KPMG

Make it, or break it

Reimagining governance, people and technology in the construction industry

Global Construction Survey 2017

KPMG International

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Foreword

The moment of truth

How can the engineering and construction industry overcome fragmentation, external competition and inconsistent performance by reimagining its approach to governance, people and technology?

Taking back control over projects

Achieving change in a hesitant industry

Over the past decades, owners and contractors have made considerable strides in improving the delivery of capital projects. We've seen a host of advances in the form of new construction techniques, project delivery strategies, and enhanced processes and controls for safety, risk management, budget, scope and schedule.

But the industry's overall performance during this period continues to tell a discouragingly different story, replete with a continued inability to increase productivity, raise performance levels and reduce project failures — a record that pales against the achievements in other sectors.

KPMG's 2017 Global Construction Survey — which reports the views of engineering and construction companies and project owners — reflects this apparent contradiction. More than 80 percent of respondents report confidence in their organization's ability to deliver projects on time and within budget. An even bigger proportion (92 percent) say their systems produce timely and accurate project and portfolio reporting.

Yet half admit that, in the past 3 years, adverse project performance significantly impacted their company — rising to nearly 60 percent for contractors. Additionally, just a quarter believe the industry as a whole has reached an acceptable level of performance in delivering capital projects on time and within budget.

Which begs the question: Can we make the kind of step change needed to bring performance in line with stakeholder expectations? With the industry under threat from the inevitable disruption caused by innovative and agile outsiders, it's imperative to swiftly address this issue.

Missing links in the transformation story

To achieve a step change in performance, engineering and construction companies and owners alike need to reimagine governance, people and technology. Currently, despite significant investment, the industry is not integrating these three performance drivers sufficiently. It's not enough to address these components independently — we have to find new ways to make them work together in an integrated fashion. Our survey delves deeply into each of these critical areas to take a more holistic view of their impact upon project performance.

Only by investigating and addressing these missing links can we attain the kind of improvements that other sectors have achieved. Standardization and optimization are worthy goals, but they are unlikely on their own to produce transformational progress. In the future, successful owners and contractors are likely to be those with a strategic vision that can expediently innovate and adapt, and cultivate a workforce and culture that embraces new technology while respecting the proven effectiveness of sound project management.

In the following pages, we discuss how, by assessing, rationalizing and rethinking governance, focusing more on developing exceptional people, and creating a truly integrated digital strategy, we can start to make the kinds of changes that have thus far eluded us.

We would like to thank all survey participants who gave their valuable time and insights to our latest annual Global Construction Survey.

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Geno is a Partner responsible for KPMG's Global Engineering and Construction practice. He is passionate about construction and has invested almost 30 years into studying major projects and organizations — cataloging what executives do well, and applying 'reverse engineering' to failed or struggling initiatives. His experience encompasses hundreds of the largest, most complex projects and organizations globally, across virtually every industry. Geno leads a team of trusted professionals focused on guiding companies through stormy seas, and doing everything humanly and digitally possible to ensure successful projects. A strong advocate of insightful research and thought leadership, he has been personally involved in each of KPMG's 11 Global Construction Surveys since 2005. Geno lives in San Francisco, California, US.

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Clay leads the Major Projects Advisory practice for KPMG in the US and has over 20 years of practical experience and research, giving him a deep understanding of what makes projects and organizations successful. He has been at the forefront of efforts to advance industry-leading methods and tools to objectively benchmark project controls. Additionally, Clay is also on the cutting edge of applying advanced data and analytics to improve transparency, and make better use of the vast data sets associated with major construction projects. A recognized industry thought leader, Clay has published papers on topics ranging from project controls, compliance, data and analytics, mega-project management to so-called 'black swans'.

Contributors

In addition to the efforts of Geno, Clay and other experts attributed throughout this document, we want to recognize the contributions from countless KPMG professionals in our global network of member firms, who have played a vital role in helping us conduct our research by participating in face-to-face interviews. We thank each of you for your time, energy and dedication.

To achieve a step change in performance, engineering and construction companies need to reimagine governance, people and technology. It's not enough to address these components independently — we have to find new ways to make them work together in an integrated fashion.

Survey at a glance

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Reimagining governance, people and technology

How do the main performance drivers interact?

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Rationalizing governance

What's working and what isn't? Should you be shredding those ancient manuals and rationalizing your governance, risk and controls?

— Only 8 percent of respondents have what they call "push one button, real-time, full PMIS reporting," and just 31 percent have integrated systems for project reporting.

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Maintaining the human touch

With several generations of people under one roof, how can owners and contractors attract and motivate a diverse range of individuals for their project teams — and ensure these people have the capabilities and the supporting structure to achieve high-performing projects?

— Forty percent of employees are Gen X and 37 percent are Millennials, but 24 percent of respondents say Millennials do not understand the fundamentals of project delivery.

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Waiting for the technology breakthrough

Placing the right bets — and seeing the benefits from your investments.

— Ninety-five percent of respondents think technology/innovation will significantly change their business, but a mere 5 percent view their organizations as "cutting edge" when it comes to technology.

Reimagining governance, people and technology

When these three critical performance drivers work in harmony, the sum can truly be greater than the parts.

For the past couple of decades, the main engineering and construction players have focused heavily on governance, risk and controls to ensure that projects meet deadlines and budget, and to improve quality and safety. We believe it's now time for a reassessment of this approach, to evaluate what's working and what isn't.

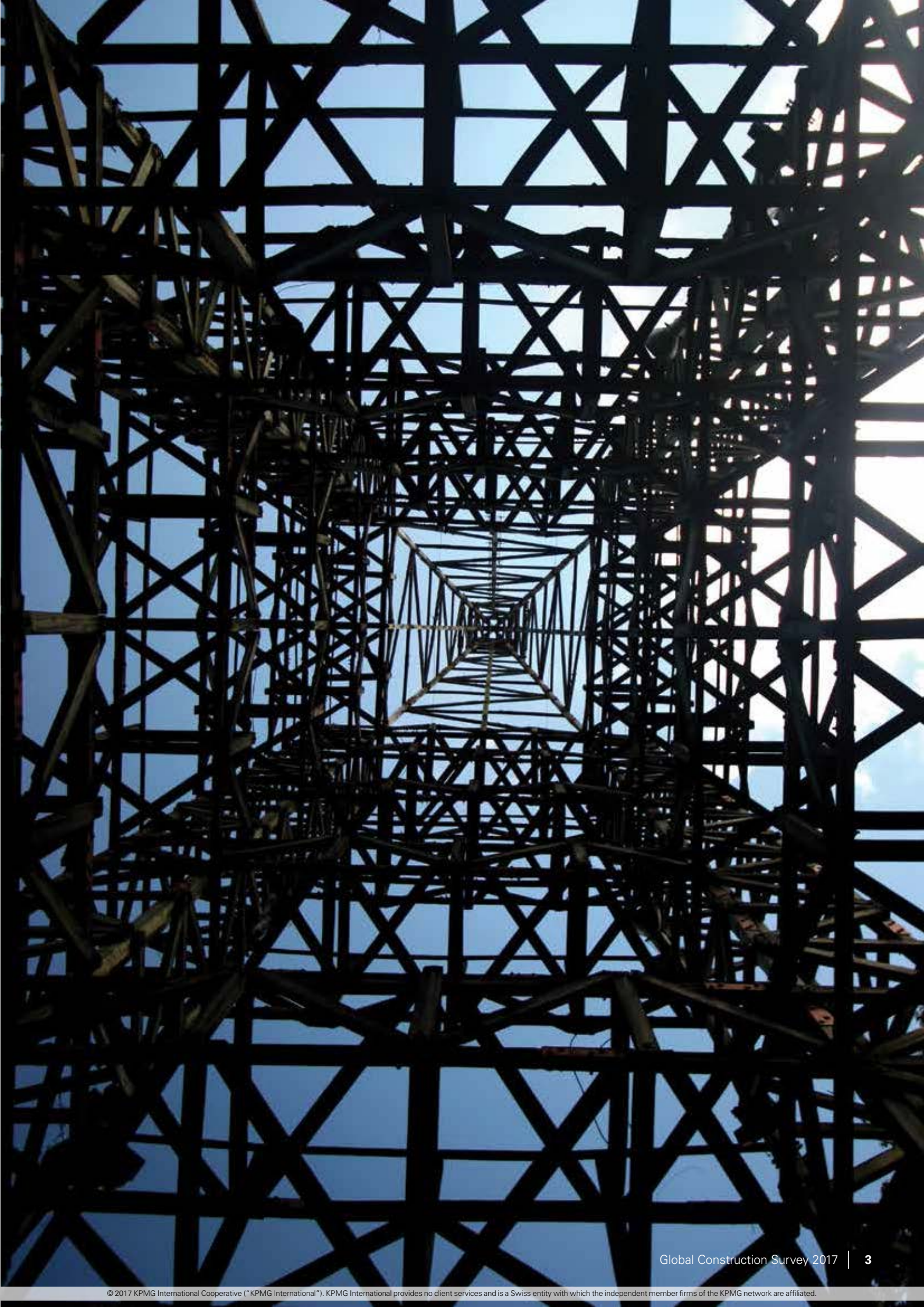
Through our observations, and our discussions with industry experts, it's apparent that project management still lacks transparency and has too many gaps in policies, procedures and controls, enabling small spokes in the wheel to become big barriers to progress. What's needed is a more reliable way to accurately assess and predict project performance, and send out early warnings, so that project teams can intervene swiftly when things aren't going according to plan.

Over the years, earned-value management systems and critical path method scheduling tools have expanded to include other, more holistic solutions. We've tracked this progress through industry research and discussion since the inception of our Global Construction Survey in 2005.

In our 2016 Global Construction Survey, the respondents gave a number of reasons for lack of effectiveness in project controls, namely: 1) overconfidence, 2) lack of consistency and 3) the 'human factor', covering issues such as insufficient soft controls and inadequate talent management. What this year's survey has brought up, in addition to these points, is the need to take a more critical examination of the three main drivers of performance: governance, people and technology. And it's not enough to simply evaluate how these drivers are working independently — it's equally important to understand how they are interacting.

For example, highly rigid controls manuals may not cut it with Millennials, who merely want some 'guard rails' that give them a freer hand. Equally, a shiny new piece of technology or software only adds value if you have the means to analyze the data, interpret the results and take action on the insights.

Much of what we discuss in this year's survey could come under the broad heading of change management. And, in an industry regarded as relatively conservative, making change happen effectively is one of the toughest challenges. We believe that the approaches recommended throughout this document represent practical tips from people that have been on the front line of construction for the past 20–30 years.



Rationalizing governance

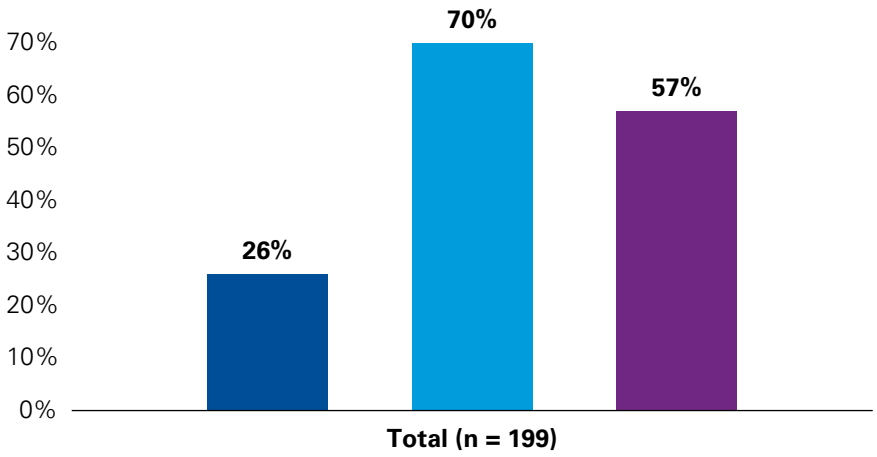
By aligning controls more closely with business strategy, and being brutal about rationalizing the number and degree of controls, owners and contractors can refocus on the key issues that make or break projects.

It's no exaggeration to say that governance and controls are the very lifeblood of projects, and which, for a large part, guide engineering and construction companies towards their objectives. These systems are the foundation for planning and monitoring progress towards a high-quality, on-time, on-budget project or program.

And we know these controls are being widely used. Of this year's survey respondents, 70 percent track project performance based on original approved baseline project schedule and budget (Figure 1). A healthy 60 percent hold routine project review meetings with management, which trigger additional reviews — and if necessary, intervention — for any issues that could impair project performance (Figure 2).

Sixty percent of respondents say their organizations hold routine project review meetings with management, which trigger additional reviews — and if necessary, intervention.

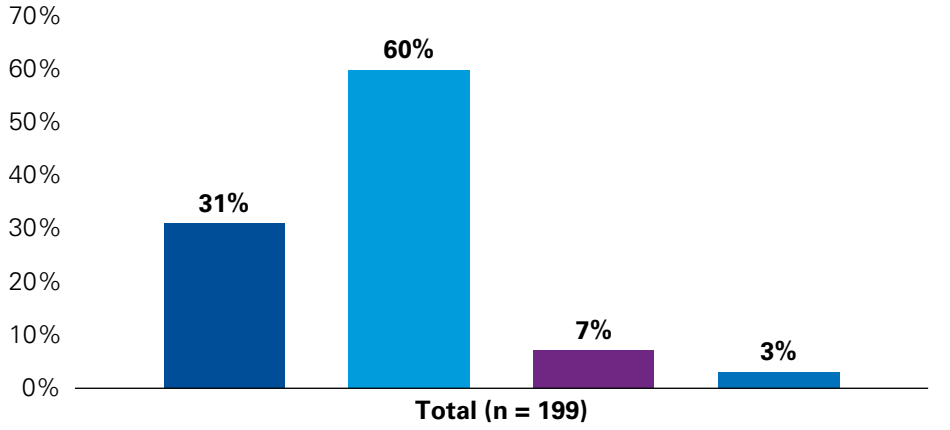
Figure 1: Against which benchmark does your organization track project benchmarks for tracking performance? (check all that apply)



Multiple responses allowed

Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 2: What triggers/KPIs are used to initiate project recovery or intervention activities?



Percentages might not add up to 100% due to rounding

Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Just 8 percent of executives surveyed say their organization's have "push one button, real-time, full PMIS, capable of project and portfolio dashboard reporting".

These findings mirror KPMG's own experience in the marketplace, where over the years we have evaluated the design and effectiveness of controls for close to 1,000 projects and organizations. Additionally, our involvement with industry-leading organizations like the Engineering Construction Risk Institute (www.ecrionline.org) indicates that many owners and contractors have made advances in the way they control projects.

So why do projects continue to underperform? When asked this question, the executives taking part in this year's global survey had a variety of responses, pointing to factors like "Wrong estimations and forecasts in planning and scheduling processes", "bad contract management and acceptance of too much risk" and "incomplete scope definition, scope creep and quantity growth, along with insufficient change management rigor".

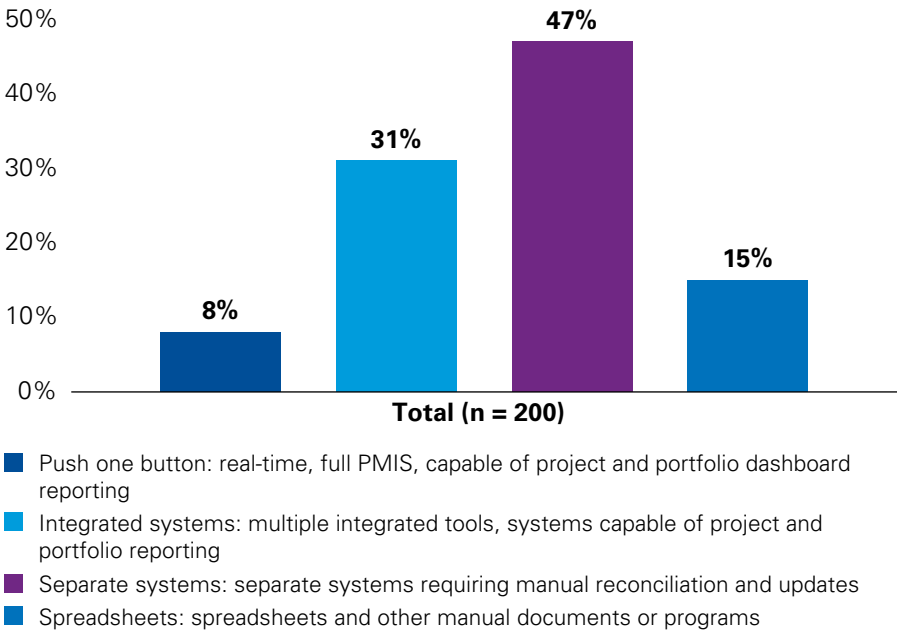
Another respondent summed up his concerns by saying that "The rate of failure seems not to have changed in over 30 years. Other than building information modeling, value seems elusive. We must give greater attention to process, measurement and how we use data to make better decisions."

A closer look at how owners and contractors approach governance, risk and controls reveals some potential areas for improvement.

Just under half (47 percent) of the respondents say their organizations have separate systems for project reporting, yet a mere 8 percent have what they call "push one button, real-time, full project management information system (PMIS), capable of project and portfolio dashboard reporting" (Figure 3). It seems that the days of instant project reporting are still some way away for most of the sector.

And only 31 percent of survey participants report that their companies do have integrated systems for project reporting, which means that most project managers lack the capability to control all elements of the work.

Figure 3: Which statement best describes your organization's project reporting?



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Cracking the code for project controls

The incredible complexity of many of today's projects is simply outpacing our ability to control them given our current governance, process transformation, and technology models and tools. They are typically larger and more integrated, with faster schedules and creative financing mechanisms that lead to tighter budgets. And in our desire to be thorough and systematic, we have underestimated the human element. Hard experience tells us rules and procedures are only as good as the people administering them. And finally, as we highlight in the last section of this report *Three steps to closing the performance gap (on page 28)*, few companies have truly exploited the new technology available to integrate each element of the controls environment.

Most owners and contractors have numerous systems for managing projects throughout the project life cycle — something highlighted in KPMG's 2016 Global Construction Survey.[1] In the search for end-to-end solutions, one option is to go for a comprehensive PMIS. However, these are affordable only for the biggest companies and are not really customized to meet the needs of the vast majority of contractors and/or owners.

An alternative is to try to enhance existing systems, or continue to bring in smaller, more control-specific IT solutions that may be very hard to integrate.

But there is another way, in the form of new data and analytics and visualization software, which costs less and is faster to implement than a huge PMIS system — and provides real-time, customized reporting. Such an approach can only succeed if the organization diagnoses its technology and data to understand current system and data capabilities, and then creates a technology strategy and 'road map' that aligns technology investment and time line with processes, governance and change management.

By linking existing disparate data and analytics software systems, it's possible to gain some quick wins to produce reporting that can aid project managers' decision-making and build the business case for broader investments.

Three steps to simpler and more effective controls

1. Make the controls flexible and aligned with broader business strategy, so that they reflect the key project priorities.
2. Rationalize all controls on an ongoing basis to ensure they are as simple and relevant as possible.
3. Balance 'soft' versus 'hard' controls (discussed further on **page 13**).

[1] *Building a technology advantage,* Global Construction Survey 2016, KPMG International.

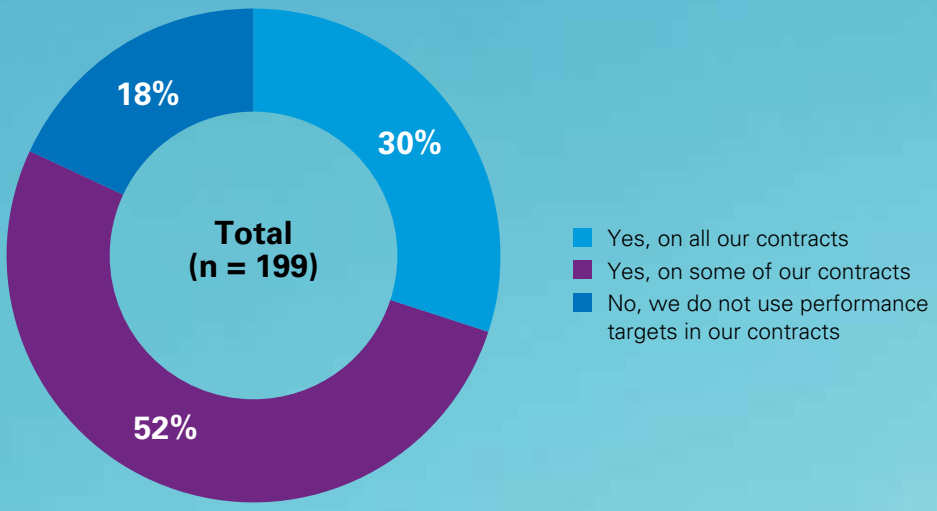
Contracts and performance

Although performance targets are an important tool for ensuring strong contractor efficiency, not all the respondents set such goals. Only 30 percent claim to incorporate performance targets into all of their contracts, with a further 52 percent including targets on "some" of their contracts (Figure 4).

Schedule is ranked as the number one performance measure, followed by cost/cost sharing. Contract performance measures for output/production, safety, subcontracting and schedule ranked considerably lower (Figure 5).

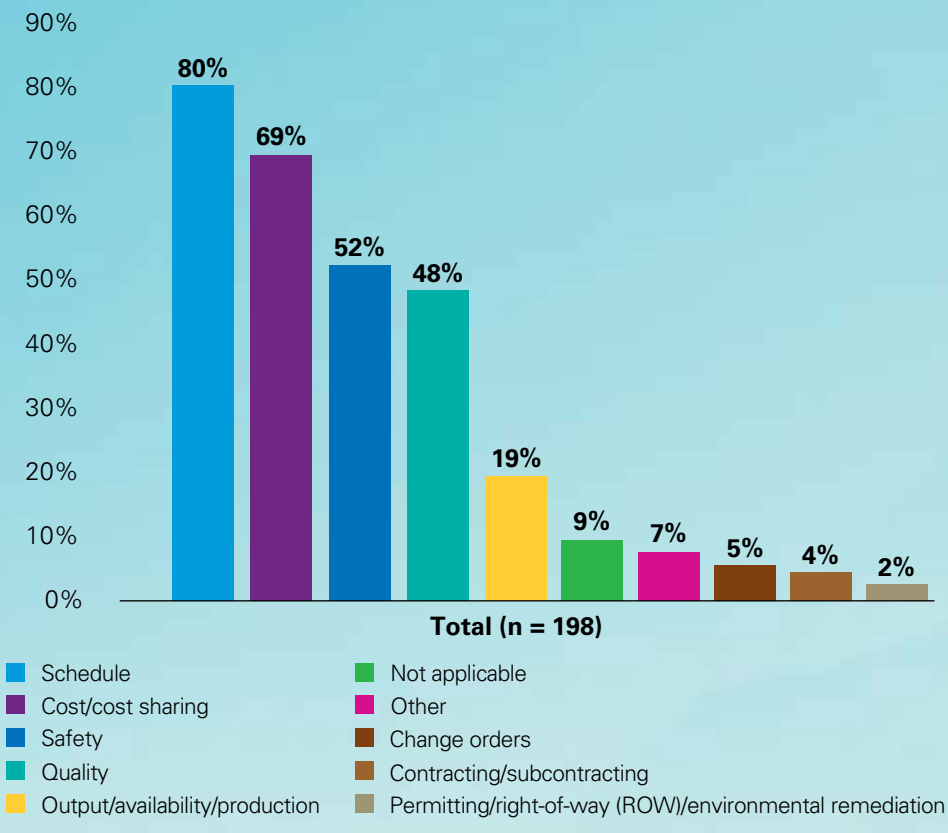
In an attempt to align all the interested parties on construction projects, a number of contractors and owners are adopting new delivery strategies such as integrated project delivery. But, interestingly, there has been little research into the impact of contract performance incentives on performance. The challenge is to come up with the kind of incentives that mutually benefit — and therefore motivate — all the stakeholders.

Figure 4: Do you incorporate performance targets into your contracts?



Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 5: What are the top three performance measures used in your contracts?



Multiple responses allowed

Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Maintaining the human touch

To cope with the changing workforce demographics, engineering and construction companies need to adapt controls to reflect new ways of working, and balance 'soft' versus 'hard' controls.

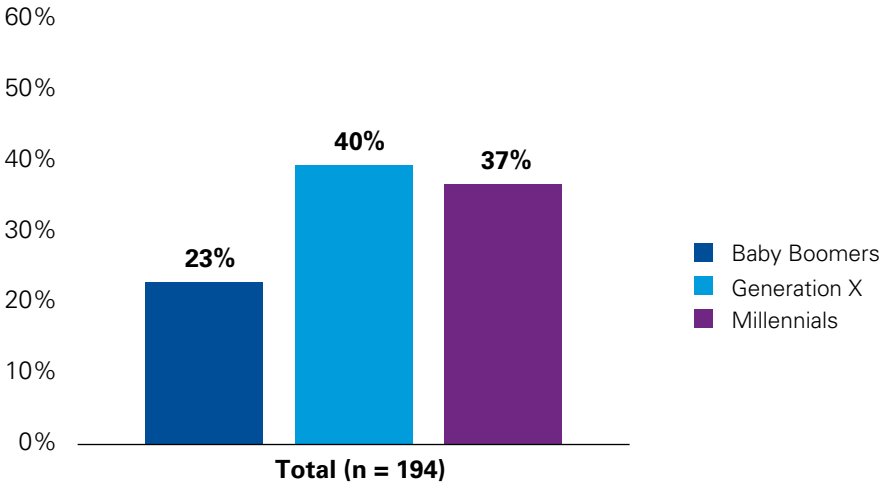
Given that more and more elements of projects are dependent upon sought-after graduates working in white collar roles, it's perhaps little surprise that 86 percent of respondents say that the "human element" significantly influences project delivery. But what are engineering and construction firms and project owners actually doing to optimize this precious resource?

As Baby Boomers approach retirement, new generations of workers are taking their place. According to the professionals participating in our global survey, just 23 percent of their workforces are comprised of Baby Boomers (born 1945–1964), 40 percent of Generation X (born 1965–1979) and 37 percent of Millennials (born 1980–1994) (Figure 6).

What are the implications of this generational shift — especially for Millennials who've grown up in the digital age and, additionally, don't always have the nurturing hand of Baby Boomers around their shoulders to help them learn the tricks of the trade?

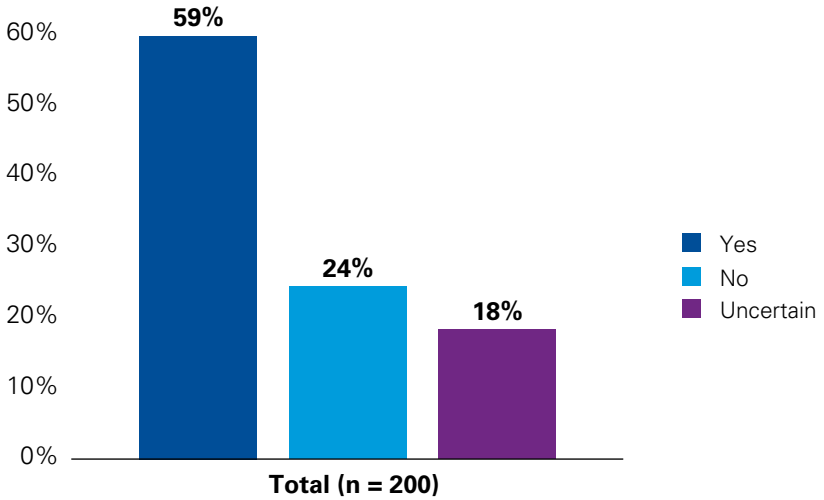
According to respondents, 40 percent of employees are Gen X and 37 percent are Millennials.

Figure 6: Which generations make up your workforce?



Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 7: Does the Millennial generation understand project delivery fundamentals?



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Just 40 percent of the organizations in the survey have formalized soft controls as part of their project delivery framework.

When it comes to understanding the fundamentals of project delivery, more than four in ten respondents are concerned that Millennials are not fully up to speed with skills like scheduling, cost-control, risk management, procurement strategies and earned value management (Figure 7). The challenge is even more acute for project owners, with more than half uncertain about Millennials' knowledge in these critical areas.

Giving younger employees the skills, experience and confidence to manage major projects — and managing and motivating them in an appropriate manner — is one of the most important tasks facing the sector. It's also broadly the case that the younger the worker, the greater their digital skills and confidence. Millennials are attracted by technology, and engineering and construction companies should recognize that investing in a digital workplace could increase their ability to attract and enthuse this demographic. If they don't take these steps, then, as we argue on page 32, in our section *Optimize human performance,* the brightest young engineering talent is likely to opt for careers in more 'shiny' sectors that embrace technology.

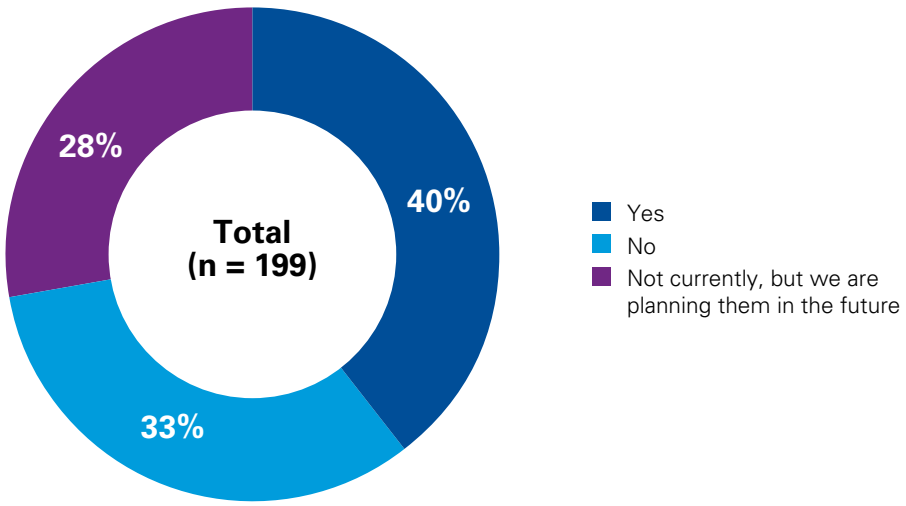
'Hard' versus 'soft' controls

In this year's survey, we've talked at length about 'technical' project controls. But what some refer to as 'soft' controls — ensuring that all staff are clear about their roles, feel free to raise issues or concerns, are confident that they will be listened to, and, ultimately, embody the right values — are, arguably, equally important to project success.

According to the executives involved in this year's survey, just four in ten organizations have formalized soft controls as part of their project delivery framework (Figure 8). Contractors are more likely to operate such controls than owners (45 percent versus 34 percent). If companies fail to encourage the right behavior, their workforces are unlikely to have the awareness, the confidence or the motivation to apply the harder, technical controls consistently and accurately.

Some of the executives involved in the survey spoke of younger workers feeling constrained by too many rules and regulations, which suggests that the traditional focus on hard, technical controls may be inappropriate for Millennials. Again, this relates closely to our findings in the previous section on controls, where we discuss rationalizing the number and degree of controls, to have a more manageable system that users of all generations are likely to use effectively.

Figure 8: Are formalized soft controls part of your project delivery framework?



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Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Viewpoint

Professor Muel Kaptein
Partner
KPMG in the Netherlands

Viewpoint: Balancing hard and soft controls

Historically, when projects have gone off track, the automatic response has been to add layers of hard controls — like additional authorizations, expense approvals, reduced delegations or project performance reviews — in an effort to make one or more persons accountable.

We believe this is too much stick and not enough carrot, and does not necessarily lead to better outcomes. A better balance is to combine traditional hard controls — such as segregation of duties, system restrictions and authorizations or approvals — within tangible soft controls that promote desired behavior.

Despite acknowledging the importance of the human factor in projects, the respondents in this year's survey have yet to establish a systematic way to leverage soft controls in managing projects.

They also lack a common view of what constitutes a soft control, and of how best to use soft controls to strengthen the overall project control environment.

Before investing in further hard controls, owners and contractors should carefully consider how human behavior impacts projects, and evaluate how soft controls can address any weaknesses and encourage positive behavior.

To introduce greater objectivity to this process, we have developed a model that integrates soft controls into project delivery frameworks and the project control environment. The model is based on extensive scientific research and has been widely used by a number of global organizations, who have benefited from greater clarity of roles and greater commitment to enforcing controls.

The fundamentals of organizational culture: eight soft controls

Source: *KPMG's Soft Controls Methodology* developed by Professor Muel Kaptein, Partner, KPMG in the Netherlands.

Only 33 percent of respondents report that their organization's employee promotion process is "very standardized".

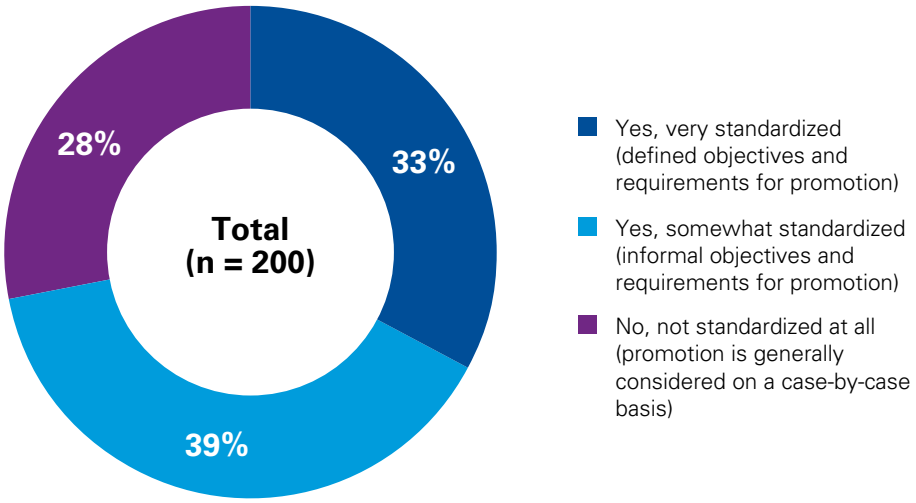
Charting a career path

When compared with options like entrepreneurial technology start-ups, engineering and construction may not always appear to be the most exciting career for today's graduates. This makes it more important than ever to find effective ways to recruit and retain the right talent. When it comes to building a career in the sector, our survey suggests that many companies have some way to go.

Twenty-eight percent of survey respondents admit that there is no common approach at all to their employee promotion process and promotions are generally considered on a case-by-case basis (Figure 9). The responses suggest that project owners from financial services and retail have the least degree of standardization, while industries like natural resources and chemicals, industrial manufacturing, and power and utilities are most likely to offer a standard career path. These latter sectors typically employ far greater numbers of people on capital projects — possibly more than 10,000 globally — and, arguably, have a bigger need for a common approach.

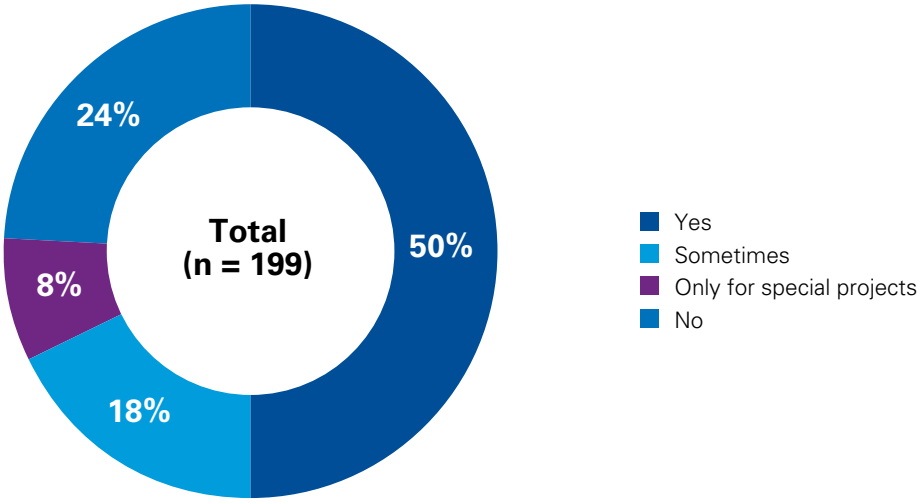
The survey also indicates that owners from Asia — especially China and India — are the most likely by some way to offer clear promotion paths, which is in stark contrast to other regions of the world (Figure 11).

Figure 9: Is your employee promotion process standardized?



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 10: Do you offer performance-based project bonuses, variable compensation or incentive mechanisms?



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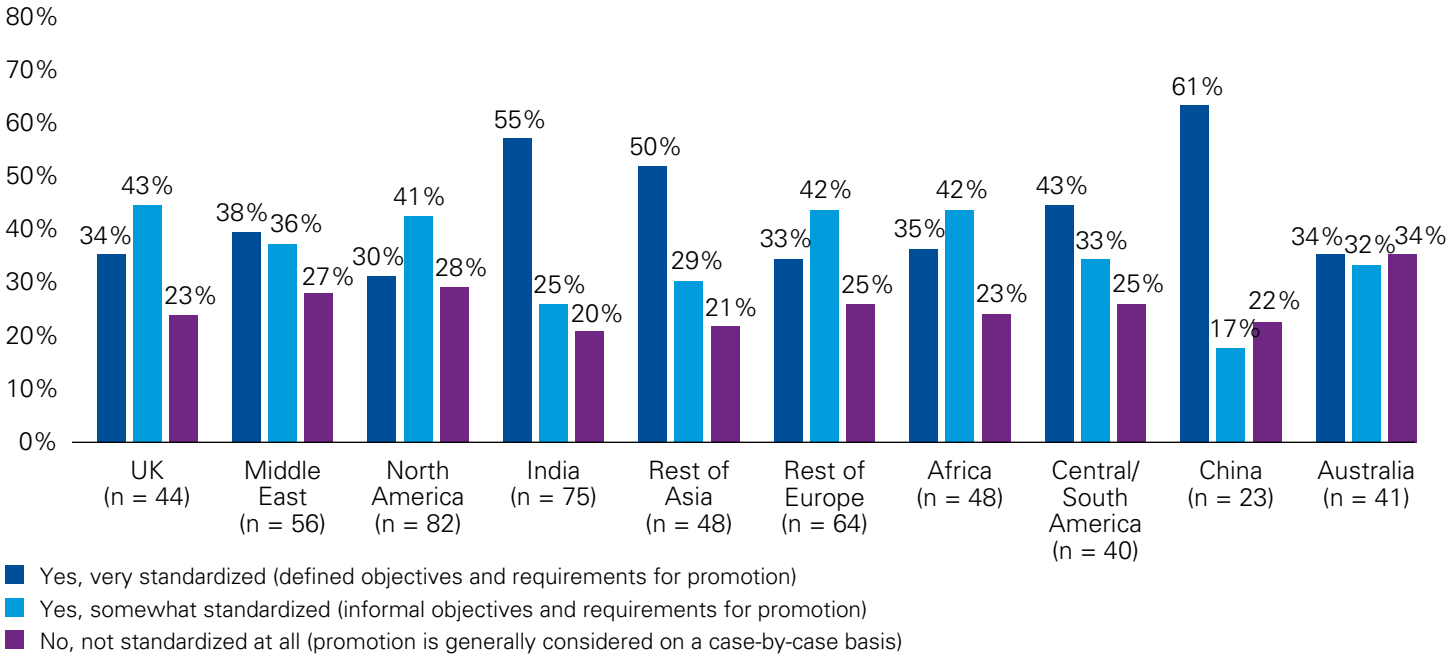
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

And only half of the executives participating in our survey say their business routinely offers performance-based project bonuses, variable compensation or incentive mechanisms (Figure 10). Indeed, 24 percent offer no incentives at all — a figure that rises to 31 percent for project owners, reflecting the fact that capital projects are often not seen as core to the business. But, if they fail to provide suitable financial motivation, owners and contractors could be reducing the opportunity to meet critical time and budget targets.

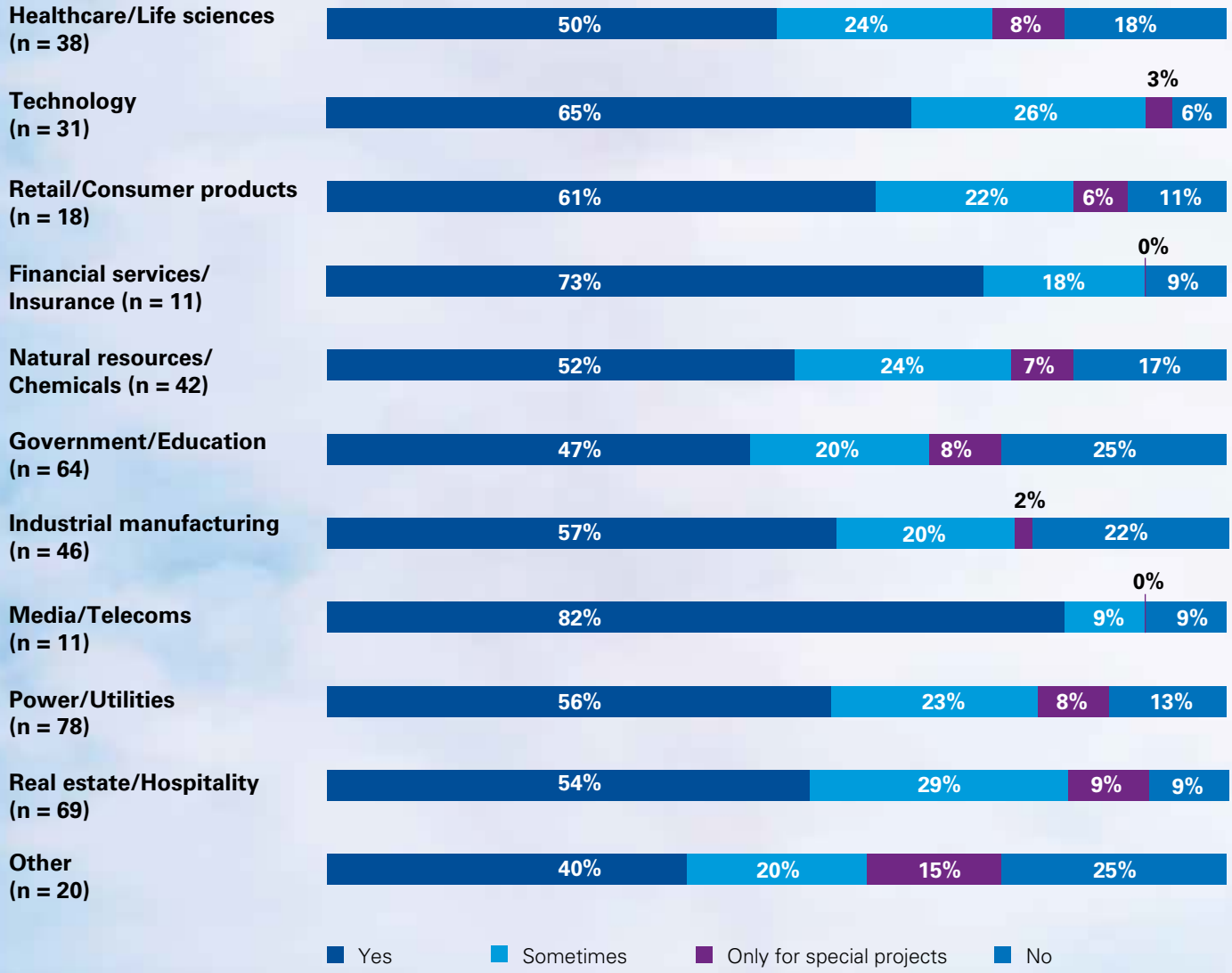
Interestingly, our survey results suggest that financial services and media are the two industries with the highest incidence of performance-based pay, which could reflect a wider, incentive-based culture in these two sectors (Figure 12).

Figure 11: Is your employee promotion process standardized? (regional perspectives)



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 12: Do you offer performance-based project bonuses, variable compensation or incentive mechanisms? (industry perspectives)



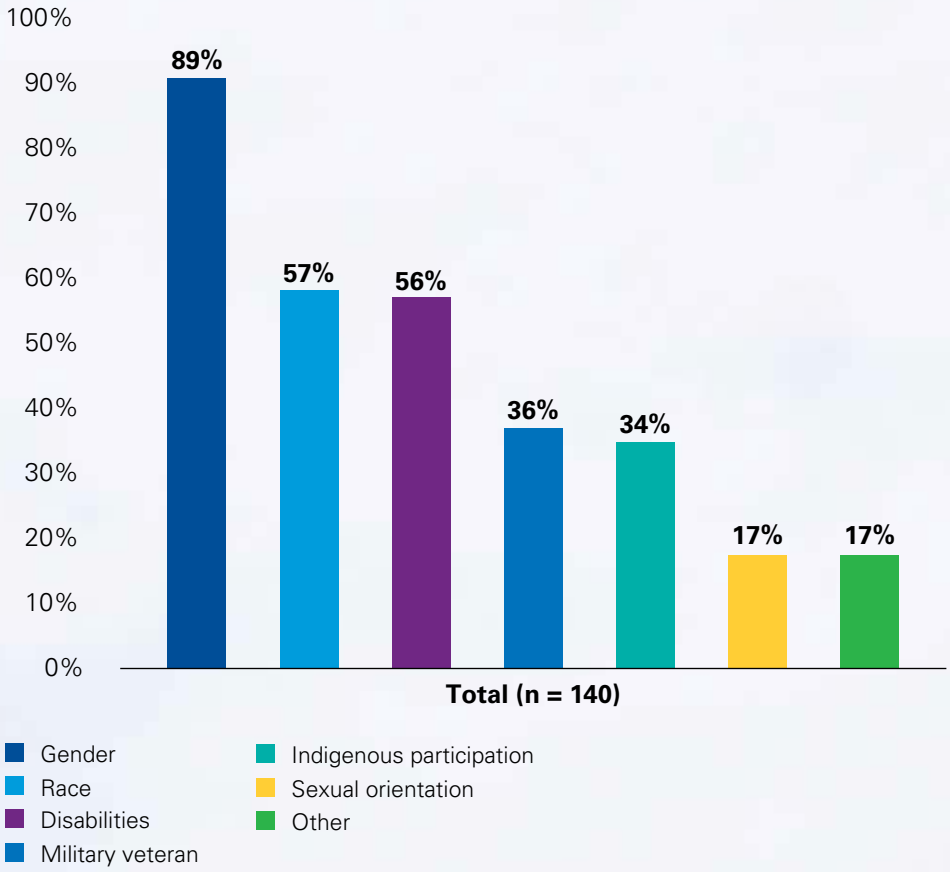
Percentages might not add up to 100% due to rounding

Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Creating a truly diverse industry

One of the keys to the future talent challenge is to improve diversity in the engineering and construction sector. While a large majority of respondents say their organizations track gender diversity, fewer assess employees along lines of race, disability or sexual orientation. And 30 percent do not track or measure diversity in any way (Figure 13).

Figure 13: What categories of diversity targets does your organization track? (check all that apply)



Multiple responses allowed

Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Waiting for the technology breakthrough

It's not just about investing in technology; it's about knowing which specific technologies can improve performance — and then aligning digital and business strategies.

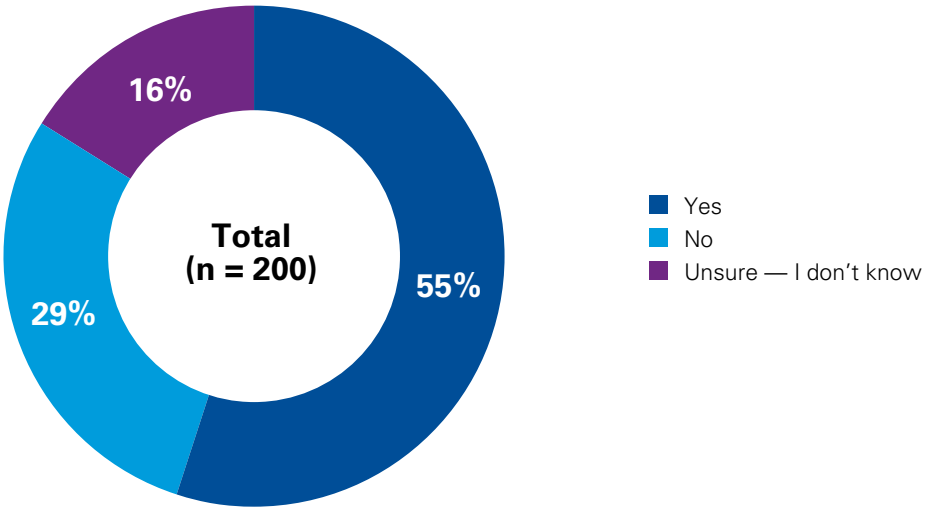
With exciting innovations like robotics, automation and drones, and powerful data analytics to improve design and project management, engineering and construction would seem to be a perfect stage for showcasing the technological revolution.

This year's respondents are certainly bullish about the potential of technology. Fifty-five percent feel the industry is ripe for disruption (Figure 14), 95 percent think technology/innovation will significantly change their business and three-quarters (74 percent) believe such a change will happen in less than 5 years.

And 72 percent of respondents say that technology innovation or use of data plays a prominent role in their strategic plan or vision (Figure 15).

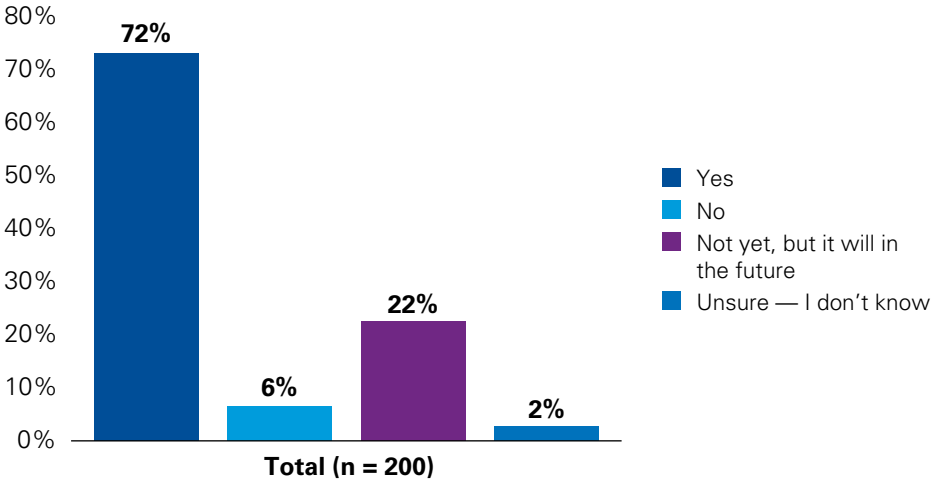
Seventy-two percent of respondents feel that technology, innovation or use of data plays a prominent role in their strategic plan or vision.

Figure 14: Is the industry ripe for disruption?



Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 15: Is technology, innovation or data prominent in your strategic plan or vision?



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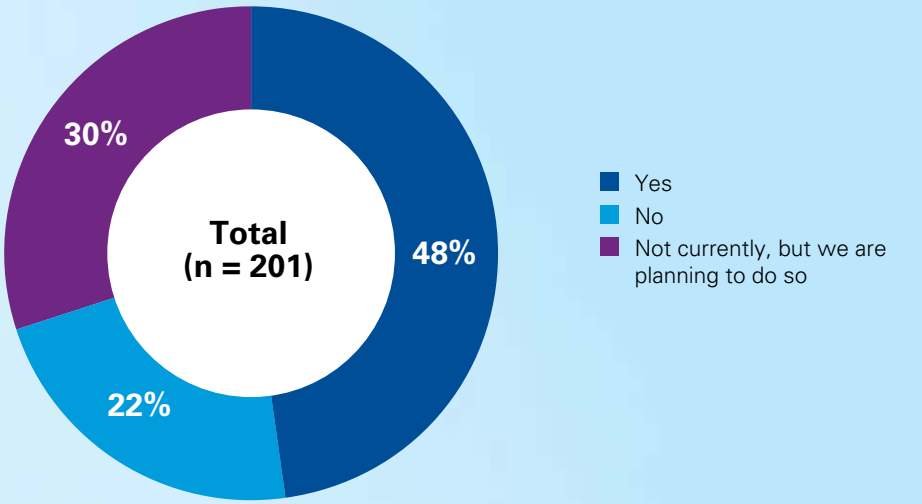
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Just 20 percent of respondents' organizations have implemented PMIS across all projects.

Figure 16: Have you developed a data/technology strategy or road map?



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

A separate global 2017 KPMG survey of CIOs (conducted in conjunction with Harvey Nash) also showed enthusiasm for all things digital, with 63 percent of respondents from engineering and construction companies seeing technological disruption as more of an opportunity than a threat.[2]

Yet, as last year's 2016 Global Construction Survey *Building a technology advantage* demonstrated, the industry is yet to fully harness the power of technology.[3]

Fewer than half of the respondents to this year's survey (48 percent) say their company has developed a data/technology strategy or road map (Figure 16). Of all the technologies, PMIS is considered to have the greatest potential to deliver value, yet just one-fifth (20 percent) have implemented PMIS across all projects, and a mere 8 percent say they have a real-time, full PMIS, capable of project and portfolio reporting.

[2] *Navigating uncertainty* — the Harvey Nash/KPMG CIO Survey 2017.

[3] *Building a technology advantage,* 2016 Global Construction Survey, KPMG International.

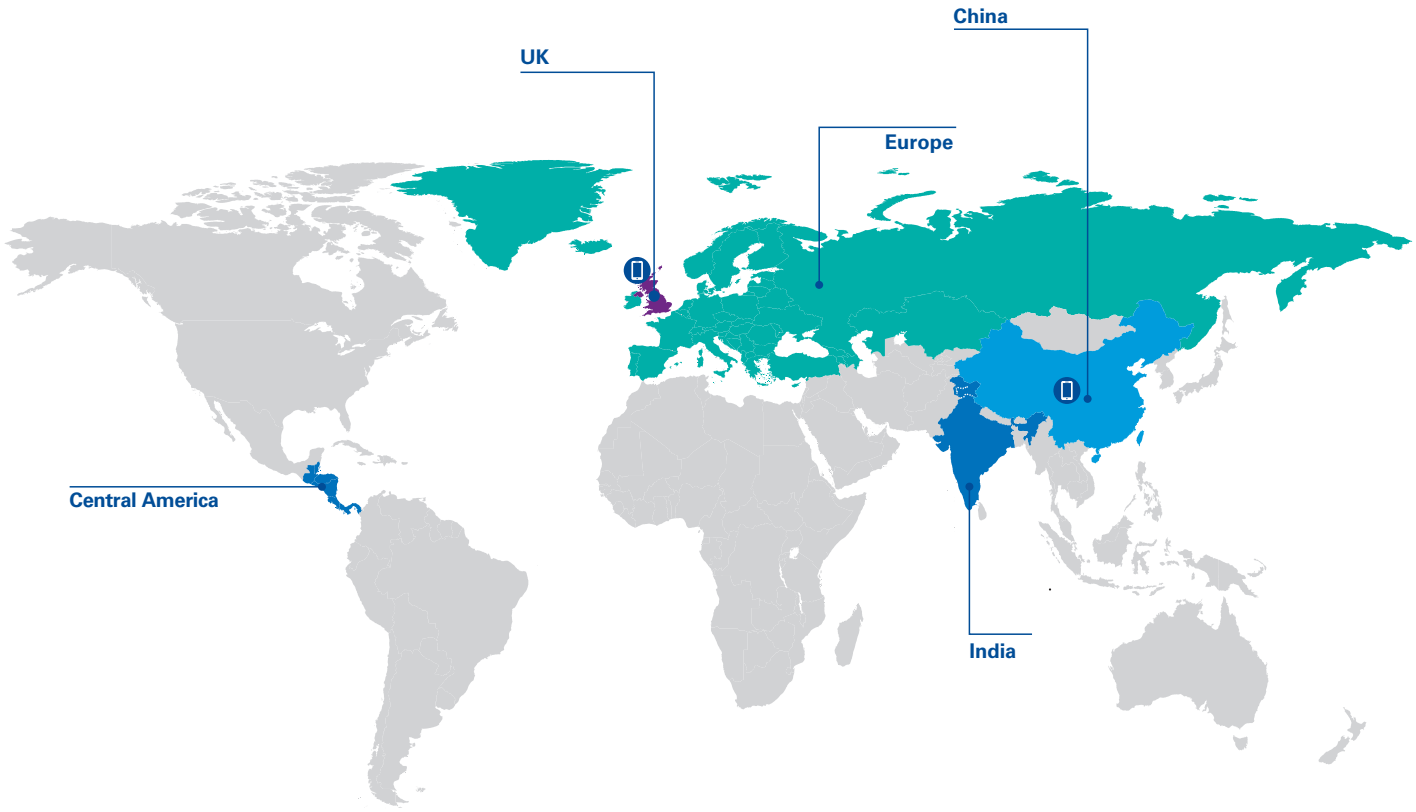
Who's ahead of the digital game?

Which regions and industries are pioneering the adoption of technology? Our survey responses reveal some fascinating findings. For example, China appears to be leading the pack when it comes to advanced data and analytics and building information modeling, and shares top place with the UK for use of mobile platforms. Owners and contractors from the UK, meanwhile, are the most likely to be employing drones and virtual reality.

India and Central America are at the forefront of integrated PMIS, while Europe (excluding the UK) has assumed the lead in digital labor and robotics.

Respondents from Australia report the highest uptake of 3-D printing.

Looking at specific industries: media and telecommunications executives say their sector is the fastest adopter of integrated PMIS and, along with financial services, is at the forefront of advanced data and analytics usage. Healthcare leads the field in building information modeling and virtual reality, with financial services ahead in mobile platforms and drones. Finally, respondents from natural resources are the most likely to say their companies use smart sensors for remote monitoring, quality verification and construction status.



- China — Advanced data and analytics and building information modeling
- UK — Drones and virtual reality
- India and Central America — Integrated PMIS
- Europe (not including UK) — Digital labor and robotics
- China and UK — Use of mobile platforms

When asked about their organization's technological maturity, a mere 5 percent consider themselves "cutting edge".

Cutting edge or behind the curve?

In KPMG International's 2016 Global Construction Survey, we assessed the rate at which owners and contractors were adopting technology, and found that just 5 percent were "cutting-edge visionaries", with 69 percent either "followers" or "behind the curve".

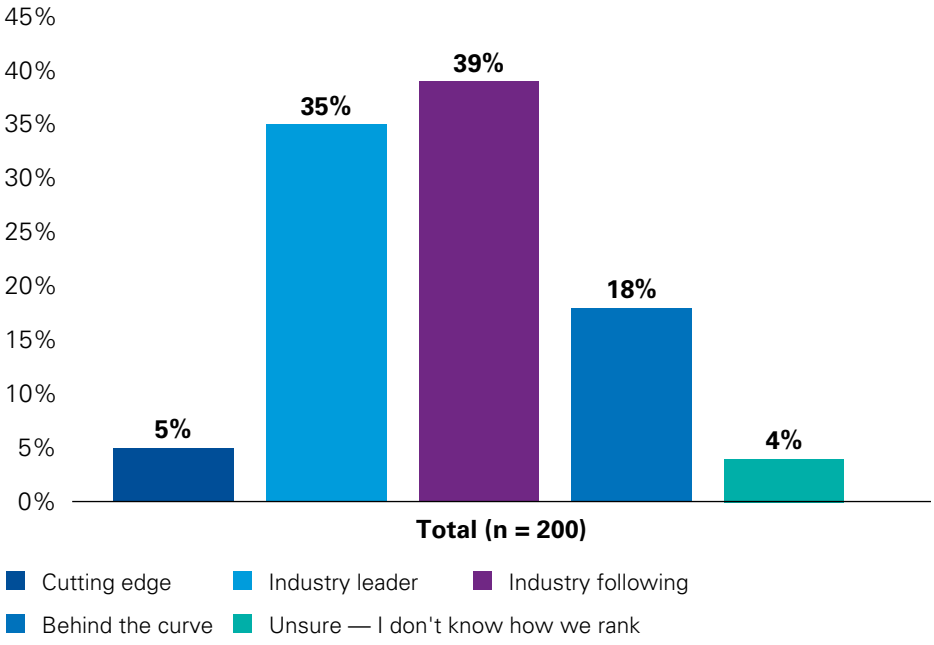
Despite a small improvement over the past 12 months, 57 percent of respondents to this year's survey still consider themselves to be "followers" or "behind the curve", and the proportion that view their organizations as "cutting edge" remains at 5 percent (Figure 17).

Those that choose to invest in the right disruptive technologies have the opportunity to gain a step change in performance, but the industry's innate conservatism appears to hold back its efforts to tackle the complexity of today's projects. In the Harvey Nash/KPMG CIO Survey 2017, for example, respondents from the engineering and construction sector feel that "improving operational efficiencies" is only the third most important technology priority.[4]

Data analytics and statistical models can help identify patterns and outliers, predict trends and make more accurate forecasts of completion estimates. Meanwhile, 3-D building information models have a big role to play in construction time-and-cost monitoring, operational preparedness, asset commissioning, maintenance planning and asset management. Drones can perform flybys at construction sites feeding the management teams with a better view of construction progress. And advances like augmented reality (AR) and virtual reality (VR) can be used in design engineering for large construction projects and also in identifying the most suited execution/construction delivery methods.

Yet a look at the responses to this year's survey shows that only a very small proportion of owners and contractors are using any of these technologies routinely.

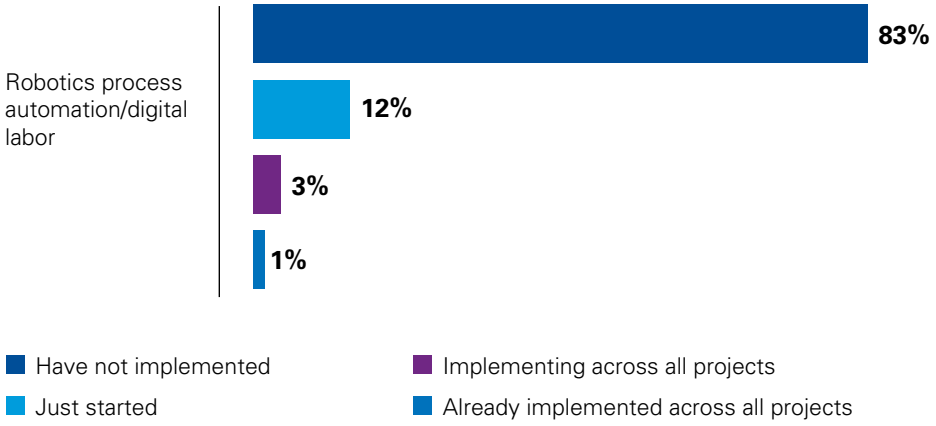
Figure 17: Where would you rank your organization with regards to technological maturity?



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

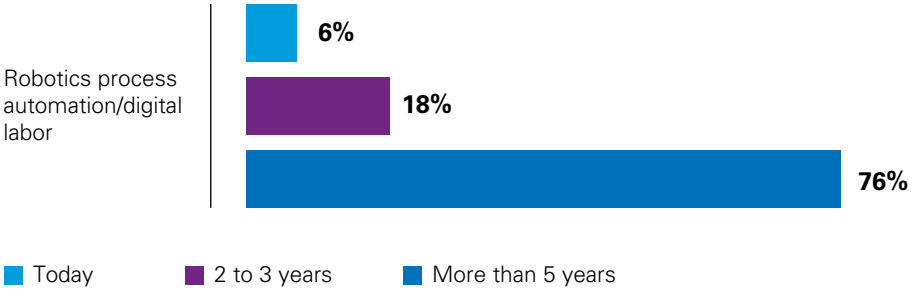
[4] *Navigating uncertainty* — the Harvey Nash/KPMG CIO Survey 2017.

Figure 18: Rate of technological adoption in your organization.



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 19: When will the construction industry fully embrace the following technologies?



Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Robotic process automation and/or digital labor have a particularly exciting potential and are taking off in many other industries, with machines and computers replacing humans. Once again, engineering and construction lags behind. The vast majority of respondents (83 percent) say their organization has not yet implemented such technologies (Figure 18), with most expecting a wait of 5 years or more before they become more common (Figure 19). And it's a similar picture with cognitive machine learning, another technology that lends itself to automation.

On the surface, engineering and construction seems ripe for such transformation, with a host of tasks like payment processing, engineering calculations, and data and information management that could be automated. In an industry that is heavily resistant to change, such advances may be viewed with trepidation, along with the fear of losing jobs. Yet, as the KPMG International paper on digital labor, *Rise of the humans,* argues, "Cognitive technologies can spur a growth in jobs and enhance human skills and expertise. Ultimately, they can make every employee an innovator and transform the enterprise into an engine of unconstrained innovation."[5]

[5] *Rise of the humans,* KPMG International, 2016.

Viewpoint

Becoming a digital leader

Clay Gilge

Head, Major Projects Advisory
KPMG in the US

"Engineering and construction companies fall short of cross-industry effectiveness benchmarks in several key IT capabilities.[6]"

The 2017 Global Construction Survey finds the industry's players long on enthusiasm for the digital revolution, but short on action to help realize their digital potential. And these findings are mirrored in the 2017 KPMG/Harvey Nash CIO Survey, where engineering and construction respondents are far less likely to maintain an enterprise-wide digital business strategy than other industries. Even those organizations that do have a digital strategy report much lower levels of effectiveness than their peers in other sectors.

Indeed, the CIO survey reveals that engineering and construction companies fall short of cross-industry effectiveness benchmarks in several key IT capabilities, including executing projects, aligning IT and business strategy, developing the right culture, and facilitating the use of data and analytics.

To better understand these somewhat contradictory findings — and find a way to get more out of technology — we need to look at the industry's structure. Unlike many sectors, engineering and construction has a supply chain comprised of numerous vertical layers of architecture and engineering firms, contractors, subcontractors, suppliers to owners, consultants, sureties, banks and regulators. To compound this, each of these layers is highly fragmented in all but a few geographies.

This means that, for virtually every project, data is not only scattered across numerous organizations but also across multiple disaggregated systems, programs and databases. With such a lack of visibility, it's no wonder that the industry is struggling to move the needle on performance and productivity. In such a fragmented environment, companies rarely get the benefit of their investment in technology, as the other links in the supply chain are not matching their efforts, due to lack of either funds or appetite. A sophisticated data reporting solution won't be effective if most of the project data is inaccessible. In this vicious circle, it's little wonder that businesses are hesitant to bet big on digital.

Such structural inefficiencies will not disappear overnight, so in the meantime, both owners and contractors can follow a simple, three-step approach to get more out of technology:

1. **Today:** Optimize current systems and leverage data and analytics and visualization to create insightful reports and to make better decisions that improve performance.
2. **Tomorrow:** Develop a technology road map to identify those areas of technology and systems that have delivered a proven return on investment.
3. **The future:** Adopt a technology-enabled business strategy that aligns technology and business strategies — and start piloting appropriate new technologies.

[6] *Navigating uncertainty* — the Harvey Nash/KPMG CIO Survey 2017.

Viewpoint

Making more of disruptive technologies

John Herzog
Managing Director,
Major Projects Advisory
KPMG in the US

"Owners and contractors should accelerate the use of technologies that impact labor and material installation, to increase productivity among craft and labor workers."

The engineering and construction industry is no stranger to disruption. Over the last few decades we've seen the introduction of numerous new technologies, from fax machines to PCs, cell phones to email, and of course, internet to 3-D computer-aided design.

Yet, as we've discussed, none of these has shifted the needle when it comes to construction productivity, which has lagged frustratingly behind other sectors.

There are a number of reasons for this. Firstly, most of these innovations benefited the architects and the engineers, but not the craftspeople like welders, ironworkers or electricians — who are all critical to performance. Secondly, the adoption of some of these technologies has been slow except in the very biggest firms, due to their expense in a sector characterized by low margins, where leaders are innately cautious about large outlays. Contractors in particular are loath to invest in longer-term technologies when their income stream doesn't stretch beyond the next project.

And thirdly, the remote nature of many construction sites has made it harder to implement more recent technologies like robots or modularization.

On top of this, we've had a relatively older set of leaders who've been less technologically literate and more resistant to change in what is a conservative industry. The KPMG/ Harvey Nash 2017 CIO Survey reflected this risk-averse culture. It found that, when attempting to implement digital strategies, engineering and construction companies are far more likely to face resistance to change than firms in other sectors.[7]

So how can we make the technology leap to better performance? A good start is to continue to adopt technologies that improve information flow and decision-making. In fact, most of these already exist and are appearing on some projects, like drones, sensors, 4-D and 5-D modeling, mobile platforms and cloud computing.

Owners and contractors should also accelerate the use of technologies that impact labor and material installation, to increase productivity among craft and labor workers. These include 3-D printers that can fabricate parts on-site in remote places, rather than wait weeks for manufacture and delivery. And, as technologies become more affordable, we also need to embrace robotics in the field in the form of bricklaying robots, welders or other automated processes, which result in increased production and fewer errors.

Work package planning tools could also have a big, positive impact, to ensure that workers can be productive faster, as they have greater clarity over their daily tasks. 'Exoskeleton' tools may sound like science fiction, but they're already out in the market, and helping those on-site perform tasks that used to require more heavy lifting equipment.

And last but not least, everyone in the industry should be making better use of the vast amounts of data collected on construction sites. The respondents to this survey appear to have digital strategies, but it seems that many still need to further advance their digital/data road maps.

I'm highly optimistic that, by following some or all of these recommendations, the industry can finally start to reap the huge benefits of the digital revolution.

[7] *Navigating uncertainty* — the Harvey Nash/KPMG CIO Survey 2017.

In conversation:

Bent Flyvbjerg, Professor of Major Programme Management at Oxford University's Saïd Business School and one of the world's leading authorities on construction projects, talks with KPMG's Geno Armstrong about optimism, disruption and burning those binders!

Geno

Not for the first time we've highlighted the engineering and construction industry's inability to overcome productivity and performance barriers. And yet we're also seeing a lot of optimism. What's your take on this?

Bent

The industry is run by optimists! Which is not a bad thing, so long as you mix it with a degree of realism. Unfortunately, often unwarranted optimism runs deep, for instance, the belief that initial problems can be solved later, rather than addressing them early and head on. This is a recipe for delays, followed by cost overruns. Plus, we don't like passing bad news to our superiors, so it gets suppressed until it finally surfaces in a big way, and you get delays and failure. On the flip side, when executives create a transparent culture where people are actually encouraged to speak up about problems as soon as they surface, you tend to get better performance.

Geno

I agree. On the one hand, if we weren't crazy optimists, we wouldn't create such amazing physical monuments. But on the other hand, you want a balance on your team. I have heard you speak about 'optimism bias' — maintaining optimism despite convincing evidence to the contrary — which is a term that resonates with both high- and low-performing teams we encounter. When I was in the field, we used to joke about needing a 'Chief Pessimism Officer'.

Bent

That's right, although I'd perhaps rename the position as 'Chief Realism Officer' and suggest that people take turns in this role, so no one gets stuck as the naysayer-in-residence. We do need optimists with a 'can-do' attitude to get things done. However, project teams also need hardheaded realists who know the 'physics' of costs and schedules, and are good at diagnostics. Finally, we need a culture that actively identifies and escalates unpleasant news and leadership that knows how to act quickly on such news.

Geno

In your experience, are there many instances where we have more reason to be optimistic?

Bent

We've been studying projects in 100+ countries and the most remarkable result is how persistent problems with underperformance are across geographies — North to South and East to West. In looking for geographies that may have better performance than others, we have found that The Netherlands and Hong Kong stand out in particular, being better than others at delivering certain types of projects. This gives players from other regions something to think about and, potentially, learn from.

from the Stone Age to the digital age

Geno

Over the years our surveys repeatedly throw up the contradiction of ever-increasing investment in controls that can't seem to overcome poor performance. What's your view on this dilemma?

Bent

Frankly, I want to blow up the entire system and replace it with technology. Our industry is literally thousands of years old but some of the techniques we use have barely changed in all that time. Contrast this to the automotive industry, which is only a hundred years old, yet has embraced technology and innovation to make vastly superior products. Put it this way: I wouldn't be confident in placing a house on wheels on a freeway and running it at eighty miles per hour!

Geno

So, burn the binders that contain all the rules and dictate how we run our business! And swing to technology.

Bent

Absolutely. You need real innovation to overcome the productivity gap. You need to digitize, to get one data system running an entire construction site. We've had building information modeling for a long time, but it hasn't really taken off like people expected. Why? Because, as your colleague Clay Gilge points out, the industry is so fragmented, both structurally and geographically. Going digital can bring the economies of scale and the systematic learning we've been seeking for so long. Industries like automotive and aerospace are doing just that, and we need to study and learn from their approach and methods.

Geno

It's almost like engineering and construction is due its Uber moment.

Bent

It is due its Uber moment, and, like many other industries, the disruptors may well come from outside, which would not be pleasant for the current players. But, as we all know, disruption occurs when industries are inefficient. My advice to the construction industry is, disrupt yourselves before you get disrupted. If you're a leader worth your salt, this is what you will do.

Geno

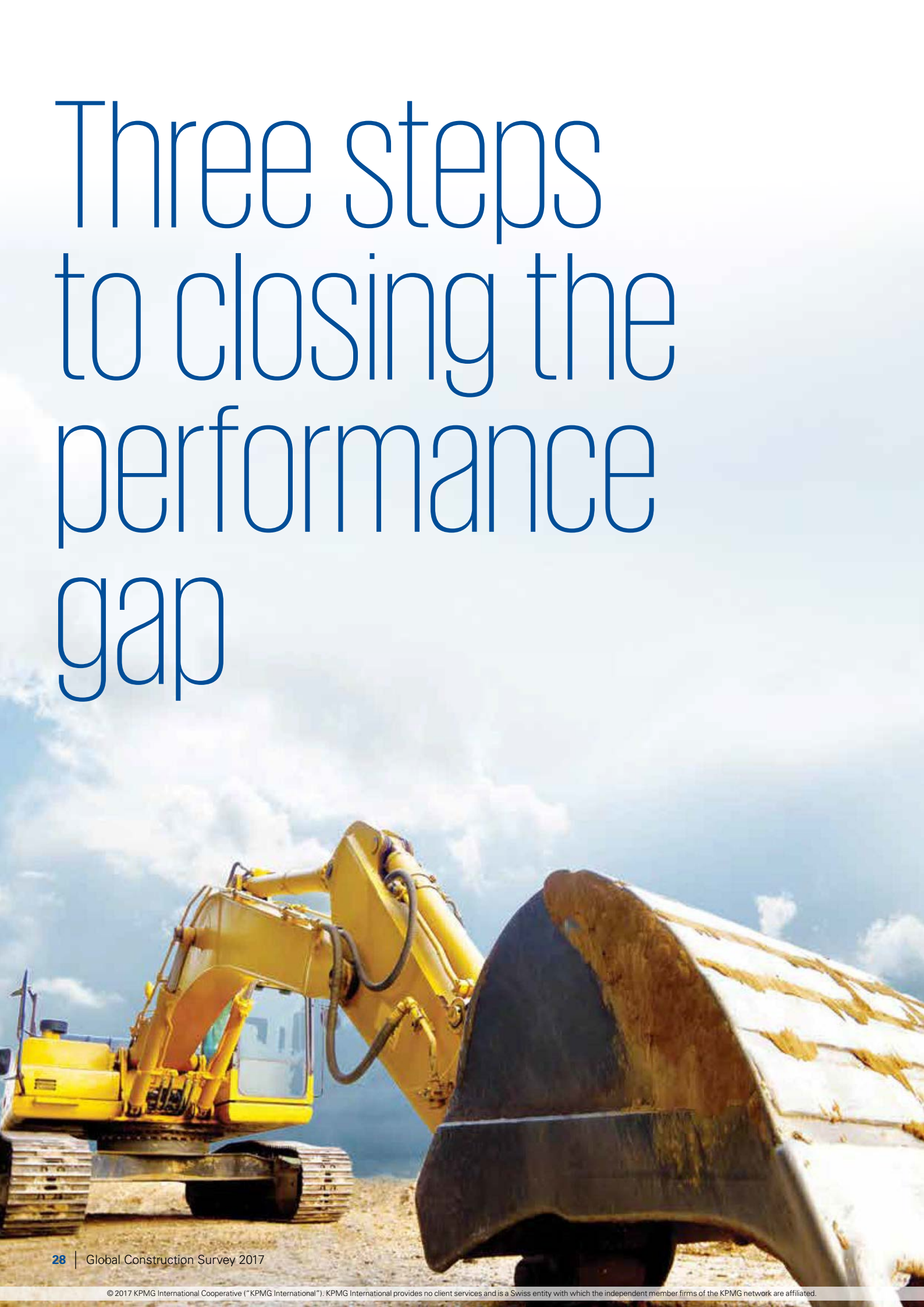
I'm sure you're right. Perhaps the solution is less about making constant tweaks to controls, systems, contracting, training, material tracking, estimating, and so on, and more about breaking the value chain, to make the leap out of the Stone Age. An Uber-type solution could cut through the entire structure of players in the value chain (owners, designers, project managers, contractors and vendors) and put the owner directly in contact with manufacturers, at a stroke removing the layers of complexity you've talked about.

Bent

There's every chance that may happen. Right now, project owners may already be wary of going direct to contractors because they don't have full confidence in them. So I can't believe that it will be long before an Elon Musk-type figure is disrupting the industry.

> **"My advice to the construction industry is, disrupt yourselves before you get disrupted."**
>
> **Bent Flyvbjerg**

Three steps to closing the performance gap



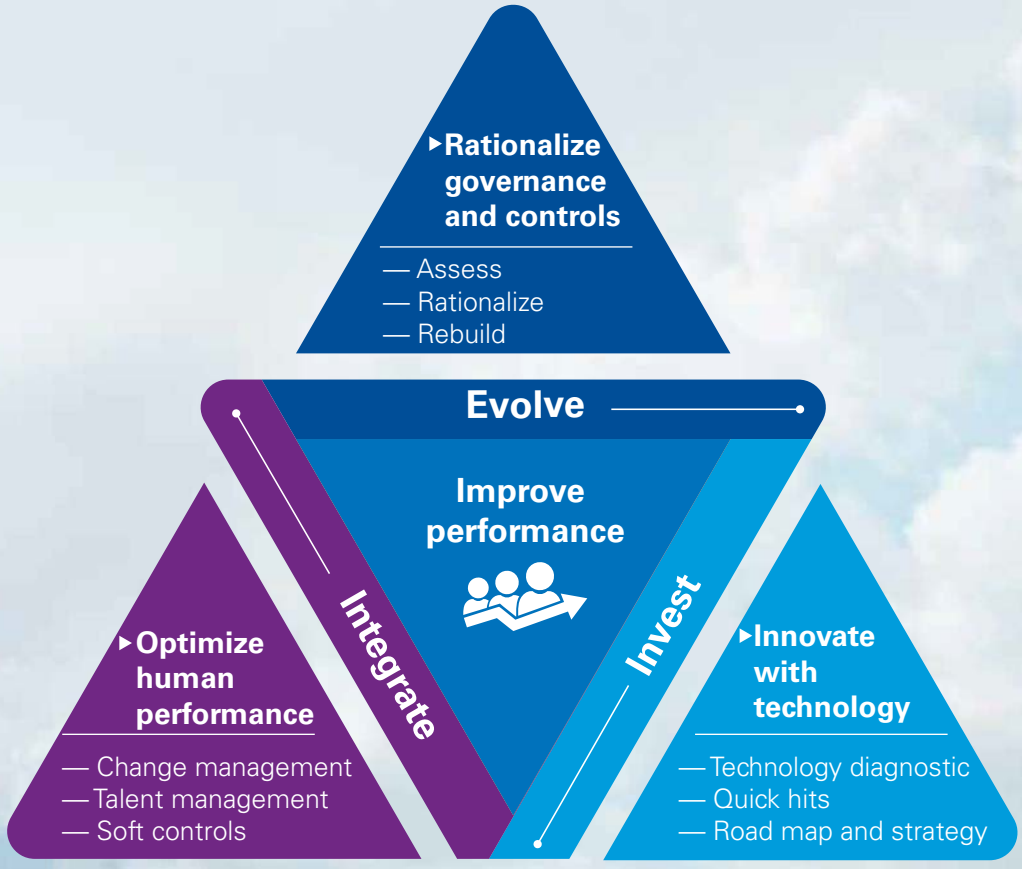
In this survey we have discussed a lot: from how owners and contractors have made progress with governance and controls to new and exciting efforts to attract and retain talent as well as effectively deploy the latest technology. The next step is to ask how an organization can take this information and turn it into action to achieve step-change performance improvement. We have developed an integrated framework that reimagines governance and controls, people and technology around three key principles that we believe will drive this elusive step-change performance improvement:

- Evolve by rationalizing governance and controls.
- Innovate through investment in technology.
- Integrate by optimizing human performance.

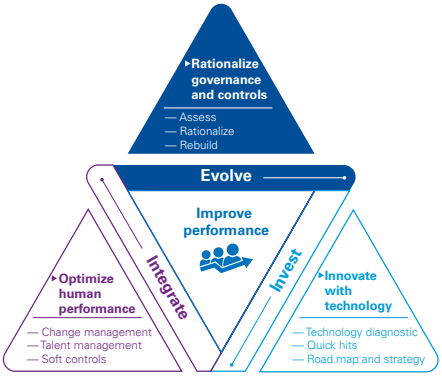
In the following pages we have also outlined a three-step process for developing a strategy around this integrated framework that balances the need for results today with the more strategic goals of tomorrow.

For most owners and contractors, project governance, risk and controls remain static, manual and paper-based activities that do not report events in real time.

Three steps to closing the performance gap:



Source: *Three steps to closing the performance gap,* developed by Geno Armstrong, Global Sector Leader, Engineering and Construction, KPMG International and Clay Gilge, Head of Major Projects Advisory, KPMG in the US.



1. Rationalize governance and controls

For most owners and contractors, project governance, risk and controls remain static, manual and paper-based activities that do not report events in real time. And over time, these controls have become ever more complex and lengthy, to the extent that they bombard users with too much information and too many tasks, so that project managers struggle to make sense of the data to make meaningful decisions. The inflexible, rules-based approach can provide a straitjacket for users — especially for younger generations. Our three-point response to this challenge is:

Point 1: Assess

It's time to take stock of all your governance, risk and control procedures and assess each one carefully. This should help you objectively and methodically assess the design and effectiveness of your overall control environment.

Point 2: Rationalize

Once the governance has been assessed, the organization should take a hard look at which controls are missing, which are inadequate, which are 'overbuilt', and which are simply ineffective. Newer generation workers are likely to have a fresh and critical perspective on what is needed to create a strong and effective controls environment, so it's important to consult and involve Gen X and Millennial employees.

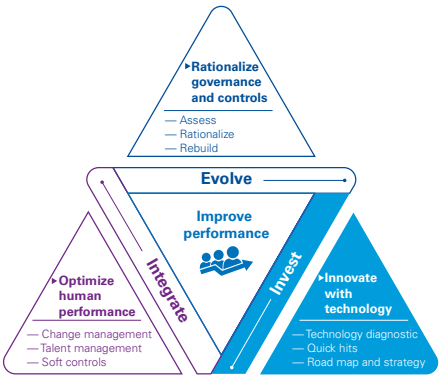
Point 3: Rebuild

Governance should be closely aligned with the organization's business objectives and strategy, and with the overall project environment. Any investments in technology should be evaluated to ensure they support your strategy. And, of course, all controls should be designed with the end user in mind.

- **Monitored:** Controls have been designed for standardized use across the company. Some periodic testing is completed to report on effectiveness of design and operation.
- **Optimized:** Integrated controls have been designed and are adequately documented, with real-time monitoring being completed and continuous improvement efforts implemented.
- **Standardized:** Many controls have been designed, but there are no established monitoring activities from which to test and improve the control framework.
- **Unreliable/informal:** Unpredictible environment where many controls are not designed or in place, in which no documentation exists, and therefore, no monitoring or improvement activities are occurring. Some controls may have been designed but are not adequately documented, monitored or refined.

Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

2. Innovate with technology



Like most industries, technology lies at the heart of the future engineering and construction company. It can help attract younger talent (who may be excited by the prospects of transforming project delivery) and add much-needed transparency to project reporting. Robotics and automation should aid efficiency, and data and analytics can help to better understand trends in project delivery. But if the main players don't take up the mantle, they could find themselves disrupted and displaced by newer entrants — as has happened in so many other industries.

Engineering and construction are competitive, thin-margin businesses, where companies have to fight hard to win every new piece of work, and then deliver highly complex projects while keeping a close eye on the bottom line. In an industry that is both competitive and fragmented, different players will require different strategies. For example, what makes sense for a large global engineering and construction firm is unlikely to be right for a regional subcontractor. But, no matter what the size or scale of the organization, there are some common and consistent steps that should provide some order to the exciting yet chaotic developments in technology.

Point 1: Create a technology/ data diagnostic

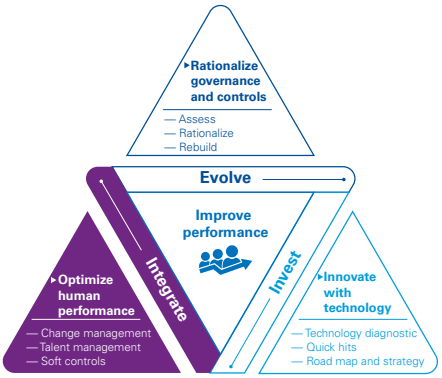
It's crucial to understand the current state of your organization's data, systems and overall technology, to evaluate where to invest to gain the maximum benefit. This means taking a close look at systems and interconnectivity, data and data quality, and the way technology is used to deliver, report and monitor projects.

Point 2: Find quick wins

A great way to build momentum is to find and highlight areas of the operation where technology is visibly improving performance. This will prove the value of technology to skeptical Baby Boomers and demonstrate to Millennials and Gen Xers that the organization is forward-looking. Many organizations focus all their efforts on one or two large, multi-year investments that not only fail to deliver their promises, but also foster a wider negative sentiment and resentment towards technology. One obvious starting point for quick wins is data analytics: finding cost-effective ways to get the most out of the data you already have (much of which sits in your current systems and tools).

Point 3: Create a clear digital strategy and road map

Equipped with a solid understanding of the current technology position, and having gained momentum with quick wins, the organization can now develop a digital strategy and road map. It's important to try to be both pragmatic and visionary, to imagine innovative uses like robot welders or 3-D printing of parts on-site. But a road map alone is not sufficient. Your technology/digital strategy cannot sit in isolation but should be integrated into your broader business strategy, to put you in the driver's seat.



3. Optimize human performance

Susanne DiCocco
Partner, Advisory Services
KPMG in Canada

Paul Krasilnick
Director, Advisory Services
KPMG in the US

Today's engineering and construction companies may employ as many as four different generations of worker. In the face of rapidly changing technology and increasingly complex, large-scale projects, how can they overcome generational barriers to create a high-performing workforce up to such challenges?

Point 1: Create a culture that works for everyone

The classic Baby Boomer tends to be respectful of rules and procedures but resistant to new technologies and processes. As we've discussed, newer Millennials are totally comfortable with technology but more likely to shun strict rules and regulations. The answer to this dilemma? Targeted communications with different messages (and media) for different groups of employees, with more direct instructions for the older guard, and more collaborative approaches for the younger members, to ensure they feel part of the solution.

This goes right back to the recruitment process. Many bright young people want to work in 'cool' industries that embrace cutting-edge technology and adopt an entrepreneurial spirit common to tech start-ups, which presents a wonderful opportunity for companies to embrace technology, both as a route to innovation and efficiency, and a way to attract fresh talent.

Point 2: Balance hard versus soft controls

Soft controls relate to culture, leadership and communication: the way that people think and behave. Baby Boomers may be more comfortable with a top-down, hierarchical organization, with traditional values. But Gen X and Millennials, expect a more contemporary approach that values sustainability and diversity, and gives individuals more personal freedom.

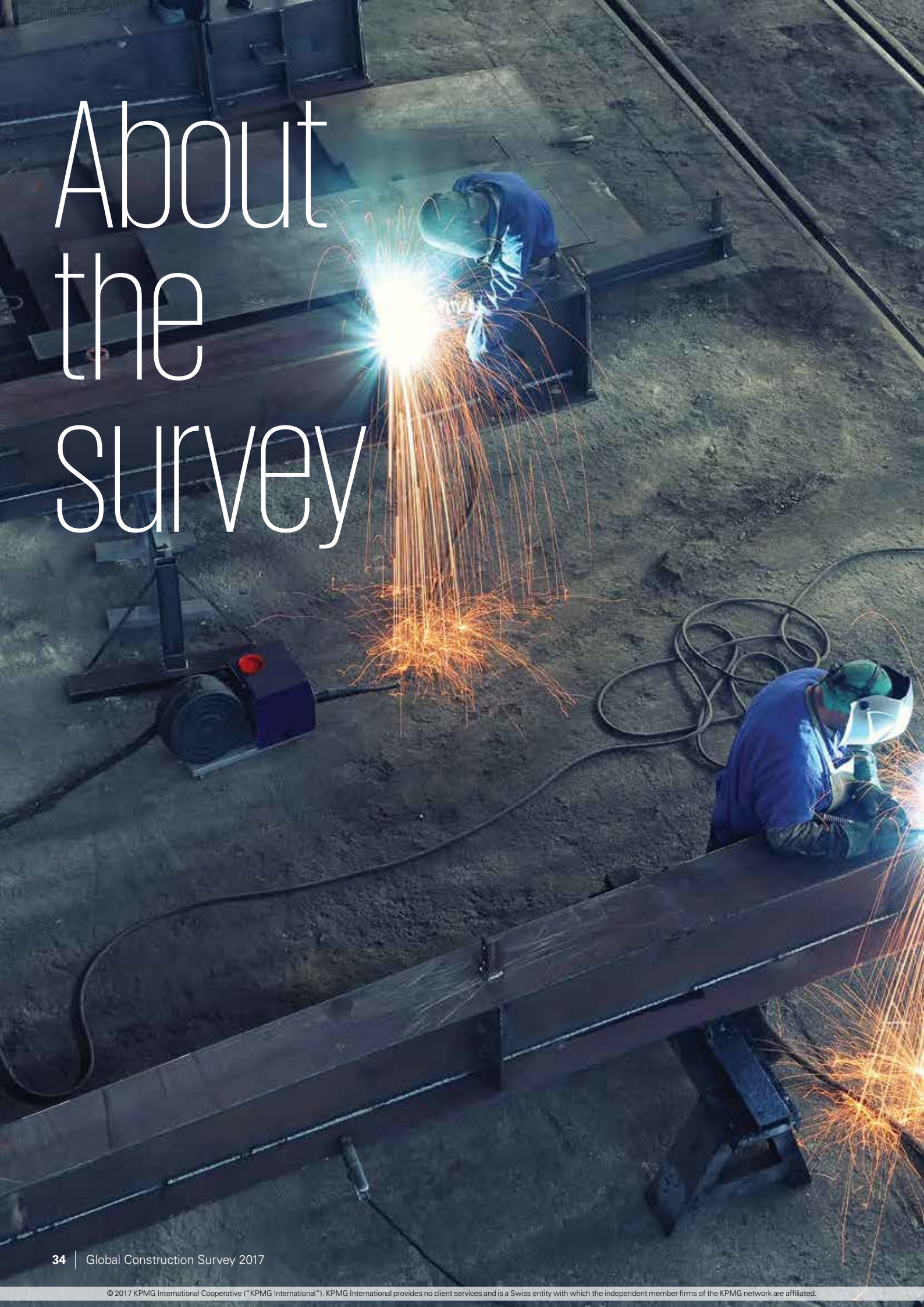
And it's not just about managing people's feelings and expectations. Shareholders, customers and the wider public expect companies to practice the right values. Furthermore, employees devoted to 'doing the right thing' are arguably more likely to practice hard controls, on the grounds that it makes both ethical and business sense. We're not suggesting that organizations throw out the rule books; but, as we've argued on page 4 of our section *Rationalizing governance*, regulations and procedures should at the very least be rationalized.

Point 3: Rethink talent management

Owners and contractors need to embrace technology to build what we call 'workforce intelligence'. By using data and analytics, companies can assess which skills they need for the next few years as part of a strategic workforce plan, identify attrition rates, and build this into their recruitment activity. For example: If a company is investing heavily in automation, then it may need fewer manual workers but more analysts to manage the ensuing data. On a shorter timescale, a similar approach can ensure that the right people are available for specific projects.

Workforce optimization means utilizing resources effectively, by understanding the capabilities and potential of your high performers, and giving them the platform to build experience and develop fulfilling careers, and addressing issues that could cause them to leave. And finally, workforce analytics is all about improving performance, by understanding how workers collaborate and behave, and spotting gaps.

About the survey



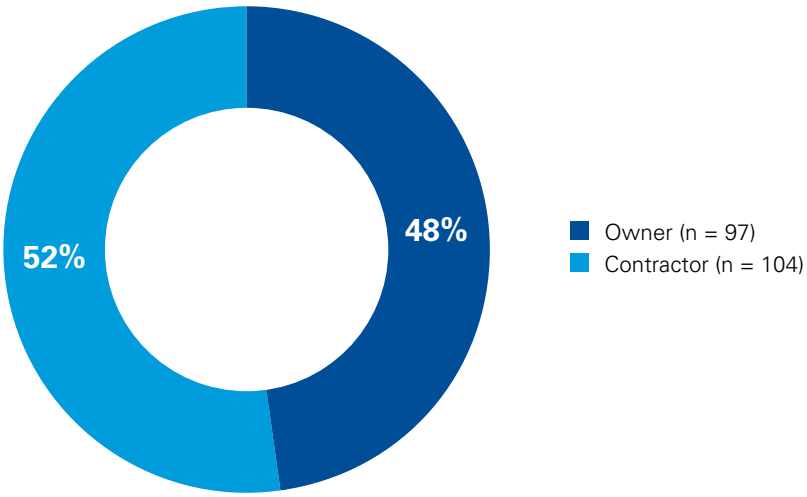
All survey responses were gathered through face-to-face interviews in mid-2017 with 201 senior leaders — many of them chief executive officers. Ninety-seven respondents are from organizations carrying out significant capital construction projects (owners); 104 are from engineering and construction companies (contractors) (Figure 20).

The questions were compiled by a steering team of senior representatives specializing in the engineering and construction industry from KPMG member firms, and reflect current and ongoing concerns expressed by clients of KPMG member firms. These same professionals also carried out the interviews.

Respondent organizations' turnover/ income ranged from less than US$1 billion to more than US$20 billion (Figure 22), with a mix of operations from global through regional to purely domestic (Figure 23). The annual capital expenditure budget varied from around US$10 million to over US$5 billion.

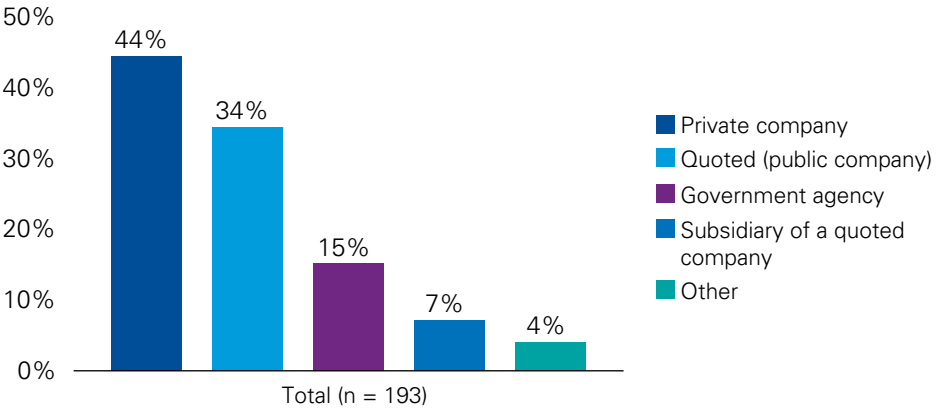
Thirty-four percent of the project owners are public bodies (Figure 21) — typically government agencies — and some of the main industries represented include energy and natural resources, technology and healthcare (Figure 24).

Figure 20: Company category



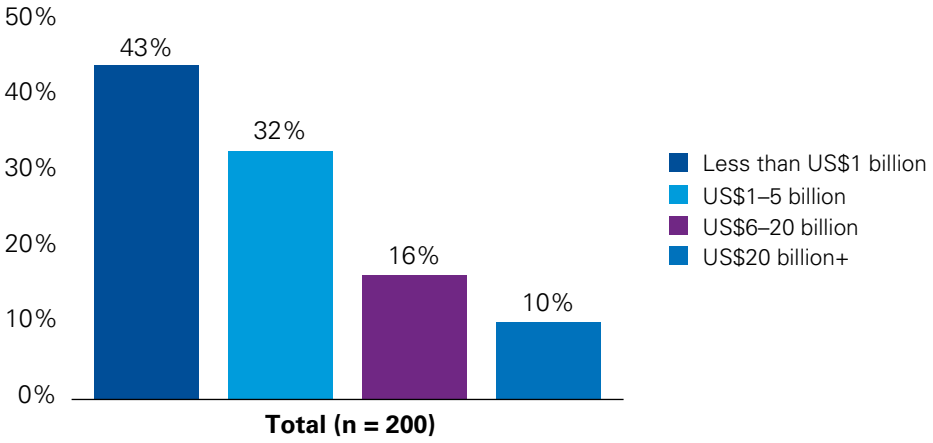
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 21: Type of entity



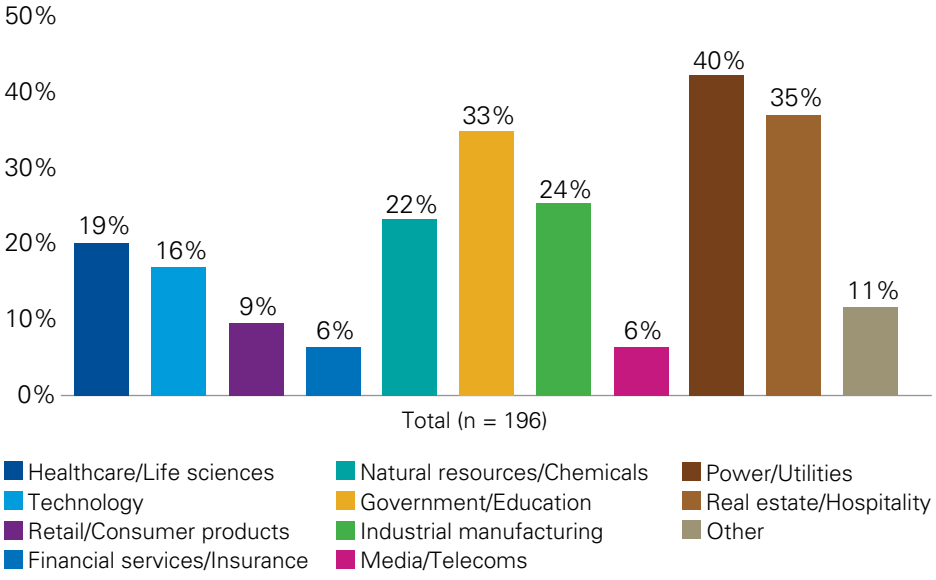
Multiple responses allowed
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 22: Entity turnover (revenue from operations) in FY16



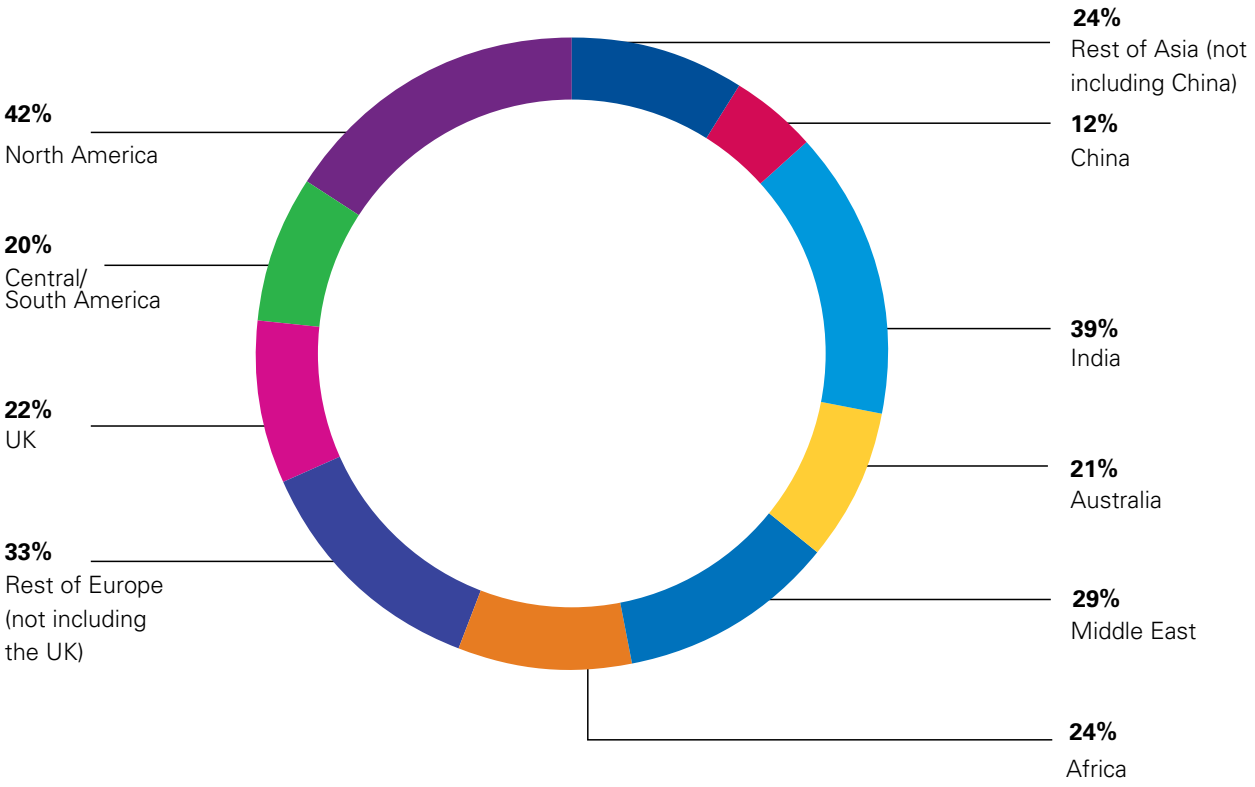
Percentages might not add up to 100% due to rounding
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 23: Company sector



Multiple responses allowed
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

Figure 24: Subregions (n = 196)



Multiple responses allowed
Source: *Make it, or break it,* 2017 Global Construction Survey, KPMG International.

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When engineering and construction leaders turn to KPMG member firms for advice, they do so because KPMG professionals understand the industry on a local, national and global level. For decades, we have provided services tailored specifically to meet the needs of the industry. To do this, we have created a diverse practice that includes certified public accountants, professional engineers, architects, project managers, owner representatives, contract and procurement specialists, finance and tax professionals, business valuation specialists, cost estimators and specialists, certified fraud examiners and forensic technology specialists.

KPMG's Engineering and Construction professionals provide strategic insights and relevant guidance wherever our clients operate. Services are delivered through the global network of KPMG member firms by over 2,000 professionals in more than 40 countries worldwide.

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For further information, please visit us online at kpmg.com/infrastructure or contact:

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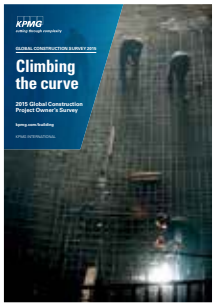
Building a technology advantage

The 2016 Global Construction Survey reviews how the industry can harness the potential of technology to improve the performance of major projects.



Climbing the curve

The 2015 Global Construction Survey focuses on the challenges facing owners as they seek to climb the maturity curve.

Ready for the next big wave?

The 2013 Global Construction Survey catches the industry in a more upbeat mood focusing on trends and opportunities for growth.

Rise of the humans: The integration of digital and human labor

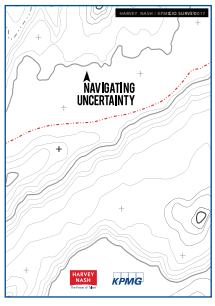
Five key steps to understanding the potential impacts that digital labor will have on the shape, size and functions of organizations.

Insight Magazine: Globalization

This issue of Insight Magazine discusses the globalization of the infrastructure and construction industry including: taking global infrastructure to local markets, putting stakeholders and communications at the heart of major infrastructure projects and breaking the cycle of new construction.

Insight Magazine: Globalization

This issue of Insight Magazine discusses the globalization of the infrastructure and construction industry including: how Brazil's construction companies are emerging from scandal, how we can encourage a culture of ethics and how we can diversify the workforce.



Harvey Nash/KPMG CIO Survey

The 2017 Construction/ Engineering Sector Findings provides survey responses from 119 industry companies on some of the key topics, and highlights several areas where this sector's responses differed significantly from those from across all industries.

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