WORLD QUALITY REPORT 2015-16

Capgemini
CONSULTING.TECHNOLOGY.OUTSOURCING

hp

SOGETI

World Quality Report 2015-16

Seventh Edition

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

Benchmark your organization's testing practice against World Quality Report 2015-16 research data on www.worldqualityreport.com

Contents

Previous editions

World Quality Report

2009
First Edition

2010-11
Second Edition

2011-12
Third Edition

2012-13
Fourth Edition

2013-14
Fifth Edition

2014-15
Sixth Edition

3

Introduction

Govind Muthukrishnan
Senior VP, Testing GSL Leader,
Capgemini Group

Raffi Margaliot
SVP and GM, ADM,
HP Software

Welcome to the seventh edition of the World Quality Report by Capgemini, Sogeti and HP. In this edition, we continue to track the key trends in Quality Assurance (QA) and Testing.

If you are one of the **1560** 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 that were inputs to this report.

Customers are interacting with organizations in micro-moments, through devices with varying degrees of computing power. A rich, secure and multi-channel customer experience is not just a value-add; its critical to survival, making QA and testing even more important.

As Digital transformation gains momentum, the need for speed-to-market is felt severely by both business and IT. In order to achieve that pace and flexibility, organizations are adopting agile methods and DevOps principles. The report tracks the challenges of integrating testing with agile and DevOps, with due regard to security and business assurance.

We have also highlighted the year-on-year growth in QA and Testing budgets across sectors and regions. As you go through the report, you will see many trends in line with last few years. However, some trends run counter to one another or have plateaued or even reversed. We encourage you to go through the full report, and start to connect the dots, because we believe that these different trends on TCOE or resources or new development for example are strategically connected to other trends like the increased focus on test environment and data management. All of them help our customers in their QA transformation either to repurpose their focus on efficiency or quality gains, or prepare them for Digital, agile and DevOps journey.

Over the next 12 months, we plan to share these insights with the industry through conferences, social media outreach and client workshops. I encourage you to get in touch with your Capgemini or Sogeti account manager to discuss how this research might shape your plans. You can complete an online version of the research study to compare your organization's QA and Testing practices with the findings of the report. To do this, please use the myWQR2015-16 benchmarking tool available from www.worldqualityreport.com.

I am very happy to share the results from the World Quality Report 2015-16. Each year we explore the major trends and issues that consume IT and QA leaders' attention and then share the results to help you put the changes into context and plan how to respond.

In 2011, Marc Andreesen wrote in the Wall Street Journal **"Software is eating the world"** about how software is driving and accelerating disruption in almost every industry. He described a future where business innovation and agility is directly related to the velocity and quality of software delivery. We've witnessed the rapid adoption of Agile and now DevOps, moving into the mainstream where IT leaders around the world are finding ways to accelerate IT and meet the needs of their business customers.

The results from this year's World Quality Report highlight how IT leaders are responding to these changes, resulting in a need to deliver applications faster than ever before while maintaining application quality and the overall user experience. Regardless of the type of application, it is clear that quality is more important than ever.

We partner with and help IT leaders like you to increase velocity and deliver amazing apps that you can be confident meet the needs of your consumers. Accelerating agile adoption and enabling continuous testing, our solutions are designed to help delivery teams succeed in this period of rapid change.

We're innovating with Big Data analytics, building on HP's Haven platform to help software teams tap into historical data to learn and anticipate the future, further streamlining their software delivery. We help you accelerate mobile testing, and ensure that the apps you build can perform, scale and are secure.

If you would like to learn more about HP agile, DevOps and quality technology go to: www.hp.com/go/alm

I want to thank the team at Capgemini, Sogeti and everyone who participated in the research to create this seventh edition of the World Quality Report.

Mark Buenen
VP, Global Solutions Lead
Testing Global Service Line
Capgemini Group

Ajay Walgude
VP, Solutions Lead
Financial Services GBU
Capgemini

Executive
Summary

A year is a long time in corporate Information Technology (IT). This seventh edition of the World Quality Report reflects the rapid adoption of digital strategies across all industries over the past 12 months. These digital transformation initiatives are having a big impact on the Quality Assurance (QA) and Testing function. It must respond to the demand for greater assurance that interconnected systems are both secure and consistent for all users in order to protect the corporate image.

With increased adoption of agile and DevOps delivery, the QA and Testing function has to support faster software development lifecycles to avoid becoming the bottleneck that slows down the release of market differentiating IT solutions.

It also has to adapt to new approaches, test environments and digital capabilities, such as mobile solutions and Cloud.

The Internet of Things as a component of this Digital Transformation continues its relentless journey. It is enabling connectivity with customers, employees and partners through a growing number of devices; and it supports data sharing between machines, equipment, products and business. This latter capability is essential in our data-rich world, in which delivering value to the consumer depends on where that data is gathered from, and how effectively it is interpreted, shared, and used.

The role of IT is transforming in line with these changes. As we reported last year, it is no longer simply about delivering applications, providing the essential infrastructure, and maintaining business-enabling technology services. The CIO is now more integral to corporate strategy than ever before. CIOs have responsibility for understanding what the business needs in order to achieve its vision and, as we increasingly see in the results of this year's research, for bringing Digital Transformation to life.

The strategic role of QA and Testing is growing in tandem with these trends. This is reflected in the changed perception amongst executives interviewed this year of the most important QA and Testing objectives. There is a shift from simply detecting and preventing defects in software, to protecting the corporate image, which has strategically important security ramifications for corporate IT. This requires real focus and understanding of how the IT features used today (and the end-user experience of these features) can have a direct impact on the brand reputation.

This year's research among 1,560 CIOs and IT and testing leaders, from 32 countries across the globe, finds that protecting the corporate image is the highest QA and Testing strategic priority, with an average score of 6.1 (on a scale of 1-7, with 7 being most important). This is followed in equal measure (6.0) by the need to ensure end-user satisfaction and to increase quality awareness among all disciplines.
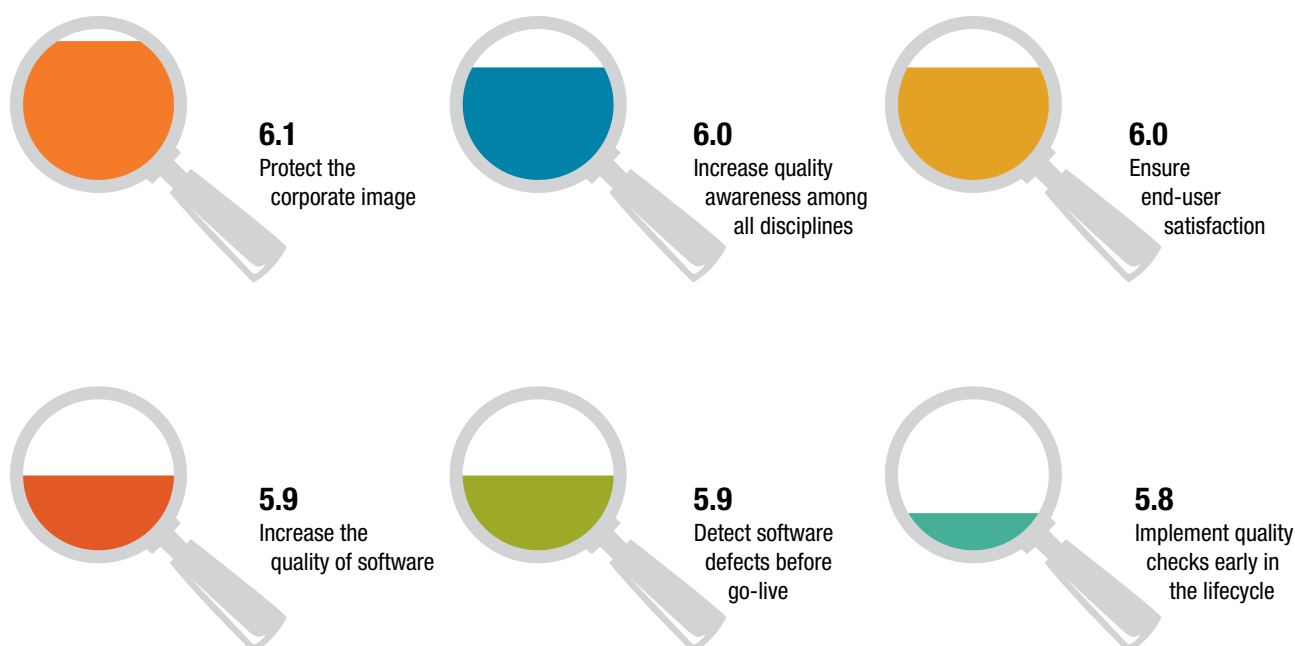
The end-user satisfaction priority implies that QA measures will have to be targeted not only at the validation of pure technical software operation, but also at more meaningful IT outcomes and real end-user value. The need for increased quality awareness is, again, reflective of the role IT now plays in ensuring end-user value. It highlights the need to focus testing teams on the implications of IT failures for corporate image.

The three top QA and Testing objectives mesh with the wider IT strategy priorities. Across all industries, security, customer experience, cost optimization, higher quality of software, and better responsiveness to business demands are the top five IT strategy priorities.

As the chapter on budgets illustrates, however, there is a concern that, until now, QA and Testing has not kept up with the requirements needed to ensure IT achieves these objectives. A higher level of IT spend allocated to QA and Testing this year indicates a need for greater levels of testing efficiency to keep pace with Digital Transformation initiatives.

Executive management objectives with QA & Testing

FIGURE 1

6.1 Protect the corporate image

6.0 Increase quality awareness among all disciplines

6.0 Ensure end-user satisfaction

5.9 Increase the quality of software

5.9 Detect software defects before go-live

5.8 Implement quality checks early in the lifecycle

World Quality Report Findings

1. A focus on customer value and the impact of IT quality on the end-user experience is a driving force.

Digital Transformation puts customer value and end-user experience at the heart of digital initiatives. Get it wrong and the company's reputation will suffer as customers vent their dissatisfaction via social media. Thus the ranking of protecting the corporate image as the top QA and Testing strategic priority is wholly understandable, with an average 76% of the executives interviewed saying it is important or very important. It is clear that IT performance and quality have an immediate effect on business outcomes due to the impact they have on both customer experience and adaptive business operations.

New vulnerabilities and continued developments in mobile and cloud-based technologies are also causing a shift in the focus of QA and Testing activities. The focus is now on the usability aspect of customer experience, as well as on security and performance.

2. QA and Testing budgets have experienced an unprecedented, and worrying, climb.

A significant 9% increase since 2014 in the amount of IT budget allocated to QA and Testing to 35% is a concern.

Budgets are seemingly spiraling out of control. This is despite the fact that QA and Testing is a maturing discipline, as indicated by the growth in automated test cases to 45%, the continuing adoption of agile, and a reduction in the overall challenges across most test areas.
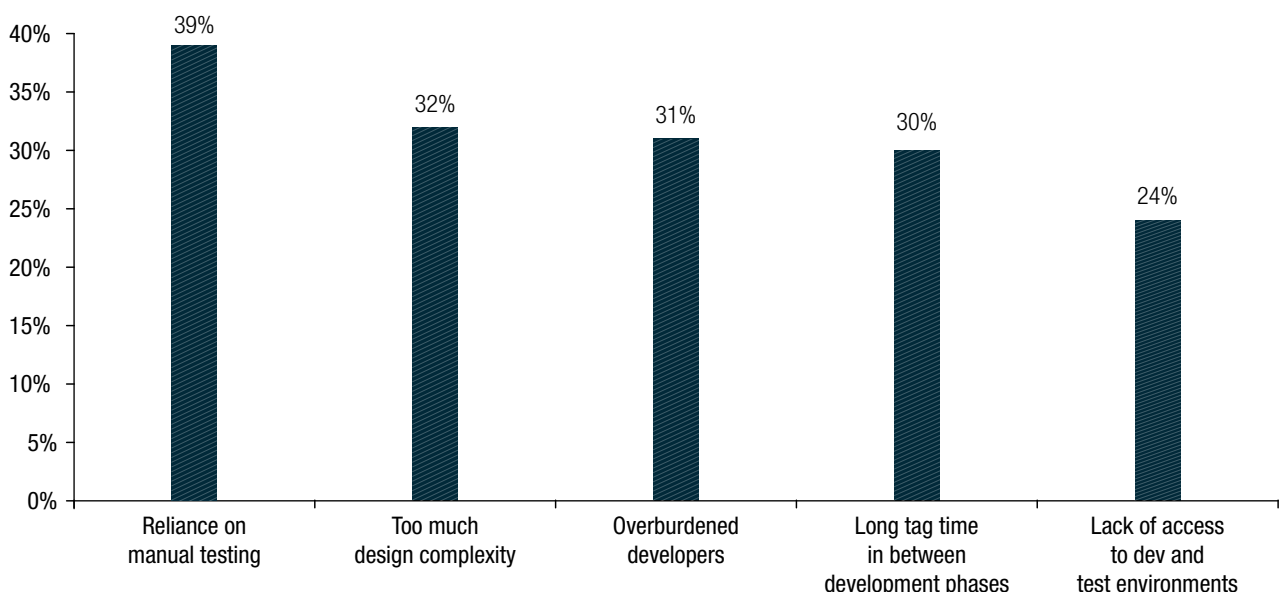
While the budget increase suggests a growing awareness of the value of QA and Testing, it also implies that the practice is not able to meet increasing demands and still maintain a sound level of efficiency. Certainly, a reliance on manual testing demonstrates a need for greater maturity.

This reliance on manual testing in the application development lifecycle is cited as the number one technical challenge by 39% of the respondents. This is ahead of too much design complexity (32%), overburdened developers (31%), the long time lag between development phases (30%), and a lack of access to development and test environments (24%).

The heightened level of spending also suggests that QA and Testing operations are not being managed as efficiently as they could be, and is a clear indicator that solutions must be found, such as more automation.
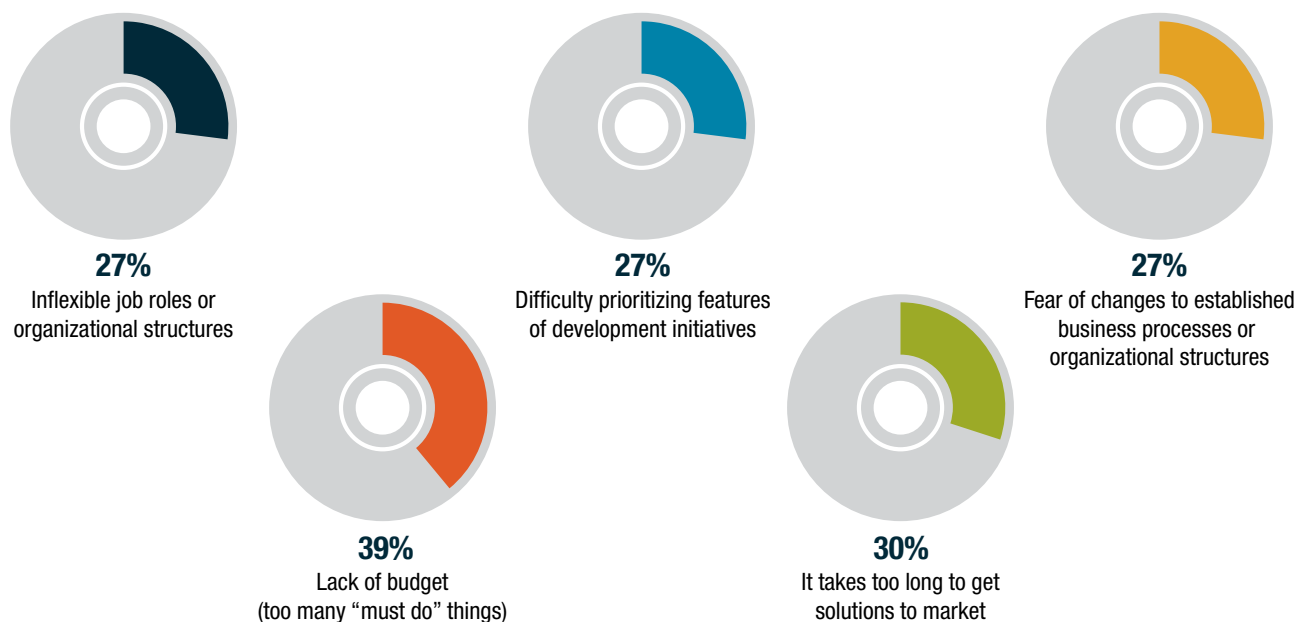
Top 5 technical challenges in Application development

FIGURE 2

Top 5 business challenges for Application development

FIGURE 3

27%
Inflexible job roles or
organizational structures

27%
Difficulty prioritizing features
of development initiatives

27%
Fear of changes to established
business processes or
organizational structures

39%
Lack of budget
(too many "must do" things)

30%
It takes too long to get
solutions to market

3. Digital Transformation is a factor in all industries and geographies, although there are marked maturity differences.
Digital Transformation is a true mind shift for both business and IT as new technologies are rapidly created to drive quick competitive advantage.

New potential vulnerabilities are emerging and the top five business challenges for application development in this digital landscape are related to budget availability (39% cite it as a challenge), time to market (30%), inflexibility of the delivery organization (27%), difficulty in prioritizing (27%), and challenges with implementing changes in processes and organization (27%).

Budget availability for application development is urgently needed to meet the increased demands from business as the rapid pace of change continues. Likewise, time to market is essential for gaining first-mover advantage. The challenge with inflexible delivery organizations is being addressed with the adoption of agile and DevOps.

There is an interesting trend amongst organizations in sectors that are the most mature and advanced on the Digital Transformation journey. They appear to be spending the most on QA and Testing, indicating that they have made a direct connection between quality and achieving business outcomes.

4. Security is now the most pressing concern making an impact on today's IT strategies.
Security is rated by respondents this year as the number one aspect of IT strategy. This concern with security is understandable in our increasingly connected world. IT solutions are no longer contained in isolated environments. Web-based, mobile and cloud-based solutions are accessible from multiple platforms. The enormous collection of data across these platforms (traditional and cloud-based) and the proliferation of data transmission via multiple channels have led to increased risks.

This prioritization of security aligns with concerns about reputational damage. A data breach has the potential to cause huge damage to the corporate image, making security testing a critical component in Digital Transformations.

Security testing is split between static code analysis and dynamic security testing before go live, and penetration testing on applications that are in production. The research findings show a clear increase of security QA and security test activities in almost all phases of the application development lifecycle. Organizations take security QA and Testing very seriously and are increasingly using dedicated teams of security specialists to perform these tasks.

The wider availability of a greater number of tools has improved flexibility, ease of use and test coverage for this type of testing. However, a reliance on manual security testing is still a challenge in terms of the lack of speed and labor intensity. More automated security testing solutions will emerge with the growing attention now being paid to the security aspect of IT strategy.

5. Agile and DevOps adoption calls for extreme levels of testing speed and integration.
Agile has become widely adopted and is being scaled to enterprise level. More than half of this year's respondents (54%) have adopted agile development, and testing is increasingly a part of this.

The concerns with integrating testing in agile are diminishing, showing a marked reduction over last year's findings.

Nonetheless, the top three challenges with testing in agile today are: difficulty in identifying the right areas on which testing should focus (33%); a lack of appropriate test environment and data (31%); and a lack of professional test expertise in agile teams (31%).
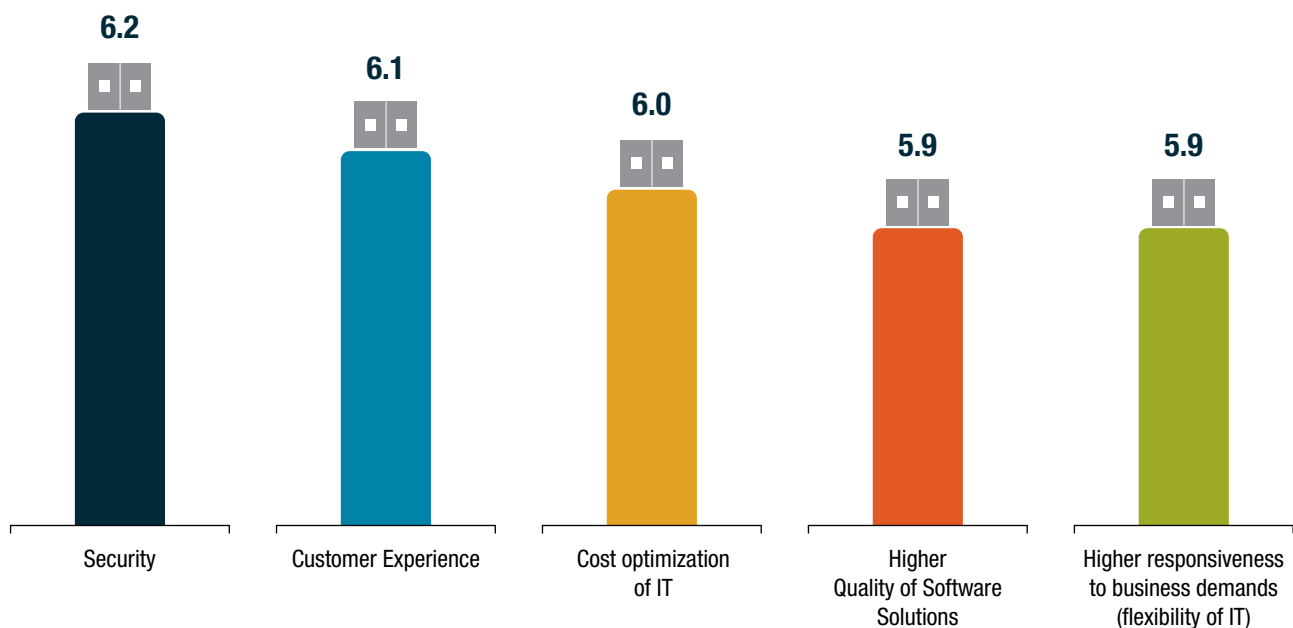
Agile continues to extend into the highly collaborative DevOps methodology. DevOps is being embraced enthusiastically by almost everybody. However, for most organizations it is still early days and initial steps, approaches and levels of DevOps are not yet well organized.

DevOps dismantles the traditional application lifecycle silos,and helps organizations transition from traditional release-based deployments to a continuous process of updating their IT applications. The key challenges for QA and Testing in DevOps are: how to achieve meaningful testing in ever shorter time frames; how to achieve maximum automation of testing; and how to transform from testing and validation before go live to more predictive forms of testing and real-time quality monitoring.

The shorter time frames demanded in an agile and DevOps-driven environment can only be met by increasing levels of automation.

Top 5 most important aspects of your IT strategy

FIGURE 4

6.2	6.1	6.0	5.9	5.9
Security	Customer Experience	Cost optimization of IT	Higher Quality of Software Solutions	Higher responsiveness to business demands (flexibility of IT)

6. Both mobile and omni-channel are integral to the customer experience aspirations of today's digital enterprise.
Thus, mobile and front office (customer channel) solutions are consuming the largest part of QA and Testing budgets for new developments (35%). Mobile testing is maturing with 92% of organizations applying it today. This is indicative of the growing trend for consumers to engage with suppliers and service providers via their mobile devices.

Both mobile and omni-channel solutions still come with a number of challenges. The most important in terms of testing omni-channel solutions is how to get the right coverage of end-user expectations in the test set. The major challenge with testing mobile solutions is a lack of the right in-house test environment, although the challenges are reducing in the absolute sense as mobile testing continues to mature.

7. The traditional Testing Center of Excellence (TCOE) is evolving in more agile and hybridized form, and a new mix of skills is emerging.
The traditional adoption of the TCOE as a centralized function to organize testing is plateauing, with around 24% of organizations running fully operational TCOEs. Instead, more and more organizations are seeking ways to transform or build their TCOE in an agile and flexible mode that is much more integrated with development. Most organizations surveyed are looking for a co-managed TCOE model, rather than a complete outsourced service.

The new formula for success of the modern TCOE is thus to be co-managed and fully business aligned with more collaboration across the agile software development lifecycle supporting Digital Transformation. With ever increasing adoption of Cloud and virtualization, and the demand for agility from business, the TCOE is embracing new test service delivery models on a pay-per-use basis.

Within this new, collaborative TCOE, the QA and Testing skill set is also taking on new flavors. In the ecosystem of business, development and operations teams, testers must now strive to understand customer value, business operations and end-user adoption. As part of multi-disciplined teams, they need to understand more about development and more about customer expectations and business operations.

Testers must now assure QA beyond their own activities, as testing driven development (TDD) and behavior driven development (BDD) are becoming standard practice. They need to be experts in the latest tool sets for QA and Testing activities.

The new role of Software Development Test Engineer (SDTE) is emerging. It is complemented by business QA testers, specialized testers (for performance, security and infra testing), as well as test automation specialists and developer testers.

8. Test environments are being enhanced with virtualization and cloud solutions.
Test Environment Management (TEM) and Test Data Management (TDM) are both maturing with fewer challenges being experienced across tools, skills and processes. Virtualization and cloud-based test environment solutions are being adopted for their criticality in testing in agile and DevOps development environments. This is demonstrated by the research data showing their use by 51% of respondents for DevOps test solutions.

Cloud-based environments can be quickly set up and changed on an as-needed basis. This enables faster and more agile test services without the traditional test environments bottlenecks. Nonetheless, there remains a balance of physical, virtualized and cloud-based test environments.

Through increased focus on TEM and TDM, we are seeing new test efficiencies, although a number of challenges must still be addressed to meet the need for increased volume and velocity.

9. Level of test automation is increasing.
With the increased adoption of agile methodologies, test automation is integral to continuous testing as part of continuous delivery. Results from this year's research show that the average percentage of test case automation has increased from 28% to 45%.

The constant and rapid changes being introduced during agile make it vital that defects due to these changes are caught earlier in the lifecycle. As a consequence, respondents this year rank better detection of defects as the number one benefit of automation. Better control over testing services is ranked as the second most important benefit, ahead of cycle time reduction, which is ranked third.

World Quality Report Recommendations

1. Re-focus QA and Testing on customer experience and business assurance.
Digital Transformation has brought customer experience and security into sharp focus. This demands a new business assurance focus on the part of the QA and Testing function. This will help to determine whether or not new and/or changed applications are leading to increased end-customer satisfaction.

Consumer usage patterns must drive the setup of testing scenarios, which should be the principle basis for designing the focus area of quality checks. In addition, a business assurance focus enables teams to correlate identified risks and test outcomes with the implications for business, such as increased revenue, customer retention, corporate image, and innovation capabilities. It will see a new style of testing focused on these risks, with a particular emphasis on end-user experience, security and performance aspects.

2. Transform the traditional Test Center of Excellence (TCOE) in response to the growing adoption of agile and DevOps.
Development initiatives using agile and DevOps need to be supported in a way that enables QA and Testing activities to be performed by all roles. There should be maximum use of automated solutions, but still with a continuous focus on maintaining the efficiency and effectiveness of QA and Testing activities. This requires provisioning of environments, automated solutions and specialist QA expertise on an as-needed basis.

Quality-based performance indicators on throughput, such as percentage of delivered features accepted for go-live first time, price point per accepted feature, and test velocity, will help to control QA costs and still allow flexible and agile QA activity across disciplines.

Shift left techniques, such as structural unit testing, TDD, BDD, and application program interface (API) testing and services, are viewed as the greatest lever for agile delivery. Such techniques, along with test automation frameworks, cloud-based environment provisioning, as-needed-QA expertise, and on-demand specialist test services, can be managed and organized in the distributed TCOE for agile and DevOps.

3. Make continuous and automated security testing a key strategy.
Security testing has emerged as the top priority for IT strategy in this year's research. While the results show an increase of security QA and security test activities in almost all phases of the application lifecycle, security testing is still largely conducted as a manual testing activity relatively late in the development lifecycle.

Organizations should increase their own security checks in the design phases and focus on increasing the automation level of dynamic application security testing. In addition to this, they should seek ways to leverage the expertise of external security specialists for increased scalability and to secure state-of-the-art expertise and tools for the security test activity.

Existing or planned TCOEs should be expanded with a shared specialist function that can provide security test activities on a continuous basis.

4. Prioritize testing using predictive analytics and continuous feedback during the software development cycle (SDLC).
The integrated and collaborative SLDC using DevOps brings all the activities and disciplines, from business to development and operations, in a continuous process of application development and deployment.

One of the leading challenges in these ultra-short development cycles today is the inability to decide on what to test and what not to test. This is needed to enable QA and Testing teams to define minimum viable, yet sufficiently secure, quality solutions to go live. Predictive analysis and continuous feedback will become major enablers for the prioritization of tests: with continuous feedback from real-world monitoring, QA teams will be able to predict the risk levels and identify the areas to test.

Predictive analytics will enable QA and Testing teams to construct strategies for effective testing of upcoming project/ release/sprint/build using automated solutions for analyzing historical data on projects, releases and builds. This Big Data analysis will enable testers to understand the impact of changes made in development on the whole lifecycle, and to identify the required associated test coverage to achieve a minimum viable product.

This analysis will also help testers to identify *focus areas for testing* based on production feedback, as well as *the size and skills* of the testing team required to ensure on-time delivery. These data points will also be input parameters for any risk-based testing taking place. The use of predictive analytics will drive shift left testing approaches earlier in the application development lifecycle.

5. Keep investing in test automation and move towards continuous test automation.
Increased and instantaneous levels of test automation will be mandatory for coping with the growing demand for velocity. The 2015 research data shows that the reliance on manual testing has become the most important technical challenge for application development.

With the further advancement of QA and Testing tools, organizations will be able to build a solid backbone for automation that can be expanded with specialist niche solutions to be consumed on an as-needed basis.

As noted above, predictive analytics tools will enable further automation of the test strategy for each project/release/build by identifying the appropriate coverage areas for testing. Test case generation and test data generation tools will advance further, and migration of manual test cases to automated test cases will become simpler.

The future of testing will be a maximized digital environment in which test services can be consumed, managed and reported.

6. Continue to build virtualization and cloud testing platform capabilities to align with the move towards DevOps.
Virtualization and cloud platforms provide the flexibility and instantaneous setup of complex test environments needed to perform testing as required, including at early phases in the software lifecycle. The future QA and Testing function within agile and DevOps requires this investment to support iterative delivery.

Greater adoption of test data and environment automation techniques will speed time to market, as will an increase in the use of deployment tools and cloud technology.

7. Expand the skills of testing teams beyond manual and test automation.
Digital Transformation, along with wider adoption of agile, DevOps and cloud practices, demands specialist skillsets. Testers are required to test not only the functionality of the applications, but the customer experience aspects as well.

They must be able to work at a cross-functional level, collaborating effectively with business analysts and development teams to create test acceptance criteria. They should have the ability to use virtualization tool sets to enable them to work effectively with the teams building test environments.

An understanding of application architecture and the ability to deploy effective automation (UI or non UI services level) strategies are now part of the modern testing skillset. Predictive analytics and the ability to interpret feedback from production will enable them to prioritize and ensure the right amount of testing is targeted at the right things.

Finally, testers need to become the enabler of continuous delivery, whilst effectively detecting and helping eliminate the application defects and risks earlier in the lifecycle. Thus collaboration and strong technical knowhow about tools, TDD and BDD techniques are key elements, alongside functional and manual testing, in the new DNA of QA and Testing.

Current Trends in
Quality Assurance & Testing

Digital Transformation

A disruptive mind shift with huge impact on QA and Testing

John Jeremiah, Technology Evangelist, HP SW ADM Digital Research Team Leader

Digital Transformation is driving the need for a heightened focus on QA and Testing. A true mind shift for both business and IT operations, it is not just about using new digital technologies to become better or faster; it is about being inventive in using the new digital technologies ahead of the competition. It is about thinking out of the box and creating radical business models. And it is about applying this all with a single core focus on customer value.

The existing digital innovations and developments around social media, mobile, Big Data analytics, Internet of Things and smart devices are the enablers of Digital Transformation.

They equip companies with the tools to get closer to customers, empower their employees, and transform their internal business processes. This transformation is occurring rapidly in all industries.

So what is so radical about this customer-value driven thinking? In the first place, it puts customer and end-user experience at the heart of digital initiatives. It changes the typical strategic owner of digital development from the traditional CIO to the Chief Marketing Officer or the Chief Digital Officer.

Percentage of Organizations with a dedicated Chief Digital Officer

FIGURE 5

Legend:
- No - We dont have a Chief Digital Officer and no plans are in place
- No - We dont have a Chief Digital Officer but plans are in place (for 2017+)
- No - We dont have a Chief Digital Officer but plans are in place (for 2015-16)
- Yes - We already have a Chief Digital Officer
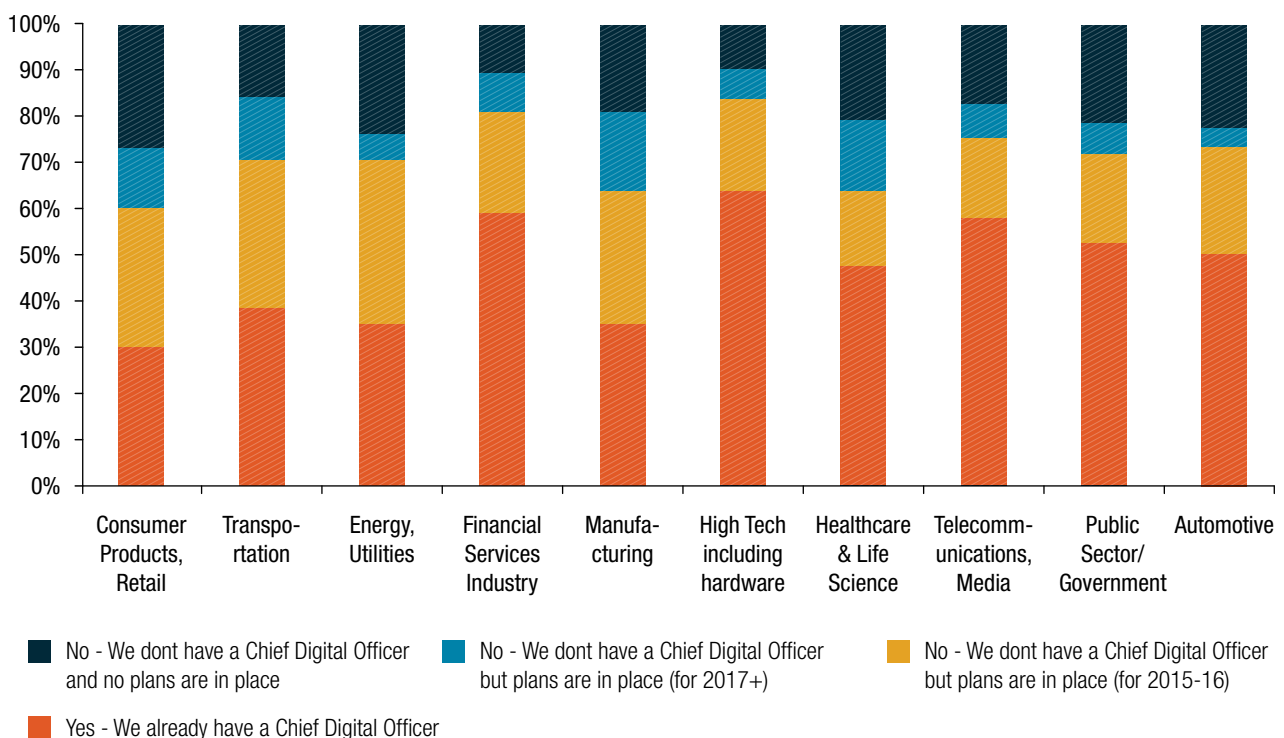
Secondly, customer-value driven thinking is about increased velocity and agility. New developments must be delivered faster than ever in a more entrepreneurial mode. Gone are the traditional long-term release cycles. If not perfect, solutions will be at least minimally viable with the actual usage behavior and user comments tracked to inform on-the-spot adaptation by the agile IT organization. So Digital Transformation is the driving force for more agile and DevOps delivery processes. Thirdly, digital is about rapidly adapting and using cutting-edge technologies.

This change in mind set has an enormous impact on the role, the focus and the skill sets of QA and Testing. This is demonstrated by the results of the World Quality Report 2015 research. While Digital Transformation is strategic for all industries and geographies, there are some marked maturity differences. Our research shows that 48% of the organizations interviewed now have a Chief Digital Officer (CDO), and 23% are planning to establish the role this year. This is a clear sign that many organizations view Digital Transformation as a serious strategic driver.

The High Tech and Financial Services sectors are leading in Digital Transformation, with 62% and 57% of organizations respectively now having a CDO. The Telecommunications (54%) and Automotive (51%) sectors are close behind. Consumer Products, Retail and Distribution (CPRD) (32%), Energy and Utilities (36%), and Manufacturing and Transportation (each 38%) are the laggards.

> ❝
>
> ## The user experience comes first. People are now expecting a beautiful simple user experience.
>
> **Senior VP**
> *Financial Services, North America*

Digital Transformation changes QA and Test focus to customer experience

This year's research findings place security and customer experience at the top of senior management's strategic IT priorities. As a consequence, QA and Testing must adapt. More attention has to be given to the specialist subject of security testing. While the need to test technical coverage of user requirements or lines of code remains, there must now be a stronger focus on customer-experience-driven testing.

Customer-experience-driven testing means a combination of more behavior driven testing (where the focus is determined by understanding or analyzing the actual end-user usage of different software application features) and more exploratory user scenario-based testing. Furthermore, testing must provide insight into the assurance levels of the different customer journey steps affected by the new/changed IT solution.

We cannot test everything because there is simply not enough time. Thus shorter deadlines drive the need for increased levels of automated testing. This implies a shift from traditional testing phases in the application lifecycle to more continuous testing and quality monitoring (also in production stages).

Corporate reputations are more fragile than ever, thanks to the ubiquity of social media and likelihood of web-enabled peer criticism to go viral. As such, protecting the corporate image has become the number one objective of QA and Testing, with a score of 6.1 out of 7 in the 2015 survey. This implies that Quality Assurance must transform to Business Outcome Assurance. This new protective role has three elements:

• Assure easy end-consumer access to services and products by focusing on ease-of-use and fast-responsiveness of end-user apps with reliable 24x7 availability;

• Smooth and error-free handling of back office processes;

• Validate the prevention of potential security and data privacy breaches.

In addition to protecting the brand, QA and Testing must help to strengthen the brand. New products and services launched ahead of the competition must get to market with an assurance of quality. Without this assurance there is a risk of severe damage to corporate reputations if things go wrong.

The World Quality Report research data shows clearly that this has been acknowledged by the budget holders [see the chapter on testing budgets]. There is a direct correlation between industries that consider Digital Transformation at a strategic level and the amount of budget being spent on QA and Testing. Of the testing budget for new developments, 53% is consumed by new digital technology solutions – mobile, Cloud, Business Intelligence (BI) and Business Analytics (BA). Compare this with the 17% consumed by testing for other front office solutions, and 29% for ERP and legacy backoffice solutions.

Mobile solutions and front office solutions take highest share of QA

This year's research found that 35% of the QA and Testing budget for new development is spent on mobile and front office (customer channel) solutions, which are the key customer focused solutions. This is clearly ahead of Cloud (18%), BI and BA (17%), back office legacy (16%) and back office ERP solutions (13%). This is consistent across all industries.

This is indicative of the growing importance of mobile in business as consumers increasingly choose to engage with suppliers and service providers via their mobile devices. In the workplace too, mobile enables peer-to-peer collaboration, increased productivity, and flexible working, all of which add to an organization's bottom line.

Overall, beyond the spending on mobile, front office, Cloud, BI and BA testing that we associate with Digital Transformation, we shouldn't forget the additional spending category. This is, of course, the considerable 29% of the new development QA and Testing budget being spent on back office legacy systems and back office ERP solutions.

QA and Testing budget split for new developments

FIGURE 6
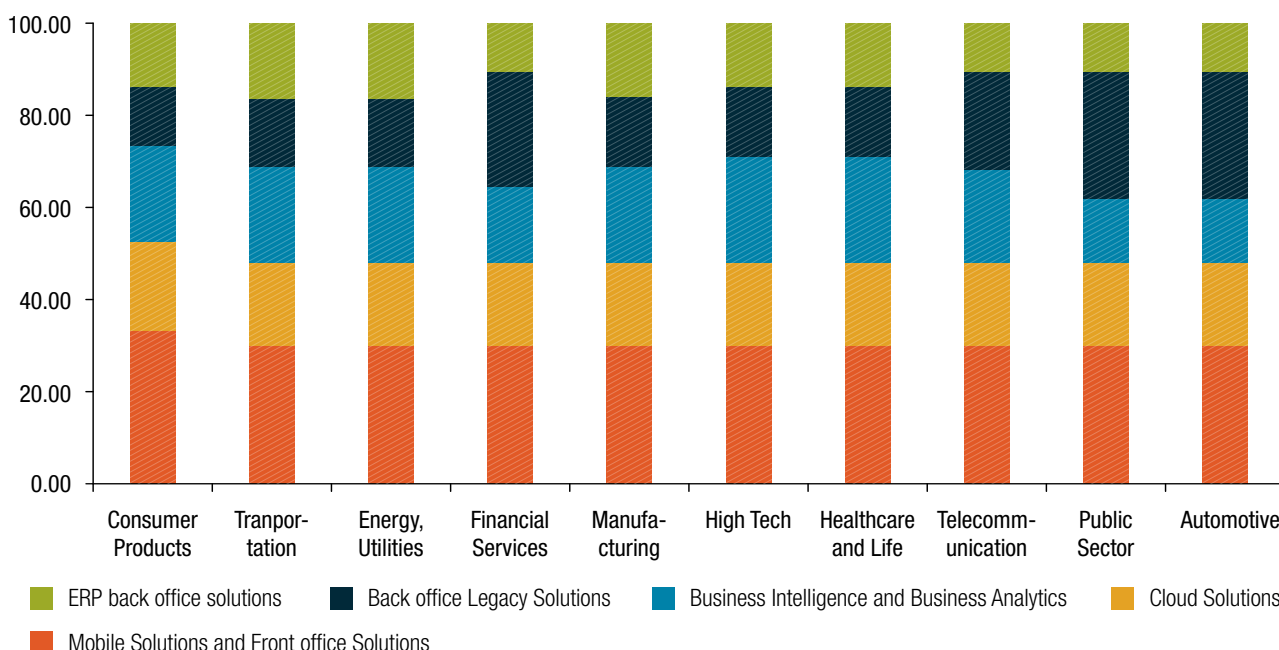
New digital solution implementation creates new testing challenges

New technologies associated with Digital Transformation are causing specific challenges for the QA and Testing function. Testing integration of services across local platforms, private clouds and public clouds is ranked as the priority digital implementation challenge by 30% of respondents. Almost a fifth of organizations view the testing of end-to-end workflows and the orchestration of data and services a challenge. But 35% of respondents say the number one digital implementation challenge is the need to achieve consistency across different channel interfaces (mobile, social and traditional systems).

This reflect show difficult organizations are finding it to test and compare the consistency of graphical user interfaces and application operations across different customer channels (front desk support system, customer accessible web portals, and customer accessible mobile apps). This is especially so in the light of a rapidly escalating number of machine configurations and browser versions, as well as proliferating mobile devices, including smartphones, tablets, wearables and their operating systems. So the major digital implementation challenge is directly related to the validation of customer experience.

When we dive into the challenges with testing customer experience across multi-channel solutions in more detail, (on a scale of 1-7) the most pressing challenge is getting the right coverage of end-user expectations and requirements in the test set (with an average of 4.8). This reflects the multitude of ways and situations in which a customer will interact with these systems, and what their – often implicit or situational – expectations are. This priority is followed by: having test tools for customer experience testing (4.7); and difficulty in designing the test cases for these tests (4.7). This is clearly a signal that testing customer experience demands a different approach and a different set of skills to traditional system testing.

Challenges for Testing Customer Experience in Multi-channel solutions

FIGURE 7
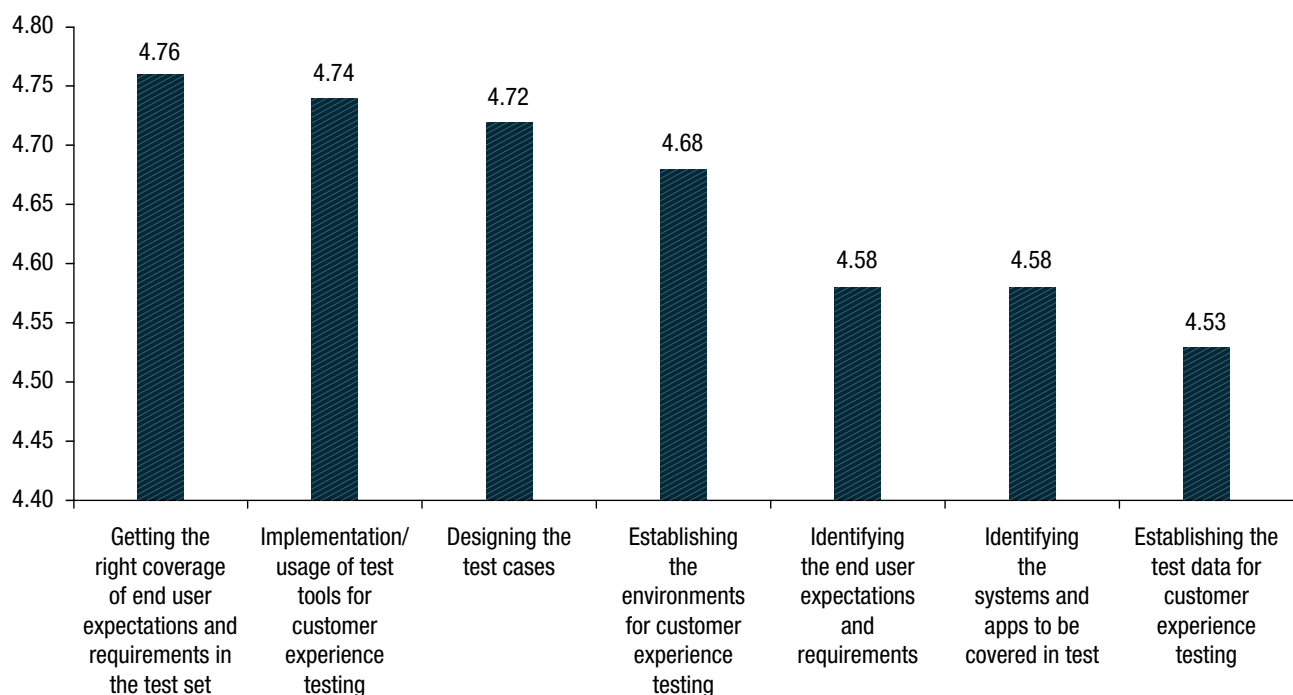
The content and focus points of testing are also shifting in relation to the new cutting-edge technology solutions that are at the core of Digital Transformation initiatives. Compared to last year's research, there has been a shift of attention in the testing of mobile solutions from more traditional functional and compatibility testing to security testing (prioritized by 55% of respondents). This is followed by performance testing (54%), ease of use testing (47%), and an increased focus on compatibility testing (45%). Functionality testing remains important (48%) but its prioritization is in decline.

This shift is understandable. Organizations are seeking to rapidly launch adequately viable solutions capable of working on different browsers and devices, that are easy to use and perform well, and where the validation of the functionality value is based on the real-life experiences of end users. Of course, appropriate security testing stays at a high focus level in the light of its strategic importance.

Compared with last year's research findings, there is also a strong decline in almost all the challenge areas for mobile testing. This is evidence that organizations are becoming more mature in testing mobile solutions. Again, this is understandable in the light of the sharp increase in mobile testing experience: the percentage of organizations performing mobile testing has increased from 55% to 92% in just two years.

Focus areas for testing mobile applications

FIGURE 8

Legend: 2015, 2014, 2013

Security (protection of sensitive data on the phone or over the air)
- 2015: 55%
- 2014: 54%
- 2013: 56%

Efficiency / Performance (including network-related)
- 2015: 54%
- 2014: 51%
- 2013: 59%

Functionality
- 2015: 48%
- 2014: 54%
- 2013: 43%

User interface / Ease of Use
- 2015: 47%
- 2014: 45%
- 2013: 36%

Compatibility/Regression Testing
- 2015: 45%
- 2014: 42%
- 2013: 29%

Portability (the same binaries could be executed on different devices powered by the same technology)
- 2015: 34%
- 2014: 40%
- 2013: 38%

Certification of Application
- 2015: 33%
- 2014: 35%
- 2013: 34%

The two biggest challenges remaining when it comes to testing mobile and multichannel solutions are: the lack of an in-house test environment (for 38% of respondents) and the lack of sufficient time to test (36%). The first of these is due to the escalating number of devices and various network bandwidth simulations that have to be tested. The latter challenge of insufficient time is aligned with the increased velocity of applications going live, as discussed earlier. Those organizations for which testing is still a traditional phased activity will find this a particular challenge.

Greatest challenge in testing mobile and multi channel (Mobile, Social, Traditional) applications

FIGURE 9
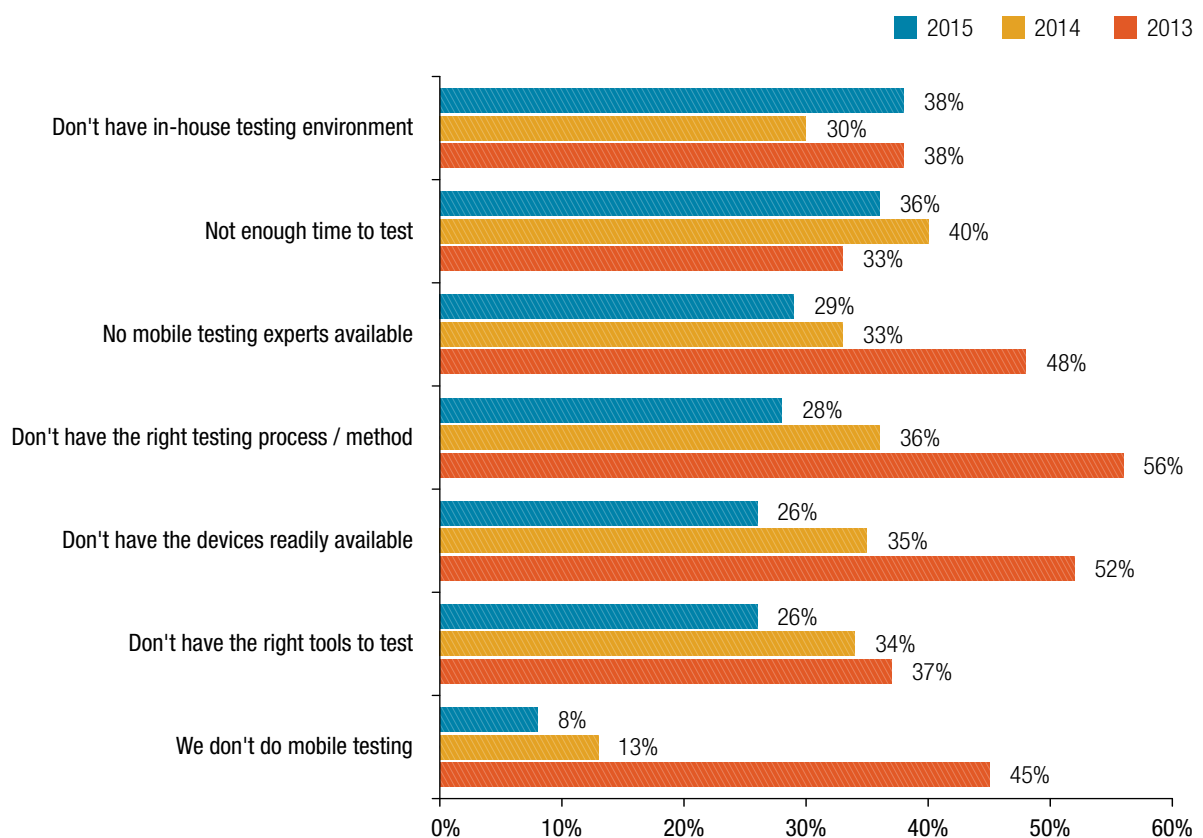
> We keep business applications internal, but everything else, like email systems, office tools, is managed on the cloud.
>
> **CIO**
> *Manufacturing, France*

Testing cloud-based applications is becoming normal practice

The increased use of cloud-based applications delivered as a service (SaaS) is another enabler of Digital Transformation. Cloud solutions enable organizations to use and adapt their IT and software architecture almost instantaneously on an as-needed basis.

The adoption of cloud-based solutions is progressing, with the research findings showing a clear preference for private cloud. Of all cloud-based applications, 43% run in private cloud, 28% in hybrid cloud, and 27% in public cloud. It is not surprising that the highest percentage users of private cloud — with its inherent security — are Public Sector and Healthcare organizations at 47%. This reflects the strict data privacy requirements with which both sectors are governed.

Testing of cloud-based applications takes up 18% of the QA and Testing budget for new developments. This is just a little more than the proportion spent on BI solutions (17%).

Last year's World Quality Report noted the need to adapt testing of cloud-based applications and services and this is clearly continuing in 2015. Up to 76% of respondents say they have adapted a specific approach for testing cloud-based services. What is remarkable, however, is that a big and growing number of organizations (from just 4% in 2014 to 24% this year) claim not to be using a special or different approach. This is an indication that testing of cloud-based solutions is becoming a business as usual practice for many organizations.

When testing cloud-based SaaS applications, 52% of respondents pay special attention to both security and performance risks. In addition, 38% report focusing on peak load performance. These focus areas demonstrate that organizations accept the functionality of SaaS as a given, but need to ensure the safety, responsiveness and performance capacity of the service.

For the coming years we predict continued growth in the adoption of cloud-based solutions to increase organization agility and scalability. The improved control and management of risks relating to performance and security will enable orgnizations to use cloud solutions to their advantage without jeopardizing their corporate image or operations.

Changing the QA and testers' skillsets

The disruptive mind shift of Digital Transformation is affecting the role and focus areas of QA and Testing, with a direct impact on the professional skills and a change in focus of software testing. This is especially noticeable in the changing QA and Testing needs of mobile and front office solutions, which are most directly connected to the end-customer.

The testing of functionality is shifting towards more adaptive and exploratory customer experience-focused testing. In addition, usability tests and performance tests are becoming more important because they have a direct impact on the customer experience. More extensive use of technological solutions such as BI and BA require more data analytical-skilled testers. The testing of new smart devices that will be integrated in all kinds of day-to-day processes requires highly technical engineering skills, while the growing importance of security validation knowhow is undeniable.

New specializations are also emerging with the move to more experience-based and behavior-driven testing. The survey data shows that 67% of organizations use business/predictive analytics specialists. These specialists identify the risk areas of new developments based on the growing amount of insight from real-life application usage and collected historical project data.

Mobile test specialists are employed by 53% of organizations for testing the mobile solutions. These specialists know how to work with different devices across multiple platforms and have in-depth knowledge of the risk areas of each. They also have a thorough understanding of the specific tools available for automated mobile testing, simulation of networks, and simulation devices. Finally, data scientists specialized in analyzing data and validating data quality and data correctness are employed by 54% of the survey respondents, especially for BI/BA testing.

By organizing these specialist teams as virtual shared service teams in an industrialized Testing Center of Excellence model, and by involving specialist vendors in a co-managed relationship, organizations can shift to a continuous level of on-demand and as-needed delivery models for the many different types of testing.

QA and Testing budgets outperform predictions

Meeting an urgent need to catch up with a fast changing world

Is Quality Assurance (QA) and Testing failing to keep up with business needs in today's digital world? This is the implication from the World Quality Report 2015 survey finding that the IT spend on QA and Testing has outstripped predictions over the past twelve months. This indicates a real concern that, while awareness of the value of QA and Testing has been growing, a lack of innovation in the development of efficient solutions has resulted in testing becoming a bottleneck in today's fast-paced business environments.

In 2015 budgets for QA and Testing have risen to an average of 35% of the total IT spend, covering all aspects of QA and Testing, including processes, tools and resource costs. This exceeds last year's prediction that, while spending would

continue on an upward trend, it would only reach 29% by the year 2017. The jump to 35% from 26% last year, rising from 18% in 2012 and 23% in 2013%, is thus substantial. According to the survey respondents, the proportion of the IT spend allocated to ensuring application quality and performance will continue to rise, reaching 40% by 2018.

At one level, this increase in spending is a positive trend in that it demonstrates the value now being afforded to QA and Testing and its acknowledged importance at a strategic level for assuring business outcomes. But it also suggests an urgent need to invest more in the efficiency of QA and Testing. Indeed, it is our belief that any level above 30% is an indicator that testing needs to become more efficient.

Budget allocation as percentage of IT spend

FIGURE 10

| 2012 (realised) | 2013 (realised) | 2014 (realised) | 2015 (realised) | 2018 (predicted) |
| 18% | 23% | 26% | 35% | 40% |
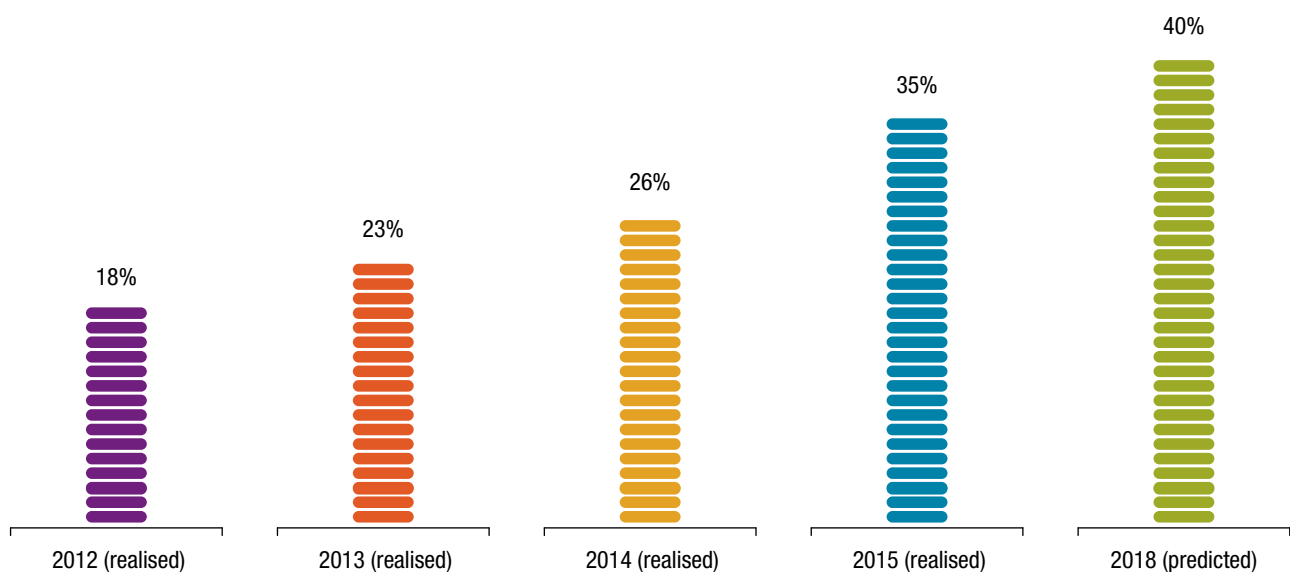
As we have seen in the previous chapter, the importance of, the need for, and the demands on QA and Testing have increased: there has been a clear shift in focus to customer experience and security. The end user experience in this interconnected world is an important differentiator for customers, guiding them in their choice of providers. Investing in getting this end customer experience right implies that all the many distributed systems and applications running across multiple platforms in a complex technology landscape work seamlessly together. This includes those digital interfaces that are considered a potential risk, such as mobile devices proliferating both in and outside the enterprise. The escalating volume of transactions and data coming into and leaving the organization across these many different touch points increases both performance and security challenges.

The ramifications for QA and Testing budgets in this complex digital landscape are clear. The increased complexity and interconnectivity of IT systems and devices present a higher probability of defects. With a defect having the potential to go viral in minutes, senior managers are more focused on protecting their corporate image and view this as the key objective of QA and Testing. Add to this the recent high profile data breaches hitting headlines, and it should come as no surprise that, on a scale of 1 to 7 (with 7 being very important), protecting the corporate image (6.07) is the top most important QA and Testing objective for executives interviewed in this year's survey. Ensuring end-user satisfaction (5.98) is placed third in this category. Interestingly, the second most important objective is increasing quality awareness (5.99), which demonstrates how organizations want QA to extend across all roles, from end user to architect, and from designer and developer to operations manager.

Concerns about IT spend being diverted from new developments

While the increased focus on QA and Testing is admirable, it also raises a concern about the amount of IT spending being diverted away from new developments and innovation. The more being spent on QA and Testing, the less budget there is for supporting the innovation needed to increase competitiveness and efficiency. One reason for the high spend on QA and Testing is a continued use of costly manual testing in the process, despite a significant increase in the proportion of testing budget consumed by automated testing (45%) this year. The 2015 survey data reveals that 39% of respondents feel a reliance on manual testing is the number one technological challenge in application development today. This is a clear signal that the testing approach is not at the level of maturity and efficiency required to support today's complex IT operations.

Another concern is the lack of sound analysis of what needs to be tested, and to what depth. Indeed, getting the right test coverage of end user requirements and expectations is the second most pressing challenge when it comes to customer experience testing for multi-channel applications, cited by 41% of respondents. Similarly, the number one challenge with testing in agile development projects is the difficulty in identifying the right area on which the test should focus, ranked as a challenge by 33% of respondents [see chapter on agile and DevOps]. This failing causes inefficiency because the optimal test sets for validating IT solutions are not available.

In addition, too little re-usability of test sets is a downside of the low levels of test process industrialization and standardization. There are new opportunities on the horizon for changing this, however, such as predictive analytics. This uses the captured data across project management, test management, defect management and development management tools to predict risk levels and risk areas before deployment. It can reveal the relevance of specific test cases and be used to plan for their efficiency, resulting in an improvement in productivity levels.

One reason for QA and Testing immaturity is that, in most organizations, these operations remain dispersed and not treated as a cohesive, standalone discipline. This disparate way of working is evidenced in the survey data by the fact that only 37% of respondents have a Testing Center of Excellence (TCOE), of which only 25% claim it is fully developed and operational. This lack of test cohesion results in little transparency of multiple test streams in different parts of the business, so much so that most organizations don't have a clear picture of their QA and Testing budget. On the other hand, a fully operational TCOE, similar to the application development factories currently driving efficiency in this area, will give transparency of all testing activity.

Organizations most aware of the impact of digital transformation spend more

The survey shows that digital leadership and greater maturity of QA and Testing operations go hand in hand. The increased spending on QA and Testing is another indication that Digital Transformation is fueling the increase of QA and Testing budget. It correlates with those sectors that have taken the lead in appointing a Chief Digital Officer (CDO): High Tech (62% of respondents with a CDO), Financial Services (57%), and Telecoms, Media & Entertainment (TME) (54%). These same three sectors allocate the highest percentage of their total IT budget to QA and Testing: TME (38%), Financial Services (37%) and High Tech (37%). Organizations in these sectors recognize the quality challenges and risks and are forcing themselves to spend a higher proportion of their IT budget on assuring these risks are mitigated.

These industry leaders in Digital Transformation are aware of the impact of good IT on achieving business goals and have typically been the most mature in their QA and Testing operations. They are, as a consequence, more acutely aware of the importance of end-customer satisfaction, and the impact of poor quality on corporate image and business outcomes. TME in particular, with the rise of mobile, makes considerable effort to bring out new products and services that have a positive impact on the customer experience. This reflects the sector's ongoing battle to attract and retain customers through innovative solutions and service packages. At the lower end of the budget allocated to QA and Testing are Manufacturing (31%) and Healthcare (30%).

QA & Test budget versus Digital Maturity

FIGURE 11
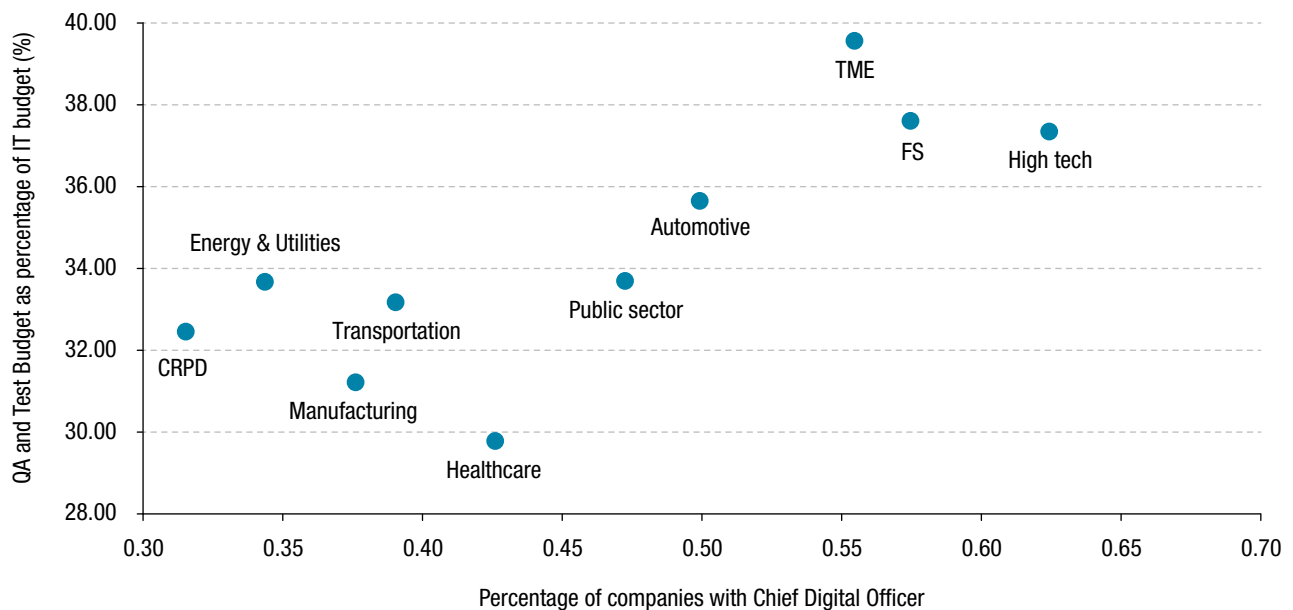
If you are paying the perfect price, you want the perfect product meeting the expectation.

Deputy CIO
Public Sector, UK

Equal distribution of budget between new development and maintenance

The World Quality Report survey has been tracking the budget distribution between new development and maintenance in recent years. Maintenance used to take the lion's share of the QA and Testing budget, but the trend has been for a continuous decline in maintenance spending and an increase in new development spending. In 2014, for the first time, new development took more than half of the QA and Testing budget, but this slipped slightly by 2% to 50% of that budget in our 2015 survey. It is difficult to explain why the upward trend in new development did not continue this year, and we certainly don't assume that there is a slowdown in new developments or a lessening in their potential impact on corporate image. It should be pointed out that the High Tech, TME, and Transportation sectors did buck this year's trend by spending several percent more on new developments than on maintenance, which is alignment with their digital maturity.

Last year's upward trend in human resources spending is reversed

How the QA and Testing budget is spent provides another interesting signpost to changes in QA and Testing operations. The survey considers the distribution between human resources (staffing), tools, and hardware and infrastructure. After an increase in investment in human resources last year, we see a shift in 2015. The marked increase in the proportion of the QA and Testing budget spent on personnel in 2014 has not continued, with a 5% drop to 33%.

This can be attributed to smarter utilization of resources and external specialists. More efficient use of external vendors with global delivery capability in a co-managed approach has made a big impact on the operational cost of testing personnel in recent years. Savings in order of 25% or more are not uncommon. The big advantage of this engagement model is that organizations can use managed models to scale up resources in a flexible and agile way and, essentially, adopt a pay-per-use approach for capacity provisioning. They can then employ smaller internal core teams, at the highest utilization rate, helping to reduce the cost of human resources in testing.

Another delivery model that helps to reduce the cost of permanent test staff is the use of a Testing Center of

Split of QA and Test Budget

FIGURE 12

Legend:
- Tools (Software Licenses)
- Hardware and Infrastructure
- Human resources
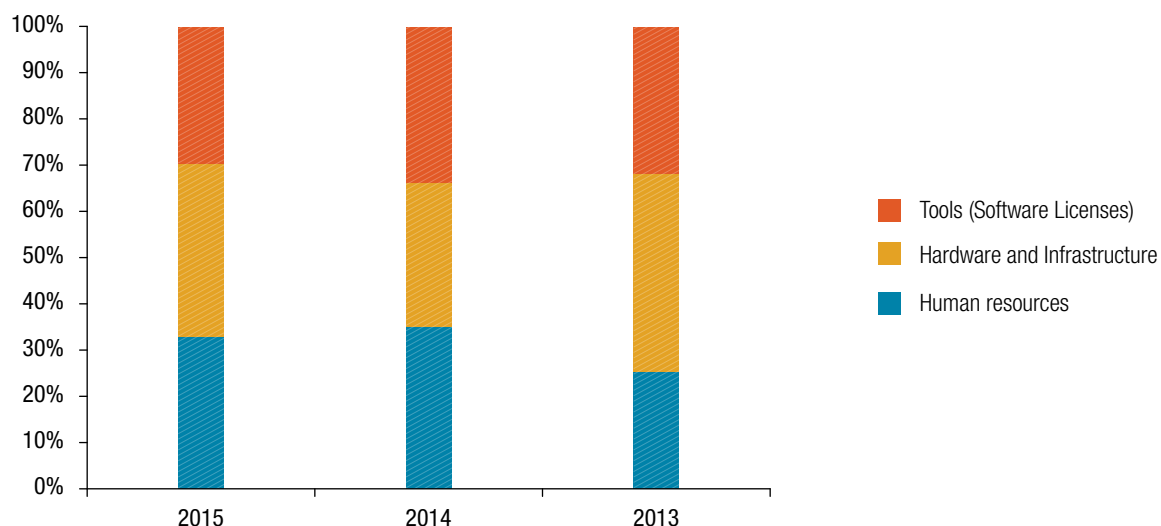
Excellence (TCOE), although as discussed in the chapter on industrialization and automation, we are seeing a plateauing of the trend towards TCOE adoption. Here workload can be managed with a factory model approach, whereby not all testing needs to be carried out by the most mature person. Instead, by allocating less specialist work to more junior team members the cost can be reduced.

Spending on tools as a proportion of the test budget also saw a slight decline on last year to 30%. The use of test tools has been common practice by test teams for a number of years. The most predominantly used are tools for: test management; automated functional testing; load and performance testing; defect management; and service simulation and virtualization. While the cost of spending is slightly decreasing, this is not interpreted as a slowdown in the use of such tools. On the contrary, usage is going up and the challenges related to tools are reducing across all areas. The increased level of test automation (from 28% of test cases automated last year to 45% this year) is a clear indicator of that.

There are several reasons for the decrease in spending on tools. The first is the availability of more tools to choose from for each test practice. These range from freeware to light versions at low cost, and on to platinum versions at higher cost. In addition, with the tool sets now more integrated, QA and Testing teams are increasingly able to pick and choose the best solution at the best price. A second reason for the smaller share of the budget is undoubtedly the greater availability and use of cloud-based testing-as-a-platform tool solutions. These come with clever and highly granular pay-per-use license consumption models: granularity is shifting from a perpetual user license model to a price per

user-day model, and on to price per user-hour and even price per user-minute models. By changing to these models the volume of licenses sitting idle has been quickly and significantly reduced. Thirdly, by using a full service model from external service providers that includes the required test tools, organizations have been able to scale down the number and cost of licenses for testing.

In the third area of QA and Testing budget allocation — that for hardware and infrastructure — we saw an interesting reversal this year. A rise of 4% from 2014 to 37% of the budget saw spending on hardware and infrastructure moving back towards the 40% witnessed in 2013. In light of the increasing uptake of virtual and cloud solutions that do not require hardware and infrastructure, this trend is unexpected. While undoubtedly many organizations still have large, permanent infrastructure on which to run testing and enable continuous releases, the wider adoption of Cloud should bring down the cost. The percentage of testing taking place in a cloud-based test environment is discussed in the chapter on Digital Transformation.

So, with this year's significant increase in the total IT spend allocation, it is clear that the awareness of QA and Testing is growing. However, despite ongoing innovations in efficient and effective organization, processes and tools, the testing industry has a major challenge to keep budgets spiraling out of control during ongoing Digital Transformations. Later chapters will discuss how developments in agile and DevOps testing, along with the creation of agile TCOEs, increased use of automation, and further technologically advanced solutions for test environments and test tooling, are being used as an enabler of this budget efficiency.

Security Testing is the Top IT Strategy Priority

Multiple Platforms Increase Risk

Yves Le Floch, Vice President, Head of Business Development, Cybersecurity TLI, *Sogeti*

Industry reports suggest some 80% of security breaches occur at the application layer, while 86% of web applications have issues involving authentication, access control, and confidentiality. This stark reality undoubtedly sits behind the strategic importance of security identified in this year's World Quality Report. In terms of IT strategy, security scores most highly with a ranking of 6.2 on a scale of 1 to 7. This is ahead of even customer experience (6.1) and IT cost optimization (6.1), which are understandably high scorers. Just one industry – Transportation – fails to place security in its top three priorities.

At a geographic level, security is the number one IT strategy priority in all but two regions, the Nordics and South East Asia, which place customer experience first.

The heightened awareness of security is driven by Digital Transformation, which increases the number of vulnerable touch points, and drives mobile access and data proliferation. An average 80% of our survey respondents (85% in Financial Services) say security is important or very important.

Until recently, the security of applications was viewed as low risk because they were largely internal, so securing the infrastructure was sufficient as a priority for protecting against security risks. But IT solutions are no longer contained in isolated environments. Web-based, mobile and cloud-based applications capture and hold sensitive corporate and customer data, and are accessible from multiple platforms. However, they are highly vulnerable to intrusion, hacking, etc. Despite this increased vulnerability, the pressure to release

Focus areas for IT Strategy

FIGURE 13

Cost optimization of IT   Customer Experience   Security
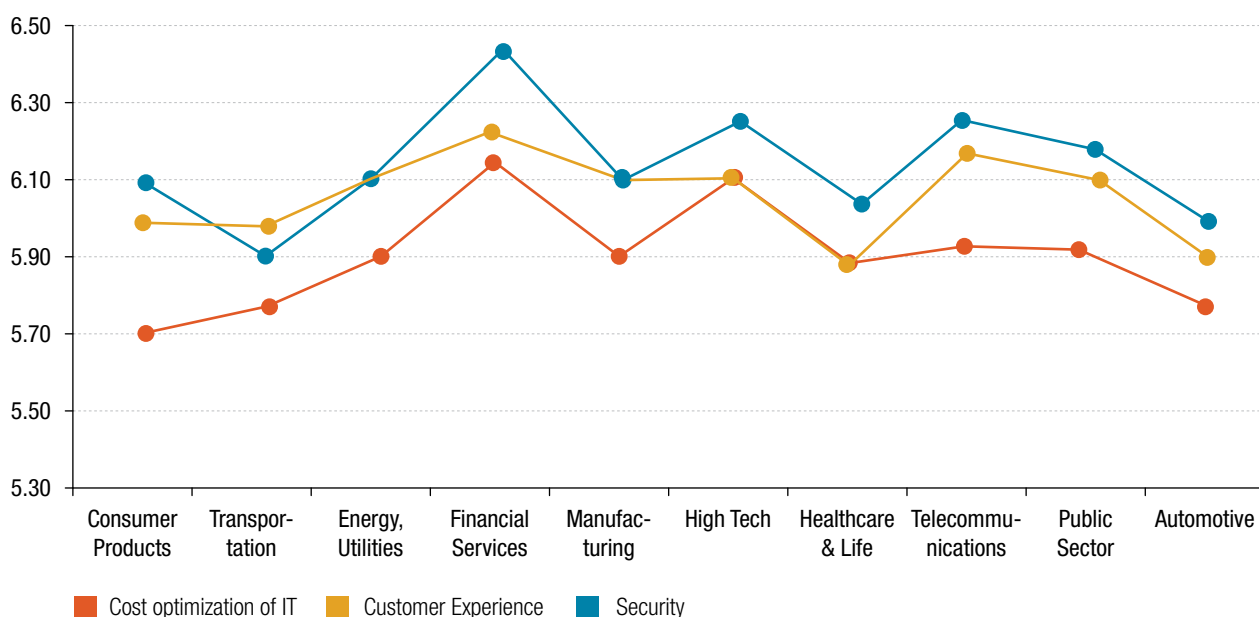
quickly often means the security checks needed to manage applications and systems in depth are incomplete.

Lack of security in this complex digital IT landscape has significant ramifications for the business, notably in terms of the potential for financial loss, competitive disadvantage, and reputational damage if a security breach becomes public. It is proven a high number of people will leave or avoid companies that have had security issues. It is no surprise, therefore, that security testing has become a business imperative for many organizations. Indeed, this year's World Quality Report survey data reveals that protecting the corporate image is ranked as the single most important objective for QA and Testing. In the light of the huge damage to the corporate image that a data breach can cause, security testing is a critical component in Digital Transformations.

Healthcare and High Tech top the tables for systematic security

Responses to the survey reveal that 46% of participating organizations are systematically performing security testing on every application release. Despite security being the highest priority, nearly 25% are failing to systematically perform security tests on all applications, preferring to limit this activity to critical ones only.

There is considerable divergence in the amount of systematic security testing across different industries. The Healthcare (88%) and High Tech (85%) sectors stand out as the biggest users of systematic security testing. At the lower end of the spectrum, but still with a high priority rating, the Public Sector (57%) performs the least amount of systematic security testing.

The survey reveals a similar divergence geographically, although not as dramatic in terms of percentage. Leading the pack in systematic security testing are UK and Ireland (89%), South East Asia (85%) and North America (83%). At the other end of the scale, although again at a fairly high level, are Western Europe (68%), Southern Europe (63%) and Australia and New Zealand (62%).

> We are in a financial services industry; the data that we have is personal, and any leak of data would be bad for business and our customers. There is an extremely strong emphasis around security, both internal as well as the external.
>
> **VP,**
> *Financial Services, North America*

Increased automation enables security testers to do more with less

It is far less costly to remove a critical vulnerability before a service goes live than after it has been launched (or breached). Thus the primary function of application security testing is to identify and fix vulnerabilities early during the software development lifecycle in order to reduce costs, improve efficiency, and enhance application security. Automated security testing is playing an increasingly important role in this.

The 2015 research data reveals the steady progress of automation in the wider testing of applications, with 45% of all test cases now automated. There is still a high dependency on manual work, however, when it comes to security testing. For example 52% of the organizations perform manual code review as part of their security testing activities. This has both cost and resource ramifications, with the physical line-by-line code checking to identify anything that might produce vulnerabilities in production being slow, costly and labor intensive. Test coverage is also a challenge with manual testing, something that automation addresses.

Add to this the concerns about the availability of skilled testers in some regions, especially a scarcity of security specialists, and the only practical approach is to move to more automated, or partly automated, security testing as the way ahead. This automation is already taking hold in many places with a number of different types of automated security testing being used, such as dynamic application security testing and static application security testing. There are several tools available for this, either proprietary or commercially available, and we are seeing an increase in the use of such tools.

More than half (57%) of respondents perform dynamic security testing, where security testing is performed by actively running security test cases against the application to uncover vulnerabilities. This is the most used security testing approach today, and is designed to find those vulnerabilities most prone to exploitation. It takes place later in the development lifecycle, just before code is released in production. In combination with penetration testing, which is performed on the application in a live production environment, (currently used by only 39% of respondents), dynamic security testing is a powerful security test solution.

Penetration testing adds another layer of security testing, in that it goes beyond just applications to try and exploit infrastructure vulnerabilities. The 39% figure shows that structural penetration testing still has room to grow within most organizations.

Static security testing is used by more than half of the organizations interviewed, scoring 52%. It is typically performed by development teams using scanning tools to check code as it is written. Static security testing finds many more vulnerabilities than dynamic testing, but not all of these will be exploitable. Taking place earlier in the development lifecycle— during the development phase — static security testing is a valuable approach for reducing the cost of application development because of the well-known principle that the sooner an issue is identified, the less it will cost to fix.

The right approach to security testing will require a solid combination of manual test activities by security specialists and automated security checks and tests. For maximum benefit organizations should combine automated testing, which is typically comprehensive, repeatable and scalable, with manual testing focusing on the areas that can't be tested automatically.

In the security testing space, the increase in automation is helping to identify vulnerabilities at different stages in the development lifecycle, from requirements definition onwards. Up to 44% of the participating organizations carry out application security assurance activities during requirements definition although, as outlined below, there is still greater use of security testing at the later stages.

Commonly performed security testing activities

FIGURE 14

2015

| 57% | 52% | 52% | 39% |
| Dynamic application security testing | Manual code review | Static application security testing | Penetration testing |
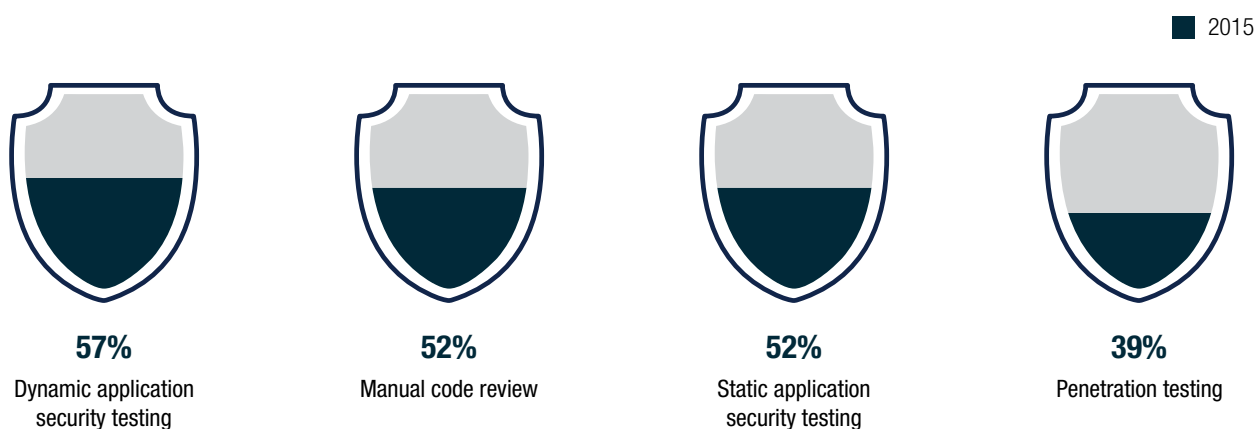
Mixed approach to how security testing is conducted

There is a mix of approaches to performing security testing, comprising internal, external, and managed services provision. It is a function requiring specialist security skills and some organizations prefer to use their own internal specialists due to the commercial sensitivity of what is being tested. In other cases, the unique role that security testing has in wider testing activities, and its incidental nature, make it an area of testing that will benefit from external security specialist support. External providers bring deep experience of security issues across multiple organizations and sectors. The World Quality Report research found both internal and external experts being used to perform security testing, along with a range of technologies and engagement models.

At a global level, the findings can be broken down as: 51% use internal experts with own tools; 32% use internal specialists with pay-per-use tools; 35% use external managed security test services; 34% use external security experts on a project-by-project basis; and 30% use external

security test staff augmentation. There are large geographic differences, however, with South East Asia notable for its use of a fairly even combination of internal and external resourcing. Interestingly, three industries in particular use more managed services than other approaches: High Tech, Financial Services, and Automotive.

The importance of security is indicated by the investment in internal security teams, with over half of organizations using them. However, there is the risk that internal teams might have less exposure to or experience of new security issues and therefore miss certain security checks. Speed of release and volume present internal teams with a big challenge because reliance wholly on in-house specialists limits the scalability and reactivity needed for this highly specialized test approach. Further investment in security and automated security testing, in combination with some form of external application testing support, can help to mitigate this risk.

Type of security testing team

2015

Internal security testing team with own tools	51%
Managed application security testing services	35%
External security testing team on a project-by-project basis	34%
Internal security testing team with pay-per-use tools	32%
Staff augmentation (time and material)	30%
No application security testing	17%
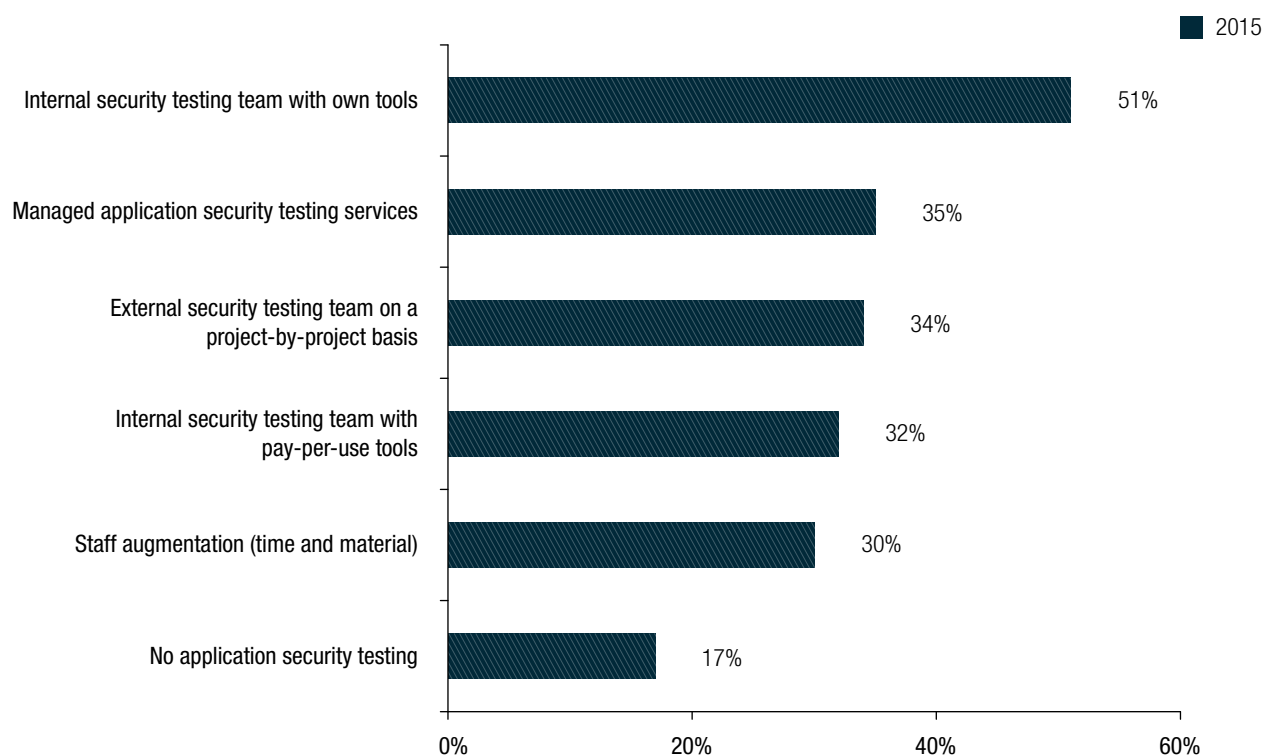
Last stage application development is where most QA and security testing is performed
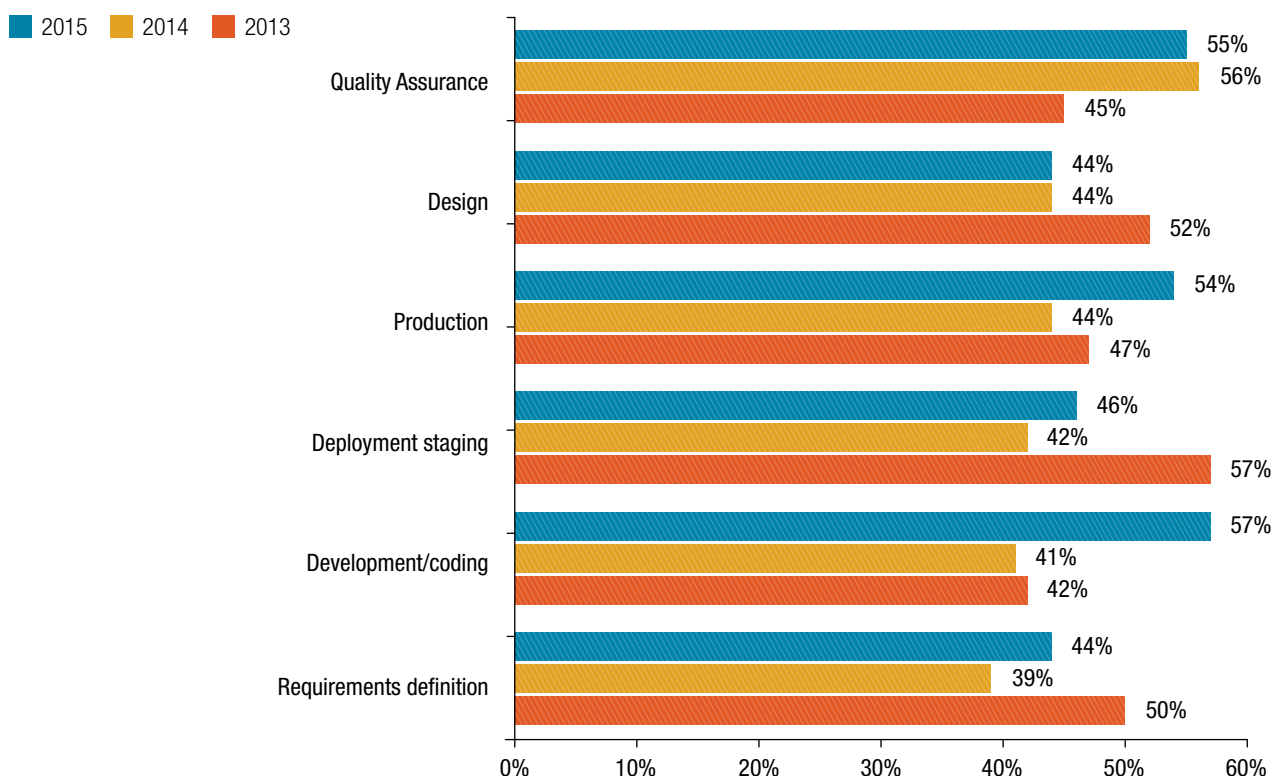
Where in the application development lifecycle should application security testing take place to reduce risk? For organizations participating in the World Quality Report 2015 study, it appears to be later, rather than sooner in the lifecycle, as indicated by the greater use of dynamic application security testing discussed earlier. In general, however, there is increased attention being paid to security testing in all phases of the application lifecycle.
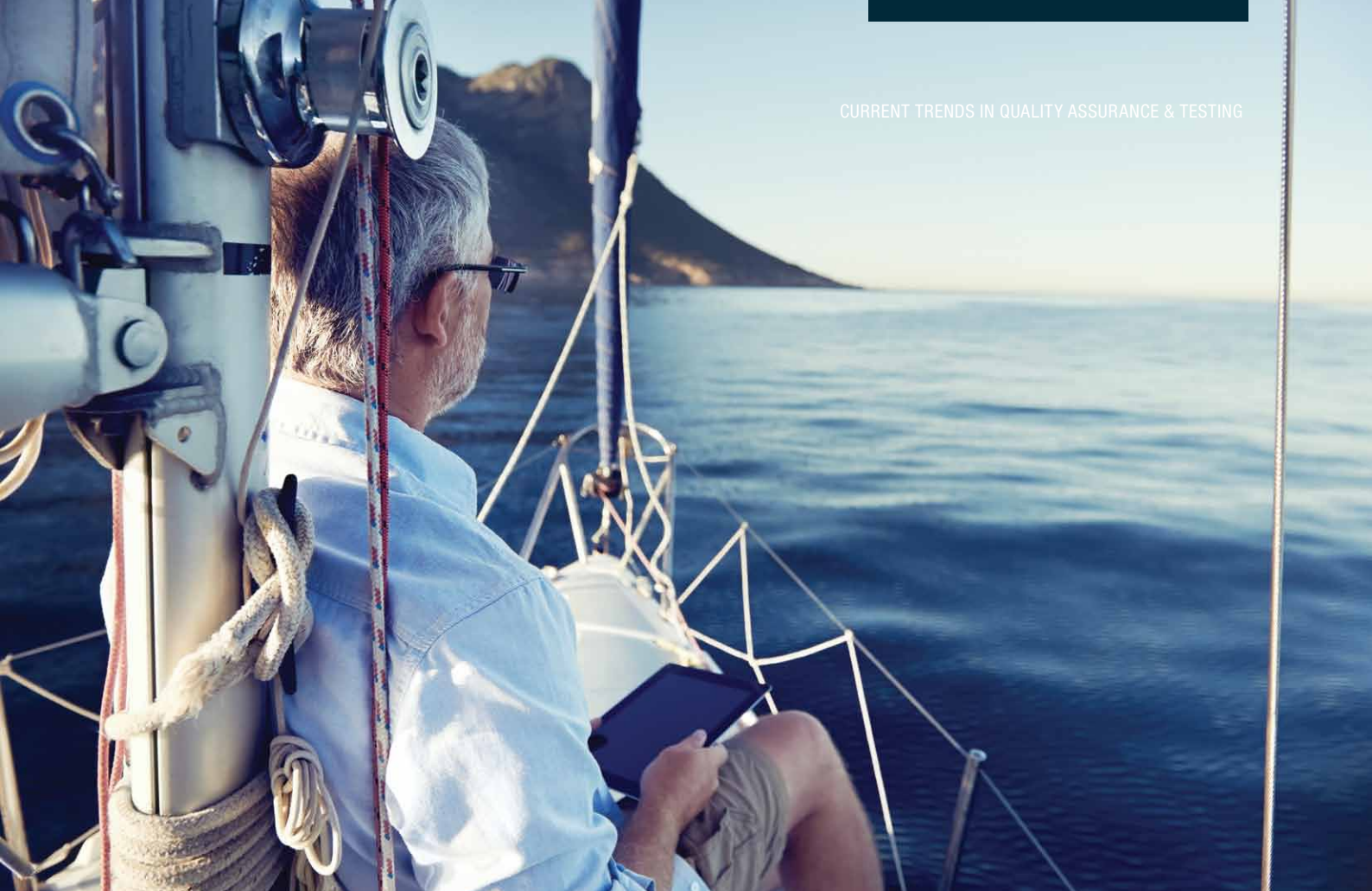
More than half (57%) perform security testing in the development/coding phase, with the Financial Services, Telecom and Automotive sectors giving this phase their highest ranking. This is a big increase from last year's 41% at this lifecycle stage. Security testing is performed the least during requirements and design phases (44%), while 55% of respondents perform security testing during their QA, a marginal 1% drop over last year.

There are different lifecycle stages at which organizations undertake application security assurance activities. Some will focus more on requirements during early stages, while others concentrate more on testing during later stages. The attention being paid to security QA has increased in almost all phases of the application development lifecycle. The development/coding phase shows the fastest increase, which is understandable because this signals the increase of static code analysis and dynamic security testing (for which one needs to have the developed code available). Also the increase in the production phase is notable, and this is a signal that organizations are paying more attention to security monitoring and penetration testing of applications in production. It is encouraging that attention to security has also increased in the requirements phase. However, the focus on security in the design phase is still at the same level as last year. As security QA matures further, we expect to see a greater level of focus on security aspects in this phase.

Top 3 Aspects for IT Strategy for security testing across Industries

FIGURE 16

Legend: 2015, 2014, 2013

- Quality Assurance: 55% (2015), 56% (2014), 45% (2013)
- Design: 44% (2015), 44% (2014), 52% (2013)
- Production: 54% (2015), 44% (2014), 47% (2013)
- Deployment staging: 46% (2015), 42% (2014), 57% (2013)
- Development/coding: 57% (2015), 41% (2014), 42% (2013)
- Requirements definition: 44% (2015), 39% (2014), 50% (2013)

Looking ahead for security testing

The rate at which today's fast-paced world continues to release new applications designed to enhance the user experience is speeding up. Cloud-based testing in general is on the increase, but security testing in or from the Cloud is approached with more caution in certain regions. For example, there is a big difference between North America (46%) and Western Europe (33%) performing security testing in a cloud-based environment. Where caution does exist, issues of trust, of massive surveillance and high profile security breaches have resonated, slowing the uptake of security testing in a cloud-based environment. Security is the biggest area of focus for testing mobile applications (55% of respondents that do mobile testing), ahead of scalability and performance testing (54%). The proliferation of mobile devices and applications, with their inherent security challenges around control of access points and device security, means this looks set to remain a trend for the future.

Looking ahead, the findings from this year's World Quality Report study will make interesting comparisons in the coming years. Many organizations feel that there is not enough time to spend on testing digital applications (social, mobile, Cloud, Internet of Things) due to the pace at which they are released and this increases the risk to their critical business applications. This is also likely to shape the future approach to application security testing with higher levels of automation and industrialization.

The use of external security testing services, either on a project-by-project basis or as managed services, is becoming more established and will alleviate the pressure on often costly and hard to retain internal talent. The focus for internal security expertise should be on hiring key senior level personnel, such as a Chief Security Officer to advise the executive on application security and testing. Handing off the day-to-day work, or increasing automation, will enable more application development projects to reach the production stage, faster, safer, and with more scalability.

While more permanent relationships with external security testing providers are desired, security testing has not yet reached that level of maturity in many cases. Certainly, with 54% of respondents saying they do not perform systematic application security testing on every release of every application, despite security being the number one strategic IT priority, too many organizations are exposing themselves to major application security risk. This is something to watch out for in the future.

Agile Testing Maturing to the Enterprise

Continuous Testing is a Strategic Enabler for DevOps

Mark Standeaven, Group Delivery - Engineering & Knowledge Leader, *Capgemini*

The World Quality Report 2015 study reveals that 61% of overall respondents rate time-to-market as an important or very important part of their corporate strategy. The promise of speed to market is immense. Business metrics, such as return on revenue (ROR), return on investment (ROI), and throughput efficiencies, are deeply integrated with achieving time-to-market, which is driving the proliferation of agile across industries. From a testing services perspective, the discussion has moved away from cost of quality to focus on cost to achieve test velocity. Quality is a given.

While agile as a development methodology has been used for more than a decade, integrating testing into agile projects has been a challenge. Concerns about how to embed the more traditional phased approach for independent testing in an integrated agile process have largely kept it in the slow lane. Nonetheless, due to the eager adoption of agile development, the use of agile testing methods has also been accelerating over the past few years. Agile is now being taken further into DevOps, and this trend is also speeding the development of agile testing techniques. This is all driven by the overriding need for speed to market as Digital Transformation programs gain pace.

More than half of this year's participating organizations (54%) have adopted agile development. In these organizations, an average 44% of projects use agile testing, an increase from last year's 36%. Agile development is most used in Financial Services, with 72% of the respondents in this sector stating it is integral to their IT projects. This is followed by both Manufacturing and High Tech (64%), then both Consumer Products, Retail and Distribution (CPRD) and Energy and Utilities (55%). The high figure for Financial Services is interesting. The industry has been a pioneer in the use of managed testing services and has mastered the art of running global centralized test organizations. With time-to-market becoming a critical business need, organizations in this sector are moving towards agile test methods to shrink time from inception to deployment.

At a regional level, the Americas (including Latin America) is the biggest adopter of agile (83%). Latin America as a standalone entity serves as an excellent same timezone, low cost, nearshore center for agile testing to the American market and records the highest degree of adoption overall (88%). While agile is omnipresent across regions, the survey data shows slight variations: UK and Ireland (73%), Eastern Europe (63%) and South East Asia (61%).

> I see a trend in a shift towards test driven development, which is likely to lead to successful agile delivery.
>
> **Senior Director**
> *Telecom, North America*

Multiple testing frameworks meet diverse portfolio needs

Analysis shows that agile development is being driven by digital programs and mobile initiatives. The Scaled Agile framework (SAFe) methodology is the most used guideline and framework for testing (31% of respondents). SAFe offers a range of strategies and patterns for overcoming challenges with large-scale, enterprise-wide agile development efforts. At a sector level the biggest adopter of SAFe as a guideline for testing is CPRD (55%), followed by Automotive (47%) and High Tech (43%). Regionally, North America is the biggest adopter of SAFe, used in 42% of the organizations that have adopted agile. Most organizations in America have successfully experimented with agile at the small team or program level across sectors using varied frameworks. They are now interested in implementing a consistent agile approach at an enterprise level and SAFe provides the framework to guide this.
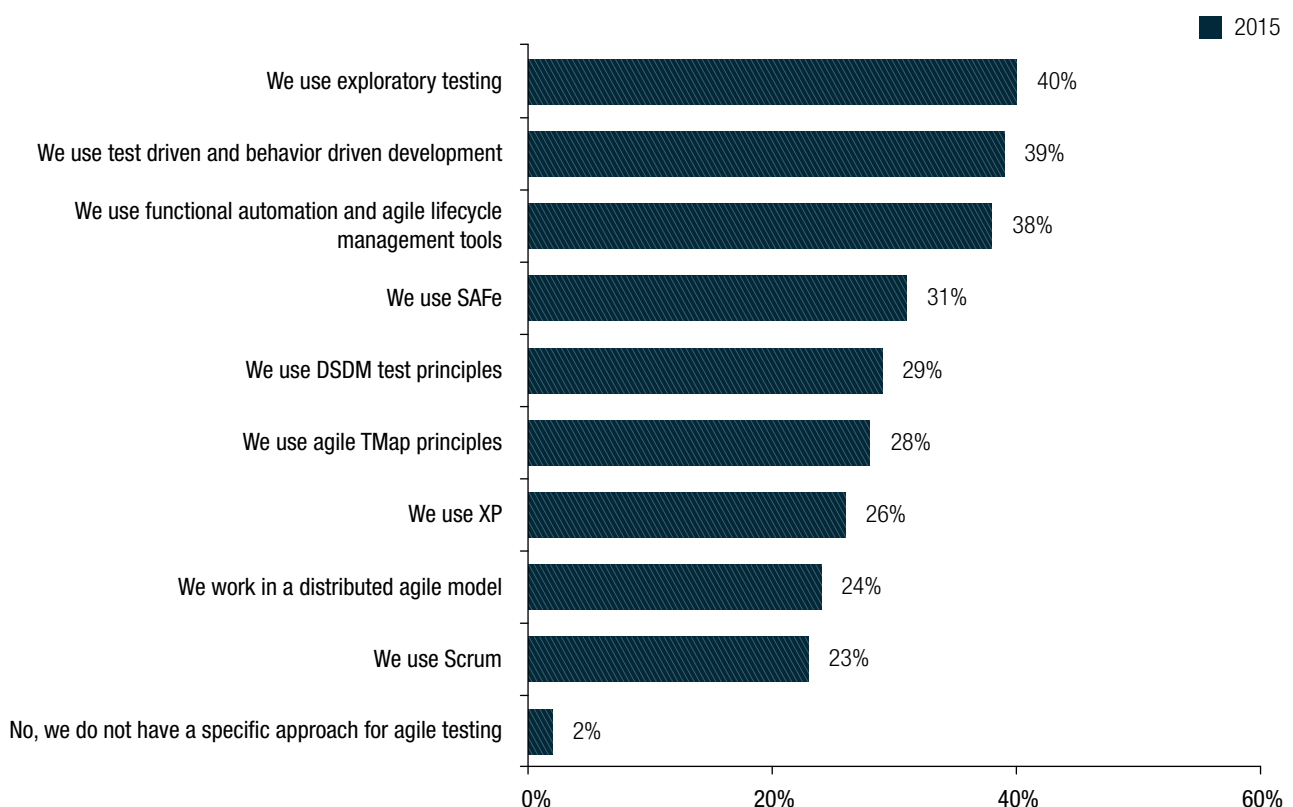
Other development frameworks are not far behind, but one in particular has seen a significant decline in its use. Dynamic

Systems Development Method (DSDM) has dropped from last year's 45% of those organizations surveyed that have adopted agile, to just 29% this year. We also see the use of TMap® dropping to 28% from 35% last year. This shows that these two methods are going out of favor for agile projects and being replaced by modern and more comprehensive frameworks like SAFe. SCRUM (23%) and Extreme Programming (XP) (26%) are still used, although their adoption rates vary considerably when viewed regionally. For example, XP is used in 40% of agile projects in North America, as opposed to just 14% in UK and Ireland. Likewise 40% of agile adopters in North America use SCRUM, compared with only 18% in Western Europe.

This proliferation of multiple frameworks, as opposed to a single framework, is due to the unique needs of different application portfolios. Typically we see projects delivered using a combination of DSDM, SCRUM, and XP, noting that SAFe is enterprise driven.

Approaches to testing in agile in your organization

FIGURE 17

2015

We use exploratory testing	40%
We use test driven and behavior driven development	39%
We use functional automation and agile lifecycle management tools	38%
We use SAFe	31%
We use DSDM test principles	29%
We use agile TMap principles	28%
We use XP	26%
We work in a distributed agile model	24%
We use Scrum	23%
No, we do not have a specific approach for agile testing	2%

Agile testing finds its place in development

The 2015 survey looked at the role of testing and appropriate methods to support iterative delivery within the agile development environment. The challenges identified in previous reports are diminishing, although still present. This is a sign that QA and Testing is now better integrated within agile projects. As an example, in last year's survey, 61% of respondents said they did not have a good testing approach that fitted with agile development. In contrast, the 2015 research data shows that only 29% of users who have adopted agile are struggling with this challenge.

Despite the reducing difficulties, however, important challenges with applying testing to agile developments till remain. Indeed, 82% of the respondents say they have difficulties with testing in agile, although this is a 4%

improvement on last year. The top three challenges are: difficulty in identifying the right areas to test (33%); lack of appropriate test environment and data (31%); and lack of professional test expertise in agile teams (31%).

The preferred global delivery model for QA and Testing teams within an agile development project is co-location, with only 24% of those respondents practicing agile using a distributed agile testing model. This is likely due to the challenges of a distributed model, including: communication challenges; demand for frequent interfacing with product owners and development; data and security concerns; and an absence of the right tools to facilitate collaboration between distributed teams.

Challenges faced in applying testing to agile development

FIGURE 18
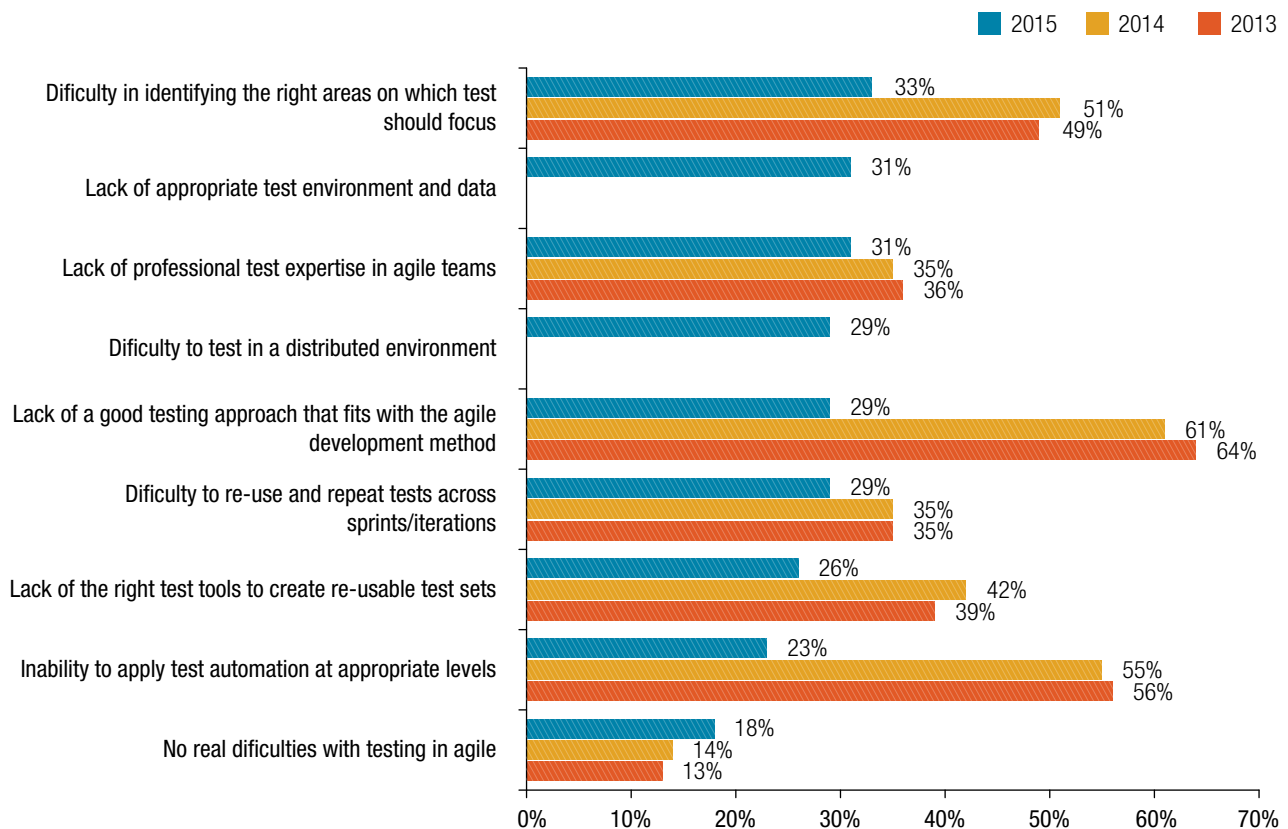
De-centralized hybrid Testing Center of Excellence (TCOE) model is the solution for agile (yet structured) testing

There are a number of challenges being encountered or anticipated in the setting up of an agile TCOE. In this year's survey, the most frequently cited challenge (45% of respondents) was agile being used as an excuse to avoid developing documentation. This is because, when setting up an agile TCOE in such an environment, objectives, scope and expectations are unclear and volatile, making the designing, preparation and detailing of test cases almost impossible. Other challenges include: testing teams not being as agile as development teams (42%); traditional test design methods being used that are unsuitable for agile delivery models (42%); the necessity to co-locate teams,

denying cost savings through globally distributed delivery models (41%); and an unwillingness by independent testing vendors to engage in "pair programming" with development teams (36%).

To address some of these issues, organizations should implement an enterprise-wide agile test process toolkit comprising checklists, guidelines, estimation models and methods. Very often there is a tendency to procure a plethora of tools without defining the right process. Lean processes to improve test velocity should drive tools selection, not vice versa.

Practice methodology indicates increasing maturity of testing in agile projects

The survey data reveals three dominant testing approaches used in agile projects: exploratory, shift left, and traditional lifecycle automation.

Exploratory testing is the oldest and hence the most popular single approach, with 40% of respondents who use agile practicing it. This approach is based heavily on the experience of the testers themselves. They use their knowledge and experience to focus on areas prone to potential defects. This method requires QA and Testing experts with extensive technology, applications and business process expertise.

Shift left techniques, whereby testing moves earlier in the application lifecycle towards requirements and development, are viewed as the greatest lever for agile delivery. More focus on structural unit testing, test driven development (TDD), behavior driven development (BDD), and application

program interface (API) testing and services are examples of shift left techniques. The TDD approach to developments starts with designing test cases, which drive the overall development. BDD has evolved from TDD and describes test cases or test scenarios in a more user-friendly way, which gives developers a better understanding/description of how the function to be built should actually behave. In our 2015 survey, 39% in total of the respondents using agile adopt TDD and BDD testing.

Traditional lifecycle automation, complemented with agile tools and lifecycle management tools, has been used in testing for more than a decade. This has brought a familiarity that, coupled with a proliferation of matured automation frameworks and the availability of skilled testers, makes it a natural lever to speed up time-to-market. As a consequence, 38% of the respondents use this approach to agile delivery.
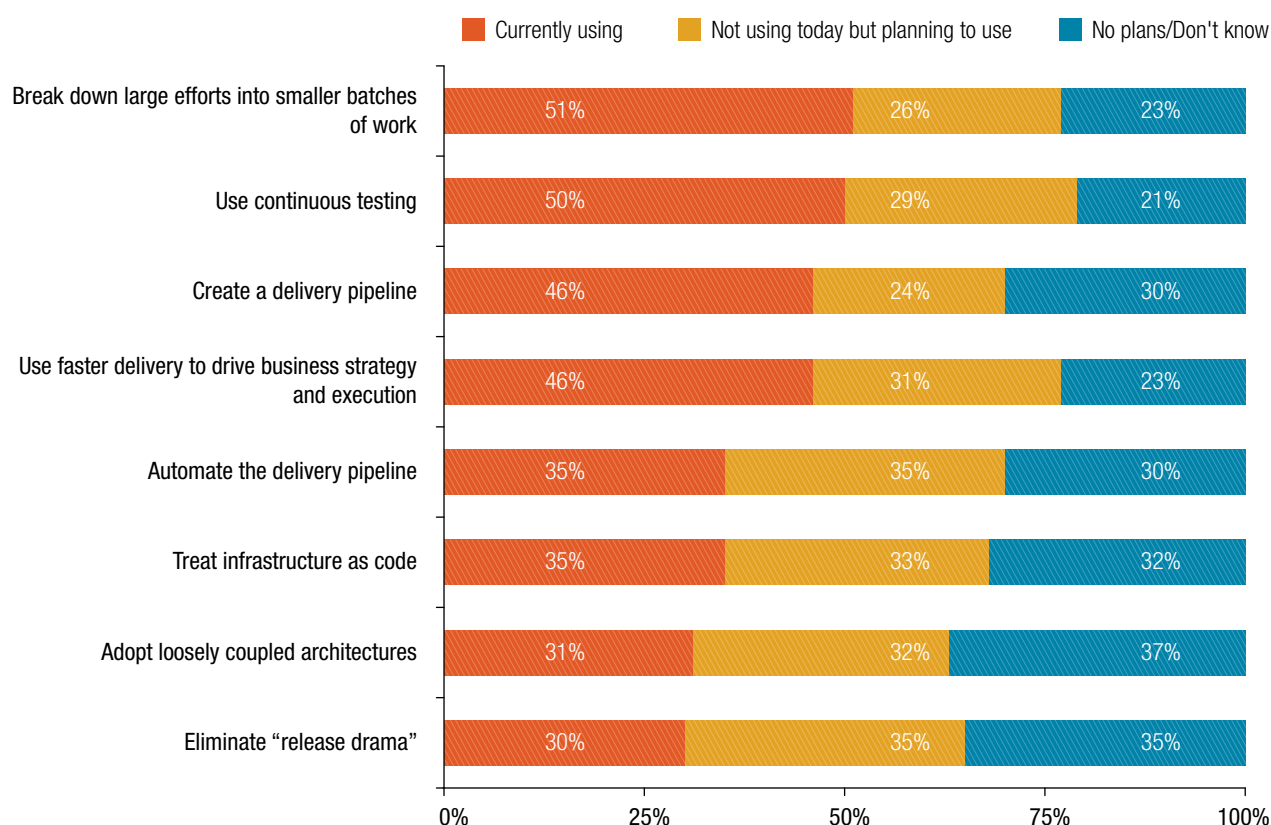
Embedding agile testing in DevOps

As agile testing matures, it is moving very quickly into the realm of DevOps where traditional silos between development and the operations responsible for deployment are broken down. DevOps aims to achieve a continuous process of changing and improving applications in production and, in doing so, to reduce release failures. DevOps is the current development hype, with organizations embracing it enthusiastically. Indeed, 67% of all respondents are using DevOps principles. Only 18% of respondents are not using

DevOps principles in executing projects. While it is proving popular, however, most organizations are still at an initial stage of adoption.

The promise of agility within DevOps is compelling, but without a testing strategy to 'continuously test' many organizations struggle to get started. Continuous business-driven testing to shrink the time from development to operations is the goal. Quality should be a given in pursuit of it.

Implementation of various DevOps practices

FIGURE 19

Legend: Currently using | Not using today but planning to use | No plans/Don't know

Practice	Currently using	Not using today but planning to use	No plans/Don't know
Break down large efforts into smaller batches of work	51%	26%	23%
Use continuous testing	50%	29%	21%
Create a delivery pipeline	46%	24%	30%
Use faster delivery to drive business strategy and execution	46%	31%	23%
Automate the delivery pipeline	35%	35%	30%
Treat infrastructure as code	35%	33%	32%
Adopt loosely coupled architectures	31%	32%	37%
Eliminate "release drama"	30%	35%	35%

> Adoption of DevOps is causing new challenges for testing. The biggest challenge to implement QA and testing in DevOps in our organization is lack of right skills.
>
> **IT Head**
> *High Tech, Japan*

Continuous testing used to reduce time between development and operation

QA and Testing serves as a bridge between all disciplines, from clients and business to development and operations in DevOps. Testing is viewed as one of the most effective levers for reducing time to market within DevOps initiatives. Just over half of the participating organizations (51%) do not yet follow a well-defined methodology for DevOps in general, but are starting to break up their larger DevOps efforts into smaller batches of work. This is a common first step in the maturing of DevOps. In terms of testing within DevOps initiatives, continuous testing techniques are used by 50% of the respondents, with 29% planning to use it, and only 21% reporting that continuous testing is not on the cards.

There are a number of continuous testing approaches embedded within DevOps projects. Virtualization of test environments is the most popular, with 51% of respondents using it. We see this as being a direct result of the need to execute fast integration tests in an equally fast-changing architecture of applications and system versions in DevOps projects. This can only be achieved quickly enough when virtualization and simulation solutions are made available for the test environment. At a sector level, the Telecom, Media and Entertainment (TME) industry leads the way with 57% of respondents who use DevOps stating that they practice virtualization. This is followed by CPRD (56%), Healthcare and Life Sciences (55%), Financial Services (51%) and High Tech (50%).

Agile testing practices, such as TDD and BDD techniques,in combination with continuous improvement (CI) testing, are used by 48% of respondents in their DevOps projects. The High Tech industry is more mature than others, with 65% of respondents using TDD and BDD along with CI. This is followed by Financial Services (52%), Automotive (49%) and Public Sector (49%), closely followed by TME (48%).

The High Tech industry is also the front runner in using a combination of automation and CI. While the average is 47%, High Tech companies come in at 73% of respondents. This sector also uses more automated environment provisioning, at 49% compared with the average of 43%. These figures clearly show the High Tech industry taking a lead in its strong adoption of DevOps practices.

Likewise, North America is the most mature region in terms of its adoption of testing in DevOps, with 63% of respondents saying they use virtualized environments, 58% using test automation integrated with CI, 57% using automated provisioning of environments, and 55% using agile test-driven practices.

The combination of High Tech and North America as leaders is unsurprising. This is largely due to the product-based companies in America's Silicon Valley being the earliest adopters of DevOps and agile as they sought to reduce the span of product deployment first from weeks to days and now to hours. This has driven proliferation of agile and DevOps.

Investment in agile setup of test environments is needed for future success

Despite the fact that working in the agile and DevOps space is based on highly adaptable and flexible self-governing teams, management still needs to understand the performance level of these teams. In the light of this, there is a strong need for a set of consistent agile QA delivery metrics mapping to business key performance indicators. Examples of such metrics are: percentage of delivered features accepted for go-live first time; price point per accepted feature; and test velocity. Greater adoption of lean design techniques and methods will reduce time-to-market in manual testing. Increasing the use of model-based testing techniques and pre-packaged assets for manual testing will drive standardization, which in turn reduces time-to-market.

The future QA and Testing function within agile and DevOps requires investment in the agile setup of test environments, infrastructure, and data to support iterative delivery. By connecting this to a flexible team of QA and test specialists, the setup of an agile TCOE will be achieved. Greater adoption of test data and environment automation techniques will speed time-to-market, as will an increase in the use of deployment tools and cloud technology. Continuous delivery — needed in the DevOps model — will be facilitated by investment in building non graphical user interface-based automation frameworks integrated with build, test and deploy tools.

Industrialization Becoming More Advanced

Testing Centers of Excellence Drive Continuous Testing

The context for QA and Testing services is shifting: IT organizations now have a new role in transforming business. As we have seen in the previous chapters on Digital Transformation and agile/DevOps, IT organizations are riding on a wave of digital and mobile technologies to ensure richer engagement with customers. Alongside this, IT has adopted agile and DevOps as the leading disrupters in the way today's business embraces the growing need to accelerate delivery and improve time-to-market. The World Quality Report 2015 study results clearly showcase the impact of these trends on the QA and Testing functions, where industrialization is becoming more advanced.

In this digital landscape, today's Testing Center of Excellence (TCOE) is a primary vehicle for industrialization and standardization. It must change in response to the ongoing adoption of digital, mobile, agile and DevOps. It is now part of a customer experience-focused and cycle time-driven ecosystem. This requires the TCOE to drive continuous testing via integration, lifecycle automation and service virtualization. This will ensure continuous delivery becomes a reality. In bringing about this transformation, the modern TCOE will enable flexibility and cultural change so that the QA and Testing function is effectively aligned with the software development cycle, especially with development teams.

In recent years testing industrialization has made significant strides. However, after last year's 4% steady growth to 26% of organizations running fully operational TCOEs, it has plateaued at 25% this year. We are seeing, instead, an increase in those planning to set up agile TCOEs, in which more decentralized teams are integrated in development teams and provide service on an as-needed basis, rather than being a quality gate after the development phase. This indicates that more and more QA teams are willing to adopt the change of ecosystem and drive efficiency across the software development lifecycle (SDLC), rather than simply during late-stage testing. SDLC quality will be the key metric alongside standard quality metrics, such as defect leakage, testing efficiency and effectiveness.

> I think as a concept the CoE is incredibly more efficient than doing testing any other way.
>
> **Senior VP**
> *Financial Services, North America*

Testing Center of Excellence as a single stream initiative has now plateaued

In addition to the plateauing trend to consolidate QA and Testing into a single stream (as a traditional testing TCOE), there is a similar plateau in the percentage of participants planning to develop a TCOE in the next two years (24% in both 2014 and 2015).

Of those 25% of respondents with fully operational in-house or third party TCOEs, the data shows a slightly downward trend in organizations using in-house capabilities (from 18% in 2014 to 16% in 2015). This in-house decline is likely due to a new set of challenges relating to digital and agile, notably the need for more integration between testing and other disciplines, and for fewer traditional silos.

Standardized/industrialized Testing Center of Excellence (TCOE)

FIGURE 20

Legend: 2015 | 2014 | 2013

	2015	2014	2013
Plan to develop internally managed TCOE within the next 2 years	24%	24%	23%
No plans in place	18%	20%	26%
TCOE is fully operational using in-house capabilities only	16%	18%	10%
In house TCOE started within last 2 years, but not yet fully operational	12%	15%	13%
Plan to use a 3rd party company with a TCOE capability	11%	15%	19%
TCOE is fully operational via a 3rd party	9%	8%	9%
Plan to start an Agile TCOE	10%		

New success formula for Testing Center of Excellence: business aligned, more collaborative across application lifecycle, and co-managed
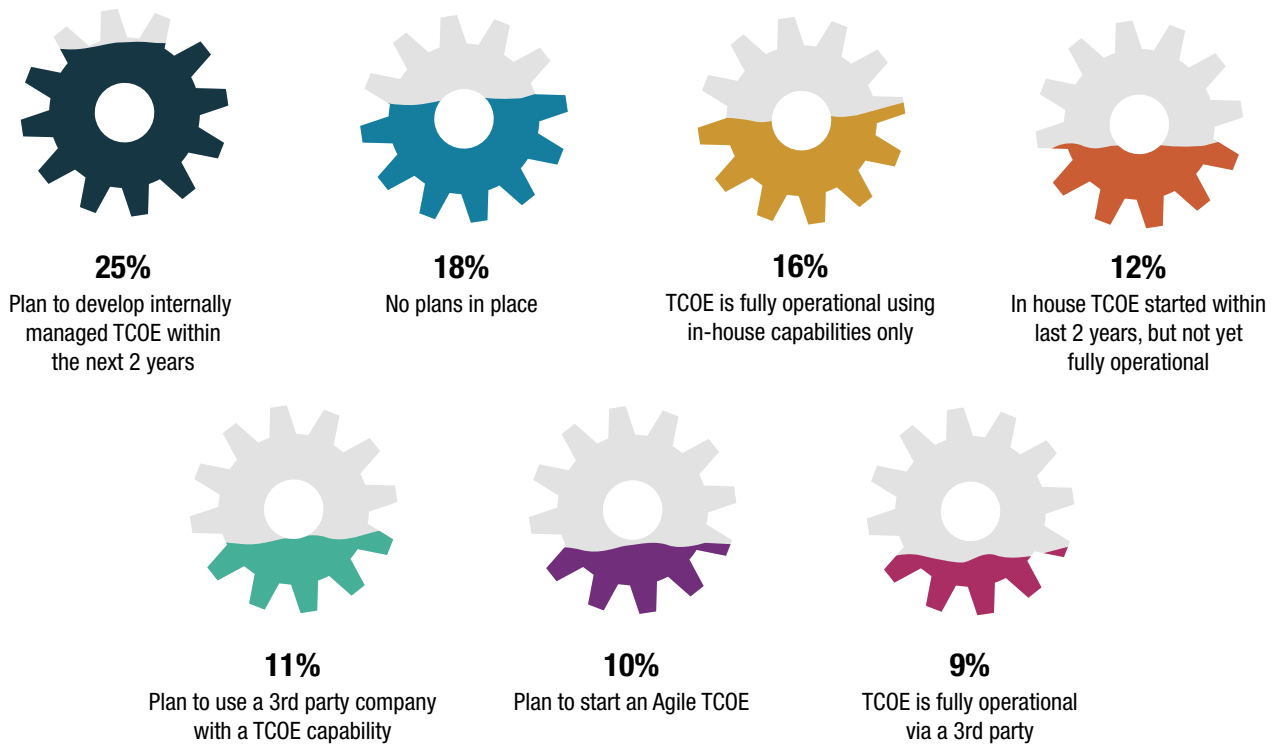
They key objective of the TCOE is to set up a highly standardized and industrialized QA and Testing factory that will consistently drive and deliver quality at optimal cost. A successful TCOE is fully aligned with the business functions and provides technology solutions as shared services functions. This enables effective use of the in-house QA teams (available locally or using captive centers across the world) and specialist QA-vendor teams for testing specialization, scale and technology know-how. Additionally, the operating model of the traditional TCOE will change.

The emergence of agile and DevOps initiatives demands more collaboration amongst teams across the application lifecycle (ALS). Traditional siloed disciplines within ALS, such as development, QA, and production management, are merging as the new collaborative model brings together the development, business and operations teams closer to QA. This also demands a Dev-QA skill set from the QA teams. As discussed in the chapter on agile and DevOps, a new role of Software Development Engineer in Test (SDET) is emerging. Testers now need to understand customer value, business operations, end-user adoption, and development techniques such as test driven behavior (TDD) and behavior driven development (BDD), as well as a multitude of tool sets for QA and Testing activities. This understanding will ensure effective "shift left" implementation as QA teams work more closely with the development and business analyst teams. Conversely there will also be a "shift right" due to the integration of development and operations, now incorporating continuous quality aspects across these disciplines. Shift right implementation will be merged with operations for continuous deployment.

Plan to create Standardized / Industralised TCOE

FIGURE 21

25%
Plan to develop internally
managed TCOE within
the next 2 years

18%
No plans in place

16%
TCOE is fully operational using
in-house capabilities only

12%
In house TCOE started within
last 2 years, but not yet
fully operational

11%
Plan to use a 3rd party company
with a TCOE capability

10%
Plan to start an Agile TCOE

9%
TCOE is fully operational
via a 3rd party

The study report has shown a steady decline of respondents saying they want to use a third-party company with a TCOE capability, from 19% in 2013, and 15% in 2014, to 11% in 2015. This year's finding demonstrates that the full black box-based outsourcing model continues to decline. Complete outsourcing of the TCOE to a third party company brings the challenge of how to ensure the right business focus, partners' business knowledge, and retention and development of in-house knowledge in the long term. Additionally, the shift to more agile development supporting Digital Transformation initiatives makes co-managed merged teams a more attractive option.

For the first time last year, the study reported an increase in organizations looking at hybrid models and building a co-managed model, rather than just internally managed or pure third party vendor TCOEs. The hybridization of testing teams reported in the World Quality Report 2014 continued this year. Embedding testers in SCRUM development teams has resulted in an increase in hybrid TCOEs.

The modern, agile TCOE involves much more distributed team working than ever before. In-house QA teams, third party vendor teams, and captive centers at strategic development locations must all manage peaks and lows in

capacity demand, with the associated fluctuations in team size. Captive centers play a critical role, dealing with sensitive information or intellectual property, as well as with business critical or complex tasks. However, the hybrid form creates a more difficult to manage distributed organization of QA and Testing professionals. The solution to this management issue is to install a Test Management Office (TMO) within the TCOE to achieve the right balance of knowledge and delivery capability. The TMO is typically a co-managed function and mitigates any knowledge risk failing to deliver a return to the business. It achieves this by leveraging investments made in the captive centers at strategic locations.

Of those IT executives with plans to set up a TCOE in the next two years, including an agile TCOE, 65% want to set up a de-centralized TCOE for improved agility and efficiency. This is followed by models that enable faster time to market and are cost effective, such as hybrid models leveraging nearshore and offshore. As discussed above, collaboration in a captive TCOE is key for maintaining knowledge effectively, which explains the relatively high interest (60%) in the Build Operate and Transfer (BOT) model for captive.

Important Elements in the setup of TCOE

FIGURE 22
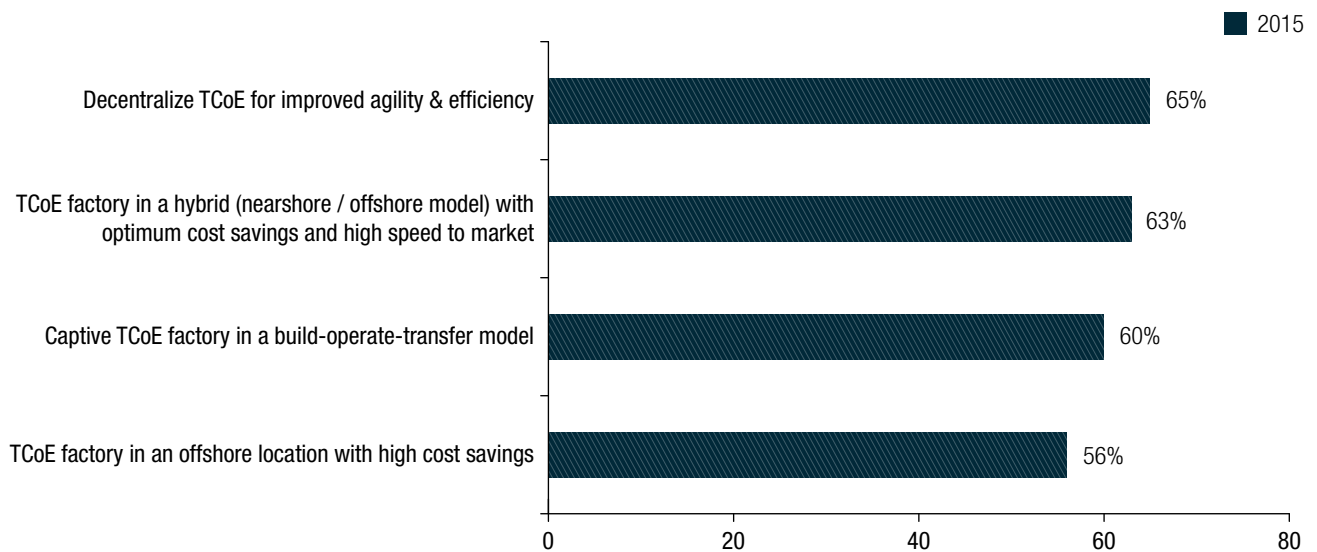
The future of the agile testing function, TCOEs and shared roles

Looking ahead for the mature agile testing organization, it will operate either as a shared function across the individual SCRUM teams, or as localized experience within SCRUM teams. The core team will intelligently organize roles, such as SDET, environment specialists, and services automation specialists, as well as business QA testers, performance and specialized testers, and both automated and functional testers. Architecture, developer tester and application programming interface (API) skills also need to be built, and business expertise must be embedded, with an understanding of customer value and business processes.
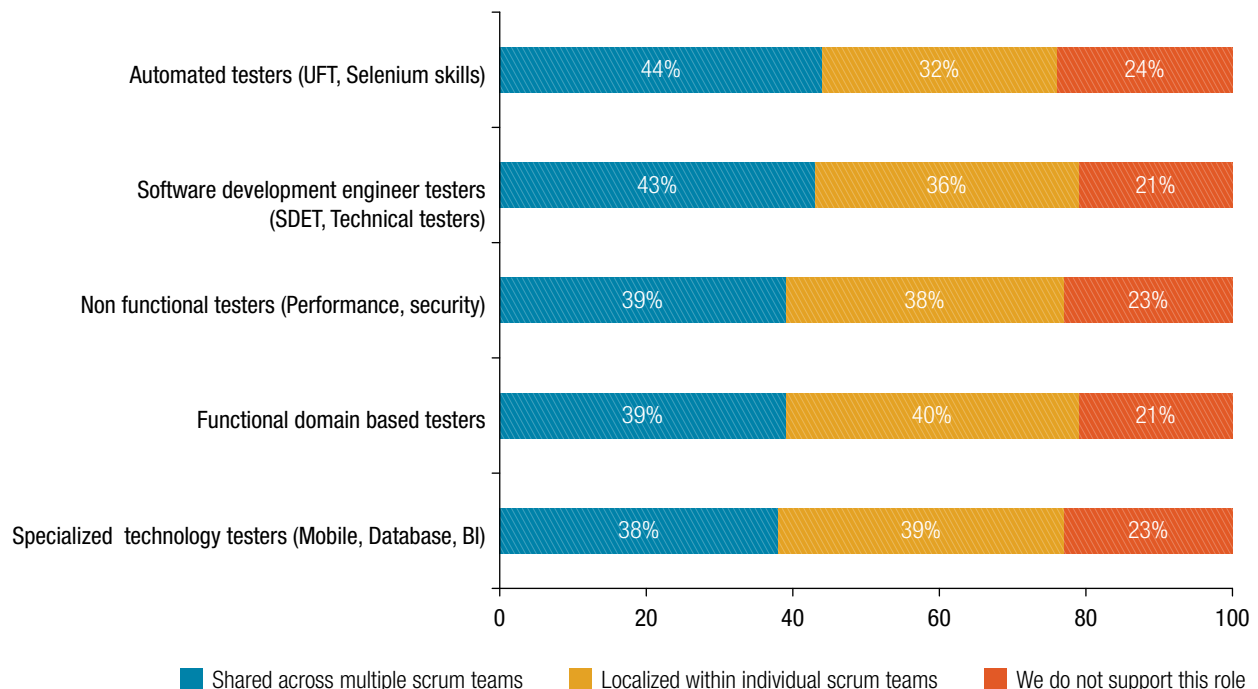
The 2015 study shows that in an agile TCOE the SDET role is already emerging, with only 21% of respondents stating they do not support this role. The data also indicates that

the more specialized roles such as automation testers, non-functional testers, and SDET are those largely shared across SCRUM teams, while functional testers are aligned with individual SCRUM teams.

We can see, therefore, that the hybrid model has truly emerged for the agile TCOE. Whether the roles of SDET, automated tester, and functional domain tester are shared or located within individual teams depends on various factors. These include agile maturity, business proximity, distributed agile choices, technology challenges, cultural nuances and communication mechanisms. Another factor in the success of QA and Testing in agile is a balanced global delivery model with greater adoption of distributed agile through the creation of nearshore teams closer to the business.

Roles in Agile TCoE

FIGURE 23

Role	Shared across multiple scrum teams	Localized within individual scrum teams	We do not support this role
Automated testers (UFT, Selenium skills)	44%	32%	24%
Software development engineer testers (SDET, Technical testers)	43%	36%	21%
Non functional testers (Performance, security)	39%	38%	23%
Functional domain based testers	39%	40%	21%
Specialized technology testers (Mobile, Database, BI)	38%	39%	23%

Test automation makes significant inroads

The level of test automation is one of the key indicators of a testing organization's efficiency. It is imperative that test automation is increased. This will enable the continuous testing approaches that are gaining ground to improve time-to-market with agile and DevOps adoption in a fast-paced digital environment. Maturity and availability of a variety of test automation tools (both licensed and open source) is driving the increased adoption of test automation across the software development cycle.

Test automation has a come a long way from the traditional graphical user interface- (GUI) driven, record and playback testing and defect management. It now embraces the integrated automation of QA aspects across the lifecycle: from management of requirements, to test case generation, test data management, test environment management, service virtualization, and build deployment. It also covers provisioning of cloud-based environments at the click of a button and real-time quality status reporting.

The past 12 months have seen a big jump in the number of test cases being automated, up from just 28% in 2014 to 45% this year. Despite this jump, however, it should be pointed out that the continued reliance on manual testing is still perceived as the top technical challenge for application development by the most number of respondents across all sectors (39%). Similarly manual testing is viewed as the foremost challenge by the highest percentage of respondents in the UK (83%), Asia (49%), Australia and New Zealand (53%), Middle East

(46%) and parts of Europe (40%+). So, while automated testing is maturing, it still has a considerable way to go.

Nonetheless, the rise in automated test case usage is significant. It outstrips last year's seemingly ambitious target to see 35% of test cases automated in 2015, and even outpaces the 2017 target of 40%. This increase needs to be seen in the context of a growing adoption of agile and DevOps, and a reduction of test automation challenges. From an agile and DevOps perspective, as these methodologies mature, so new tools are introduced to enable agile and continuous testing.

Maturing automation practices, the availability of the right tool sets, and improved tester skills have all driven a significant reduction in test automation challenges, including the inability to apply test automation at appropriate levels. In 2014, 55% of the World Quality Report respondents reported that they had challenges with this; it has significantly reduced this year to 27%.

The adoption of automated testing is at its highest in Financial Services, which uses automation in 47% of test cases. This is closely followed by the Telecom, Energy and Hi Tech sectors, all at 46%. Performing the least is the Transportation sector (<41.5%). Regionally, North America, Australia and New Zealand and the Nordics are the biggest users (45 %+), while Southern Europe (39%) and the UK (41%) are lagging behind in test automation.

Percentage of automated test cases within the organization
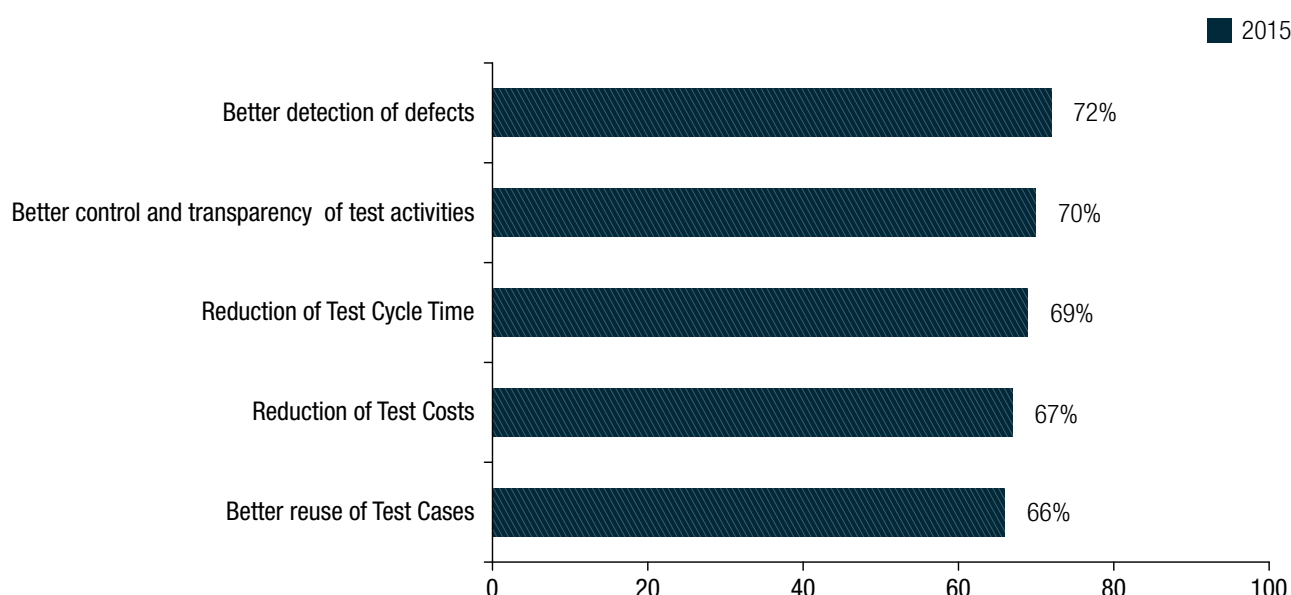
FIGURE 24

2015   2014

45%

28%

Better detection of defects is the number one benefit

There is a change in the way automation is viewed. While a reduction in cycle time is seen as the most important benefit in other aspects of testing, the highest scoring benefit of automation is to achieve better detection of defects, cited by 72% of all respondents. This is followed by better control and transparency of test activities (70%). This aligns with the traditionally accepted objective for automating, which is to

cover more tests, faster, more efficiently. Simply as a result of the higher test coverage made possible by automation, more defects are likely to be prevented. The fact that better defect detection is viewed as the top benefit points to the growing maturity of automated testing. Test automation ensures that the testing is in line with the pace of development and delivery, without sacrificing quality.

Test Automation Benefits

FIGURE 25

■ 2015

Better detection of defects	72%
Better control and transparency of test activities	70%
Reduction of Test Cycle Time	69%
Reduction of Test Costs	67%
Better reuse of Test Cases	66%

> We have seen the benefit of automating our testing process. In a few years, all our testing will be automated.
>
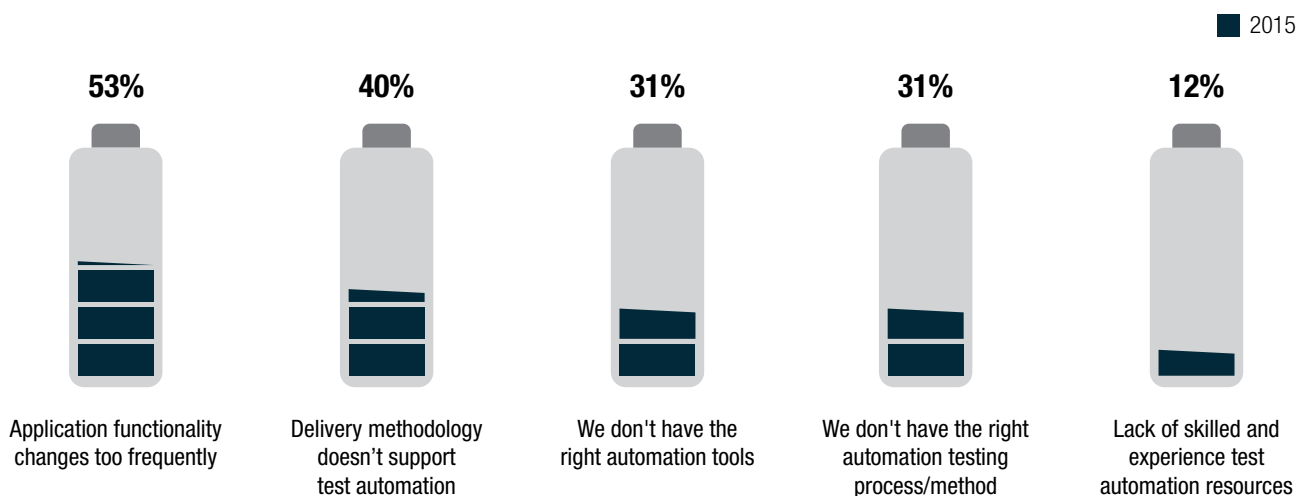> **Test Manager**
> *High Tech, Belgium*

In adopting automated test cases, one of the primary challenges is the frequency of application functionality changes. This is cited as a challenge by 53% of the study respondents, followed by delivery methodologies that do not support automation (40%). Despite these challenges, organizations have still achieved an increase in the level of automation. Nonetheless, with ever shortening time frames, the approach and ease of creating automated test cases will have to change. It needs easier-to-use tools adopted earlier in the lifecycle, with simulators and generators to allow continuous test automation in an agile/DevOps world.

Automation is a sign of testing maturity when combined with sound risk-based test strategy approaches. It should be driven to the most efficient level possible, although there will also be a need for some manual testing. In the ideal, and mature, testing environment, some 70-80% would be automated. This requires the adoption of new generation test tools, supported by a strategy to automate while you test. Automation should not be considered as the secondary activity behind manual testing. In future all the tight integration of various tools across testing will enable development of automation scripts during the requirements phase itself. These scripts will mature as the lifecycle progresses, driving unit and integration tested code as soon as the developer finishes building. It will then trigger functional, regression and progression automation once it is automatically deployed on the target test environment.

Test Automation challenges

FIGURE 26

2015

| 53% | 40% | 31% | 31% | 12% |

Application functionality changes too frequently

Delivery methodology doesn't support test automation

We don't have the right automation tools

We don't have the right automation testing process/method

Lack of skilled and experience test automation resources

Test Environments and Test Data Management

Managing Multi-Dimensional Complexities in an Increasingly Integrated Environment

There is evidence of increasing maturity in both test environment management (TEM) and test data management (TDM). The challenges in TEM across tools, skills and processes are reducing year-on-year. Growing adoption of DevOps is driving virtualization and automated provisioning of the test environment. Effective use of virtualization is also reducing the complexities of test data sets during testing. These combined trends are driving new test efficiencies, which are vital for the volume and velocity required in today's digital landscape. The following chapter discusses the emerging trends in each of the two distinct, yet complementary, areas of TEM and TDM

Test Environment Management — Maturing along with new development approaches

TEM is typically a major topic of interest for those organizations intent on achieving professional and industrialized test environments. This is only increasing further with the emergence of agile and DevOps, as well as the incremental adoption of cloud technologies and virtualized solutions as a substitute for physical environments.

The World Quality Report 2015 survey findings reveal a continued decline in the challenges being faced across processes, tools, skills required, and the availability of the right infrastructure. This, along with integration of efficient testing practices, is enabling TEM initiatives to help drive testing efficiencies. The survey findings also indicate incremental growth in the automated provisioning of environments.

At one level, this is the result of the adoption of agile and DevOps practices across the spectrum, which reduces the wait time for environments and eliminates manual error in setup and configurations. At another level, this is also the result of a technology push paving the way for cheaper, faster and better TEM tools. Market competition is also resulting in
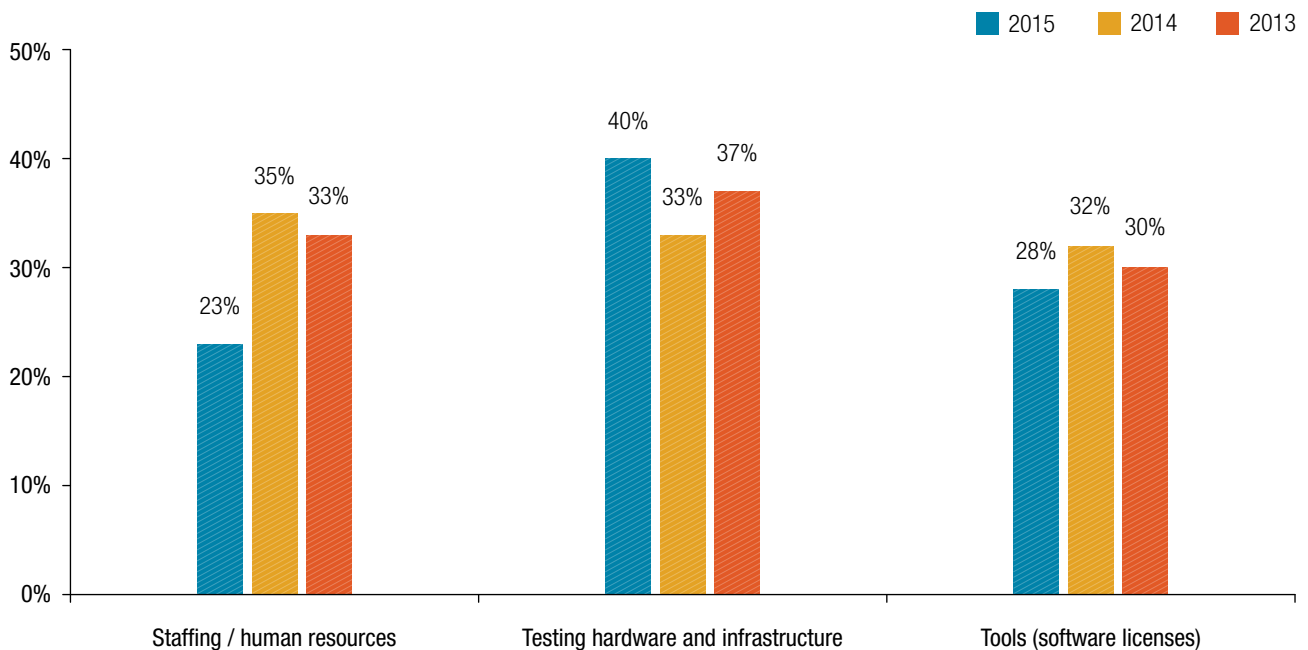
the adoption of new technology. With all the Open Source freeware and inexpensive cloud options, the barriers for use are low. Agile and DevOps take advantage of this and QA has to keep pace.

The 2015 research data indicates a 4% increase (to 37%) in the QA and Testing budget allocated for the testing of hardware and infrastructure, reversing last year's decline. This is allied with a reduction in the budgets for both tools and human resources.

In the 2014 research, the drop in budget for testing hardware and infrastructure was attributed to a number of reasons, including the growing use of virtualization to replace traditional infrastructure, and an increased use of Cloud. This year the survey data points to the QA community seeking to get the right balance between dedicated/permanent physical environments (44%), virtualized (46%) and cloud (41%) environments.

Allocation of Testing Budget

FIGURE 27

Legend: 2015 · 2014 · 2013

Staffing / human resources: 23%, 35%, 33%
Testing hardware and infrastructure: 40%, 33%, 37%
Tools (software licenses): 28%, 32%, 30%

> We have taken huge efforts to generate a suitable testing environment.
>
> **IT Director**
> *Retail, Germany*

DevOps driving forward Virtualization and Automated Provisioning

DevOps initiatives across all sectors are driving more adoption of virtualization and the automated provisioning of test environments. As mentioned above, an average 46% of respondents use a virtualized test environment (embracing both hardware and services virtualization, with the emphasis on hardware in this instance). This reduces dependence on the availability of physical infrastructure and eliminates manual error in setup and configurations.

For organizations using DevOps, this percentage is higher at 51% overall. In this latter group, and with the cost pressures building, small (58%) and medium-size enterprises (53%) have taken the lead in test environment virtualization. This is a substantial amount more than large institutions, where 42% of those organizations with more than 10,000 employees use virtualization of test environments in DevOps.

This test environment virtualization (hardware and services virtualization) is most used in the Telecom, Media and Entertainment (TME), Consumer, Product, Retail Distribution and Logistics (CPRD), and Healthcare sectors. A 50%+ usage by respondents in each of these sectors indicates they use it as a regular practice. Regionally, the more mature regions with a higher adoption rate of both virtualization and automated provisioning of test environments include North America, Australia and New Zealand, and the UK.

Test environment virtualization, along with automated provisioning, is enabling continuous testing. This improves time to market by providing an almost instantaneous and flexible solution for setting up integrated test environments. More over these solutions are helping to reduce the complexities of achieving consistent test data sets for integration testing, which is a plague for traditional physical integration test environments.

Test Environment types

FIGURE 28
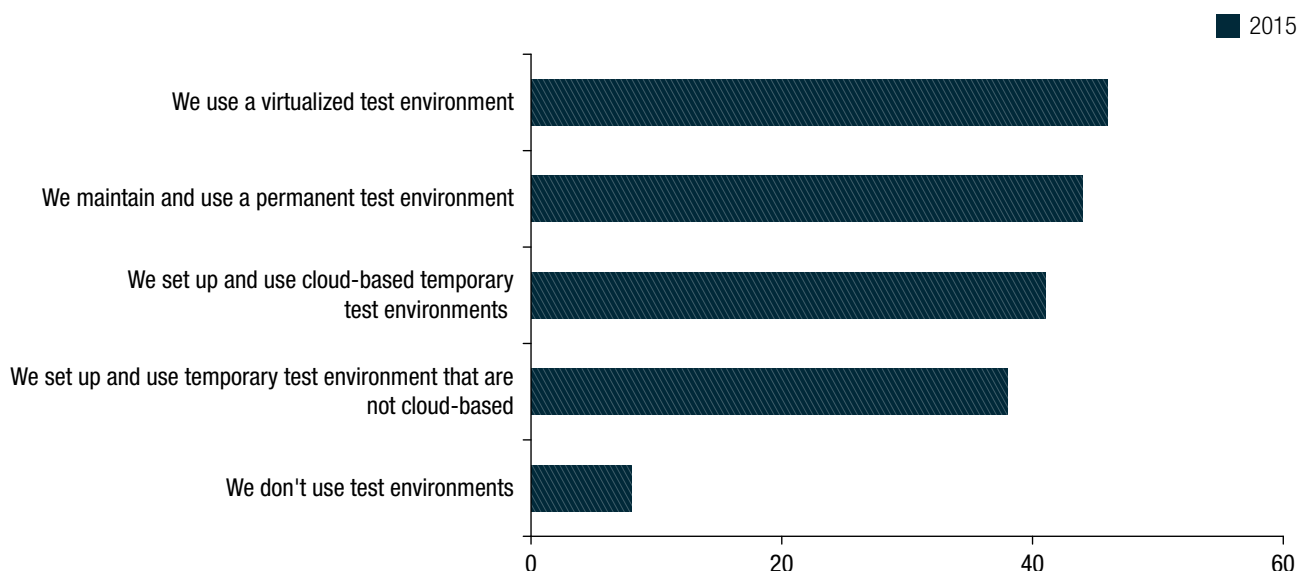
We have decided to go for a structured approach in order to gain full control of all our testing data.

QA Manager
Telecom, Germany

Adoption of Cloud-Based Test Environment is on the rise; there are still some cautious players
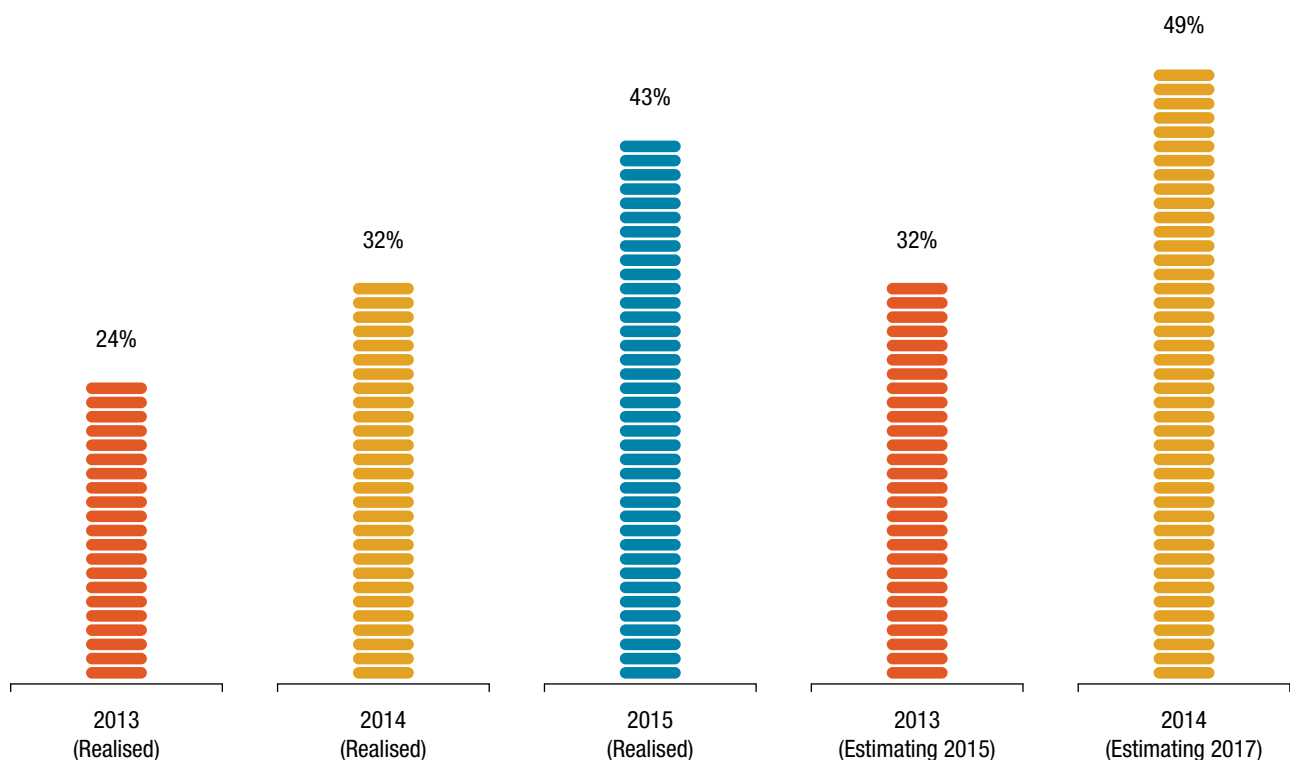
Over the past three years there has been increased adoption of cloud capabilities to provide alternative test environments. Energy and Utilities, High Tech, including hardware vendors, and TME organizations are the biggest adopters of cloud-based test environments.

While this adoption is on the rise in the modern digital enterprise, there is a growing trend of using it for testing internal critical applications and a decreasing trend for external applications.

Risk averse sectors, such as Financial Services, still rely largely on physical test environments, more than cloud-based or virtualization. However, we believe that as security and scalability concerns are addressed as part of ongoing Digital Transformation programs in the near future, there will be more adoption of these flexible test environment solutions in these sectors.

Percentage of testing performed in a Cloud-based test environment

FIGURE 29

2013 (Realised)	2014 (Realised)	2015 (Realised)	2013 (Estimating 2015)	2014 (Estimating 2017)
24%	32%	43%	32%	49%

Real Challenges, but not around process, tools or skills

Continuing the trend from the 2014 research report, the test environment challenges relating to having the right hardware and infrastructure, as well as process and skills, are further reducing. The automated provisioning of environments, along with cloud offerings, means that it is possible to replicate environments at a single click across the network, significantly helping to create environments on the fly. This is reducing the time to build an environment from months or weeks, down to hours and minutes. Last year 54% of respondents indicated that they still had problems with the right test environment tools, but this trend has significantly reduced in 2015, down to just 30% of respondents. This clearly indicates that with access to the right tools, hardware and skills, the test environment practice is maturing.
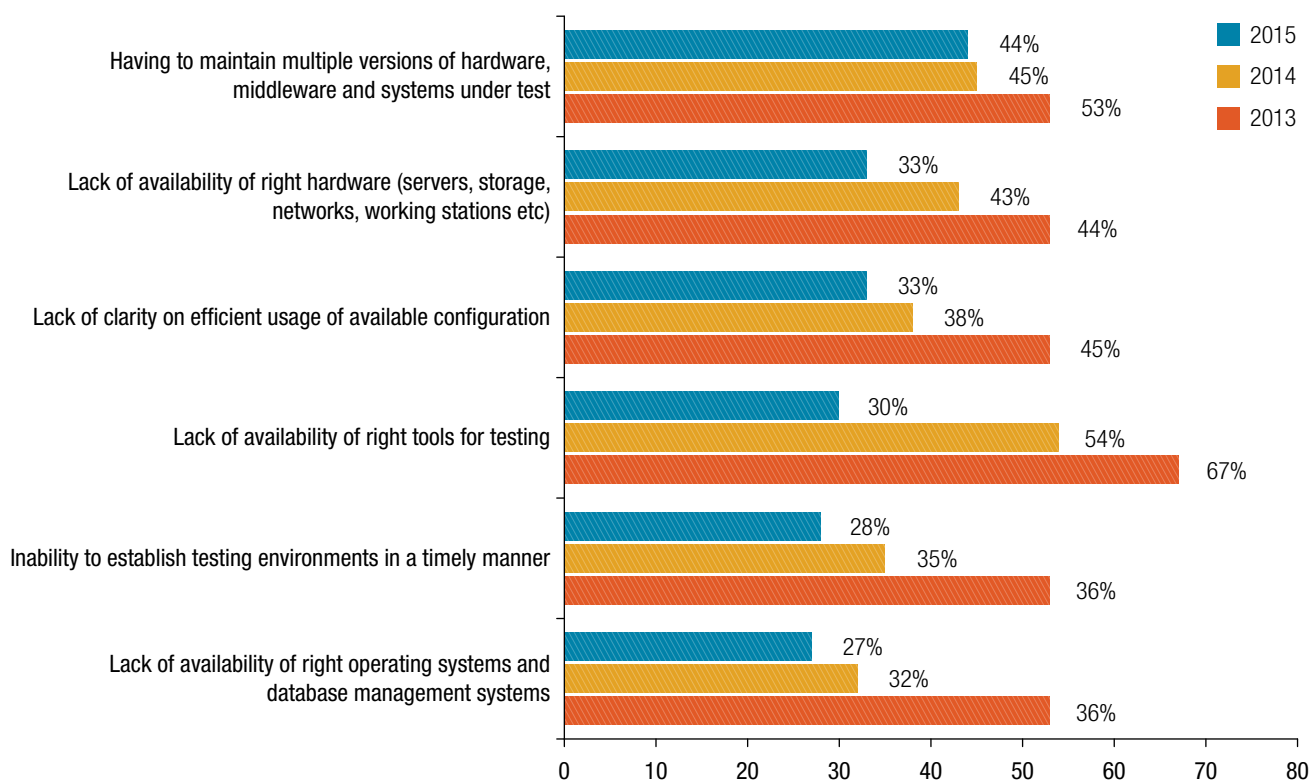
But the challenges still exist around managing and maintaining multiple versions of hardware and systems under test. There are also difficulties with the effective utilization and scheduling of environments, with multiple stakeholders seeking to use shared environments. Another key challenge emerging is the need to build and maintain the environments (physical or virtual) in the event of complex integrated setups. This difficulty arises as a result of the growth in number and complexity of integration points between newly introduced digital services and the traditional, often legacy-based, back office systems.

With increased agile trends and interdependency, as well as the increasing complexities of test environments, it has become difficult for testing teams to have end-to-end test environment availability. In future, better environment orchestration layers, combined with Cloud and service virtualization, will not only reduce the challenges around building complex environment, but also improve time to market and drive down costs.

Challenges with Test Environment Provisioning

FIGURE 30

Challenge	2015	2014	2013
Having to maintain multiple versions of hardware, middleware and systems under test	44%	45%	53%
Lack of availability of right hardware (servers, storage, networks, working stations etc)	33%	43%	44%
Lack of clarity on efficient usage of available configuration	33%	38%	45%
Lack of availability of right tools for testing	30%	54%	67%
Inability to establish testing environments in a timely manner	28%	35%	36%
Lack of availability of right operating systems and database management systems	27%	32%	36%

Test Environment will become more automated and incorporated in Testing Centers of Excellence

Last year's report highlighted the changing scope of the Testing Center of Excellence (TCOE) delivery model, with more incorporation of test environments. This trend continues in 2015 and gives the testing team better control over the availability of the test environment, time needed to set it up with required test data, and environment booking to avoid any conflicts. Interestingly, 20-30% of the TCOEs offer the test environment as a horizontal shared services function. This is an emerging trend observed in mid- and large-size organizations across different geographies. It offers better control over the testing lifecycle and system complexity/interdependency of test environments, enabling end-to-end testing. The scope of TEM teams has expanded from application installation, configuration, data provisioning and continuous monitoring and services management. With the help of system administrators and database administrators (DBAs), the scope now embraces build and deployment as well. The infrastructure piece of the puzzle is still, in most cases, managed by independent infrastructure teams, either in-house or by vendor partners.

Looking ahead, TEM will be integral to testing organizations and TCOEs rather than testing being a consumer of TEM services. It will also be highly automated and integrated with DevOps solutions. Highly automated test-focused environments, along with test data provisioning, will be the reality to drive testing efficiency higher in the near future.

Test Data Management remains complex

In a rapidly changing environment, organizations continually need their applications to be modified, integrated and enhanced with new functionality and improved performance. With this amount of change, flexibility, speed, and cost effectiveness have been identified as key to success. The creation and management of test data required to run tests and validate outcomes is a challenge of its own.

Specific to application testing, organizations recognize the importance of creating a solid centralized approach to test data management (TDM). The test data strategy and management are, in most organizations, still fragmented. We observe that most enterprises are looking to enable test cycle time efficiencies through managed data deployment and usage. Organizations also want to eliminate single points of failure, test data corruption, usage conflicts, and inconsistent practices/processes.

As a part of TDM strategies, test data privacy has become a central focus. In this context, the term "privacy" includes the concepts of data masking and personal data anonymization. In addition, enterprises recognize that to meet current and future demands, they must be able to utilize suppliers' (domestic and international) testing capabilities. Importantly, without the ability to anonymize data in a secure, consistent and efficient way, the use of external suppliers (particularly those offshore) will be limited.

Where previously there was a lack of understanding about the importance of effective TDM, the emergence of the Testing Data Manager role is evidence that it is beginning to get the attention it deserves. The right data available at the right time is essential for making predictions about what needs to be tested. And with the rise of test automation, which requires a fixed set of data, this has never been more important.

The challenges around test data are largely reducing with the help of various data generation techniques. These include synthetic data creation using the graphical user interface (GUI), in-house custom made scripts, leveraging standard industry tools, and test data generation by taking production data and masking it.

While there is a net decrease in the challenges encountered with test data, there are continuing difficulties as a result of the adoption of agile, DevOps and cloud initiatives. These make the test data creation and maintenance process complex. In these situations it is difficult to synchronize the testing, control the data, and maintain the right set of test data across multiple versions of hardware, middleware and systems under test. For example, when applying testing in an agile environment, 31% of the 2015 survey participants report that a lack of the right test data and test environment is a challenge.
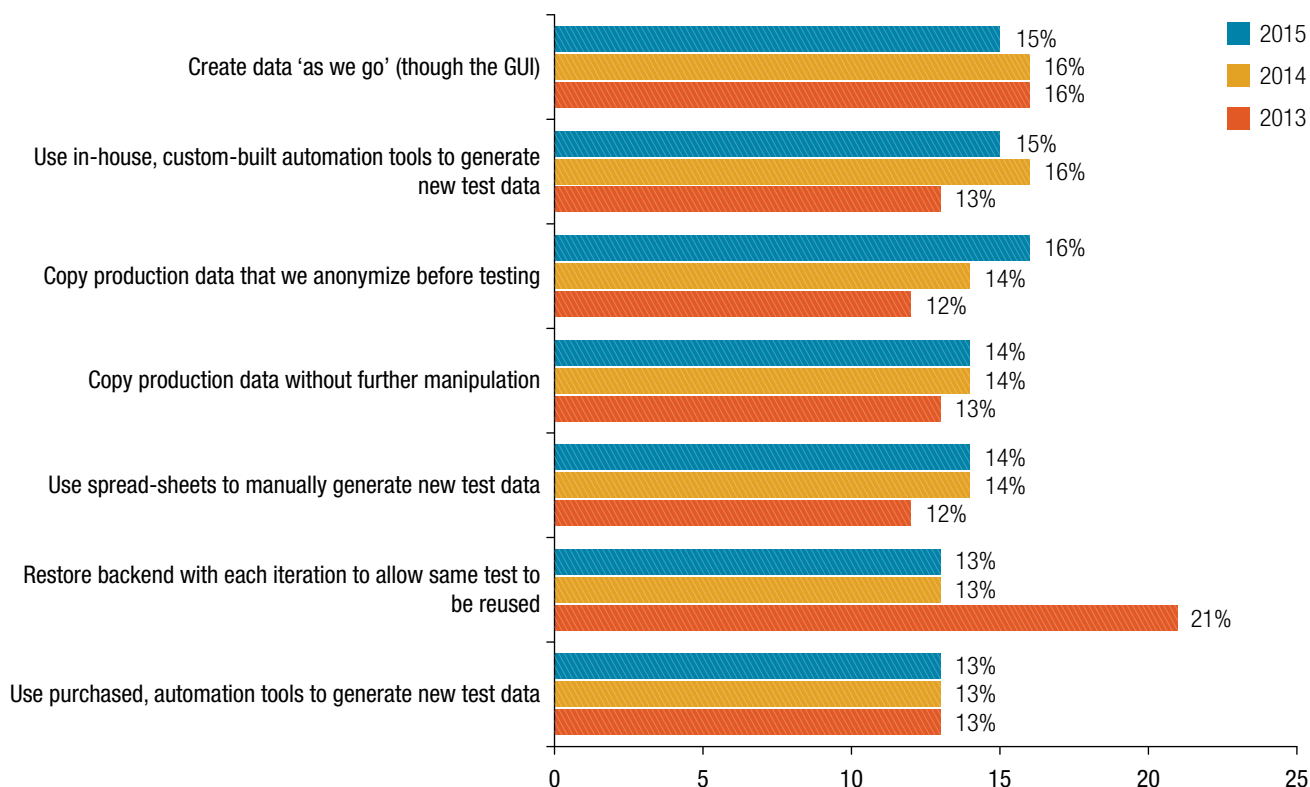
Managing test data in general is a growing concern (the only one to increase over last year). Some 44% of survey respondents report that maintaining the right test data set versions with different test versions is a challenge. In contrast, with more organizations planning to adopt service virtualization as an alternative to physical test environments in the future, the creation of complex test data sets for end-to-end workflows will become easier. For example to validate the entire banking transaction via a mobile application, the testing team can test it against a virtualized service instead of creating end-to-end test data sets across multiple applications stacks.

It is clearly evident from the 2015 findings that TDM continues its progress on the maturity curve. Use of the right tools for synthetic data creation, managing the size of the data, effective use of the data masking techniques for production, and addressing data security and data privacy regulation are all having a positive effect. Despite concerns around major data breaches and a significant focus in some organizations on addressing TDM challenges, the reducing trend in test data challenges from 2013 to 2014 has continued in 2015.
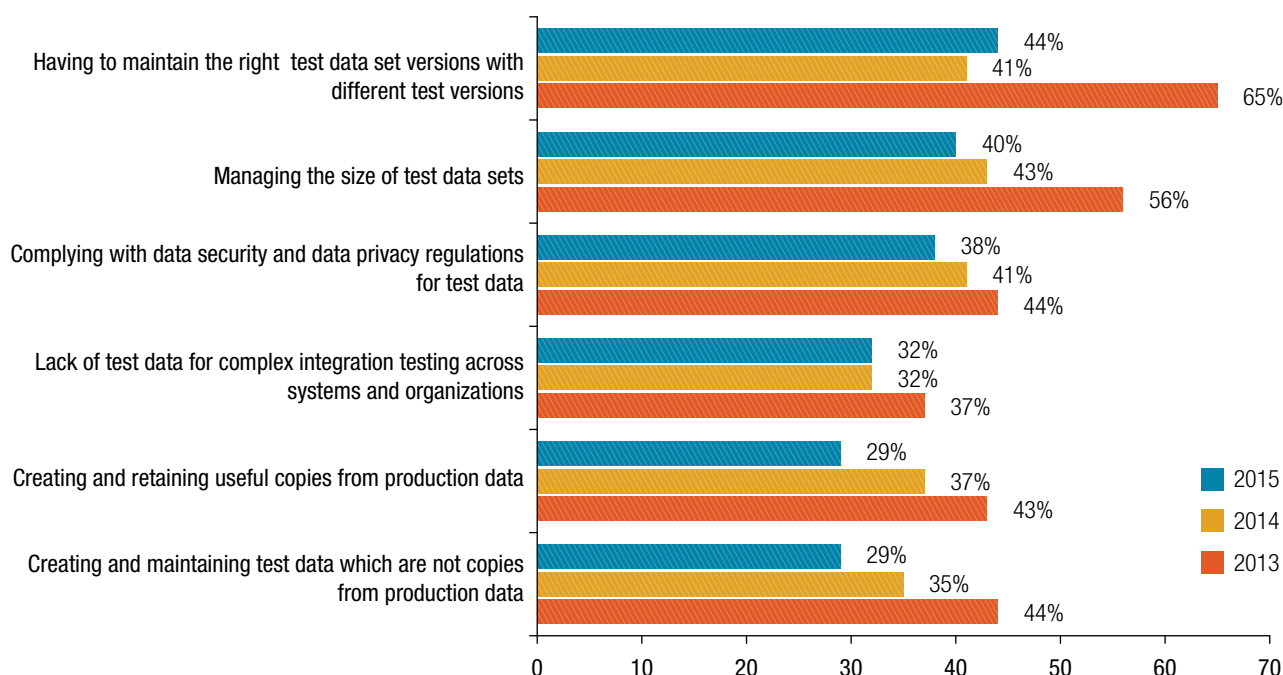
Test Data Generation techniques

FIGURE 31

55

Challenges in managing test data

FIGURE 32

Having to maintain the right test data set versions with different test versions
- 2015: 44%
- 2014: 41%
- 2013: 65%

Managing the size of test data sets
- 2015: 40%
- 2014: 43%
- 2013: 56%

Complying with data security and data privacy regulations for test data
- 2015: 38%
- 2014: 41%
- 2013: 44%

Lack of test data for complex integration testing across systems and organizations
- 2015: 32%
- 2014: 32%
- 2013: 37%

Creating and retaining useful copies from production data
- 2015: 29%
- 2014: 37%
- 2013: 43%

Creating and maintaining test data which are not copies from production data
- 2015: 29%
- 2014: 35%
- 2013: 44%

Legend: 2015, 2014, 2013

Multiple solutions for creating Test Data are in use

There is no clear leading technique being used for TDM, but the survey data points to an incremental adoption of custom made and off-the-shelf tools (overall 30%+). There has also been a slight (2%) increase over the last year in the use of production data with or without masking and manipulation techniques (used by 30% of respondents). Using production data for testing is always questionable, so must be managed carefully.

The increasing percentage of survey participants using copies of production data without any manipulation or masking is a concern. That's because these organizations are likely to breach data security and data privacy regulations in doing so. Moreover, using production data limits the possibility of automated test scripts running unattended. While using production data for test is a practical approach if there are few or no alternatives, the issues around increasing cloud adoption, and its associated security concerns when using production data, indicate that a different way of generating test data must be explored. After all, with protecting the corporate image identified as the top strategic priority of QA and Testing in this year's survey, few organizations can risk the potential security issue this approach could cause. As an alternative, masking on-demand features should be implemented before the data is used for testing in all future scenarios where production data is used.

Integrating testing on an enterprise level and beyond the enterprise sees a reliance on other firms and suppliers. There is often a dependence on service providers to perform tasks and their independent working can give rise to the challenge of how to create test data. One route is to generate the tools yourself and the World Quality Report 2015 survey findings show that this is happening. Synthetic data creation with the aid of off-the-shelf tools and custom built spreadsheets or tools is being used by 30% of respondents. This supports the quick generation of data in a consistent manner, making it an ideal method for test case data in continuous testing, as used in DevOps. More synthetic end-to-end test data creation techniques and an on-demand masking feature will significantly reduce the dependency on data restoration from back-end systems.

Looking ahead, while the perfect test data management solution is not yet here, there is growing adoption of the tools needed to manage complex data sets. There is a case for technology partners to help the testing profession change the way it functions. Such partnerships should support a more structured and balanced approach using synthetic data creation, with less reliance on leveraging production data to facilitate continuous testing in every maturing testing space.

Sector
Analysis

Automotive

Putting the customer at the heart of digital transformation

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

The Automotive industry is experiencing uneven growth depending on which region in the world we turn the spotlight. North America and the UK both exhibit a buoyant Automotive sector, whereas growth in the likes of Latin America, Russia and the biggest vehicle market China has slowed. What is consistent, however, is the significance of Digital Transformation. This is a continuing and strategically important trend. At the heart of this Digital Transformation sits the customer.

Automotive companies are viewing customers across the vehicle-owing lifecycle. They should stay in contact from the early stages of customer interest, through purchasing, maintenance, re-selling and, ideally, re-purchasing their next car. Digital, or more specifically the data it brings to the mix, is crucial to helping companies build a life-long loyalty to their brand. Today's connected cars have digital embedded in them and the Automotive sector is at the forefront of using digital to interact with the end customer.

Modern, digitally enabled cars are a node on the network from which data about driver behavior and preferences can be gathered. The Original Equipment Manufacturers (OEMs) are taking this very seriously. A number have formed their own datacenters equipped with data analytics capabilities to capture, interpret and act on the information gathered. The World Quality Report 2015 research findings reveal that 66% of respondents in the Automotive sector now have business/predictive analytics specialists in their testing organizations,

and 47% use predictive analytical techniques to construct test strategies. They use 'Big Data' to inform the nature of new vehicle variant releases and pricing bands. In the coming years, ownership of that data will be a commercial, and potentially legal, battlefield.

Investment in connected cars is very much about new generation vehicles, rather than retrofitting old cars. The feeling is clearly that people will want to buy new smarter cars with all the connectivity that comes with them. This connectivity has led to an interesting trend. As discussed earlier in this report, security is ranked the highest in terms of IT strategy priority and the Automotive sector is no exception to this. Smart, connected vehicles have the potential to be hacked. This poses the risk of criminals unlocking keyless cars simply by hacking into the software. This was demonstrated recently in Germany in a high-profile 'ethical hack' of a leading manufacturer's software.

This has implications for the entire software development cycle, not just testing. Quality Assurance must start at the beginning: with the architecture. In particular, the mobile architectures on which the connected vehicle is built must have security at their core.

Testing behaviors have to respond to this increasing security challenge too. Customer features in mobile applications need to reflect that users can be anywhere, at any time, doing anything. The testing cycle must focus on the user

experience to address how, where, and which applications are being used and make them secure.

With the growing uptake of smart vehicles and challenges around both security and the need to get to market quickly with new variants on existing models, it isn't surprising that the sector is spending more on QA and Testing. In 2015 it allocated 35% of the overall IT budget to QA and Testing. This is 6% higher than the 2014 allocation and exceeds last year's forecast for 2017 of 29%. Looking ahead, after a fairly big increase over the past 12 months, the sector predicts this to rise by just 2% to 37% by 2018.

This spending embraces diverse security testing activities. This ranges from manual code review (59% of respondents), to static application testing (54%), dynamic application testing (64%) and penetration testing — ethical hacking — (39%). The sector also utilizes a mix of delivery approaches, with its own internal security testing team and tools most used at 48% of the 2015 study respondents. Not too far behind, however, is the use of managed application security testing services (43%), and external testing teams on a project-by-project basis (41%).

The need to industrialize QA and Testing to become ever more efficient is a general IT trend. For the Automotive sector, some 25% of organizations surveyed (a 5% increase on last year) say they plan to develop an internally managed Testing Centre of Excellence (TCOE) within the next two years, with all the inherent industrialization and process controls that this brings. A further 20% already have a fully operational TCOE using in-house capabilities, while 13% plan to use a third party company with a TCOE capability.

Discussion within the industry is ongoing about the merits of both internal and external TCOEs. There is no clear picture yet as to which one will prevail in the coming years. Large automotive vendors are bundling test activities together and investing in offshore TCOEs in low cost countries for their own IT and infrastructure engineering requirements, including testing. But the trend is to do this with the support of large IT vendors proficient in industrialization. Some 10% of the Automotive sector participants in this year's study say they already have a fully operational TCOE via a third party.

In the coming years, as confidence in external TCOEs grows with awareness of the potential benefits of industrialization, automation and shared functionality, we expect more use of TCOEs and offshoring.

Agile development and testing is an increasing trend in the Automotive industry. Almost half (47%) of the executives interviewed for the 2015 study from this sector now use agile development methods. Of these, 67% use functional automation and agile lifecycle management for their agile testing, followed by exploratory testing (53%). Automated regression testing within agile is important in terms of speed to market. Traditionally it took six years to take a car from concept to production, making it incredibly difficult to predict demand. Agile is changing this with shorter development cycles creating a more dynamic marketplace. The huge programs of concept and software development have shrunk and agile is enabling more regular and faster release of new vehicle model variants.

Using agile and DevOps, manufacturers are able to respond to the demand of their marketing teams for more customer-centric products, launched more often. The predictive analytics of Big Data helps them to understand specific-customer preferences in order to differentiate their portfolios. Agile development and testing then enables faster release of new software with which to populate niche vehicle models targeting different age groups, country-specific trends, etc.

As a product-centric industry, the Automotive sector's test coverage is big and will continue to grow as the concept of connected vehicles takes even stronger hold. Research is ongoing into the further development of 'hands-free' or autonomous cars, although it is unlikely that we will see big changes in every-day driving experiences for a decade or so. Currently, in the eyes of the law, smart functionality assists drivers, rather than takes over the responsibility. If, or perhaps when, this responsibility switches to the technology itself, QA and Testing will be even more crucial.

Consumer Products, Retail and Distribution

Direct consumer interactions demand product and service quality that exceeds expectations

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

Etienne Cartigny, Testing Delivery Leader, *Capgemini Netherlands*

Greater consumer intimacy is an overriding trend in the Consumer Products, Retail and Distribution (CPRD) sector. It is driven by consumer preference for more personalized experiences, and enabled by Digital Transformation within an inherently multi-channel market model. There are complications, however, due to concerns around how (much) data is collected, handled and used.

Organizations in this sector want to talk directly with their customers via every possible channel, such as mobile, (support) websites and web stores. By applying advanced Big Data and analytics solutions to all available information relating to product selling, consumer behavior, marketing results, etc., CPRD companies are able to respond rapidly to changes in customer demands. This data transformation and the demand for more personalized end products have an impact on IT as the number and velocity of applications built and deployed increases.

Unsurprisingly, 80% of CPRD executives interviewed for this year's World Quality Report cite customer experience as an important or very important aspect of their IT strategy. Security comes in a fairly close second (76%). Both of these strategic priorities demand effective QA and Testing

at pace, and this function now consumes 32% of the overall IT budget, just 3% below the 35% all-industry average. A 9% increase over last year, this reflects the fact that CPRD organizations cannot afford the reputational damage of an application failing to live up to its promise, or perhaps a breach of online payment systems allowing personal data to be stolen. In 2014 and early 2015, several high profile data breaches online, as well as in the bricks and mortar space, caused major financial and image damage, increasing public calls for better protection of their data.

Test case automation is a factor in helping assure quality and speed-to-market. Up to 42% of test cases are automated in this sector, just 3% lower than the 45% all-industry average. The 2015 research data reveals 80% of these organizations cite better detection of defects as a benefit, which is 8% higher than the all-industry average. A reduction in test cycle times is the second most achieved benefit of automation. Reflecting the need for faster time-to-market, it is cited by 70% of the CPRD respondents, a marginal 1% higher than this year's study average.

Of the overall testing budget, some 38% is spent on testing hardware and infrastructure. This is up from 33% last year

and is in line with a similar increase across all sectors [see the chapter on budgets]. Staffing/HR accounts for 33% and tools (software licenses) 28%.This is a slightly different picture to last year, where staffing had the bigger share of the budget. The increase in hardware and infrastructure spending can be viewed in light of increased demand for non-functional testing (performance, security, fail over, etc.), which requires more extensive test environment configuration. A 4% drop in the budget allocated to tools is indicative of greater use of cloud-based testing, which is up from 29% last year to 38% of all CPRD testing in 2015. This is below the 43% all-sector average across this year's research participants.

As an integral element of Digital Transformation, cloud solutions are helping to change the CPRD IT landscape. For testing purposes, 67% of those testing in a cloud-based environment perform functional testing of cloud services, which is similar to last year. Both performance (43%) and security (36%) testing in the Cloud are on the increase, which aligns with the leading objective of QA and Testing in this year's report– that of protecting the corporate image. This is cited by 77% of CPRD respondents, slightly ahead of ensuring end-user satisfaction (74%).

The growing importance of security testing (whether in or outside the Cloud) is similar across all sectors. In CPRD, security testing and reporting are increasingly being requested before production in the development lifecycle. There is often a knowledge gap in this respect and compliance and risk teams are looking externally for specialist help in this matter. This will be a growing challenge as Digital Transformation continues to change the way in which companies interact with their customers. For example, 59% of CPRD organizations focus their mobile applications testing efforts on security, ahead of user interface/ease of use (54%), and functionality (52%).

Agile development is used by 55% of CPRD organizations, which is on par with the cross-sector average of 54%. As in other sectors, there is also a huge appetite for applying DevOps in CPRD organizations. However, 30% do not use DevOps principles, which is significantly more than the 18% cross-sector average for those not using DevOps. This is indicative of the industry's slower IT maturation in comparison to some other sectors, such as Financial Services and Telecom. In CPRD, IT has typically been a business support rather than a driver of change, but this is changing fast as Digital Transformation gains pace.

Data compliance is a hot topic in this sector and many companies are investing in data masking to enable them to use production data safely for testing. In order to be able to perform integration testing across systems, the test data needs to be correct and consistent across these systems. Special care must be taken to preserve this consistency after data masking and scrambling. In addition, when it comes to testing Business Intelligence (BI) applications, validating the correctness of aggregated data results is the most challenging activity for all the CPRD research participants. They rate this as 5.07 on a scale of 1-7, with 7 being very challenging. This is followed by finding the right skilled experts to perform BI testing (4.93), and both validation of data quality and establishing test data sets for BI (each at 4.81).

The adoption of Testing Center of Excellence (TCOE) delivery for standardized and industrialized testing is interesting when compared with all other sectors covered by this year's World Quality Report. Some 26% of CPRD organizations state they have no plans in place for a TCOE, compared with the 18% cross-sector average. On the other hand, 30% have plans to develop an internally managed TCOE within the next two years, 5% above the 25% cross-sector average. Only 5% currently have a fully operational TCOE via a third party, which is below the 9% average. This can be attributed to a recent increased focus on external costs and to multiple vendors managing different aspects of the IT landscape.

Despite the below average use of fully operational TCOEs, CPRD organizations are clearly open to external testing services based on the knowledge that testing is a specialization not always available within limited in-house IT functions. For example, the biggest challenge in testing mobile and multi-channel (mobile, social media and traditional) applications for the CPRD study participants is a lack of an in-house testing environment.

Up to 43% or respondents say a TCOE factory in an offshore location with the ensuing cost savings is important in the setup of a TCOE. In addition, a decentralized TCOE for improved agility and efficiency is viewed as important or very important by 60% of the CPRD executives interviewed, followed at 52% for a hybrid onshore-offshore TCOE. This sector is augmenting its testing services, but on its own terms in a global delivery model. This enables the necessary business interaction and shared language/know-how as needed for successful requirements, design, UAT and run phases.

Finally, on a three-year horizon, the CPRD sector expects the proportion of the IT budget allocated to QA and Testing to increase from 32% this year to 37% in 2018. As discussed in the chapter on budgets, the increase in IT budget allocation is a general trend across all industries, where the average jumped from 26% in 2014 to 35% this year.

Energy and Utilities

Focus of spending turns to managing risk and security as smart solutions mature

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

The pace of the smart revolution in the Energy and Utilities (E&U) industry is slowing as smart grids and metering programs mature. Instead, a number of other trends are currently shaping the industry IT landscape. One of these is the convergence of Information Technology (IT) and Operations Technology (OT). The delineation of what engineering uses and what the business uses as a system is breaking down. Operations depend on data analysis just as much as much as business does. We can see this in the trend towards asset analytics.

In an asset-intensive industry, effective asset management has always been a strategic imperative, but new digital technology and ways of working are driving even more value. Predictive analytics and maintenance tools can yield huge savings. The ability to carry out data links and analyze data in real time for many more assets than has previously been possible is driving efficiency and improved customer satisfaction. This year's World Quality Report study findings show that 64% of respondents from the E&U sector have installed business/predictive analysts in their testing organizations. They are making use of tools such as data lakes and the ability to have large volumes of data in-memory.

In certain E&U industry subsets it is typical for a number of operations to be subcontracted out as-a-service, such as drilling and refining in oil and gas. There is currently a trend for vendors of equipment, such as sensors, to seek to supply a complete package within annuity contracts, and to implement, control, and maintain the equipment for their customer in the field. The way in which some organizations are sourcing QA and Testing services is indicative of this wider procurement model. For example, there is a move towards as-a-service delivery models and managed service contracts.

Even with new service models, the responsibility for outcomes, successes and failures still rests with the energy or utility company itself. If an accident happens, a system fails, or a customer-facing app doesn't deliver on its promise, it's the primary brand — not the third party supplier — that risks being damaged. Thus QA and Testing programs are needed across all operations.

The increase in the proportion of the IT budget allocated to QA and Testing, from 27% last year to 33% this year, can be attributed in part to this need to manage risk. There is evidence of more spending on risk compliance and security. The role of Chief Risk Officer embraces not just assets in the field, but the issue of cyber security, and reputational damage if something goes wrong. In this year's survey, 78% of E&U respondents say security is an important or very important aspect of their IT strategy. It is ranked the single most important aspect with a rating of 6.08 out of 7.

Unsurprisingly, therefore, application security assurance is embedded in every stage of the application lifecycle, from requirements definition (30% of E&U research participants) through development/coding (51%), and on to design (53%) and QA (55%). When asked if they systematically performed security testing in their organizations, 51% said they did so on every release of every application.

A heightened awareness of security is just one of the outcomes of Digital Transformation. There are three dimensions emerging in the Digital Transformation of Energy and Utilities companies: traditional customer engagement; asset and operational excellence; and new business models. In terms of traditional customer engagement, E&U firms are seeking to use digital to engage with their customers and enrich the experience across all channels, whether with mobile apps, online, or via contact centers.

Digital's role in driving asset and operational excellence reflects the trend mentioned earlier of IT and OT converging. Operational systems are used to monitor and manage assets, and safeguard critical national infrastructure. As more and more sensors are installed on equipment in line with the steady progress towards Internet of Things-style platforms, we will see a greater level of QA and Testing rigor on these systems than is typically needed for more traditional ERP and business systems. This is due to their operational significance.

The emergence of new business models built on digital is disrupting traditional ways of operating. Technology developments, such as solar and photo voltaic, are opening the market to new players 'born digital'. Some existing energy companies are looking to expand and become utility providers, adopting service-led models. Mobile apps informing customers about their energy use and enabling remote home-energy system programming are already differentiating the digital leaders. Interestingly, E&U companies allocate the bigger share of their new development testing budget to mobile solutions (18%), alongside similar spending on Business Intelligence (BI) and Business Analytics (BA). This latter spending priority aligns with the increased use of predictive analytics enabling better asset management. Meters, batteries, storage, and other equipment used in this digital environment need to be continuously monitored in order to identify faults before they become a problem. QA and Testing will follow suit, moving from a classical approach to ongoing, real-time monitoring.

These three trends are still emerging and it should be noted that in the recent Capgemini and Massachusetts Institute of Technology (MIT) research into digital mastery, the industry was flagged as 'conservative'.

Driven by customer experience and need for differentiation, utility companies are starting to create more mobile apps for their customers, although in the World Quality Report 2015 study data it is interesting to note that maintenance (52%) gets a bigger share of the QA and Testing budget than new transformational work (48%), reversing last year's trend. As more mobile applications are developed, this figure may see a reversal, although currently 35% of organizations say they don't have the right testing process/method for multi-channel, which includes mobile.

The 'conservative' approach to digital is echoed in the industry's use of agile-DevOps. While the survey data shows that 32% of companies are using DevOps principles in 20-50% of projects, and a further 32% are using DevOps in 50-70% of their projects, in reality this is not a CIO priority at present. Indeed, 45% of E&U survey respondents say they do not use agile testing methods.

Cloud too is an interesting area with CIOs recognizing that they do need a cloud strategy. Currently, 17% of the testing budget is allocated to cloud solutions, behind BI/BA and mobile spending. Strategies are evolving, however, and companies are looking at how to offer complete cloud-based services. For example, can they run new renewable energy businesses in the Cloud alongside existing businesses? New market entrants are likely to be more cloud-based and traditional companies will need to respond and be more aggressive in their Cloud adoption to compete. Managed services will be a factor here, enabling established companies to adopt and use Cloud painlessly.

There has been only a slight increase (just 2%) in companies using a Testing Center of Excellence (TCOE) model, with 26% of respondents saying they have a fully operational TCOE (either in-house or via a third party). This suggests usage has plateaued. However, as the industry continues to monitor more and more assets, the data will need to be passed to QA and Testing teams for assurance and governance purposes. Thus plans to develop internally managed TCOEs within two years (32%) or to use a third party company with a TCOE capability (16%) are in place.

Financial Services

Consolidation, convergence and collaboration characterize an industry that has returned to growth

Anand Moorthy, Global Testing Leader, Financial Services GBU, *Capgemini*

Matthew Chessler, Principal, Financial Services GBU, *Capgemini*

The economic growth reported in last year's World Quality Report has continued over the past 12 months. The Financial Services (FS) sector – banks, capital markets firms, and insurance companies – is in positive mood and looking for growth opportunities. There are a number of trends reflecting this. These include substantial consolidation of regional and local banks, largely in the US but in other areas of the world too, as well as in the insurance sector.

IT landscapes are also consolidating, with data centers, assets, systems, and practices coming together. This latter consolidation in certain cases is a result of mergers, for example in the health insurance sector. Digital Transformation, with its ultimate objective of driving customer value, also brings together multiple platforms, from mobile and web, to customer interaction and back office solutions.

Likewise, more and more FS organizations are looking at jointly working with their technology and IT service vendors. Co-ownership models bring a mutual sense of ownership as FS firms no longer pass off entire functions/ projects, but share the responsibility with their partners. The 2015 research data reveals that 9% of FS respondents plan to use a third party company with a Testing Center of Excellence (TCOE) capability; another 11% already have a fully operational TCOE via a third party. Combining both internally-run and those via third parties, there is an increase

in those with fully operational TCOEs, up to 36% this year, from 30% in 2014.

There is also a convergence of markets, for example in the way in which customer touch points and reward programs operate. A retail outlet, for example, may have an ATM, and banks are revolutionizing loyalty points programs by offering customers greater freedom of where they redeem their points.

This process of consolidation, convergence, and collaboration naturally has an impact on QA and Testing practices. It is no surprise, therefore, that the FS industry respondents to the 2015 research study reportedly allocated a substantial 37% of their total IT budget to QA and Testing. This is a significant 11% increase over 2014.

There is also a growing desire to get more value from QA and Testing as it gains in maturity. For example, those organizations that have moved to hybrid QA and Testing delivery models and realized the efficiencies they were seeking, are now asking 'what next?'. While willing to spend more, they want to know that they will also get more from their investment. New testing approaches, such as entitlement testing (see later in this chapter), new tools, such as test analytics, and different ways of working, including DevOps and cross team cooperation, should yield this value.

DevOps is already a feature in the application lifecycle, with 68% of FS survey respondents saying it is an important or very important aspect of their IT strategy, 5% higher than the cross-industry average. Only 13% of respondents do not yet use DevOps principles, again putting the FS sector ahead of cross-industry norms in its adoption of DevOps.

FS organizations are also looking at more virtualization of their test environments to increase the value from their QA and Testing investment, although there is still a reliance on physical environments. On a par with other sectors, 51% of those FS organizations using DevOps have adopted a virtualized test environment. Testing in a cloud-based environment is also growing in use, but concerns about data security and privacy mean there is hesitancy around putting data in the Cloud. Instead, it is more likely that the FS sector will adopt cloud-based testing in deliberate stages.

As a driver for greater virtualization and gradual adoption of Cloud, there is an emerging trend in Financial Services to switch from a CapEx spending model to OpEx spending. This is evident in the firms looking at moving from large infrastructures to as-a-Service models for their IT delivery. Viewing the test environment as a function that can be managed virtually and with greater automation will enable closer collaboration between test environment and testing teams. Previously, the test environment has often been a bottleneck in the development process due to its lack of automation compared with production environments. This should now begin to change.

Driven by the increased need for collaboration, due to agile and DevOps, along with the shift to automated testing/continuous integration and deployment, many FS organizations are looking at moving operations onshore. This is also due to a focus on improving the Return on Investment. While offshore sourcing of IT services brings cost efficiencies as a given, the move onshore is more about value. Keeping client and vendor in close proximity, preferably in the same time zone, brings its own efficiencies. One US-based FS organization has taken this a step further, locating not just its IT provider closer to home, but taking its entire internal IT function and moving it to a lower cost location within the US, slashing high-cost real estate budgets and reducing CapEx.

There is a knock-on effect on the resourcing of QA and Testing operations in this new, collaborative, often virtual world. Traditional testers are making way for a mixed skillset, with agile and DevOps demanding both technology and development skills in single QA projects. At present, of those FS organizations applying testing to agile development, only 27% lack professional test expertise in their agile teams, which implies that a solid proportion of projects are getting the resources they need.

The continuous testing approach is leading to a higher skill, lower volume strategy, enabling more rapid testing of more frequent application development projects. Indeed, the 2015 study data shows that 51% of the QA and Testing budget this year is focused on new transformational work, with 49% allocated to maintenance. This is a slight drop in the proportion allocated to development compared with last year. One explanation for this is that companies are looking to do smaller releases on a much more frequent basis, hence the shift to what could be considered maintenance.

Financial Services is a leading digital adopter, with 57% of survey respondents already employing a Chief Digital Officer. But this has raised a number of concerns for the QA and Testing function; after all, the impact of getting QA and Testing wrong in this digital environment is severe. Can they provide enough test coverage — and automation — to effectively test networks, devices, and operating systems? And how can they make better use of analytics? As a point of interest, this latter area is something in which capital markets firms are leading the way, using analytics to manage risk exposure and inform trading decisions.

Finally, digital brings inherent security concerns. CIOs are aware of the need to secure the data proliferating across digital channels, devices and systems. And as more organizations move to paperless transactions or re-brand digital operations as e-business offerings, it is no wonder the FS industry places security at the top of its IT strategy priorities. Some 88% of FS participants in this year's survey say security is important or very important. How to secure data throughout the application development cycle has given rise to a new testing approach known as entitlement testing. It is expected that this will be adopted throughout the lifecycle, so that at any given time management will know who is accessing what data and for what reason. With the right process in place, it will be possible to restrict data access and manipulation to appropriate parties depending on the lifecycle stage. Currently still emerging, entitlement testing is something to watch for in the future as the FS industry leads the way in finding new testing approaches that safeguard applications and data.

Healthcare and LifeSciences

Subsectors integrating ways of working with a focus on the lifecycle of care

Michael Mittelstadt, Senior Vice President, NA MALS Sector Head, *Capgemini*

Shakthi Kumar, LifeSciences Sector Leader, *Capgemini*

The coming together of healthcare providers and manufacturers in a single continuum of care is an underlying trend in the Healthcare and LifeSciences (HLS) sector. Where the processes of research and development (R&D) and manufacturing were previously distinct from frontline healthcare, there is now far more integration of the two. Life sciences companies no longer end their connection when the product is handed to the healthcare provider. Instead, a genuine interest in getting involved in the bedside care of patients by manufacturers is indicative of an overall more holistic approach to achieving patient outcomes.

For the providers of the care itself, changes in the scope (and size) of organizations, along with the adoption of digital technologies, are having a direct impact on patients and caregivers alike. As an example, in the US the Affordable Care Act (Obama Care) is leading to a change of delivery models. Systems across the whole chain of healthcare are being integrated, for example between hospitals, insurers, pharmaceutical companies, etc. Likewise in the UK, mergers, acquisitions, clinical networks, and partnerships are a feature of a health sector urgently seeking to close funding and efficiency gaps. All involve some level of systems integration. Globally, a huge investment in technology is giving patients a greater say in the care process.

Digital Transformation is the thread running through these changes, as demonstrated by the HLS participants in

this year's World Quality Report research study. They are public healthcare bodies (global/national advisory/regulatory organizations and charities); healthcare providers and hospitals (both government funded and private); and life sciences firms, including pharmaceutical companies. The study data reveals that an average 43% of respondents in this sector have installed a Chief Digital Officer (CDO). This is a little lower than the cross-industry average (48%), but with 22% of HLS organizations reporting they plan to install a CDO in 2015-2016, the sector is clearly on an upward digital trajectory.

Digital Transformation is building on social, mobile, analytics and cloud (SMAC) technologies to drive a more patient-centric care model. This reflects the over arching ambition of Digital Transformation across all sectors to put customer and end-use experience at the heart of digital initiatives. HLS executives taking part in this year's research cite customer experience as a top IT strategy priority, with an average 71% of respondents saying it is important or very important, second only to security (78%). Drilling down to sub sector level, public healthcare organizations make it their number one priority (82%), while life sciences companies rank higher quality of software (81%) as their top IT strategy priority.

The proliferation of digital technology is driving efficiency and better engagement. It is now common practice for SMS text messaging to be used to send out appointment

SECTOR ANALYSIS

reminders, cutting the number of missed appointments and thus optimizing costs. Medical information is no longer confined to the physician's office. For example, patients are able to log in to portals and gain access to customized health plans, and to provide ongoing health information on their chronic conditions. In future we will see more healthcare providers tailoring specific interventions, such as prompting patients via SMS to take their medication as prescribed. More investment in Digital Transformation, however, has to be met with spending on assuring the quality of these investments. From allocating 23% of the total IT budget to QA and Testing in 2014, this year saw HLS organizations increasing that amount to 30%.

There is a global shift in the traditional focus of healthcare and medical provision towards more preventative care. Where interventions were previously geared towards treating diseases, trauma or critical illness, now all subsectors are looking at lifestyle as a whole. For example, fitness technology, such as wearable fitness trackers and smart phone apps that use GPS to plot running routes, are all familiar sights. There is a similarity with the Automotive sector's adoption of digital in its connected car concept. While vehicle manufacturers are more digitally mature than HLS organizations, the concept of connected healthcare is growing.

The ubiquity of mobile devices is an important factor in these developments, yet 32% of HLS organizations say they do not have mobile testing experts. This is slightly more than the all-industry average of 29%. Spending on testing of mobile solutions is also below that of other sectors. The HLS sector spends an average 16.17% of its testing budget for new development on mobile solutions, against the all-industry average of 18.11%. There is, however, a slight uplift in mobile testing in the public healthcare subsector, which allocates 20% of its new development testing budget to mobile.

Cloud-based delivery is another aspect of Digital Transformation. However, while Cloud enables infrastructure cost reduction and a shift from capital expenditure to a 'pay as you consume' approach, concerns about privacy and the security of both patient information and intellectual property has previously led to its slow adoption in this sector. This is changing as confidence builds, although at an average 36% of testing taking place in a cloud-based environment, adoption is still below the all-industry average (43%).

The gradual uptake of Cloud has, in turn, fueled a change in the computing of healthcare data. Analytics is being enabled through the collection, analysis and interpretation of information stored in the Cloud. This is driving better outcomes and quality. For the QA and Testing function, however, this brings its own challenges. When testing business intelligence (BI) applications, the top challenge for HLS organizations is finding the right skilled experts to perform BI testing, ranked 5.30 (on a scale of 1-7). The second biggest challenge is validation of data quality (5.11).

Nonetheless, data analytics is having a big impact across this sector. Manufacturers are using it to help them predict whether investments are likely to yield a worthwhile return. Comparative research using data analytics is also helping to drive product and drug investment decisions. Analytics has the potential to be a vital tool in helping budget-stretched healthcare providers keep down costs. For example, it can capture information on the prevalence and likelihood of hospital acquired infection (a huge cost) and use it to enhance quality of care. Unsurprisingly, across the HLS sector an average 59% of organizations surveyed now employ data scientists, and 67% have business/predictive analytics specialists.

The software development lifecycle within this increasingly connected landscape is changing. Some 41% of organizations now use agile development methods and this is transforming the traditional testing model. In a sector where a system, information, or product failure can cost lives, testing has to be incorporated earlier in the lifecycle. For example shift left approaches, such as test-driven and behavior-driven development, are being used by 45% of those adopting agile development. However, 39% of HLS organizations struggle with a lack of professional test expertise in their agile teams.

Testing in this data-rich environment has to embrace data from diverse information pathways, including electronic patient records, medical practice, R&D, and real-time patient information at the point of care. It can them be used to inform what to test and to what depth. Of those HLS organizations reporting they use agile development, however, 36% have difficulty in identifying the right area on which to focus testing.

Test automation is helping to address the need for increased test velocity and quality in this environment. Up to 78% of Healthcare and Life Sciences industry participants in this year's survey report reduction in test cycle time as a benefit of automation, closely followed by better detection of defects (74%).

High Tech

Product and IT testing merge as use of machine-to-machine connectivity grows

Nicholas Schaeffer, Testing Leader, *Sogeti High Tech*

The High Tech sector encompasses hardware and equipment manufacturers, software companies, aerospace, and defense contractors. It is a diverse sector steadily embracing the Internet of Things in a world that is increasingly paperless and innovation driven. More systems connectivity demands more assurance of quality and security. Unsurprisingly in this context, the sector allocates more of its IT budget to QA and Testing (37%) than the average recorded in this World Quality Report (35%). This is a big leap from last year's 31% and the research participants predict that it will jump still further to 43% by 2018.

The steadily growing use of connected machines (machine-to-machine capability) has brought about a merger of traditional High Tech product testing and IT testing. Previously, product testing was viewed as a separate entity to software testing, but now there is increasing evidence of the two coming together. With more IT embedded in products, so the testing has moved beyond the product itself to assure the connectivity in this digital landscape. This is all part of ongoing Digital Transformation initiatives in the High Tech industry, which is the leading adopter of the Chief Digital Officer role. With 62% of High Tech respondents reporting they have installed a CDO (25% higher than the lowest adopter), it is clear that digital is viewed as a strategic enabler.

The volume and velocity of testing in this industry is also changing. Automation is helping organizations to operate test beds 24 hours a day, seven days a week to meet the demand for more products, released faster, with fewer defects. This is borne out by the research data that reveals High Tech companies are among the highest users of test case automation, with 46% automated, against the marginally lower all-sector average of 45%. These companies derive their benefit from selling products, so the less time spent on developing them generates more value for the business. Testing is now viewed as part of this development cycle, and automation is the lever for greater volume and velocity. Some 77% of respondents in this sector say automation has realized a reduction in test cycle time.

Another trend shaping the QA and Testing function is that High Tech IT leaders are increasingly open to outsourcing certain aspects of their testing. Testing product quality has typically been a core part of development and production. However, with the inclusion of more software testing in the overall process, High Tech companies recognize that this is no longer a 'core' part of the business. Instead, they are using external services. As an example, 16% of High Tech firms in this year's study (against the all-industry average of 9%) have a fully operational Testing Center of Excellence (TCOE) via a third party.

The emphasis on machine-to-machine (M2M) connectivity is just part of the bigger Digital Transformation picture in this sector. Companies are moving to a more paperless

environment, for example digitizing final assembly manuals. This improves quality control with digital manuals being centrally stored and manipulated, removing the problem of out-of-date paper-based documentation with little version control. Mobile solutions also support the paperless ambition. Mobility is typically used to boost performance with anywhere, any time access to data and assets. For example training manuals and virtual reality come together to provide augmented reality education for the workforce. Solutions such as these must adhere to quality parameters just as much as consumer-facing products, and 18% of this year's QA and Testing budget for new development budget is allocated to mobile solutions. Companies are also putting more and more testing on mobile devices to bring testing to the tester, wherever they're located. In addition, updated test procedures can be quickly made available on any device in line with the paperless workplace aspirations mentioned earlier.

Mobile is an area of testing, however, that presents the QA and Testing function with a particular challenge. A lack of in-house testing environment for mobile and multi-channel is cited as a challenge by 46% of this year's High Tech companies.

Cloud is part of this digital story and is growing in use. Indeed Cloud receives the biggest proportion of the QA & Testing budget for new development at 18%. The High Tech sector is global and Cloud enables companies to test the same product in different parts of the world. In this year's study, respondents reported that 46% of their testing takes place in a cloud-based environment, higher than the research data average of 43%. This is a big jump from last year's 35%, and is indicative of the increasing importance of Cloud in QA and Testing. Test automation, with the move towards 24/7/365 test benches, is also facilitated via the Cloud as test benches communicate with each other using M2M capability.

Data sits at the heart of Digital Transformation and the Internet of Things. All machines nowadays contain varying amounts of data, for example about how they are performing and how they're being used. In the High Tech industry the use of predictive analytics to monitor and manage behavior

and maintenance requirements is beginning to take off. For the QA and Testing function, this can provide predictive maintenance on test benches to enable a non-stop 24/7/365 process.

Agile development is on the rise, but only for certain types of product. Embedded software lends itself to agile development, including agile and DevOps, and 64% of High Tech companies report using agile methods. Of those using DevOps, 65% make use of test driven development (TDD), behavior driven development (BDD) and continuous improvement. However, this is not used for all development projects because hardware cannot always be virtualized and is thus not suitable for agile.

Partnerships, with external providers of devices, services, people and tools, continue to play a part in the increasingly digital High Tech industry. This can help to address key challenges in the development and testing of applications. For example, external partners can help to provide the required level of security that perhaps internal testing teams don't have the time or resource to deliver. As more and more products are released with M2M connectivity, security becomes an ever challenging concern. Up to 43% of High Tech respondents use managed application security testing services, while 37% use an external security testing team on a project-by-project basis. The High Tech sector incorporates security across the entire development lifecycle with, for example, 63% of study participants incorporating it at the development and coding stages. Only 14% (below the research average of 17%) do not use application security testing, either internal or externally provided.

Finally, while the majority of 2015 research respondents are spending an equal amount on new developments and maintenance, the High Tech industry bucked this trend. The prevailing move towards Internet of Things enabled by Digital Transformation saw this sector spending several percent more of its QA and Testing budget on new transformational work (54%) than on maintenance (46%).

Government and Public Sector

Engaging more closely with citizens using digital

Matt Howell, Head of Public Sector, *Capgemini*

Julian Clarke, Principal, Testing Leader, *Capgemini*

One of the most important drivers in the Public Sector is the determination to engage more closely with citizens and businesses. Digital is the enabler of this as all agencies strive to achieve a standard of Digital by Default service delivery. This is resulting in the proliferation of digital development projects, leading to multiple access points through which citizens, businesses, and agencies can interact. The use of open source digital platforms and technologies is growing and there is a move towards cloud-based solutions. For example, Public Sector organizations taking part in the World Quality Report 2015 research claim an average 45% of their testing takes place in a cloud-based environment.

While the digital journey is gaining pace, most western governments still operate with significant legacy technology landscapes in which they have invested billions. They are undertaking huge modernization programs as many aging platforms become obsolete.

This duality of modernization and Digital Transformation is leading to a new profile for government and Public Sector IT workers. We are seeing an expansion of their expertise from familiar email, datacenter and grant systems, to digital (social, mobile, analytics, and Cloud). Many of the traditional IT skills are currently no longer fit for purpose. As an example, 38% of Public Sector executives interviewed this year say finding the right skilled experts to test Business Intelligence applications is an important or very important challenge.

Recruitment of digital expertise from more digitally mature sectors, such as Telecoms, is helping to fill the skills gap. For example, 70% of Public Sector organizations already employ business/predictive analytics specialists in their testing organization, and 48% employ mobile test professionals. The role of Chief Digital Officer (CDO) is now firmly entrenched, with 47% of respondents in this sector saying they already have one and a further 21% planning to install a CDO either this year or in 2016.

A new requirement is also emerging at the head of the IT function as CIOs oversee the integration and connectivity of multiple platforms, IT systems and devices. This is expanding their role to one of Chief Integration Officer. The need for integration across platforms creates a challenge for the QA and Testing function. For example, 31% of Public Sector organizations rated a lack of available test data for complex integration testing across systems and organizations as a challenge in their management of test data. Similarly, when it comes to digital implementation challenges, testing the integration services, including local, private and public cloud, ranked as the biggest challenge by 33% of respondents, followed by multi-channel (mobile, social, traditional) interface (32%).

Huge fiscal deficits sit the heart of all the ongoing modernization and Digital Transformation programs worldwide. Cost reduction and customer focus remain the

driving force behind budget decisions. We are seeing a number of fascinating projects around the world in which new technology is helping to drive both. For example, there is a growing trend to use ambient control solutions, such as sensor networks for maintaining traffic flow, reducing the need for costly human intervention. In the UK, the Environment Agency is tapping into the Internet of Things with data gathering sensors monitoring potential flood risk. High levels of self-service and automation are enabling welfare and tax agencies to cut the cost of their operations with more efficient digital citizen engagement.

All of this has an impact on the QA and Testing function as it ramps up to meet the escalation in new systems and applications. For example, with customer experience being second only to security in Public Sector IT strategy priorities, it is interesting to note that 39% of Public Sector respondents say the implementation and use of test tools to test customer experience for multi-channel applications is challenging or very challenging.

Although Digital Transformations are using mobile technologies to better connect with citizens, businesses and employees, a lack of test time is currently the biggest challenge with mobile and multi-channel applications. It was cited by 46% of respondents this year, up from 38% of respondents in last year's survey. Will this trend reverse as the Public Sector continues to transform operating models with enabling mobile solutions?

Investment is moving away from purely finding and reporting defects to assurance. This aligns with the over arching survey finding relating to QA and Testing: protecting the corporate image is the number one Public Sector priority (6.18 on a scale of 1-7). This is slightly higher than the all-sector average of 6.07 as governments strive to counter the negative reporting on system and other IT failures. With 33% of total IT budget now allocated to QA and Testing, up from 25% last year, there is clearly recognition of the strategic importance of this function.

Within this cost-driven, yet customer-focused testing landscape, agile development and testing methods continue to be implemented alongside a more traditional waterfall approach. The large-scale, high-cost enterprise modernization programs with multiple suppliers can be highly complex and are typically not the right candidates for agile development and testing. However, some 46% of Public Sector respondents are using agile testing, 8% lower than the cross sector average. Agile testing techniques are also used in the Public Sector to drive and ensure that agile development cycles deliver meaningful results. So, while 35% of organizations in this sector use exploratory testing, even more are using shift left techniques, with 39% of respondents saying they have adopted test driven development (TDD), behavior driven development (BDD).

The increased use of cloud-based testing (45% of testing) mentioned above, can be further analyzed to understand the direction in which the Public Sector's adoption of Cloud is moving. Performance testing (58% of respondents testing in the Cloud) is the most used type, followed by functional testing of cloud services (56%). Government organizations will never use public cloud in its entirety for obvious security/sovereignty reasons. Nonetheless 27% of Public Sector applications are now cloud-based, up marginally (1%) on last year. Private cloud takes the lion's share (47%) with hybrid cloud (26%) just one percentage point behind public cloud. More internal applications (56%) than external (44%) are tested in a cloud-based test environment.

Industrialization, driven by the significant cost-reduction agenda, is a slowly growing feature of Public Sector testing. Currently, the Testing Center of Excellence (TCOE) model is not widely used and, where it is, there is a preference for onshore (near shore) locations. Some 32% of respondents are planning to develop an internal managed TCOE within the next two years, much higher than the cross-sector average of 25%. Currently, just 6% have a fully operational TCOE via a third party, and 14% are fully operational with an internal TCOE.

Industrialization via a TCOE can help speed up the adoption of risk-based testing already widely used in other sectors. The disciplines and methods typically found in an external TCOE, such as continuous testing and automation, might help to address the concern of software failures and security breaches through the application layer that prevails in some agencies. This concern has led to too many applications being tested at depth when this isn't required, tying up valuable budget and resources.
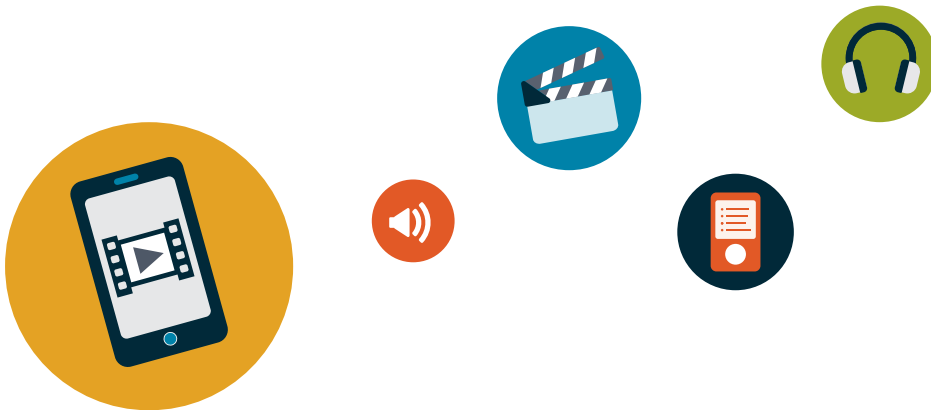
Telecom, Media and Entertainment

Customer experience and M&A activity shaping QA Assurance and Testing

Darren Coupland, Vice President, *Sogeti*

Suresh Ramakrishnan, Director, *Capgemini*

Technology is the lifeblood of the Telecom, Media and Entertainment (TME) sector. Companies range from telecommunications equipment manufacturers, telecom service providers and software developers, to media organizations and digital content providers. This year sees technology playing a key role in understanding, managing and improving the customer experience. In a highly competitive market, this is essential for gaining competitive advantage, attracting new customers and retaining existing ones.

The World Quality Report 2015 research found that customer experience is second only to security in terms of importance. It is rated important or very important by 79% of TME organizations, with security cited by 82%. The two are interlinked, with heightened levels of security helping to instil customer trust in the company brand. Cost optimization is the third ranked strategic IT priority, rated highly by 72% of organizations. This ties in with a high level of merger and acquisition (M&A) activity in this sector. One goal of this is to increase market share, consolidation and rationalization of IT estates to deliver OpEx savings.

Business performance measures, such as Net Promoter Score (NPS), are becoming more prevalent in IT management. Use of digital technology and excellent customer experience are a way to achieve higher customer satisfaction (NPS measures) and the revenue that comes with it. This is driving the emphasis on customer experience and the need for stable systems to assure it. For the QA and Testing function, the question is how do you validate customer experience? With competition fierce, this is an important strategic concern in the fight to stop customer churn and attract competitors' customers.

This is particularly valid in light of the M&A activity. As organizations merge, IT leaders must monitor the NPS rating during the consolidation of systems, platforms and applications. This will help to ensure the IT service remains stable and key processes that have an impact on the customer, such as billing, are correct. QA and Testing is integral to this and the 2015 research participants reflect this understanding. Ensuring end user satisfaction is rated highest amongst QA and Testing priorities, with a mean score of 6.11 on a scale of 1-7 (with 7 being highest). This is some way above the cross-industry average of 5.98. Directly linked with end user satisfaction, and ranked second as a QA and Testing priority, is protecting the corporate image (6.05).

This is manifesting itself in shift left techniques moving testing earlier in the development lifecycle. For example, 48% of those companies using DevOps make use of test driven development (TDD), behavior driven development

(BDD) and continuous improvement shift left techniques in their DevOps testing. In tandem with this, user stories and use cases enable test teams to identify whether the right testing is being undertaken. Currently, of those 56% of TME companies using agile development, 39% report having difficulty with identifying the right areas on which to focus testing. The key is greater collaboration between customer experience teams, business analysts and IT to find out what is having the biggest impact on the customer journey. Testing should get involved at the front end with marketers, as well as early in the lifecycle with the business and developers.

Some organizations are using split (A/B) testing of digital technologies, whereby two different transaction flows are tested based on user profile to determine which generates the best results. This adopts agile techniques, such as exploratory testing, which used in 35% of all TME agile testing.

While agile and DevOps are a factor in the development lifecycle, there is still a clear use for traditional waterfall methodology, especially in telecoms. Two different types of systems stacks characterize this industry and thus two different approaches. Back-end support, operational support and network technologies are best suited to a more standard waterfall methodology that is appropriate to business as usual-type change. Customer-facing digital applications, owned or operated by marketing, are built on agile principles.

In this consolidating business landscape, the TME industry is seeing media and telecoms companies coming together to form quad play services. Companies are seeking to extend their traditional areas of operation to embrace all four aspects of mobile telecoms, fixed telecoms, television and internet. This will require a seamless customer experience, with single bills for all services, etc. A whole new set of products and services is being developed to support both this and the wider adoption of digital capabilities (social media, Cloud, etc.). Thus, the bigger proportion of the testing budget allocated to new transformational work (53%) against that allocated to maintenance (47%) is understandable.

The overall budget for QA and Testing has increased significantly this year. In 2014, 28% of the IT budget was allocated to QA and Testing, up from 24% in 2013. This has leapt to 38% this year, a little higher than the 35% all-sector average. This can be attributed to the high level of M&A activity, which requires QA and Testing's involvement in extensive integration programs.

The increasing complexity of IT is potentially another reason for this increase in budget allocation. As the Internet of Things continues to take hold in this sector, so more and more access points increase an organization's vulnerability.

Telecom companies, for example, are investing in machine-to-machine connectivity as part of their market drive into the B2B sector. Connected cars and devices utilize the telecom bandwidth and there is a change in voice, SMS and data models, with these being embedded in and connected to devices. This demands more technical know how, and new technical awareness of how products are used — bringing us back to the whole user experience scenario.

Digital Transformation too, which puts customer value at its core, is changing both the type of skill required and approaches to test environment management. For example, 47% of TME respondents set up and use cloud-based temporary test environments. Of those companies testing in the Cloud, 72% perform functional testing of cloud services, by far the highest testing type. Then, indicative of the importance of the customer in this digital environment, 47% of respondents carry out functional testing of customer-facing applications, such as portals and mobile solutions. This is the second highest level of testing in the Cloud. The share of the testing budget given to new development allocates the highest amount to cloud solutions (21%) and mobile solutions (19%), with the least being spent on ERP back office solutions (12%).

Different skillsets are thus beginning to characterize testing in this sector as teams develop their understanding of customers' behavior and interests, new processes, and industry-specific technology. But there is clearly room for upskilling. Currently, 40% of this year's TME research participants report they do not have an in-house testing environment for mobile and multi-channel applications, and 30% do not have mobile testing experts. Furthermore, as traditionally separate IT testing and telecoms network testing merge, tomorrow's QA and Testing professionals will need to be able to test across both domains to deliver a seamless experience.

While organizations in this sector continue to outsource some of their testing activity, Digital Transformation, notably the testing of networks and devices, has created a challenge. Network and device testing activity requires external testers to access the customer network. The challenge of how to extend the network to offshore locations is currently being addressed by some service providers, and both device and mobile apps are being successfully tested offshore.

Finally, there is an increase in the move to standardization via the use of a Testing Center of Excellence (TCOE) to achieve better value and access specialist test capabilities, especially in digital. Up to 62% of the TME study participants report that a decentralized TCOE for improved agility and efficiency is important.

About the
Study

The World Quality Report 2015-16 is based on research findings from 1,560 interviews carried out during March, April and May 2015 using a mix of CAWI (Computer Aided Web Interviews) and CATI (Computer Aided Telephone Interviews).

Web-based online interviews are self-completed and telephone interviews are assisted by a professional market researcher. Quality measures were put in place for both methodologies to ensure the questionnaire was understood, answered accurately and completed in a timely manner by the interviewee.

Interviewees were all senior executives in corporate IT management functions, working for companies and public sector organizations across 32 countries. This year's research was based on a structured questionnaire of 42 questions, with the actual interview consisting of a subset of these questions depending on the interviewee's role. The average length of interviews was 30 minutes. 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.

CATI / CAWI Split

CATI (Telephone interviews)	**390**
CAWI (Web-based online interviews)	**1170**

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 in such a way 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. The research sample sizes for the Healthcare & LifeSciences sector were increased and countries in the Middle East were added to allow for new sections devoted to these areas.

The research sample consists mainly of senior-level IT executives. This year, the number of CIOs interviewed was 464 (of which 390 were telephone interviews and 74 were web-based online interviews).

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 2015-16 is based on a sample of 1,560 enterprises with more than 1,000 employees. 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 exactly the same questions are included.

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 1,560 sample size.

Questionnaire and Methodology

The survey questionnaire was devised by QA and Testing experts in Capgemini, Sogeti and HP (sponsors of the research study), in consultation with Coleman Parkes Research. The 42-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 33

Interviews by Country

Country	Number of respondents
USA	280
Canada	20
France	150
Germany	125
Switzerland	25
Netherlands	100
Belgium + Luxembourg	30
UK	125
Ireland	25
Sweden	85
Norway	30
Denmark	25
Finland	25
Italy	20
Spain	20
Portugal	20
Poland	30
Hungary	30
Czech Republic	30
Brazil	80
New Zealand	10
Australia	80
China	60
Hong Kong	20
Singapore	20
Japan	35
UAE*	15
Qatar	15
Dubai	10
Abu Dhabi	10
Bahrain	5
Jordan	5
TOTAL	**1560**

*UAE = (excluding Dubai and Abu Dhabi)

Figure 34

Interviews by Region

- **300** North America
- **60** Middle East
- **135** China and SE Asia
- **430** Continental Europe
- **150** UK and Ireland
- **165** Nordics
- **60** Southern Europe
- **90** Eastern Europe
- **80** South America
- **90** Australia and New Zealand
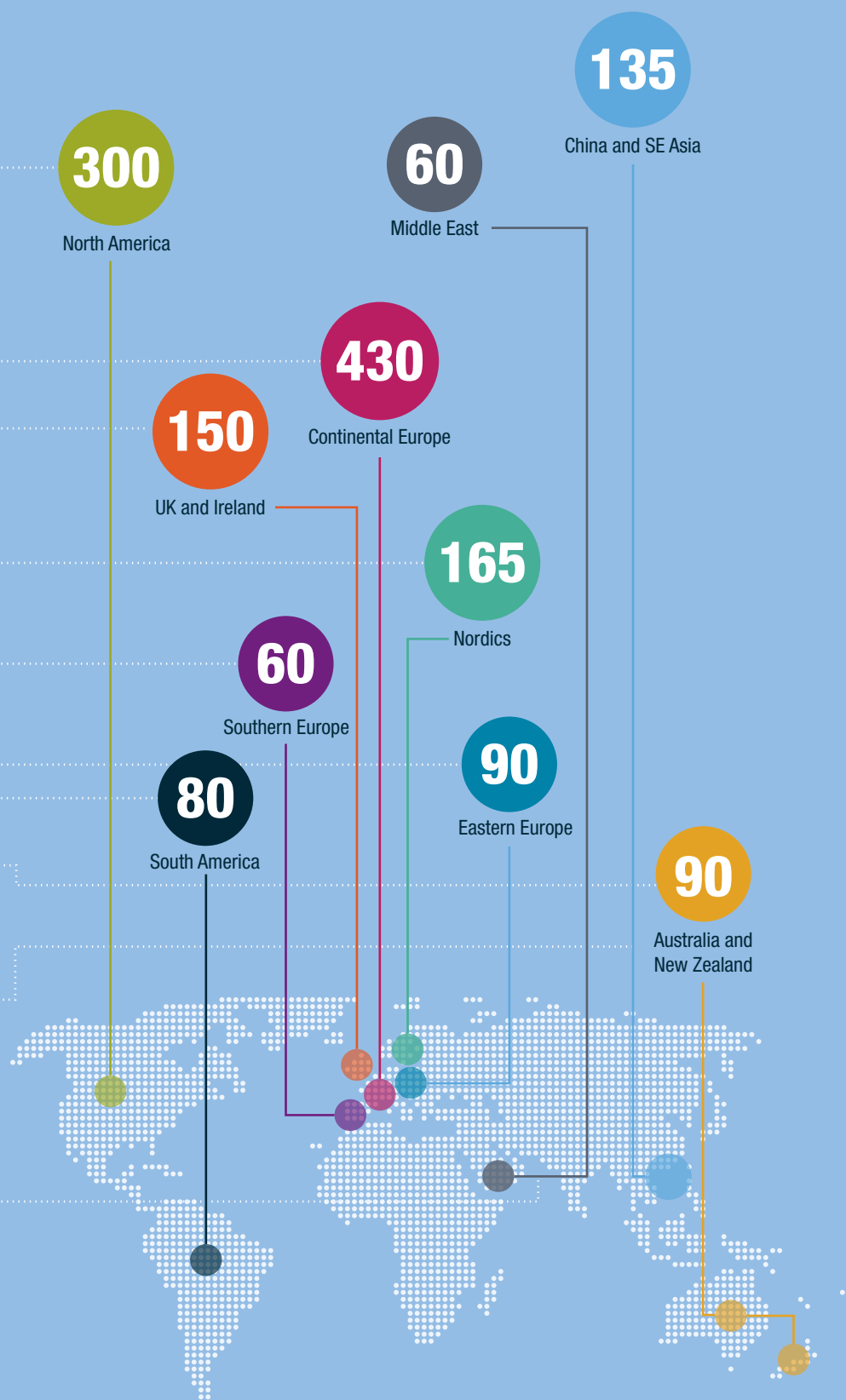
Figure 35
Interviews by Sector

120
Automotive

125
Consumer Products, Retail, Distribution and Logistics

113
Energy, Utilities, and Chemicals

327
Financial Services industry, including Capital Markets, Banking and Insurance

125
Healthcare & LifeSciences

109
High Tech including hardware vendors + Aerospace & Defense

252
Public Sector/Government

217
Telecommunications, Media & Entertainment

91
Manufacturing, (including industrial product and excluding Automotive)

81
Transportation

Figure 36
Interviews by Job Title

464
CIO

372
IT Director

291
VP Applications

332
QA/Test Manager

101
CDO/CMO

About the
Sponsors

About Capgemini and Sogeti

With almost 180,000 people in over 40 countries, we are one of the world's foremost providers of consulting, technology and outsourcing services. The Capgemini Group reported 2014 global revenues of EUR 10.573 billion. A multicultural organization through and through, we've developed our own way of working via the Collaborative Business Experience™ and Rightshore®, our worldwide delivery model.

Sogeti is a leading provider of technology and software testing, specializing in Application, Infrastructure and Engineering Services. Sogeti brings together more than 20,000 professionals in 15 countries and has a strong local presence in over 100 locations in Europe, USA and India. Sogeti is a wholly-owned subsidiary of Cap Gemini S.A., listed on the Paris Stock Exchange.

Together Capgemini and Sogeti have developed innovative, business-driven quality assurance (QA) and Testing services, combining best-in-class testing methodologies (TMap® and TPI®) to help organizations achieve their testing and QA goals. The Capgemini Group has created one of the largest dedicated testing practices in the world, with over 17200 test professionals.

Learn more about us at:
www.capgemini.com/testing or
www.sogeti.com/testing

About HP

HP is a technology company that operates in more than 170 countries around the world. We explore how technology and services can help people and companies address their problems and challenges, and realize their possibilities, aspirations and dreams. We apply new thinking and ideas to create more simple, valuable and trusted experiences with technology, continuously improving the way our customers live and work.

No other company offers as complete a technology product portfolio as HP. We provide infrastructure and business offerings that span from handheld devices to some of the world's most powerful supercomputer installations.

More information about HP (NYSE: HPQ) is available at www.hp.com

Thank you

Capgemini, Sogeti and HP would like to thank

- The 1,560 IT executives who took part in the research study this year for their time and contribution to the report. In accordance with the UK Market Research Society (MRS) Code of Conduct (under which this survey was carried out) the identity of the participants in the research study and their responses remain confidential and are not available to the sponsors.

- All the business leaders and subject matter experts who provided valuable insight into their respective areas of expertise and market experience, including the authors of country and industry sections and subject-matter experts from Capgemini, Sogeti and HP. Some of these contributors and their area of contribution are: Vincent Groener for testing budget trends, Philip Borsen and Sathish Natarajan for test automation, Shiva Jayaraman for Digital, Deepika Mamnani for agile and DevOps, Renu Rajani and Shiva Balasubramaniyan for test environment management & test data management, David Harper (HP) and Anantharaman Iyer for security testing and Max Tau for CPRD.

- Hilary Croft, Parvathy Nair and the Marketing & Communications Offshore Services (MCOS) team for their support in the production of this year's report.

Main Report Authors
Mark Buenen and Ajay Walgude

Writer *(Main Report)*
Ngaire Mckeown

Assistant Writer *(Region/Country Pullouts)*
Archit Revandkar

Program Manager
Mitali Kini

Creative Design
Partha Karmakar

Partner Management
Jean-Philippe Favrot (HP), Karthik Ranganathan, Satish Varghese, Mary Johnson, Julia Mulcrone

Market Research
Stephen Saw and Ian Parkes (Coleman Parkes Research)*

Printing and Distribution
Annie Bates and David Cole (Crucial Colour)

MIX
Paper from responsible sources
FSC
www.fsc.org
FSC® C007915

Testing Global Service Line, Capgemini Group

Govind Muthukrishnan
Senior Vice President, Leader, Testing GSL
govindarajan.muthukrishnan@capgemini.com

Mark Buenen
Vice President, Global Solutions Lead, Testing GSL
mark.buenen@sogeti.com

Capgemini Application Services

Ajay Walgude
Vice President, Solutions Lead
Financial Services GBU
ajay.walgude@capgemini.com

Anand Moorthy
Vice President, Global Testing Leader
Financial Services GBU
anand.moorthy@capgemini.com

Julian Clarke
Principal, Testing Leader
julian.clarke@capgemini.com

Sathish Natarajan
Service Delivery Director, Testing Leader
sathish.n@capgemini.com

Sogeti

Brian Shea
Chief Executive Officer, UK
brian.shea@sogeti.com

Shiva Jayaraman
Service Delivery Director,
Global Testing Transformation & Large Deals Head
shiva.jayaraman@capgemini.com

Yves Le Floch
Vice President, Head of Business Development,
Cybersecurity TLI
yves.le-floch@sogeti.com

HP

Jean-Philippe (JP) Favrot
Global Alliance Director
jp.favrot@hp.com

John Jeremiah
Technology Evangelist,
HP SW ADM Digital Research Team Leader
john.jeremiah@hp.com