



Building a technology advantage

Harnessing the potential of
technology to improve the
performance of major projects

Global Construction Survey 2016

KPMG International

kpmg.com/gcs



Foreword

The scale, ambition and complexity of today's engineering and construction projects are nothing short of breathtaking.

The industry is constantly widening its vision and raising its game. Buildings are getting taller, our search for natural resources is taking us deeper, bridges are spanning longer, and the pace of change is such that technology projects are virtually obsolete as soon as they're completed. Operating at the forefront of some of the world's greatest challenges, construction is becoming greener and more sustainable, while continuing to improve social conditions and tackle human and natural disasters.

Technology plays an integral part in helping the industry realize these goals by enabling enhanced design, planning and construction. When applied effectively, technology can significantly boost a sector that for many years failed to improve productivity.¹ Yet, despite substantial investments in innovation, the construction industry is struggling to reap the full benefits of advanced data and analytics, drones, automation and robotics.

As companies strive to improve governance, risk management, project controls, and talent, the fundamentals of sound engineering, construction and project management processes remain the same. In this year's survey — the 10th edition — we continue to look at how to improve project delivery, but with the added perspective of a technology lens, to determine who's ahead of the game, who's behind the curve, and how all firms can harness the true potential of technology.

For the very first time, we've jointly surveyed both project owners and engineering and construction companies on a number of current issues to understand whether their views are aligned or whether there are marked differences.

We also feature interviews with two leading industry professionals, both with experience in large, global projects, who give their views on the benefits — and the limitations — of technology in enhancing project performance.

Technology inevitably brings disruption in its wake, at a speed that is likely to increase exponentially in the coming years. Owners and engineering and construction firms are charged with building the next generation's infrastructure. The quicker they can embrace the exciting potential of technology, the greater will be their collective contribution to business and to society.

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

About the authors



Geno Armstrong

KPMG in the US

E: garmstrong@kpmg.com

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 thought leadership, he has been personally involved in each of KPMG's 10 Global Construction Surveys since 2005. Geno is based in San Francisco, California, US.



Clay Gilge

KPMG in the US

E: cgilge@kpmg.com

Clay leads KPMG's Major Projects Advisory practice 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 KPMG's 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 luminary, Clay is also active in thought leadership, having published papers on topics ranging from project controls, compliance, data and analytics, mega-project management to so-called 'black swans'.

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 conducting our research using face-to-face interviews. We thank each of you for your time, energy and dedication.

¹ *Productivity in Construction: Creating a Framework for the Industry to Thrive*, Chartered Institute of Building, 2016.

Survey at a glance

How we compiled the questions:

- The quantitative survey was designed by a global steering team of KPMG engineering and construction professionals with extensive experience developing major projects

Who took part:

- 218 senior executives: 119 from major project owners, and 99 from a range of engineering and construction companies
- Participating organizations included both private (listed) companies and government agencies
- Respondents' companies' turnover ranged from less than US\$1 billion to more than US\$20 billion
- Owner entities came from many industries including energy and natural resources, technology and healthcare

What they're telling us:

The industry is yet to fully embrace technology

Despite a rise in project complexity and associated risks, a mere 8 percent of respondents can be categorized as 'cutting-edge visionaries.' And just over 20 percent say they're aggressively disrupting their business models.

Data volume is rising exponentially — but many are struggling to make sense of information

They may have an impressive range of platforms and tools, but most respondents feel they lack the resources and skills to provide useful insights. And almost three-quarters don't use advanced data analytics for project-related estimation and performance monitoring.

Integrated, real-time project reporting is still a dream rather than a reality

Most executives in the survey say their organizations are held back by manual processes and multiple systems. Just 20 percent have a single, fully integrated project management information system (PMIS) across the enterprise.

There's more to come from mobile

Although mobile technology has huge potential for construction projects, less than one-third of respondents say their organizations use it routinely — and a similar proportion have no mobile platforms.

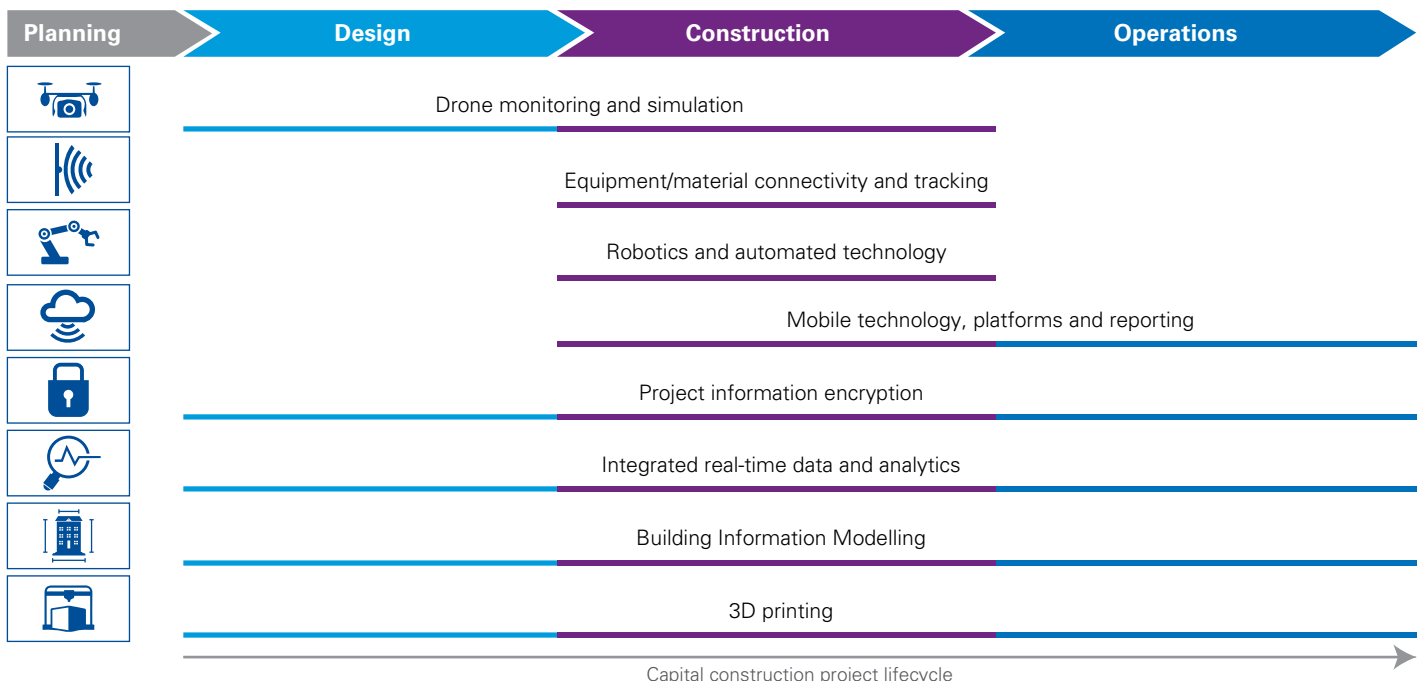
...and there's still room for improvement in project management basics

A majority of executives in this year's survey feel their organization's project controls are "optimized" or "monitored," but this hasn't halted the continued high rate of project underperformance. The inability to drive consistency across projects is part of the problem: just 27 percent say their companies have truly consistent controls globally. Respondents also recognize the benefits of Earned Value Management (EVM) as a way to measure cost and schedule performance; but a sizeable proportion — 41 percent — still don't use it.

Technology defined:

In many cases throughout this report "technology" is referred to generally, but the chart below offers insight into what types of technology are being employed in engineering and construction, across the lifecycle of capital projects.

Technology usage across the lifecycle of a project



Contents

Who's on the cutting-edge of innovation — and why it matters

02



The case for technology in an increasingly risky world

06



Technology in action: how the industry is embracing innovation

12



Exploring the limits of technology

16



Back to basics: evaluating project management controls

18



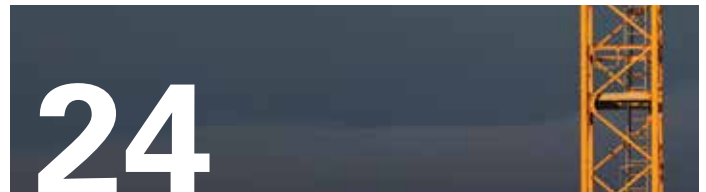
The path to becoming a cutting-edge visionary: three key steps

22



About the survey

24



KPMG's Global Engineering and Construction Practice

25



Bookshelf

26



Who's on the cutting-edge of innovation — and why it matters

Engineering and construction companies and project owners who invest in disruptive technologies should enjoy a step change in performance.

History and logic support this statement. Design tools can enable bold new structures. Data and analytics can provide a real-time picture of how projects are running, enabling swift action to resolve problems. Modeling — increasingly through mobile apps — can support more informed decisions on construction, materials and supply chain. Remote monitoring can help track faults. Automated trucks and other equipment can accelerate productivity, improve accuracy and reduce accidents.

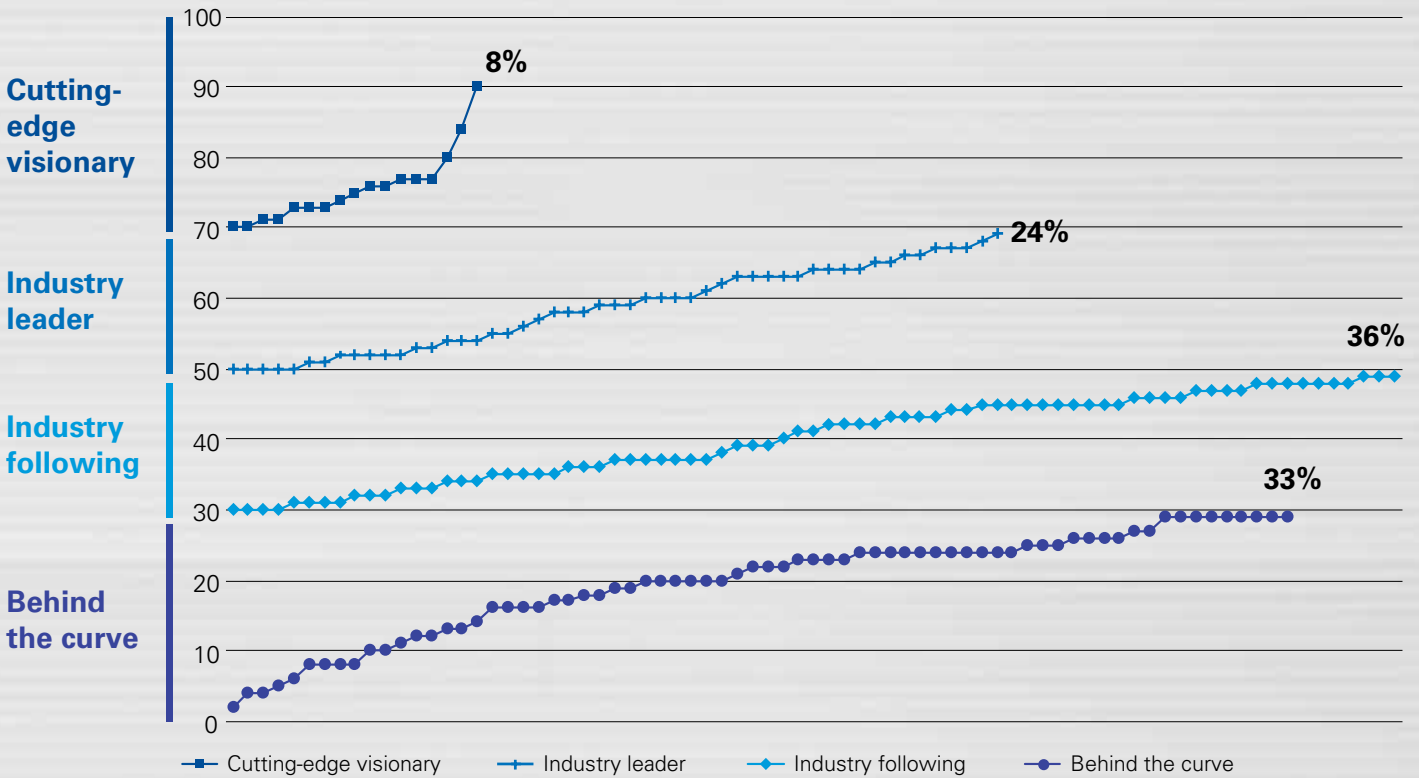
So why has the sector not fully embraced the potential of technology? For some, the cost and risk of adopting new technologies outweighs the perceived benefits. Others may be reluctant to move out of their comfort zone. One survey participant is especially critical of this reluctance to move with the times: “Little innovation has happened in engineering and construction firms over last 15 years. This has to change and they need to drive the innovation in order to stay competitive.”

Looking at the firms taking part in this year's survey, these fears appear to be justified. When it comes to technology innovation, just 8 percent fall into the “cutting-edge visionary” category, while 69 percent are considered either “followers” or “behind the curve.”

Engineering and construction companies are ahead of owners in technology adoption. This reflects the fact that, for most owners, construction is viewed more as a business enabler than a core driver of their business. By way of contrast, projects are the lifeblood of engineering



Technology adoption spectrum



Scores based upon responses to level of adoption of a number of different technologies

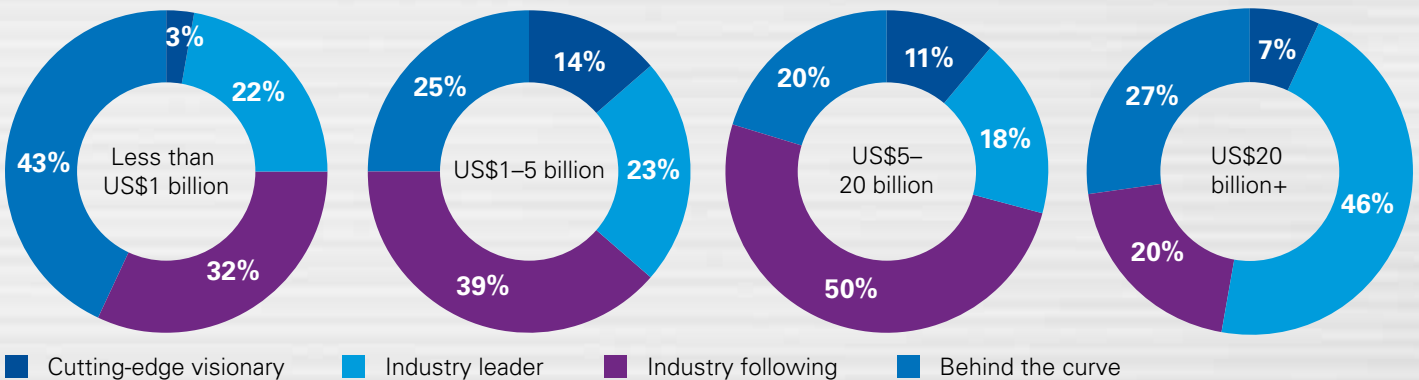
and construction firms, which are more likely to invest in a PMIS and project delivery and support technology.

The technologies that enable firms to be more innovative require significant investment, so it's perhaps not surprising that smaller firms are less likely to be spending heavily in these areas. What's more interesting is the relatively high proportion of mid-size companies (with annual turnover between US\$1 billion and US\$5 billion) that rank as cutting-edge. These organizations seem to acknowledge technology's potential to bring a competitive advantage

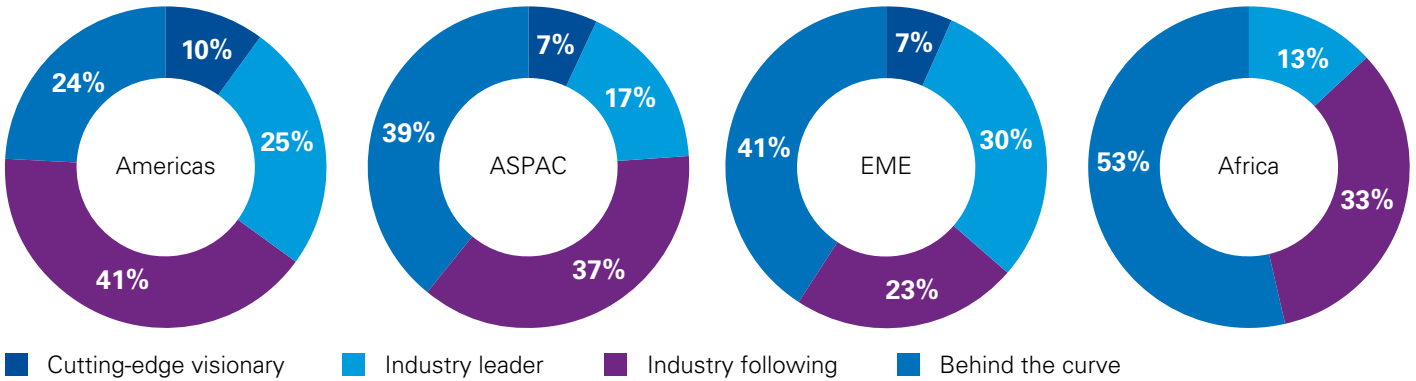
and have backed up their beliefs with sizeable investments. Being of a manageable size, they're also able to adapt quickly to new ideas.

The chart below demonstrates how respondents' firms of different sizes fit into the technology adoption spectrum. From a regional perspective, a greater proportion of companies from the Americas and Europe are technology leaders, with Africa considerably behind other parts of the world.

Technology adoption spectrum by company size



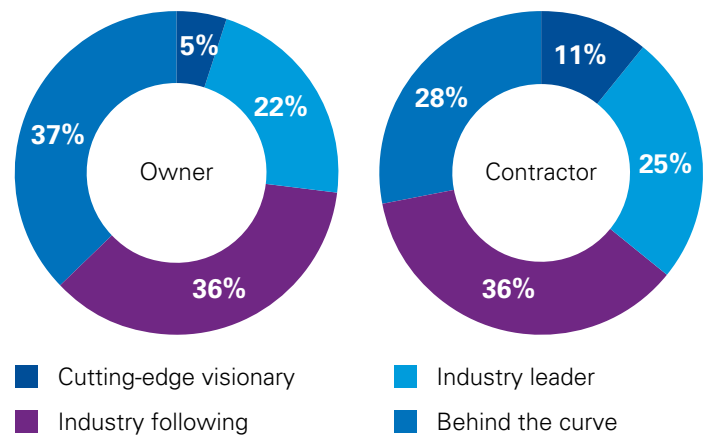
Technology adoption spectrum by region



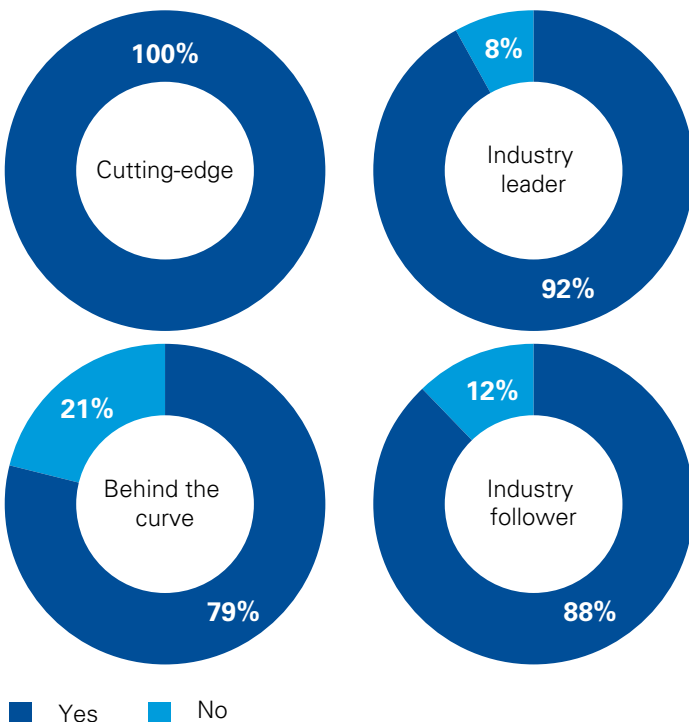
“Mid-size companies seem to acknowledge technology’s potential to bring a competitive advantage and have backed up their beliefs with sizable investments.”

It seems that project owners ranked as cutting-edge are more likely to employ standardized project management processes and controls. Equally important, these controls are frequently optimized, when compared to less tech-savvy peers.

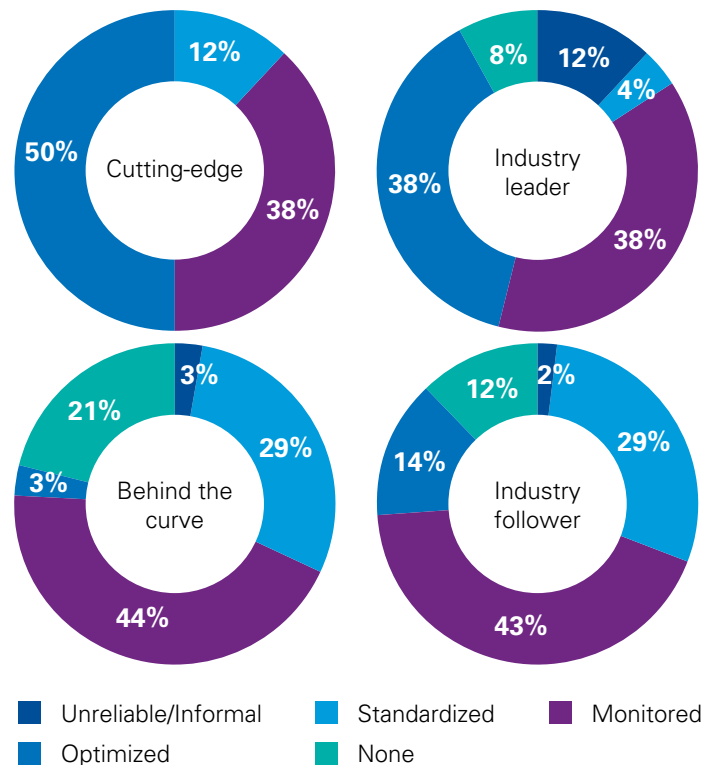
Technology adoption spectrum by entity



Project owners using standardized project management processes and controls



Project owners' degree of process/control standardization



How the technology adoption spectrum was calculated

The respondents were allotted scores reflecting the extent to which their organizations adopt various technologies such as: PMIS; robotics; mobile technology platforms; cloud computing; automated digital workflows; radio frequency identification (RFID); data and analytics; Building Information Modeling (BIM) and smart tracking sensors.

The highest possible score is 100, with score ranges for each category as follows:

- Cutting-edge visionary: 70–100
- Industry leader: 50–69
- Industry follower: 30–49
- Behind the curve: 0–29

Below is a simplified scorecard that includes some of the technology questions posed to infrastructure owners and engineering and construction firms including the scoring matrix associated with each response:

2016 Global Construction Survey: technology scorecard

1. Which best describes your technology driven project management information system?	<input type="checkbox"/> Non-existent <input type="checkbox"/> Multiple platforms, manually monitored <input type="checkbox"/> Multiple integrated platforms <input type="checkbox"/> Single, fully-integrated PMIS
2. Do you use remotely operated drone aircrafts to monitor the status of construction on your projects?	<input type="checkbox"/> Yes <input type="checkbox"/> No
3. Do you use robotic or automated technology?	<input type="checkbox"/> Yes <input type="checkbox"/> No
4. Do you employ any type of remote monitoring for project sites?	<input type="checkbox"/> Yes <input type="checkbox"/> No
5. To what extent do you use mobile technology or mobile platforms to manage projects in real-time?	<input type="checkbox"/> Not used <input type="checkbox"/> Select projects <input type="checkbox"/> All projects
6. Can you push one button to obtain fully integrated real-time data on a project?	<input type="checkbox"/> Yes <input type="checkbox"/> No
7. What percentage of your project information is stored digitally via automated workflow versus manually?	<input type="checkbox"/> 0–24% <input type="checkbox"/> 25–49% <input type="checkbox"/> 50–74% <input type="checkbox"/> 75–100%
8. Do you use radio-frequency identification to track equipment and materials on site?	<input type="checkbox"/> Yes <input type="checkbox"/> No
9. Do you use Building Information Modeling on the majority of your projects?	<input type="checkbox"/> No <input type="checkbox"/> No, but we plan to <input type="checkbox"/> Yes, 3D <input type="checkbox"/> Yes, 4D <input type="checkbox"/> Yes, 5D
10. Do you employ smart sensors to track the location of project and construction personnel on site?	<input type="checkbox"/> Yes <input type="checkbox"/> No
11. Do you require all project participants to store common information in the cloud or on a common server?	<input type="checkbox"/> Yes <input type="checkbox"/> No
TOTAL	XX / 100 points

The case for technology in an increasingly risky world

The industry's traditional conservatism is holding back its ability to tackle the complexity of today's projects.

As projects become bolder, they also become more complex, and with complexity comes risk. Take the ubiquitous shopping mall — where once the most complex component was the building structure, now there are parking lots, elevators, escalators, and a host of other facilities, as well as a sophisticated IT infrastructure.

It's a similar story with airports, which have become enormous centers for retail and dining. And then there are the exciting mega-projects like bridges, fantastically tall skyscrapers, metropolitan transport systems, inter-continental railroads, tunnels under mountains, and unimaginably deep mines.

Designers are also coming up with new and exciting ideas for creating exotic shapes, textures and features, especially for the luxury market.

The respondents to this year's survey recognize the impact of these advances on the risk landscape. Sixty-seven percent of all respondents believe project risks are increasing — a figure that rises to 78 percent among engineering and construction companies. When you factor in the 60 percent that are seeing rising project volume, then it's evident the industry has to find a better way to manage complexity if it wants to avoid failures, delays and cost overruns.

Technology is one of the key enablers for innovation: computer modeling means virtually anything that can be dreamed can be designed. Technology also provides the tools to facilitate construction cost-effectively, swiftly and safely. All of which should reduce inherent risks.

But when it comes to adopting technologies, conservatism within the industry remains, with most firms content to follow rather than lead. Many senior executives are worried about their organizations' ability to integrate disparate technologies, along with the costs and the subsequent impact upon the bottom line.

In the words of one engineering and construction leader: "If we can see an immediate cost benefit to our clients, we'll implement, and if not, it will remain on the shelf for someone else to experiment. We are all about proven solutions and quite frankly, don't have the profit margins to experiment or be on the leading-edge."

Another peer voiced a similar opinion: "We know technology and innovation is important, and we require strict use of return on investment (ROI) for any related investment. To date, however, very few initiatives have an ROI or fulfill an immediate client need, and therefore don't get funded."



A sector ripe for disruption

“Is technology a solution or a problem in and of itself? It is a challenge on its own.” This comment, from one senior executive of an engineering and construction firm, sums up the dilemma facing many industry players.

On top of the pressures that go with complexity, this executive sees a wider range of issues facing organizations: “The future of the industry is one where the global, macroeconomic environment is one of diversification; increasing debt loads and financing of public sector projects; decreasing depth of personnel as older workers retire; transfer of more risk to contractors with no increase in margin; and deterioration of design — partially caused by economic pressures from owners.”

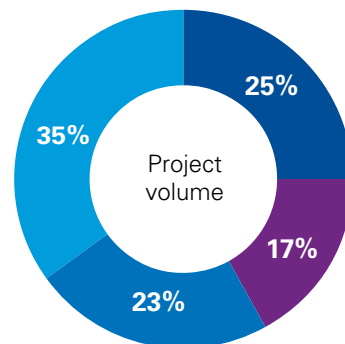
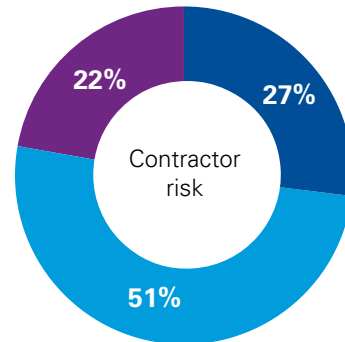
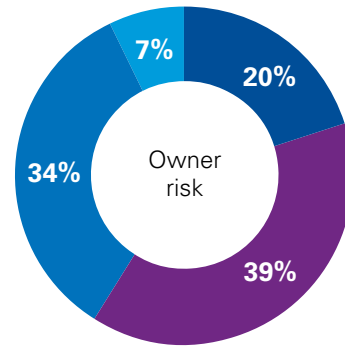
The survey suggests that the top drivers for innovation and disruption are, in order of importance:

1. Efficiency, planning and cost reduction
2. Competition and market forces
3. New markets, growth and profitability
4. Client needs, meeting demand
5. Technology and talent
6. Increasing regulation

Given these challenges, the question facing every leader in the sector is: “Do we disrupt now? Or do we wait to be disrupted?” One project owner, based in India, outlines the urgent need for change: “The construction industry in India is growing at a very fast pace. More and more projects are being executed in a shorter duration of time. Technology is the only way to improve, perform and bring standardization, thereby reducing complexities and giving better results.”

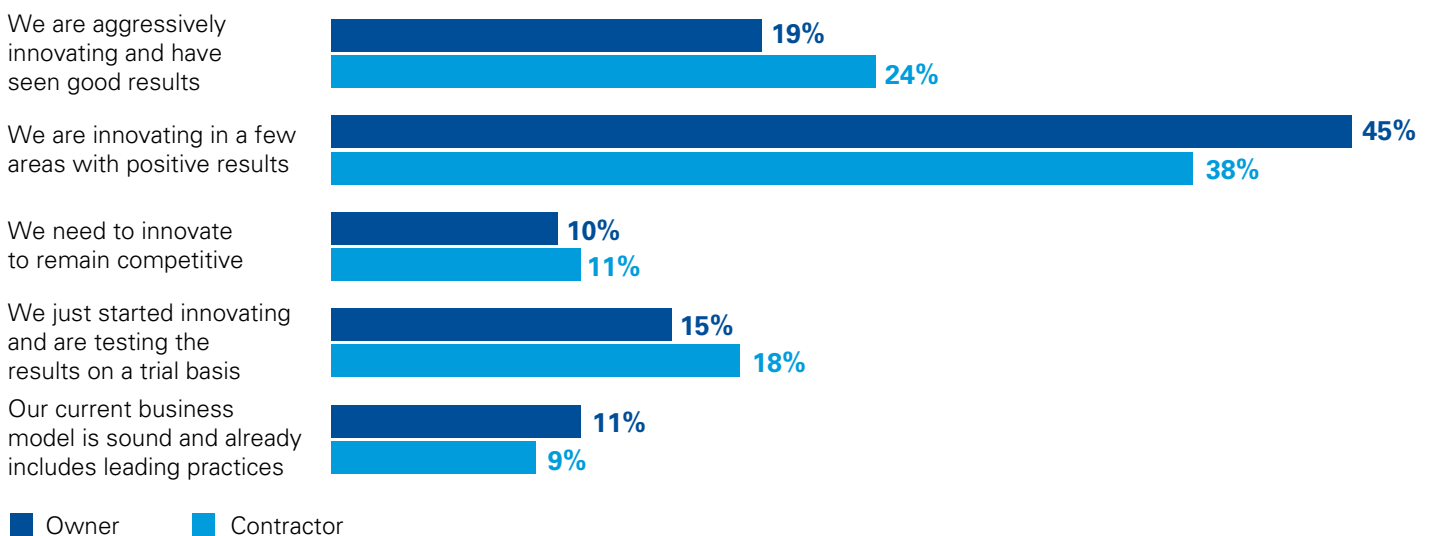
Most of the respondents recognize the need for disruption, but differ in how they’re going about achieving it. Just over one-fifth (22 percent) claim to be aggressively disrupting their business models.

Risks are rising as volume grows



■ Significantly increasing ■ Somewhat increasing
■ Neutral ■ Decreasing

A mixed response to disruption



Why technology matters and why it's hard to get it right: views from the cutting-edge

BP and Bouygues Construction are two very different organizations that are extremely active in the construction space; BP as one of the world's largest project owners, and Bouygues as a highly successful global engineering and

construction contractor. Both share a common characteristic: a forward-thinking approach to the use of technology. We spoke to senior executives from each company to find out more about how they embrace disruption.

In search of 'the next big thing'

Niall Maguire, Vice President, Project Management for BP, talks to KPMG's Geno Armstrong about the possibilities — and the limitations — of technology.

Geno Armstrong (GA): Firstly, could you tell me a little about BP's strategic approach to technology in the Upstream?

Niall Maguire (NM): We like to keep a very open mind, on the grounds that there might well be something out there that could be incredibly disruptive, or alternatively might just bring an incremental improvement. But as long as it improves what we do, we'll be interested.

But what we're not going to do is fall into the trap of thinking that technology is a substitute for competence. So we're still very focused on getting the basics right, and improving on our core project management skills. Take our information management systems: these have been refined for many years, and are not simply a result of a single piece of disruption.

GA: Engineering and construction companies typically run on small margins, and understandably, may be less proactive in investing large sums of money in disruptive technologies. Do you feel this increases the risk of them falling behind the standards expected by clients?

NM: That's a really good point. There has probably been less incentive for contractors to innovate, and to be fair, clients haven't always demanded that they do so. More and more, as we probe into the digitization of our business, we come across solutions that could improve contractors' project management. We want these companies to investigate and adopt these technologies. If they can demonstrate they are cutting-edge, then this could definitely increase their chances of working with us.

GA: Would you be willing to pay a premium for a high level of technological sophistication?

NM: Ultimately, it's all about the value a particular project delivers. If technology can help a contractor improve the value they bring, then yes, we would be interested in their services.

GA: How do you go about prioritizing your investment in technology — especially given the pressure on budgets?

NM: We have a strong focus on safety, growth and people, and modernizing and transforming the upstream business. So technology is very much part of our plans for both projects and upstream, and we've formed a steering team to establish our digitization project goals.

Our general approach to resourcing is to start with lean, performing teams, with individuals added and withdrawn according to needs. It's the same with our digitization projects.

We're willing to pay for technology and innovation if it improves performance and helps us meet schedule, cost, safety and quality targets. But we won't invest to the extent that it threatens the profitability of a project.

GA: The next generation of project managers — the millennials — will be highly tech savvy. But as we embrace technology, are we in danger of losing sight of the core skills of their predecessors?

NM: I go back to my comment about technology not being a substitute for competence. Without the right people to feed into and interpret plans and schedules, and spot trends, then projects will not succeed. Getting owners and contractors to use the same software may be a step forward, but it's not enough on its own and you still need the right people.

GA: You mentioned the possibility of 'the next big thing' in disruption. Do you have any predictions about what this might be?

NM: We actively monitor a range of potential developments and breakthroughs although, I think that 3D printing could be a major innovation with transformative potential.

But let's not forget that construction is a very physical business. In exploration we're highly dependent upon the weather and no amount of digitization will prevent a hurricane! No matter how good we get at forecasting, we're still going to have to make risk-based decisions about working around such events. These kinds of judgments aren't going to go away.



“Innovation is now at the heart of the construction business. Not just for clients and customers, but also for employees and management.”

— **Xavier Fournet**
KPMG in France

Passionate about progress

Philippe Bonnavé, Chairman and CEO, Bouygues Construction, tells us about his company's approach to technology.

...on innovation

Innovation is the means by which we have always advanced. It's our culture. But today, the complexity of the environmental, economic and social challenges we face, demands that we innovate alongside others — with our minds open. We have to share our own areas of expertise with third parties and combine them with new, non-core disciplines. Our aim is to connect with those who are imagining the world of tomorrow, whether they are start-ups, universities or large companies. Tomorrow, no one will innovate in isolation.

...on BIM

With digital modeling, the way in which we build will change forever. BIM has shaken up the construction process by shifting the challenges upstream. So we become better at anticipating costs, schedules and difficulties, and better at innovating. A revolution is underway. By modernizing every part of all our businesses, we hope to become one of tomorrow's industry leaders in BIM.

...on big data and smart grid

Buildings, neighborhoods and cities are now capable of producing and exchanging data, which means creating links between different parties, and setting up new users. Being connected means that data works to help residents by reducing energy consumption, providing more services, increasing independence, and encouraging networking. In short, helping people live better together.

...on sustainability

Nowadays, everything has to be 'sustainable,' requiring project leaders to think, calculate and anticipate. Long before the first diggers arrive at the site, we use digital modeling and lifecycle analysis to design solutions that reduce the environmental impact of our buildings and structures. And they will continue to be sustainable for decades after handover.

...on success

One thing, and one thing only, defines success: excellent work! This is not so much an ambition as an obligation. At each link of the construction process value chain, our employees' highest priority is to give the best of themselves. The success of our increasingly complex projects demands nothing less. Success is also about bringing in all our projects — large and small — on schedule and on budget.

KPMG comment: seizing the potential of technology

Since our first Global Construction Survey in 2005, KPMG has been heavily involved in the industry's quest to systemically track and improve the effectiveness of project controls. But, despite progress, projects continue to underperform or fail. Technology and innovation will play a big part in addressing this issue.

While technology advances are transforming other industries like retail, media, and auto manufacturing, the majority of construction companies operate much the same way as they did 20 years ago — relying on manual, disaggregated, and redundant processes for project planning and management. By rethinking how the enormous amount of data generated on a complex project is captured and leveraged throughout the project lifecycle, construction owners can achieve positive outcomes.

One of the respondents highlights the power of “predictive analytics to determine how design issues impact constructability and provide warnings.” Another suggests that “technology that addresses and pre-empts geotechnical conditions would help address major risks like tunneling.” Yet another talks of the potential for “sensors inside helmets to monitor safety, productivity and personal health.”

Automation can overcome many of the delays that unnecessarily hold up projects, like statutory clearances and road permit issuances.

And BIM helps to predict future success. According to one of the executives taking part in the survey: “Contractors re-build BIMs because you wouldn't bet your life on the calculations of architects.”

But often these benefits seem frustratingly out of reach. One obstacle is the role of the CIO and other technology professionals. Too much of their time is spent on IT-infrastructure-related issues, and not enough on exploring the potential of technologies like drones, automation and robotics, and getting involved in key investment decisions for these and other innovations.

Many companies show a lack of discernment when purchasing technology solutions — and compound the problem with weak implementation. System platforms are often configured and installed poorly; in effect they're set up to simply run like the legacy system they're replacing. Without change management or re-engineering, it's very hard to get the most out of a new tool. To complete the vicious cycle, the entire initiative is soon labeled a failure, further undermining the adoption of future technology.

If owners and engineering and construction companies want to reverse these negative cycles, they need to establish a clear technology strategy, with defined objectives and decision-making roles and criteria.



Steven Gatt

KPMG in Australia

E: sgatt@kpmg.com.au

In more than 30 years at the firm, Steve has built up an outstanding portfolio of engineering and construction projects, with a particular specialization in real estate. He is at the forefront of industry issues and is regularly sought after to provide valuable insights and observations into current trends, best practices, strategies and opportunities. Steve has advised on a range of capital and debt transactions for market heavyweights, and has acted as lead audit partner on many high profile real estate and construction companies.

Technology in action: how the industry is embracing innovation

Is the vast increase in data improving transparency or clouding the issue?

One of the common sentiments among survey participants is the additional complexity created by systems and technology. The manual, disconnected cost, risk and scheduling systems of the last generation may have lacked a certain sophistication, but many believe they managed to deliver practical, workable (if limited) functionality and reports.

As one executive puts it: “While we’ve made tremendous strides in implementing technology solutions, we’ve created a level of complexity we can’t fully cope with. Sometimes I feel like we’re inundated by our own data — data which we don’t understand and therefore can’t use.”

Another respondent comments that: “We’re spending 80 percent of our time collecting data and 20 percent of our time analyzing it. With technology enhancements, we’re trying to flip those percentages.”

They’re not the only ones struggling to get a grip with data. *The Creative CIO*, a 2016 KPMG/Harvey Nash global survey of engineering and construction CIOs, found that less than a third of respondents feel their big data implementation has been successful.²

The project owners and engineering and construction companies in the survey certainly appear to have an impressive and broad array of different platforms for planning, monitoring and controlling their capital projects. But few say they have the resources to analyze and make sense of the data generated by these disparate systems.

As evidence of this shortfall, just 36 percent of engineering and construction firms and 21 percent of owners say they utilize advanced data analytics in addition to cost and schedule analytics. This is not surprising, given that the majority of engineering and construction firms — as well as owners — claim to use multiple software

platforms that are manually monitored. This multiple approach adds complexity to advanced data analytics, making it difficult to process information and generate insights. It is also highly cumbersome, consuming large amounts of employee time; time that could be better spent screening and monitoring data, to help detect project issues and discrepancies.

Responses from *The Creative CIO* support these findings. Only a quarter of respondents (26 percent) feel they have the appropriate resources and funding to drive their innovation agendas, and 27 percent say that a skills shortage prevents their organization from keeping up with the pace of change.³

A number of senior executives feel that their workforces need to adapt to the wider impact of technology, as one notes: “A major concern with changing technology is the disruption to the workforce and how to deal with that, how to retrain people to keep them relevant and employed.”

Predicting the demand for people

It’s extremely difficult to forecast resource demand for a project — ensuring the right number of people, with the right skills, are in the right places at all times. This is especially tough for larger, longer projects involving hundreds or even thousands of workers, or when certain phases of the project are accelerated. The widening talent gap within the industry only adds to the challenge. In this complex environment, ballpark estimates just won’t do.

One of the most important weapons in a construction owner’s arsenal is the ability to forecast these needs accurately. It ensures that you don’t have shortfalls holding up progress or idle workers pushing up costs. And with a battle for scarce skills, it should help secure the right people ahead of competitors.

Technology opens up powerful project tracking tools that collect valuable project data on staffing and workload. When integrated into their planning processes, this can help

² *The Creative CIO*, Harvey Nash/KPMG CIO Survey, 2016.

³ IBID.

“Number crunching has always been a big part of construction — a commonly heard phrase is that construction companies are accounting companies, which happen to erect buildings.”⁴

— Bernard Marr

D&A expert and Forbes magazine special contributor

organizations better manage and forecast people resources to align with project and organizational goals.

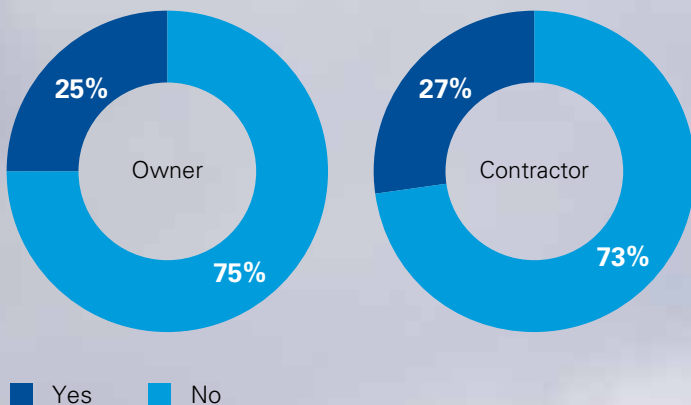
Many of the respondents to this year’s survey appear to fall short of this goal. Just 36 percent of engineering and construction companies — and only 21 percent of owners — claim to use advanced data analytics for project-related estimation and performance monitoring.

Integrated, real-time project reporting: myth or reality?

Has the promise of integrated systems really delivered? Although the cutting-edge visionary companies in the survey claim to enjoy fully integrated, centralized project and portfolio reporting, the majority of respondents state that their organizations continue to use manual processes and multiple systems.

It seems that the dream of ‘one button’ to get all project information is yet to be realized.

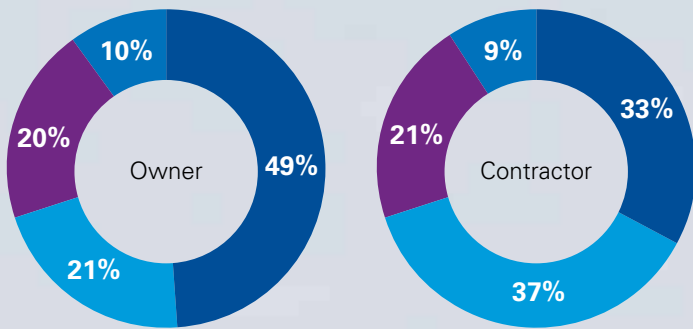
Can you ‘push one button’ to obtain fully integrated, real-time project data?



⁴ *How Big Data And Analytics Are Transforming The Construction Industry*, Forbes, 19 April 2016.



Respondents' technology driven project management information system



- Multiple software platforms that are manually monitored
- Multiple software platforms that integrate into a single reporting database
- A single, fully-integrated PMIS system is used across the enterprise
- Not used

When used effectively, a PMIS lets engineers and project managers communicate project status swiftly and accurately. It can dramatically improve project planning, scheduling, monitoring, and controlling.

A PMIS helps both owners and contractors gather reliable information for claims against performance and cost, and to reduce or prevent contract compliance disputes. The powerful analytics of PMIS tools give owners and contractors greater insight into the cost, schedule, quality, and safety performance of projects. Contractors and owners alike can accurately forecast the amount of resources required when the project scope changes, ensuring that materials and labor are budgeted and scheduled efficiently.

Forty-one percent of respondents say their companies have multiple software platforms that are manually monitored. And only 20 percent have a single, fully integrated PMIS across the enterprise. Without fully integrated automation, the effectiveness of these tools is severely compromised.

An engineering and construction executive involved in the survey explains how his firm is "...using mobile technology for the purposes of monitoring information flow and ensuring

KPMG comment: lack of PMIS integration can compromise decision-making

Senior management, board members, the audit committee, regulators, and other stakeholders demand accurate and transparent project information in order to make informed decisions and ensure compliance with statutes, debt covenants and other project requirements.

The ability to drill down to source data is vital to confirm the reliability of project team reports. But if project tools are manual, standalone or disaggregated, both transparency and accuracy can suffer.

There are multiple opportunities for erroneous data to creep into project status reports, especially if subcontractors and sub-consultants generate information isolated from an integrated PMIS and pass it along to contractors, architects and engineers, and finally to the construction manager. Errors typically occur when reports are not properly vetted or when different project account coding is used in various project tools. There may also be problems exporting data from different job cost reporting systems, as well as misunderstandings over which scope items are included in each cost category (as there may be discrepancies in work breakdown structures between tools).

In short; manual errors are hard to spot without considerable review, monitoring and audit. Even when

they are identified, it may take a considerable amount of time and energy to resolve the issue. It is imperative that project information is integrated through an effective PMIS that's managed and reviewed/audited with project appropriate data analytics tools to ensure data integrity is maintained from project start to finish.



Randy Meszaros

KPMG in Canada

E: rmeszaros@kpmg.ca

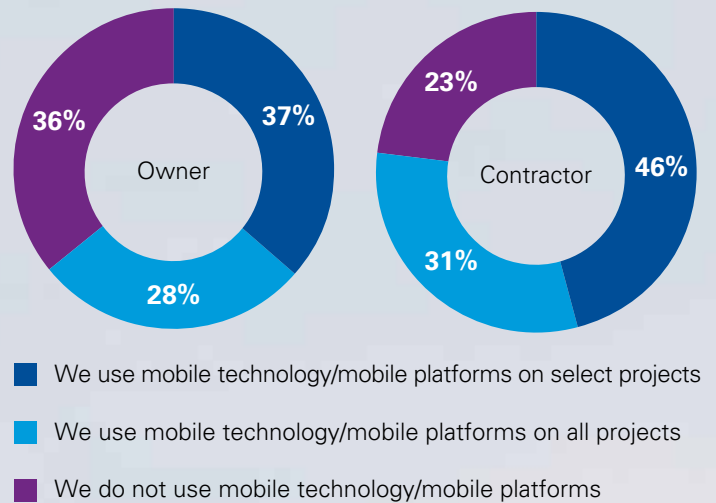
Randy is a Senior Manager in the Risk Consulting practice at KPMG in Canada. He has 28 years of combined industry and consulting experience in governance, risk, procurement, project and contract management, construction, operations, and project controls and is a subject matter expert in the mining, energy, infrastructure and government sectors. Randy has worked in Canada, the US, South America and Australia on projects involving mining/processing, power generation and transmission, oil refining, pipelines, site remediation and transportation — roads and highways, bridges, toll systems, and marine.

information is complete; efficient document management; seamless reporting; and removal of inefficient process flows (i.e. cut out middle men)."

But our survey results suggest they are in the minority, and that there's a way to go before mobile becomes truly ubiquitous. A mere 29 percent of respondents use it routinely on all their projects, while a similar proportion don't use mobile platforms at all. Engineering and construction companies have embraced mobile to a greater degree than owners, but both could arguably do more with this technology.

"Only 20 percent of survey respondents say their organization has a single, fully integrated PMIS across the enterprise."

Use of mobile technology on engineering and construction projects



KPMG comment: revolutionizing the inspection process through mobile

Traditionally, field inspectors manually reported the engineering and construction company's activity — including any unresolved issues — in a so-called "yellow book." Today, the same inspectors can capture this information — and much more — through cloud-based applications on their mobile devices direct from the work site.

Critical data like equipment status, points of non-compliance and so on can be entered from multiple sites via a hand-held tablet or smartphone. This is all now easily accessible on the centralized cloud system, enabling the owner's or engineering and construction company's home office to analyze and track performance over time. Senior management can pinpoint trends and address problems and

identify gaps, inaccuracies, and inefficiencies in the data, helping to avoid post-construction reporting and records management issues. The enhanced reliability of the data also demonstrates strong oversight diligence to regulators.

A more detailed version of this commentary is available in *Digging into Data: A Blueprint for Mega Project Success*, KPMG, 2016.⁵



Clay Gilge
KPMG in the US
E: cgilge@kpmg.com

⁵ *Digging into Data: A Blueprint for Mega Project Success*, KPMG, 2016.

Exploring the limits of technology

A futuristic industry is tantalizingly within reach — but many firms have yet to reach out and grasp the opportunity.

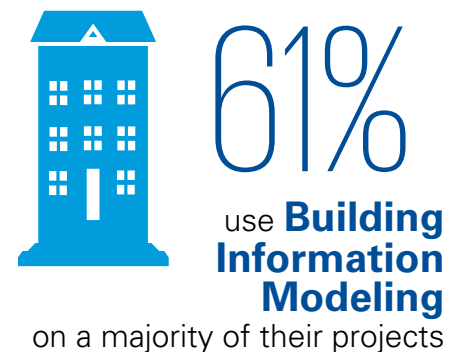
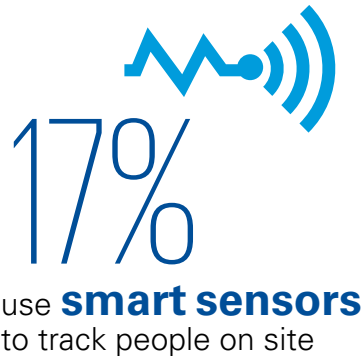
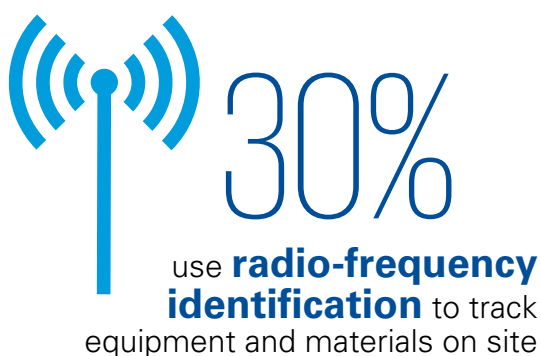
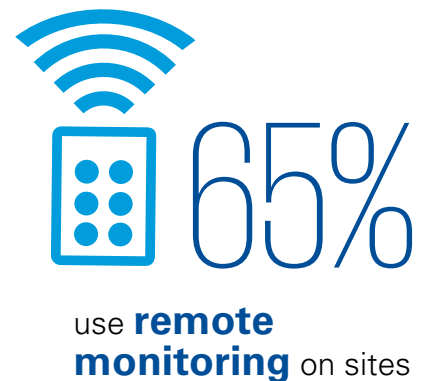
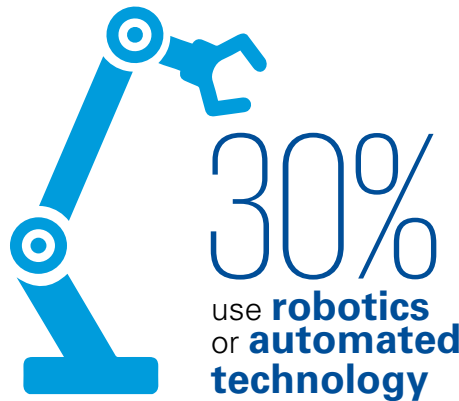
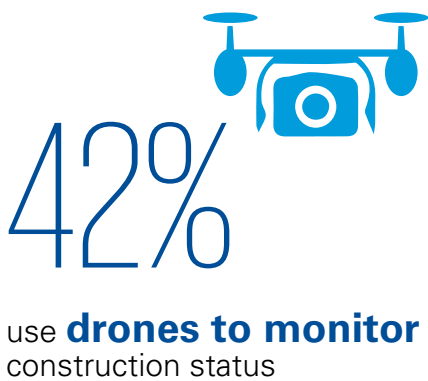
It's not exaggerating to say that we're on the edge of a revolution in engineering and construction.

Drones are hovering around sites capturing highly detailed images, which are in turn transmitted — in real time — to intelligent, automated computer systems that may be able to react without human intervention. Unlike humans, drones can easily access remote or dangerous areas and will work 24/7. When you're working on a tall building, for instance, this can save time and reduce the risk of accidents.

Then there are robots. These machines can carry out all manner of tasks like drilling and digging, laying bricks and

building beams, increasing safety and accuracy. The work can be overseen from anywhere in the world thanks to remote monitoring. Add on 3D printing capability — enabling the creation of a vast array of complex designs that can shorten supply chain times and enable modular assembly — and it's easy to understand why people are getting so excited.

The respondents to KPMG's survey are embracing these various innovations to differing degrees, with remote monitoring the single most popular choice. A sizeable minority use drones, while a third say they are employing robots and automation.



According to an executive from an engineering and construction company: "The construction industry hasn't changed much in the last 20 years but over the next 5 years our company expects big changes to make it more digital and modular. There will be full modeling before construction starts on-site and 3D printing for smaller projects. Technology will play a much greater role."

A significant majority employs remote monitoring for project sites. One of the

executives participating in the survey says his firm is "installing GPS devices on equipment and considering mobile devices with software integration for real-time reporting and less manual entry."

Only a small proportion (17 percent) of respondents employ smart sensors to track the location of project and construction personnel on site.

KPMG comment: visualization is the future of decision-making in capital projects

Rapid adoption of visualization means that virtual 'tours' of construction sites will soon become the norm, offering short videos that provide a high-level picture of what's going on — and indicating where the most urgent action is needed. These visuals are integrated with key project analysis using graphs, data trends and 3D graphics, giving management a single version of the current and projected state.

Owners, engineering and construction companies, consultants and project managers are more frequently using camera-mounted radio-controlled 'quad' devices (quad-cams) which can give a 24/7 real-time view, to monitor and survey overall progress of their construction activities. They can identify potential hazards or quality issues and are particularly useful on sites that are large or spread out.

Quad-cams are ideal for reviewing and recording the performance of large cranes and associated lifts, as well as materials movement and erection activities. When combined with the right information at the right time, debottlenecking becomes easier and not just about productivity, but overall throughput of the project increases. The analysis can help managers plan out the optimum routes for large shipments, avoiding tight turns or low-

voltage crossings and thereby enabling the wider value chain outside of the site to integrate with the wider supply chain.

As with all breakthrough technologies, the use of quad-cams will evolve and become mainstream, and should make a huge contribution to project efficiency and ultimate success.

This commentary is a concise version of *Visualization: the future of decision-making in capital projects*, KPMG International, March 2016.⁶



Puneet Narang

KPMG in India

E: puneetnarang@kpmg.com

Puneet is a Director in the Major Projects Advisory consulting practice at KPMG in India. He has 15 years of specialist experience in capital projects leadership, lean construction and design, and operational excellence in the infrastructure, government and energy sectors. Puneet has worked in India, the US and the Middle East on projects involving power generation and transmission, ports, roads and highways, and real estate.

⁶ Foresight No. 41, *Visualization: the future of decision-making in capital projects*, KPMG, 2016.





Back to basics: evaluating project management controls

Technology may have enormous potential, but engineering and construction companies — and owners — cannot neglect the fundamentals of good project management.

Underperformance is a constant thorn in the side of owners. The results of this year's survey highlight three reasons why project management controls are not producing the desired cost, schedule and quality targets.

Three reasons why project controls aren't working



Overconfidence: firms may have invested large amounts in controls and processes, but these are not as effective as they would expect them to be.



Consistency: it's an old — but true — cliché that a controls system is only as strong as its weakest link. Firms need to root out and reform any sub-standard controls.



The human factor: a combination of lack of focus on 'soft' controls (influenced by culture and behavior) and a widening talent gap is impairing organizations' ability to manage projects.

Maturity of project management controls: could do better

KPMG's 2015 Global Construction Survey of project owners found that most projects failed to come within 10 percent of budget or deadline, with over half of respondents suffering one or more underperforming projects in the previous year.⁷

⁷ *Climbing the curve: 2015 Global Construction Project Owner's Survey*, KPMG International, 2015.

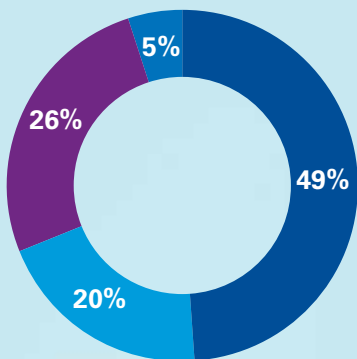
Despite considerable progress in installing and maintaining systematic project governance and controls, projects persistently fail to meet targets. Which points to one conclusion: engineering and construction firms and owners are struggling to keep up with the continued, rapid increase in project scale and complexity.

The fact that more than two-thirds of the respondents in the 2015 and 2016 surveys believe their controls are either “optimized” or “monitored” suggests processes are in place. But regular underperformance hints at a lack of application of the day-to-day operation of controls, leaving considerable room for improvement.

It’s also surprising how frequently experienced project teams ignore the warning signs of incomplete planning, and move forward with execution in spite of serious problems and unresolved issues. For this reason, it’s vital for owners and engineering and construction companies to keep investing in project controls and technology. This should help to ensure that underlying controls are soundly and consistently administered, and that project information systems and tools provide management with the information they need.

If management is not made aware of project issues until they become catastrophic, the chances of rescuing a project and avoiding failure are slim-to-zero.

Owners’ project management controls



- **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:** Unpredictable 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.

“We don’t always follow established project management processes and controls. We can attribute 100 percent of our failed projects to this syndrome.”

— Engineering and construction company executive

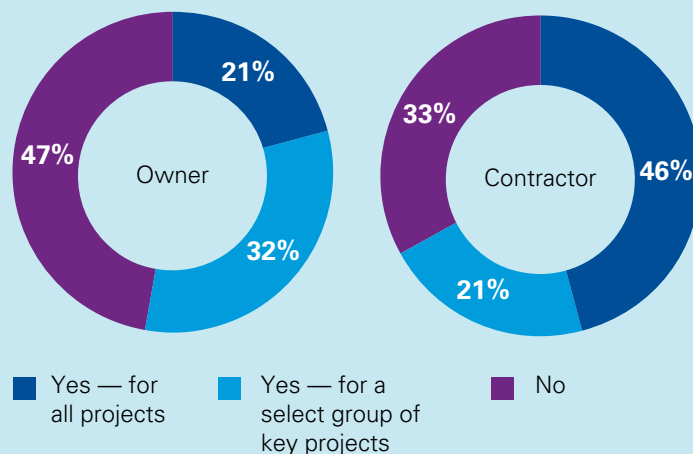
Re-establishing project management fundamentals

Management need to be made aware of project issues on a real-time — or as close to real-time — basis as possible. EVM is arguably the only industry recognized and consistent approach to measure cost and schedule performance. By measuring scope, time and costs within a single integrated system, EVM can give accurate forecasts of project performance problems.

The engineering and construction sector has enthusiastically adopted this approach, but its use is variable. Among the firms taking part in the survey, 41 percent don’t use EVM at all. There is also a big difference in usage between owners and engineering and construction companies, with the latter far more likely to embrace EVM.

Few owners have the skills, the experience, willingness and the funding to invest in technology that enables project managers to utilize EVM. A number of owners have even told us they don’t believe EVM is needed for most of their projects. In the few occasions when it is utilized, owners often outsource forecasting to their engineering and construction contractors.

Mixed use of Earned Value Management tools



Consistency — engineering and construction firms are only as good as their weakest links

Consistent, transparent controls come from a combination of strong governance and embedded culture. They give owners confidence that standards remain high regardless of the scale or geography of a project.

When engineering and construction companies bid for lucrative government contracts, their chances of success are increased if they can show evidence of controls that meet prescribed standards. Controls can also inform management when the organization may be unprepared for a tender. This could save the time and expense of bidding when there is little prospect of winning.

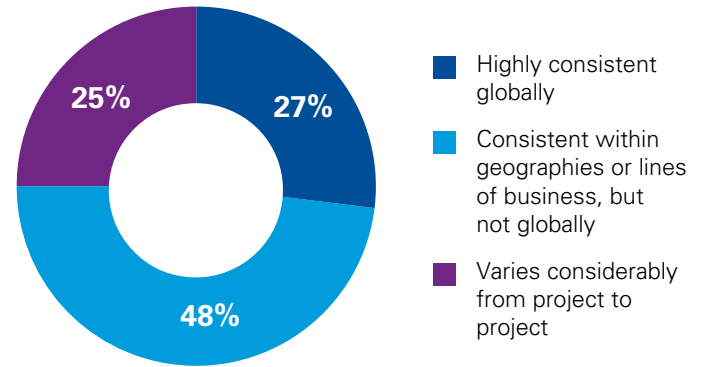
Owners also benefit from effective project controls as it gives them greater belief in contractors' ability to deliver a project on time and within budget, which should improve the relationship between the two parties.

In our experience, one of the most common reasons for inconsistent controls — and insufficient strategic risk management — is a lack of objective control standards. Conversely, successful companies frequently evaluate business risks and the internal control environment to mitigate those risks. Leading practitioners use a comprehensive set of objective criteria that serve as a consistent baseline for controls evaluation and measurement. These kinds of standards can also provide essential assessment criteria for internal audit departments.

The engineering and construction companies involved in the survey report varying degrees of success in achieving a "one firm" approach to controls. Only 27 percent believe that their controls are truly consistent globally, although a larger proportion feel there is consistency within regions and lines of business. This patchwork picture provides another explanation for project performance: firms' overall controls

are only as strong as their weakest controls or their weakest business unit. Until they can achieve high standards in controls across the enterprise, large firms are likely to keep on suffering from failed or poorly performing projects.

Consistency of project management processes



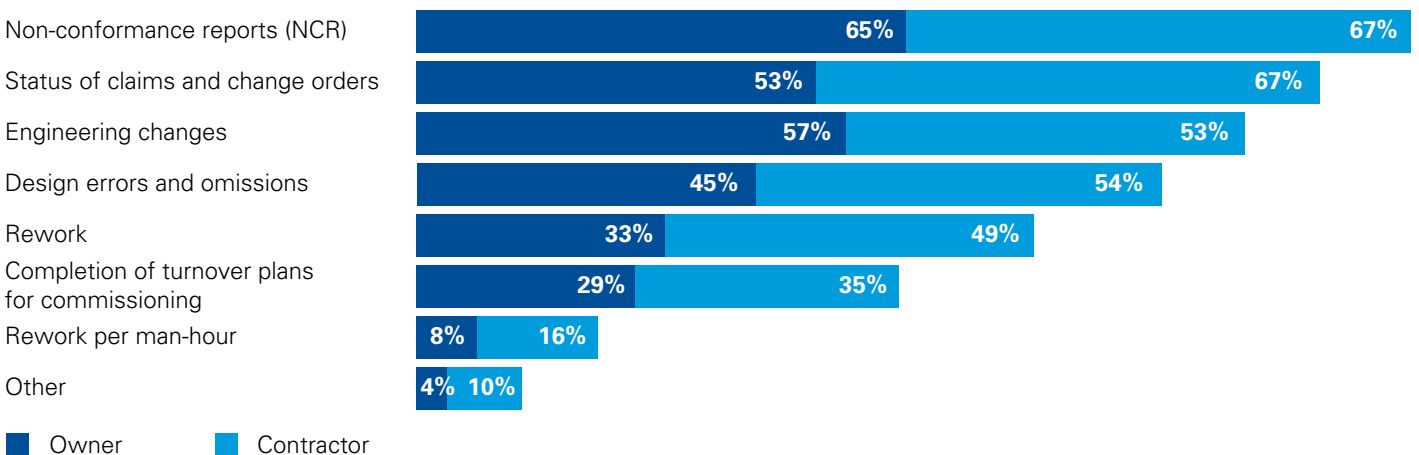
Measurement equals action

It's always a challenge to track and report on projects and give stakeholders the information they need. One of the major obstacles is a lack of integration, either of project management and financial reporting systems or between owner and contractor/subcontractor reporting systems. Failure to consistently apply metrics can increase the risk of underperformance.

Across many project areas, both owners and engineering and construction companies say they're consistently reporting key performance metrics for cost, risk, safety, procurement and schedule. But the biggest gap appears to be in the reporting of quality. Most capital projects have limited flexibility in quality, so unreported or unknown quality issues can damage future cost and schedule targets.

Only half of the respondents claim to report errors and omissions, and just one-third say they track turnover plans

Use of quality-based performance metrics



for commissioning. Without a comprehensive and consistent view of project reporting, both owners and contractors are likely to continue to struggle with performance issues. Reporting of quality is not only valuable for tracking quality; it's also another great metric for assessing and evaluating the likelihood of claims and the potential for future cost and schedule overruns.

Plugging the talent gap

Earlier in this paper we touch on the shortage of technology specialists and how this is contributing to the inadequate levels of data analysis, which is limiting the impact of technology investment.

As one executive from an engineering and construction company notes: "Technology means nothing if you don't have the right people with the right skills and background running the project."

It seems that owners have similar concerns, as another survey participant explains: "Lots of experience is disappearing from the marketplace — people are leaving because of layoffs and retirement. The people that remain don't have the experience and are more likely to put too much faith in technology without having the experience to analyze and put into perspective the results coming from data-driven systems."

Across all aspects of project management, the war for talent continues. The demographics of retiring employees are well documented by universities and colleges — as are attempts to nurture a new generation of project managers.

Clearly, training has a large role to play, which is acknowledged by the owners taking part in the survey. Three-quarters of respondents (74 percent) say that project management process training is a key part of their governance structure. And a further 60 percent are encouraging their professionals to achieve external project management certification.

"Only 27 percent believe that their controls are truly consistent globally, although a larger proportion feel there is consistency within regions and lines of business."

KPMG comment: a message to engineers: don't forget the human factor

Given the size, scale and technical complexity of many projects, it's understandable that engineers, project managers and other project professionals focus on the technical aspects of project management controls. But let's not forget the "soft" human factor that says controls are only as good as the people operating them. Technology may help to serve as the 'canary in the coal mine' but it takes people, and a strong project management culture, to listen and take action.

'Soft' controls are less technical and more cultural and qualitative, covering behavior like openness and commitment. Leaders should set an example as role models, and project teams taking the initiative to enforce controls. Without this kind of environment, formal controls are likely to be diluted and less effective. And, as we've discussed previously in this document, the vast amounts of data being produced may overwhelm decision-makers, making it hard to pinpoint the key insights into project performance.

In another article on page 9 of this paper, BP's Vice President, Project Management, Niall Maguire, emphasizes the importance of experienced people that can apply sound principles. His views are echoed by an engineering and construction leader involved in this year's survey: "We don't always follow established project management processes and controls. We have good systems and controls, but when we have deviations, that's where we get in trouble. We can attribute 100 percent of our failed projects to this syndrome."



Gary Webster
KPMG in Canada
E: gwebster@kpmg.ca

Gary is the Head of KPMG's Capital Projects Leadership practice and has been a practicing Professional Engineer for more than 30 years. He has specialized in the organization, procurement and implementation of large scale infrastructure projects and led the business case assessment, procurement and contract implementation stages for a number of very large public infrastructure programs that have included all forms of contracting. His experience has been gained across a variety of infrastructure sectors, including power, institutional, mining, health, marine, transit, highway and bridges and water and wastewater.

The path to becoming a cutting-edge visionary: three key steps

As we've discussed in this paper, the term 'technology' covers a wide range of innovations that can enhance various stages of the construction lifecycle. The responses to our survey suggest that the industry has not fully embraced technology; nor has it successfully harnessed its full potential.

To get real benefit from the tremendous opportunities that technology can bring, engineering and construction companies and major project owners have to consider how they can better integrate its use into both their processes and their culture. Here are three key steps to achieving this goal:

Step 1 Get the basics right

Establish strong internal controls

A system, and its models, are only as good as the information that goes into them; if the theory is flawed, then the modeling will be similarly defective. Take the use of integrated cost and schedule systems. These are marvelous tools that can provide a holistic view of the project status, but what if the schedule is constructed on poor logic? For example, timings for certain activities like obtaining permits may be wildly optimistic; or the engineering and construction company is not systematically measured against earned value milestones. In these circumstances, the data does not reflect reality, and those overseeing the projects cannot make accurate projections.

Before you seek modeling tools, you need to first develop a sound basis of internal controls. Back in the early days of earned value, we always advised clients to start with a good cost performance index (CPI) and schedule performance index (SPI), so they could accurately measure cost and schedule performance versus targets. Only when this was in place could they seriously consider buying software to enhance the process.

Ensure your systems are related

Assuming you have strong internal controls, then you should also have systems that are 'related': they are either connected directly or at least share common data formats. This enables

your team to collect data from different activities and different sources and make like-for-like comparisons. Some project managers believe in integrated cost and schedule systems, which clearly define project scope and build cost and schedule against that scope. Others may prefer two separate systems to provide a 'stereo' view. Regardless of which approach you choose, the systems must be related — especially in a global company with multiple systems of record.

Master proven digital solutions

Before delving into new technologies, make sure that your organization has a full understanding of existing solutions like advanced schedule analytics, Monte Carlo simulators, computer-aided design (CAD) systems or BIM software. When you're confident that you've mastered these, you should be better prepared to integrate and explore other innovations.

Step 2 Build D&A into your DNA

Don't wait to embrace D&A

Data and analytics is not the next big thing; it's today's big thing. If you don't make the most of it now, you'll fall behind the competition. Several years ago, KPMG started to replace manual job cost auditing with data analytic techniques to add greater speed and accuracy. That simple and exploratory investment laid a path to our current application of machine learning to analyze contract terms and disallowable costs.

Analysis brings a host of benefits that can transform your approach to project delivery: more precise estimating, scheduling and resource management; improved scope development; enhanced risk management and safety; and increased real-time productivity analysis.

Clean up your act

Data is of little use if it's not clean, accurate and in a common format that everyone can understand and use. This means carrying out an inventory of data to determine what's useful and what's not, and establishing a common taxonomy or data structure to ensure consistency.

Envision what you want from data

By brainstorming the potential uses of data, you can explore different ways to improve your project management. At this point it's wise to engage data scientists or other data and analytics experts to help you determine the feasibility of these goals. And be prepared to fail; by testing the limits of data you may well gain some valuable insights.

Step 3 Develop a technology strategy and vision

Given the accelerating pace of change and the significant investment costs, it's little surprise that many owners and engineering and construction executives are hesitant to plan their future technology strategy. Just 8 percent of survey respondents are considered 'cutting-edge visionaries' — and only 19 percent say they're aggressively disrupting their business models.

But without a strategy, it's hard to see how companies can evaluate, adapt and integrate new technology. If they want to drive project performance, continuous improvement and productivity, executives should:

- Engage technology leaders in the organization to help guide and facilitate strategy, and develop a future state model and a technology road map. Assess and revise/refresh the road map every 6 months to address changing business needs and economic conditions, and technology advances.
- Survey new technology and assess the potential and viability of innovations like drones, robotics, and so on.
- Identify key project performance objectives and known road blocks to project progress. Then determine which technologies can help meet these goals; for example, real-time reporting enables you to address problems swiftly, before they escalate.
- Identify what data your organization should be capturing — and any gaps.
- Discuss how to introduce transformational technologies — and associated methods — in a cost-effective and timely manner.

A technology vision in practice

One KPMG client — a higher education institution — wanted to embed a fully integrated, asset lifecycle approach to managing projects. This would enable data sharing through every stage of the project lifecycle, from design, through equipment and materials management to operations and maintenance.

The client established a road map for an integrated asset management information system. This involved developing 3D models of all of their facilities, as a basis for all new construction, operations and maintenance projects. Having electronically modeled their facilities they were able to manage assets far more efficiently. For example, a new renovation project team can develop rough estimates and schematic drawings by using existing 3D models as well as historical operations and maintenance data. This gives a complete and highly accurate view of the renovation project at minimal cost, to inform a final funding decision.

About the survey

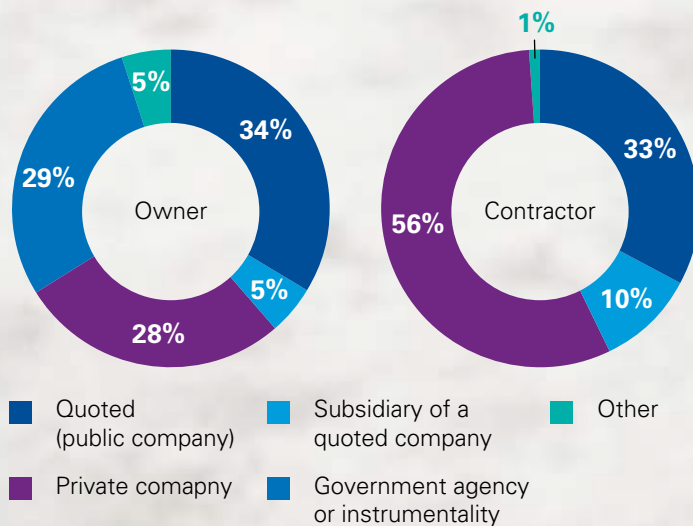
All survey responses were gathered through face-to-face interviews in mid-2016 with 218 senior leaders — many of them Chief Executive Officers. One hundred and nineteen respondents are from organizations carrying out significant capital construction projects; 99 are from engineering and construction companies.

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.

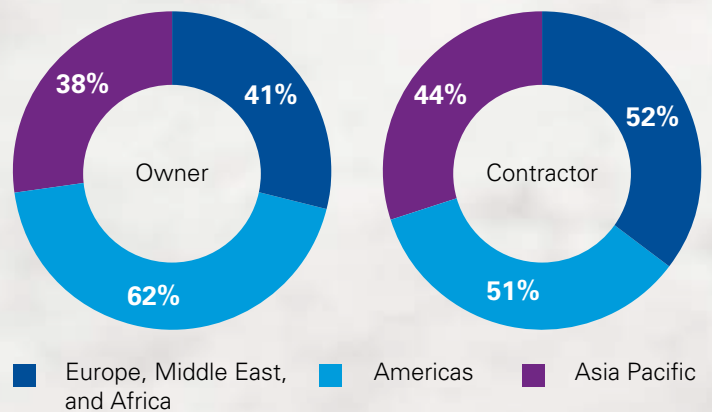
Respondent organizations' turnover/income ranged from less than US\$1 billion to more than US\$20 billion, with a mix of operations from global through regional to purely domestic. The annual capital expenditure budget varied from around US\$10 million to over US\$5 billion.

Twenty-nine percent of the project owners are public bodies — typically government agencies — and some of the main industries represented include energy and natural resources, technology and healthcare.

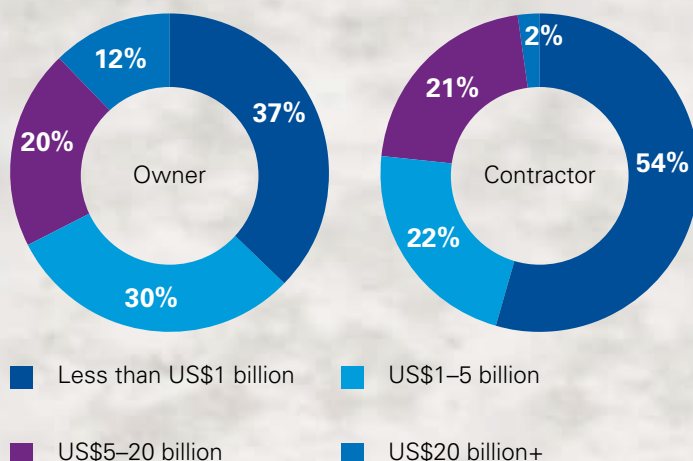
What is your entity type?



In what region(s) do you operate?



What was your entity's turnover (revenue from operations) in the last financial year?



KPMG's Global E&C Practice

When engineering and construction (E&C) leaders turn to KPMG for advice, they do so because KPMG firms understand the industry on a local, national, and global level. For decades, we have provided services tailored specifically to meet the needs of the E&C 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 E&C professionals provide strategic insights and relevant guidance wherever our clients operate. KPMG services are delivered through the global network of KPMG International member firms by over 2,000 professionals in more than 40 countries worldwide.

KPMG firms help clients identify and mitigate project risks throughout the project lifecycle. Our methodology encompasses both "doing the right project" and "doing the project right." Our services include construction program evaluations, project risk and controls assessments, contract compliance analyses and cost investigations, as well as project support on complex and troubled projects.

We provide industry knowledge, multidisciplinary teams, and substantive experience in managing both the financial and technical aspects of major capital projects and programs. Our Major Projects Advisory practice consists of professionals from diverse formal backgrounds.

By combining valuable global insight with hands-on local experience, we can help you address challenges at any stage of the lifecycle of infrastructure assets or programs — from planning, strategy and construction through to operations and hand-back.

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



Geno Armstrong
International Sector Leader E&C
KPMG in the US
E: garmstrong@kpmg.com

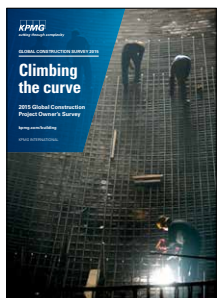


Bookshelf

A selection of relevant KPMG reports and insights. To access these publications, please visit: kpmg.com/building or email us at: gofmbuilding@kpmg.com

Global Construction Surveys

KPMG conducts the Global Construction Survey to monitor engineering and construction (E&C) issues and provide timely summaries and insights to help professionals make more informed business decisions in today's rapidly changing environment — this is the tenth edition of the KPMG Global Construction Survey.



2015 Global Construction Survey: Climbing the curve

KPMG's 2015 Global Construction Survey focuses on the challenges facing owners as they seek to climb the maturity curve and features the views of over 100 senior executives from both private and public organizations



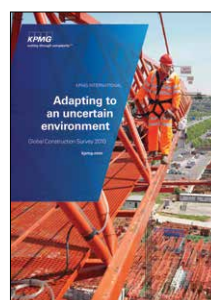
2013 Global Construction Survey: Ready for the next big wave?

The 2013 report catches the industry in a more upbeat mood after gauging the views of 165 senior executives of leading E&C firms from around the world to determine industry trends and opportunities for growth.



2012 Global Construction Survey: The great global infrastructure opportunity

The 2012 survey focuses on the insatiable demand for energy and infrastructure in all forms, and the resulting fundamental shifts in focus for nearly all E&C firms.



2010 Global Construction Survey: Adapting to an uncertain environment

The latest survey highlights the cautiously optimistic outlook of many E&C companies about their immediate prospects and the measures adopted to seize the new opportunities identified.

Other Thought Leadership

KPMG member firms work across many sectors at various stages of the lifecycle of infrastructure and capital projects. We continuously seek to share the insights we are gaining in the process to help contribute to our clients decision-making process.



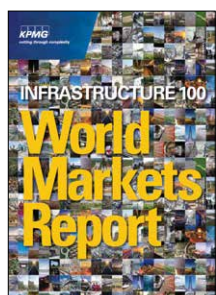
Assessing the true value of infrastructure investment

Based on global research and supported by case studies, this report provides valuable insights on the current infrastructure assessment and prioritization processes in Brazil, India, South Africa and the UK.



The future of cities

This article series addresses the challenges and opportunities facing cities as urbanization changes the dynamics of our world, and how we can work together to create better, more sustainable places to live and work.



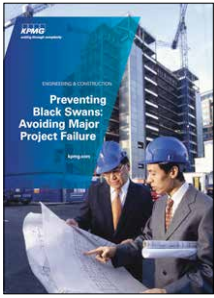
Infrastructure 100: World Markets Report

In the third Infrastructure 100, KPMG highlights key trends driving infrastructure investment around the world and a global panel of independent industry experts identify 100 of the world's most innovative and impactful infrastructure projects.



Foresight: Emerging trends in 2016

In the fourth edition of this special report, three of KPMG's Global Infrastructure leaders share their views on new trends that will influence the world of infrastructure in 2016 and beyond.



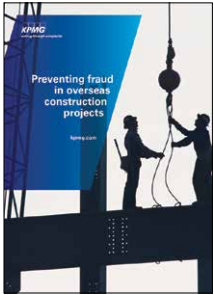
Preventing black swans: Avoiding major project failure

This paper highlights characteristics of major capital projects that can lead to catastrophic failure for owners and contractors, alternative approaches for screening projects, and red flags and triggers for early identification of troubled projects.



How to successfully manage your mega-project

Effective management of mega-projects relies on three key concepts: early planning and organizing, stakeholder communication and project controls integration, and continuous improvement. This three part series covers best practice for managing mega-projects.



Preventing fraud in overseas construction projects

Over the last decade, construction companies have increasingly recognized the imperative of geographic diversification and international expansion and while there are many benefits to investing in emerging markets, the risk of bribery and corruption may be even greater.



Project portfolio optimization: Do you gamble or take informed risks?

This paper addresses portfolio optimization by highlighting some of the challenges and pitfalls of inefficient capital allocation by providing example approaches and practices for identifying and managing projects throughout the lifecycle.

Insight – The Global Infrastructure Magazine

Insight is a semi-annual magazine that provides a broad scope of local, regional and global perspectives on many of the key issues facing today's infrastructure industry.



Issue No. 8 – Infrastructure Morality

This edition focuses on hard issues such as migration, corruption, social equality and affordability — and asks the difficult questions of infrastructure leaders at the forefront of the morality debate. It also includes a Special Report on Asset Delivery.



Issue No. 7 – Who controls our infrastructure?

This edition explores some of the big challenges and trends influencing the debate around infrastructure control. It also includes a Special Report on Rail, a sector often at the epicenter of the debate around control.



Issue No. 6 – Population

This edition takes a closer look at the link between unprecedented population changes and demographic shifts currently underway and the infrastructure needed to meet these challenges. It also includes a Special Report on Asia Pacific's infrastructure market.



Issue No. 5 – Resilience

This edition explores some of the world's most impactful stories of infrastructure resilience. It also includes an exciting Special Report on the important changes and opportunities within Latin America's infrastructure market.

MPA Project Leadership Series

KPMG's Major Projects Advisory Project Leadership Series targets owners with major construction programs, but its content is applicable to all entities or stakeholders involved with construction projects. This series describes a framework for managing and controlling large capital projects based on the experience of professionals from KPMG's MPA practice. We provide services to hundreds of leading construction owners, engineering, procurement construction contractors.

- From Concept to Project — Critical Considerations for Project Development
- Stakeholder Management and Communication
- Project Organization & Establishing a Program Management Office
- Governance and Project Controls
- Budgeting, Estimating and Contingency Management
- Monitoring Capital Projects and Addressing Signs of Trouble
- Project Risk Management (future)
- Investing in Tools & Infrastructure (future)

Contact

For further information, please visit us online at kpmg.com/building, email: gofmbuilding@kpmg.com or contact:

Geno Armstrong

International Sector Leader E&C

KPMG in the US

T: +1 415 963 7301

E: garmstrong@kpmg.com

Clay Gilge

Major Projects Advisory Practice Lead

KPMG in the US

T: +1 206 913 4670

E: cgilge@kpmg.com

kpmg.com

kpmg.com/socialmedia



kpmg.com/app



The information contained herein is of a general nature and is not intended to address the circumstances of any particular individual or entity. Although we endeavor to provide accurate and timely information, there can be no guarantee that such information is accurate as of the date it is received or that it will continue to be accurate in the future. No one should act on such information without appropriate professional advice after a thorough examination of the particular situation.

© 2016 KPMG International Cooperative ("KPMG International"), a Swiss entity. Member firms of the KPMG network of independent firms are affiliated with KPMG International. KPMG International provides no client services. No member firm has any authority to obligate or bind KPMG International or any other member firm vis-à-vis third parties, nor does KPMG International have any such authority to obligate or bind any member firm. All rights reserved.

The KPMG name and logo are registered trademarks or trademarks of KPMG International.

Designed by Evalueserve.

Publication name: Building a technology advantage

Publication number: 133729-G

Publication date: September 2016