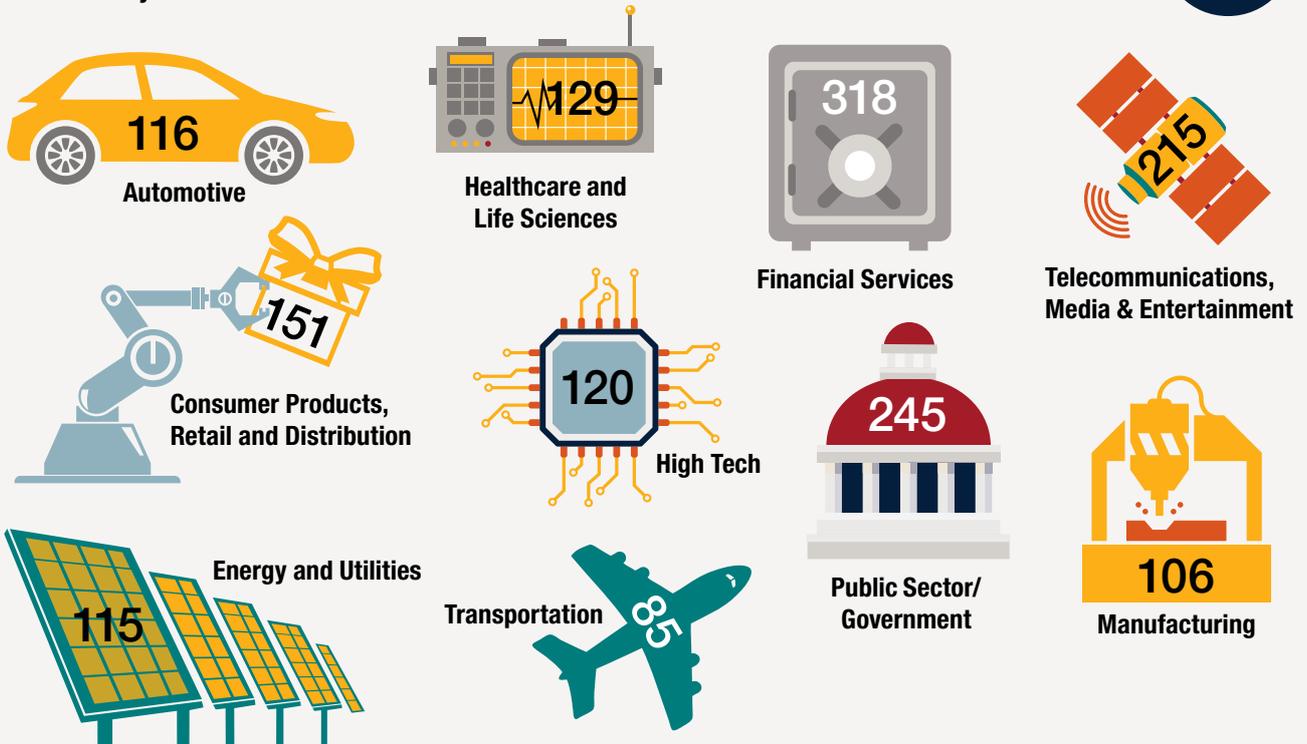
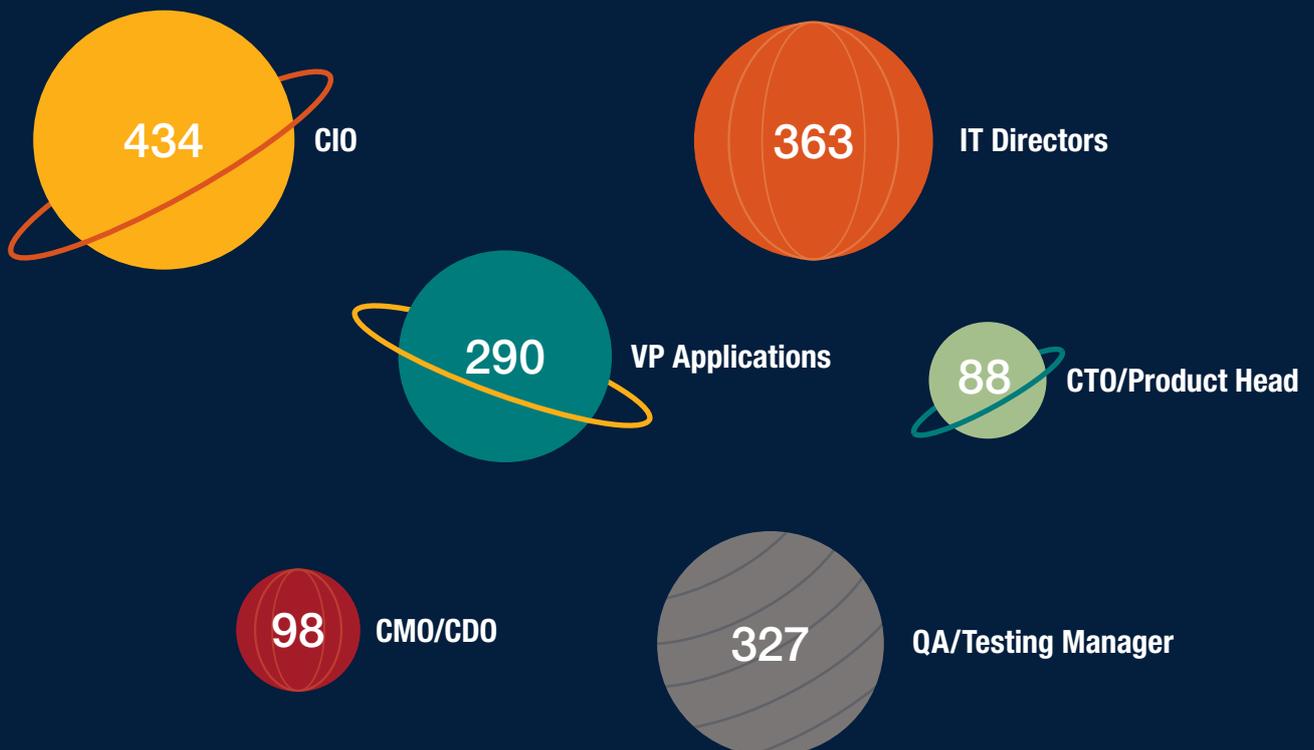


FIGURE 41

Interviews by Job Title

1600  
Total



# About the Sponsors

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With more than 180,000 people in over 40 countries, Capgemini is a global leader in consulting, technology and outsourcing services. The Group reported 2015 global revenues of EUR 11.9 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 HPE would like to thank

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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 HPE.

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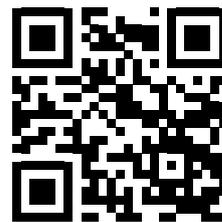
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