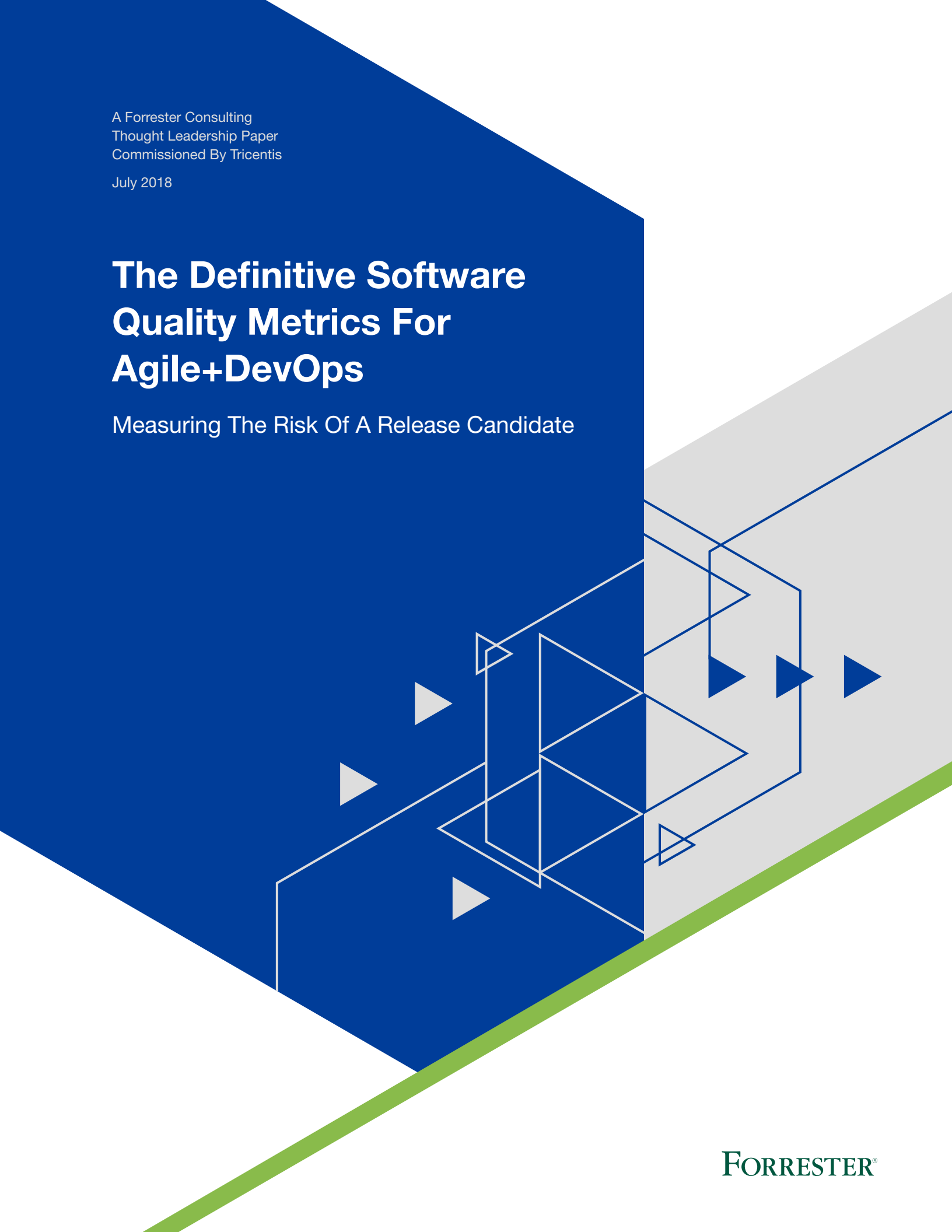
A Forrester Consulting
Thought Leadership Paper
Commissioned By Tricentis

July 2018

The Definitive Software Quality Metrics For Agile+DevOps

Measuring The Risk Of A Release Candidate



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Executive Summary

Delivering high-quality software fast is no longer a luxury — it is a prerequisite for digital success and mandatory for customer loyalty and acquisition. We are in an era where customers are empowered to choose and switch to the company that can provide them the best experience quickly and at minimal cost. Organizations that cannot keep up with their customers' expectations and adapt to new business paradigms will find themselves losing customers and business to competitors that can.

How can firms deliver with quality at speed? Implementing Agile+DevOps best practices and building in quality is the first step — and this is not trivial. Automation is the lever that development teams pull to go faster. However, if not properly managed, automation can jeopardize quality and increase risk. To ensure that quality issues and unacceptable risk do not negate the velocity benefits of automation, firms must ensure they are tracking the right metrics to measure quality throughout development-testing-deployment.

To ensure that quality issues do not negate the velocity benefits of automation, firms must track the right metrics to measure quality throughout development.

In March 2018, Tricentis commissioned Forrester Consulting to evaluate current software development and delivery priorities as well as key metrics tracked throughout the software development life cycle. To explore this topic, Forrester conducted an online survey with 603 global enterprise respondents responsible for their firms' Agile and/or DevOps strategies.

KEY FINDINGS

- **Five core practices separate successful DevOps leaders from laggards.** Firms that are more mature in Agile+DevOps do five key things differently: 1) they allocate proper testing budgets and focus on upgrading their testing skills; 2) they implement continuous testing to meet the demands of release frequency and support continuous delivery; 3) they include testers as part of their integrated delivery teams; 4) they automate end-to-end functional testing; and 5) they shift-left testing to earlier in the development life cycle. For firms that follow these five best practices, testing is a way to gain speed and efficiency, rather than a bottleneck to delivering faster.
- **Business risk must be accurately and continuously managed.** Automating software delivery without being able to accurately measure software quality is dangerous. Firms must understand the business risk — the chance of a negative user experience — that each software application carries when deciding whether to release. Unfortunately, most firms today admit they have gaps in their ability to accurately assess and manage business risk in testing.
- **Leaders ruthlessly drive end-to-end test automation.** With a better indication of risk from their testing metrics, DevOps leaders can relentlessly pursue automation to develop with quality at speed. They do this by prioritizing end-to-end automated business process test cases. They automate test design and test execution, and they orchestrate the automation of the overall dev-test-deploy process.

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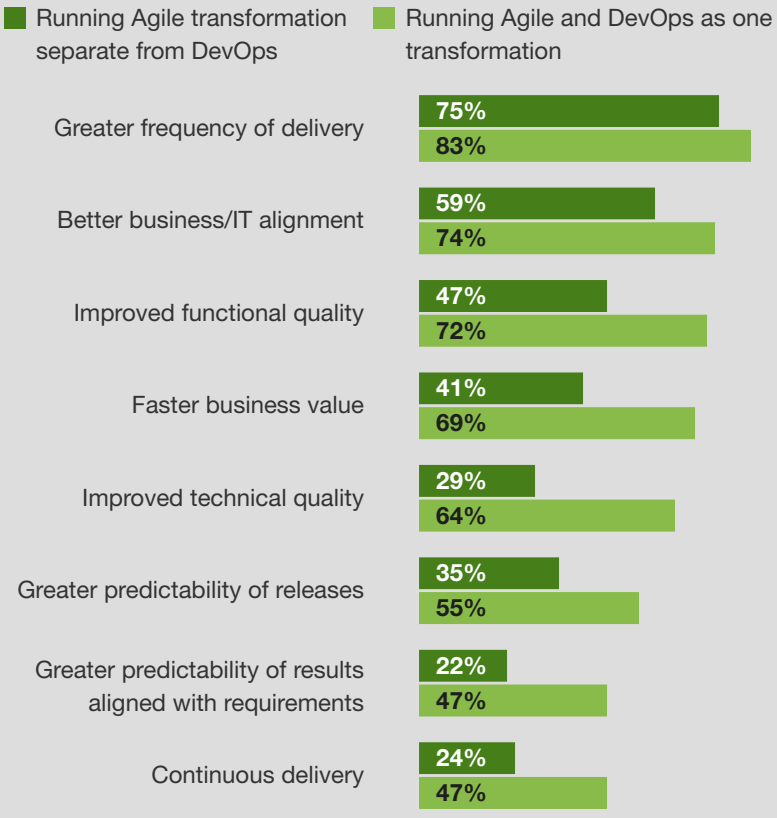
Agile+DevOps Leaders Understand They Must Achieve Quality At Speed

Development teams today must deliver high-quality software at speed with an eye on cost. To meet this ambitious goal, firms continue to steadily adopt both Agile and DevOps — preferably together. Forrester Analytics' Q3 2017 Global Agile Software Application Development Online Survey data shows that benefits, such as delivery frequency (83% vs. 75%), technical quality (64% vs. 29%), and functional quality (72% vs. 47%), dramatically improve when teams are leveraging both Agile and DevOps together, leading to faster business value (see Figure 1).[1] For this reason, firms serious about digital transformation must adopt Agile+DevOps practices — and now.

72% of firms agree that testers are critical to continuous delivery success.

Figure 1

Benefits of Agile+DevOps greatly outweigh separate initiatives



Base: 230 respondents at companies doing some form of Agile
Source: Forrester Analytics' Q3 2017 Global Agile Software Application Development Online Survey

Firms running Agile+DevOps as a single transformation are **35 percentage points** more likely to see i**mproved technical quality** and **28 percentage points** more likely to see **faster business value** in the software they release.

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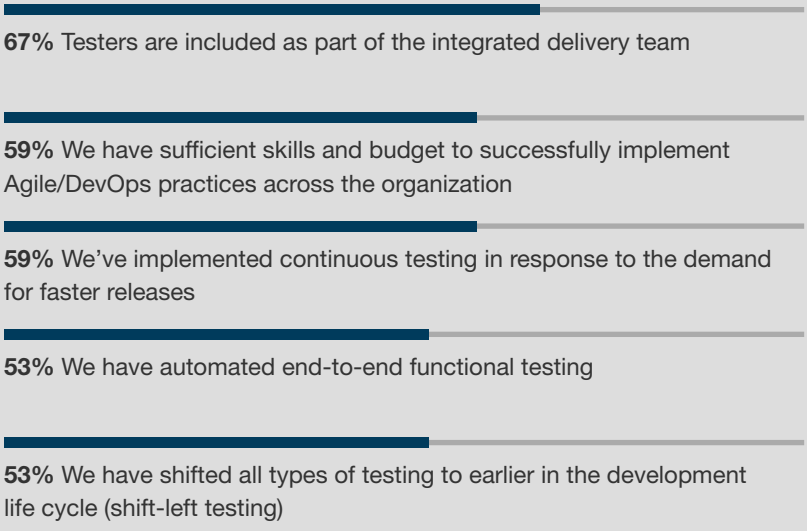
Software testing is a key part of the Agile+DevOps life cycle — 72% of firms say testers are critical to continuous delivery success. To this end, more mature firms are transforming software testing to become continuous testing by implementing new testing best practices. These firms (see Figure 2):

- Focus on building their skills while budgeting testing sufficiently to implement Agile and DevOps practices across the organization.
- Implement continuous testing in response to the demand for faster releases.
- Include testers as part of the integrated delivery team.
- Automate end-to-end functional testing.
- Implement testing earlier in the development life cycle (shift-left testing).

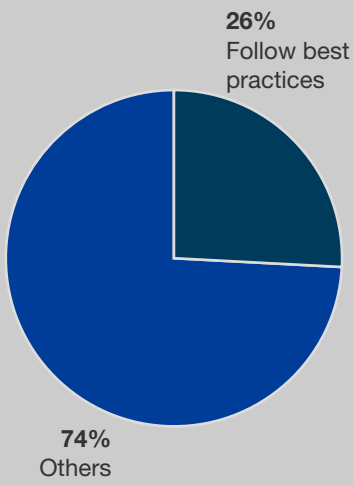
While most Agile and/or DevOps firms have implemented some of these five core testing practices, few have actually implemented all of them — only about a quarter of respondents say they somewhat or completely agree with all five best practice statements. This is an important distinction. While many CXOs and high-level decision makers believe they are ahead of the pack, our research shows that only the small fraction of firms that follow these best practices have more advanced Agile and DevOps practices compared to their peers — and their behaviors and attitudes support that assertion (see Figure 3).

Figure 2

"How much do you agree or disagree with the following statements about your continuous delivery organization and practices?"
(Only "Somewhat/completely agree" are included)



Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018



Only **26%** of firms we surveyed follow all five of these continuous testing best practices.

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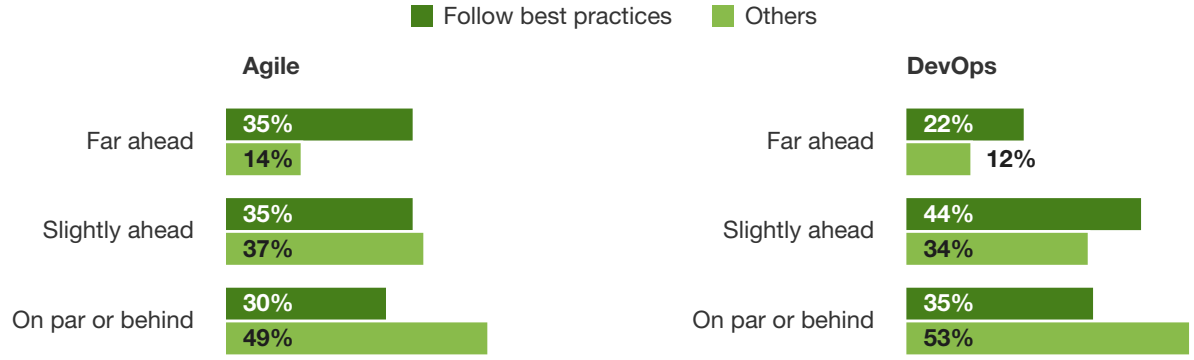
Figure 3

"How mature do you consider your Agile and/or DevOps practices compared to your peers?"



Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

These more advanced firms focus on automation with high obsession. They:

› **Consider end-to-end automation a business differentiator.** Firms that rely on manual testing are more than twice as likely to report that testing is a bottleneck (59%), compared to those that don't (26%). Automating the software delivery life cycle is a crucial component of accelerating high-quality software delivery. Automating software quality streamlines what can be highly manual and time-consuming processes. A majority of firms (53%) that follow Agile+DevOps best practices consider automating their software quality processes a critical differentiator. This is almost twice the number of "other" firms (27%) that feel it's critical (see Figure 4).

Figure 4

"Compared with other IT processes in your organization, rate the importance of automating your software quality process."

Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

Over half (53%) of firms that follow Agile+DevOps best practices consider automating the software quality process **CRITICAL,** compared to **just 27%** of other firms.

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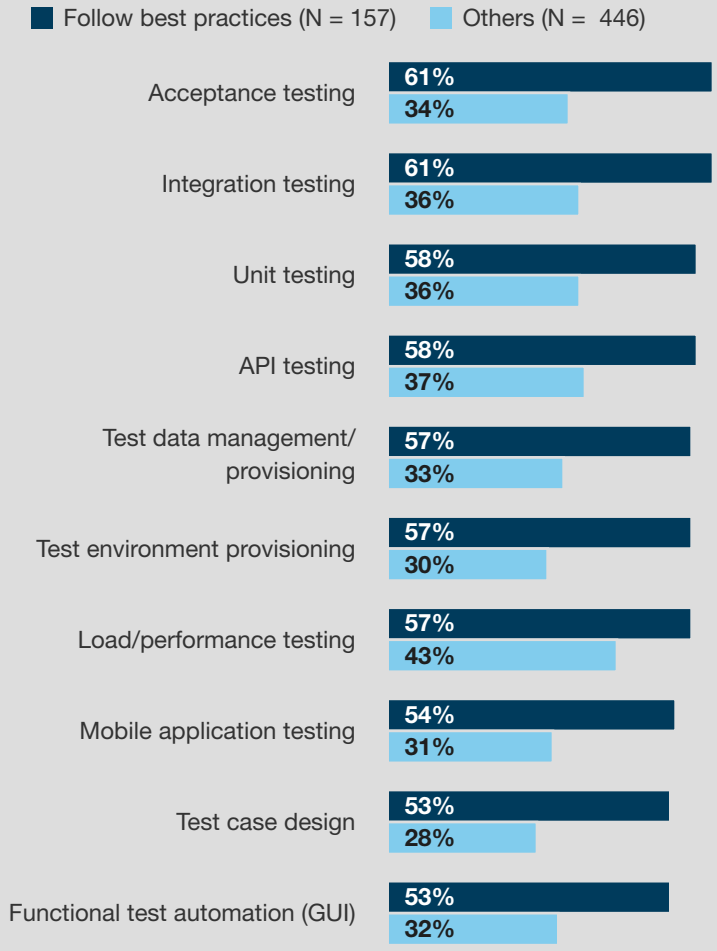
› **Automate more testing automation to increase benefits.** More advanced Agile+DevOps firms have taken the lead with automating QA and testing processes in the development pipeline. Our survey shows that more advanced firms are more likely, by 23 percentage points on average, to have automated more than 50% of their testing proceses (see Figure 5). Agile+DevOps leaders understand the major benefits that testing automation can bring to their development organziation and are taking steps to implement automation wherever possible in the development pipeline.

Figure 5

"Using your best estimate, how much do you automate each of the following?" (Showing top 10 for "Over 50% automated")



Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

More advanced Agile+DevOps firms are more likely by **23 percentage points on average** to have higher levels of automation for key testing and QA processes.

52% of more advanced Agile+DevOps firms have automated more than half of their risk-based testing, compared to just 27% of other firms.

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The Unseen Barrier To Quality At Speed: Risk

Automating the software development life cycle is an imperative for accelerating the speed and frequency of releases. However, without an accurate way to measure and track quality throughout the software development life cycle, automating the delivery pipeline could increase the risk of delivering more defects into production. And if organizations cannot accurately measure business risk, then automating development and testing practices can become a huge danger to the business.

For this study, we use the following definition of business risk: *any application shortcoming that impairs the end user's (or customer's) expected experience and ultimately erodes confidence in the business.* Business risk is different for every application and is compounded by the complexity of each organization's architecture and transaction dependencies. If firms are unable to measure relative risk for each application as software is being designed, developed, integrated, and tested, then, ultimately, they will not know the risk that a release candidate carries. Tolerance for risk is solely dependent on senior management. No matter where a firm sets the bar for risk, firms must be able to continuously measure risk to ensure final products are delivered within levels of risk tolerance.

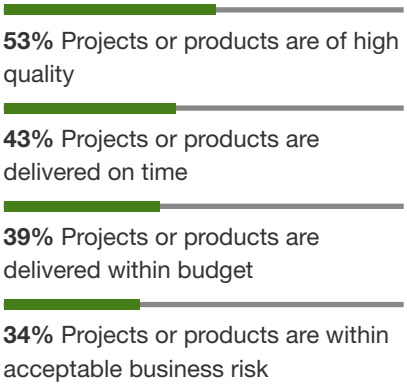
Firms looking to use DevOps to automate their software delivery must understand and accurately measure business risk. But even more advanced Agile+DevOps firms struggle to get an accurate view of risk through the software delivery pipeline. When comparing firms following Agile+DevOps testing best practices, we see that:

- **Risk relevance is not on par with quality or speed.** Most firms have not yet made the connection between speed, quality, and risk. Overall, the importance of risk in customer-facing software lags behind the established development goals of quality on time and on budget (see Figure 6). Overall, only about a third of respondents say it's very important for success that customer-facing software be delivered within acceptable business risk. When looking at firms that follow best practices, this number jumps to 50%, but risk still lags quality, on time, and on budget.
- **Firms are confident in their abilities to deliver within acceptable risk . . .** Most firms *believe* they deliver customer-facing products within acceptable business risk. A staggering 80% of respondents say they can often or always do this (see Figure 7).
- **. . . but admit there are gaps in their testing processes . . .** Fewer than a quarter of firms think that their QA and testing processes completely cover business risk in all phases of testing. Although those firms that follow Agile+DevOps best practices do better, fewer than half (38%) cover risk completely in all testing phases.
- **. . . and acknowledge the shortcomings of their test suites.** Most firms recognize that their test suites do not always give them a good indication of business risk. In fact, just 15% of respondents say this is the case today — and nearly 40% say that they have a good indication sometimes or less often. Even more advanced Agile+DevOps firms see the limitations here: Fewer than one-third of them say their test suite always gives them a good indication of business risk.

Business risk starts accruing early in the software development life cycle and can snowball throughout development if not assessed quickly.

Figure 6

"How important are each of the following to the business when determining the success of a customer-facing software release?" (Only "Very important" responses are included)



Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC.
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

50% of firms following Agile+DevOps testing best practices think delivering within acceptable business risk is very important, compared to just 29% of other firms.

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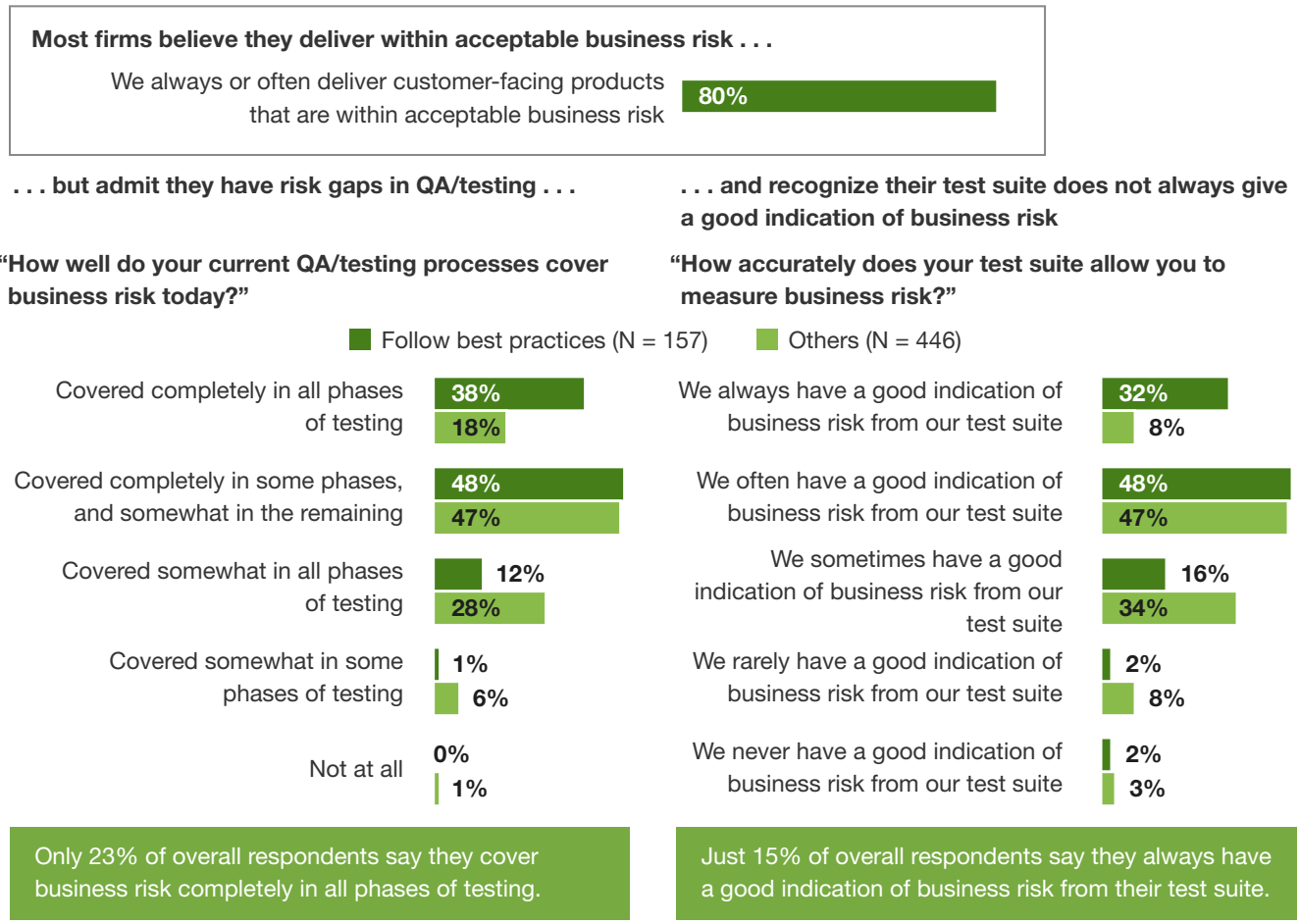
Given that most firms, even the ones following continuous testing best practices, admit that their software testing processes have risk gaps and do not always give accurate measures of business risk, it stands to reason that the 80% who say they always or often deliver within acceptable risk may be overestimating their capabilities. And, given the critical importance of automating the software delivery pipeline to deliver faster, being able to say with certainty that a software release is both high-quality and within acceptable business risk is a crucial part of not just delivery automation, but also overall software delivery success.

Figure 7



Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC
Note: Percentages may not total 100 because of rounding.
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

Manage Business Risk In Agile+DevOps With Effective Metrics

To build high-quality software at speed, organizations must build in quality and automate as much as possible during all phases of the continuous delivery pipeline. As the saying goes: "you can't manage what you don't measure," so firms need to be able to define and track the right metrics that can help enable quality at speed while minimizing risk. Therefore, metrics must be defined and tracked to determine if the software release candidate has an acceptable level of risk.

THE KEY SOFTWARE QUALITY METRICS TO MANAGE RISK

While firms today use a wide array of metrics in software development and testing, Agile+DevOps have undeniably changed the mission of software testing practices. By examining the metrics that firms following Agile+DevOps best practices use and find critical to success, firms can pinpoint the crucial metrics that manage risk and promote DevOps maturity (see Figure 8).

TOP QUALITY METRICS THAT MINIMIZE RISK

Examining the metrics Agile+DevOps leaders track in the various phases of development leads to several important considerations (see Figure 9):

- **In the build phase, unit testing done well matters.** Counting unit tests is a waste of time but understanding change impact matters. Tracking "unit" tests prioritized by risk is the key. As the code base evolves, developers and testers need immediate feedback about change impact. This feedback is significantly more actionable if prioritized by level of risk.

Figure 8

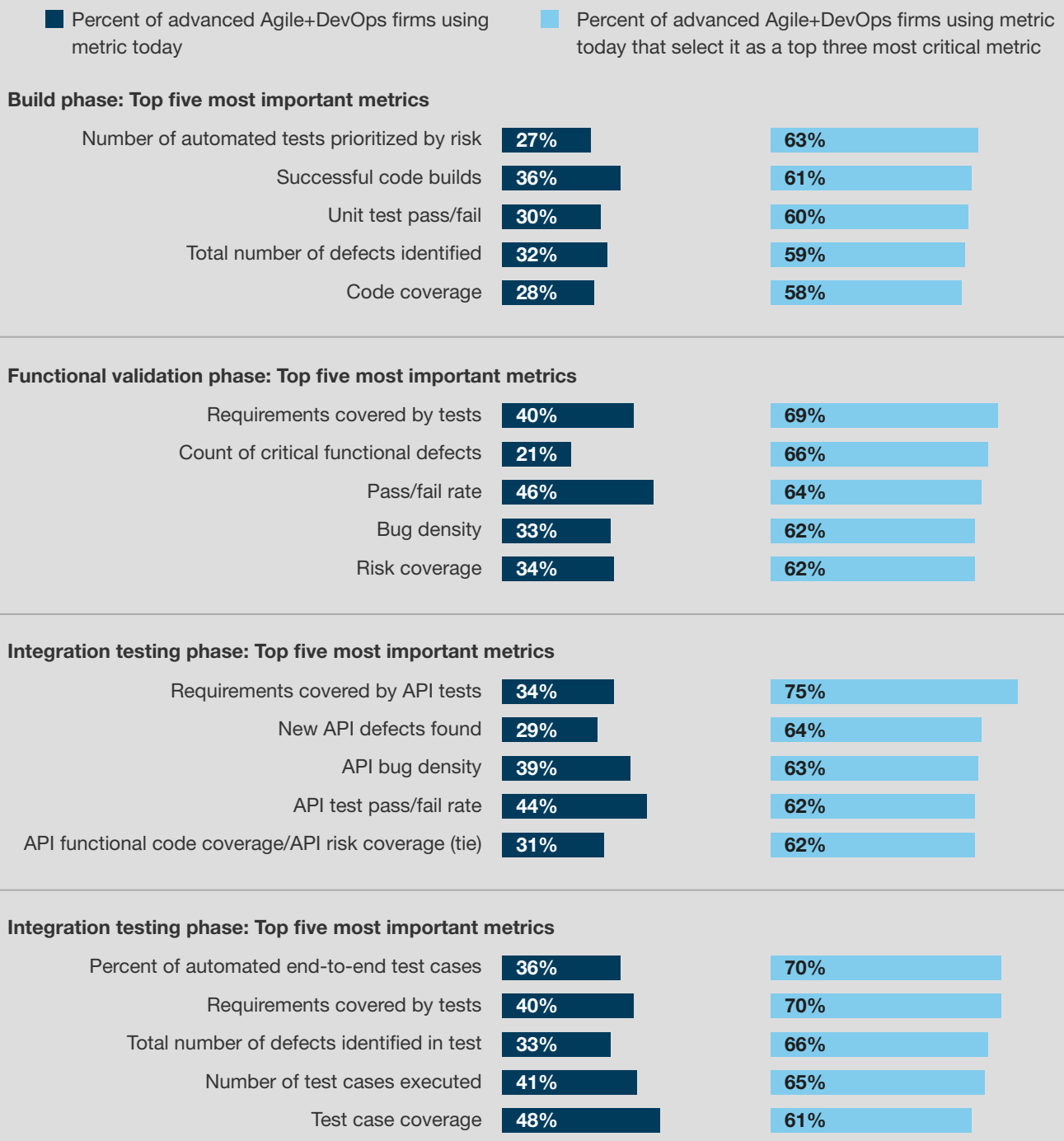
Top five most important metrics to manage risk suggested by Agile+DevOps leaders, split by development stage

	Build	Functional validation	Integration testing	End-to-end regression testing
#1	Number of automated tests prioritized by risk	Requirements covered by tests	Requirements covered by API tests	Percent of automated end-to-end test cases
#2	Successful code builds	Count of critical functional defects	New API defects found	Requirements covered by tests
#3	Unit pass/fail	Pass/fail rate	API bug density	Total number of defects identified in tests
#4	Total number of defects identified	Bug density	API test pass/fail rate	Number of test cases executed
#5	Code coverage	Risk coverage	API functional code coverage/API risk coverage (tie)	Test case coverage

Base: 157 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC that use Agile+DevOps best practices
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

Figure 9

Analysis of key development metrics for advanced Agile+DevOps firms



Base: 157 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC that use Agile+DevOps best practices
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

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Sixty-three percent of these firms consider the number of unit tests prioritized by risk as one of their top desired metrics. But far fewer can actually do so — while 34% of advanced Agile+DevOps firms track the number of unit tests run, only 27% prioritize by risk. And less advanced Agile+DevOps firms use it even less — just 15% can track the metric today. Other important metrics tracked in the build phase focus on ensuring code quality — like the number of successful code builds (61%), unit test pass/fail rate (60%), and total number of defects identified (59%).

- **When functional testing kicks in, user story/requirements coverage gets the focus.** The top goal for testers in this stage is to minimize risk by ensuring that the functionality expressed in user stories works as expected. Extending this coverage concept to business risk coverage is an additional metric that leading Agile+DevOps firms execute to advance release automation.

  Running functional tests and checking against covered requirements (69%), the density of bugs (62%) or number of functional defects found (66%), and the ratio of tests passed vs. failed (64%) are metrics that successful teams identify as important to manage risk and track quality during functional testing.

- **To deal with modern distributed architectures, measuring integration testing and API tests win all around.** With application architectures becoming more decoupled, decomposed in services and microservices, API testing increases in relevance. So much is going on beyond the user interface that it's impossible to keep quality high and diminish risk without addressing the API layer. Advanced Agile+DevOps firms in the integration testing phase prioritize many of the same metrics as the functional testing phase; this time, the focus is on APIs specifically.

  These metrics include tests run against functional requirements (75%), total number of new API defects found (64%) and API bug density (63%), API test pass vs. fail rate (62%), and API code coverage (62%). Monitoring API risk coverage is an important metric as well, with 62% of advanced Agile+DevOps firms prioritizing it as a top three metric for the stage.

- **End-to-end regression testing also gets a first-class citizen role.** In this category, leading organizations automate end-to-end tests at the process or transaction level. Automating these types of tests is not easy, and advanced test automation tools are required because speed matters. The choice of the testing technology matters because achieving and, more importantly, maintaining high levels of automation is crucial. Therefore, the more tests that are automated, the better, and so 70% of leading Agile+DevOps teams prioritize the percent of automated end-to-end test cases as a top metric.

  Many of the other metrics that leading firms rank as important in this stage are quantitative and measure coverage of functionality vs. requirements (70%), number of test cases executed (65%), and total number of defects identified during testing (66%).

Key Recommendations

Forrester's in-depth survey of global enterprises using Agile and/or DevOps about the metrics they track in software development yielded several important recommendations:

Realistically assess and up-level your continuous testing practices for Agile+DevOps. While many CXOs believe their firms are ahead of the curve on DevOps, our research shows that only about a quarter of firms are following testing best practices. Make sure your firm is implementing continuous testing as part of its DevOps strategy.

Make business risk the driver for your metrics program. Most firms acknowledge gaps in their ability to manage business risk with the right metrics but are nevertheless optimistic on risk coverage. This is dangerous for extreme automation — and exacerbated as delivery velocity and volume increase. First, you must clearly define risk. Second, you must continuously measure your exposure versus that risk. Next, use that understanding to promote releases. By focusing test automation efforts on processes and transactions that that carry higher business risk, you reduce the chance that critical defects slip into production.

Ruthlessly automate your testing and QA processes, end to end. If your goal is to deliver high-quality software faster (and it should be), then you need to automate your software development pipeline. More mature Agile+DevOps firms understand that automation is critical to driving release velocity, and they are reaping the benefits. Automating end-to-end testing is a key step in implementing continuous testing and a top priority for Agile+DevOps leaders today.

Prioritize test execution predicated around business risk. Understanding which tests deliver the greatest risk coverage is a significant advantage when speed matters. The ability to prioritize test execution depends on the implementation of a model that is collaboratively developed among the development, testing, and business stakeholders.

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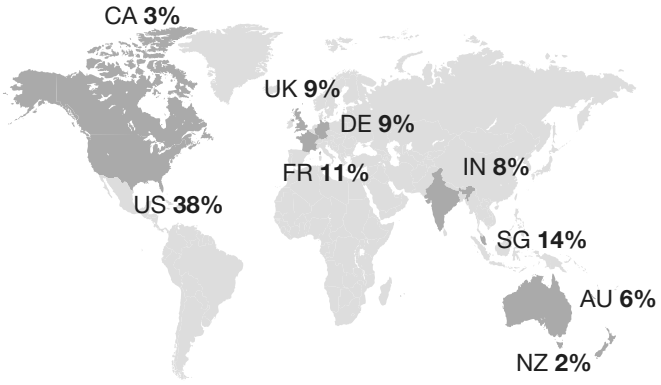
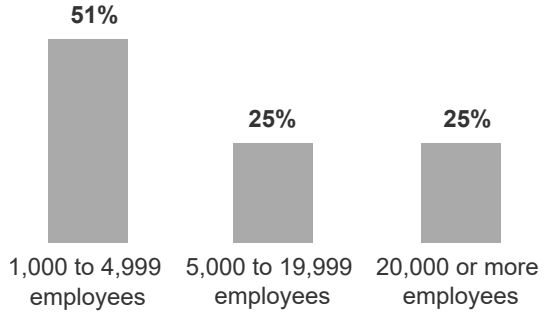
Appendix A: Methodology

In this study, Forrester conducted an online survey of 603 enterprise organizations in North America, Europe, and Asia Pacific to evaluate current software testing practices and metrics tracked during survey development. Survey participants included decision makers and individual contributors responsible for their organizations' Agile and/or DevOps development strategies. Questions provided to the participants asked about their firms' attitudes toward software development automation, risk management, and testing practices, as well as the metrics they track and value in the software development life cycle. The study was completed in March 2018.

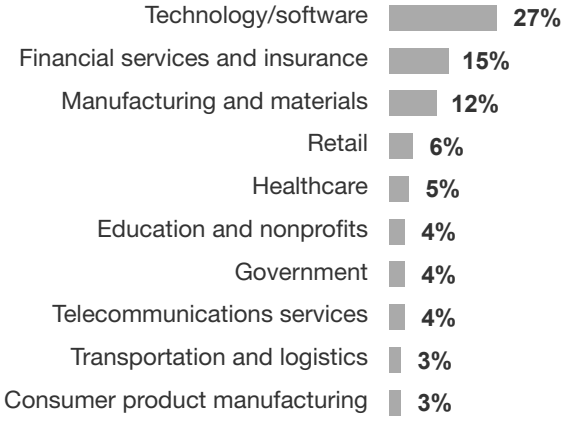
Appendix B: Demographics/Data



Company size



Industry
(Top ten shown)



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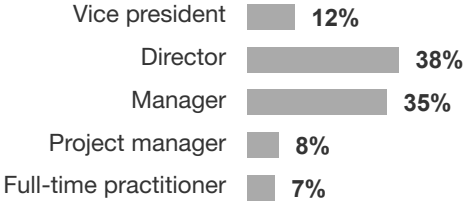
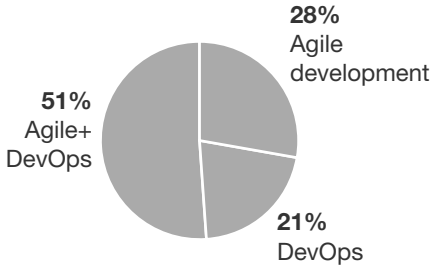
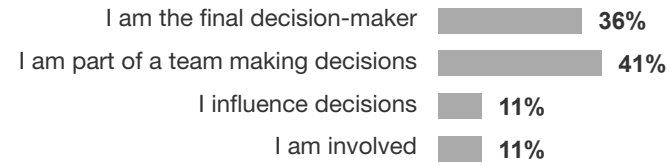


"Which of the following continuous development practices does your organization use today?"



"What is your level of responsibility when it comes to Agile and/or DevOps development strategy at your organization?"



Base: 603 enterprise Agile and DevOps decision makers in North America, EMEA, and APAC
(Note: Percentages may not total 100 because of rounding.)
Source: A commissioned study conducted by Forrester Consulting on behalf of Tricentis, March 2018

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Appendix C: Supplemental Material

RELATED FORRESTER RESEARCH

"Faster Software Delivery Will Accelerate Digital Transformation," Forrester Research, Inc., April 12, 2018

"The State Of Agile 2017: Agile At Scale," Forrester Research, Inc., December 17, 2017

"Master DevOps For Faster Delivery Of Software Innovation," Forrester Research, Inc., November 21, 2017

"Build The Right Software Better And Faster With Agile And DevOps Metrics," Forrester Research, Inc., September 18, 2017

Appendix D: Endnotes

[1] Source: "Agile Only ? No Thanks ! Agile + DevOps, Please!," Forrester Research, Inc., December 21, 2017.