GLOBAL INFRASTRUCTURE INITIATIVE
By McKinsey & Company

Voices on Infrastructure:
Transforming project delivery

June 2017

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* On the cover:
The Battersea Power Station site in London stood vacant for decades—until a unique combination of planning, expertise and funding made its redevelopment of the 7ha site possible. Now under construction, the building is scheduled to be complete in 2020 as part of a wider $12bn regeneration of the area.
Photo courtesy of the Battersea Power Station Development Company

Introduction: Transforming project delivery

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Welcome to the June 2017 edition of *Voices on Infrastructure*. This collection of articles by industry leaders and McKinsey experts builds on our previous development and financing edition published last quarter and addresses the critical phase of project delivery and execution.

McKinsey research has pointed out the need, and opportunity, for significant improvements in construction productivity. At 13 percent of global GDP, the construction industry plays a pivotal role in securing prosperity, globally and locally, through the deployment of new infrastructure—and the need for innovative approaches to building public and private assets is stronger than ever. Improved performance in project delivery is at the core to securing increased funding and meeting the challenge of labor shortages. The industry has seen flat to declining productivity for years, while other industries have significantly improved performance. Challenges of regulatory burdens, fragmented supply chains, inconsistent standards, and owner-contractor misalignment persist but are being tested by new models and approaches. At the same time, the need to move the least digitized industry into the digital era is clear. This transition will include using new materials, construction techniques, digital technologies such as the Internet of Things and advanced analytics, collaboration models, and software solutions to dramatically improve the outcomes of construction projects. New modes of working, including 5-D or 6-D building information modeling, open source, and cloud-based technology, are poised to dramatically disrupt the industry. And manufacturing-style, repeatable-construction techniques have the potential to transform the way we build—not only in the affordable housing and residential sectors but also across the entire industry. The world needs these solutions to be deployed faster—and companies need to make sure they will not be left behind.

We have dedicated this issue of *Voices* to ideas about how project delivery organizations can improve productivity. The articles describe the current challenges and feature examples of successful integrated delivery models, process standardization, collaborative contractual frameworks, proven intervention techniques, and public-private partnership delivery benefits. Our contributors look at how leading organizations are responding to these challenges with creativity and innovation. We hope you find their insights helpful in identifying better ways to deliver capital projects.

News from the Global Infrastructure Initiative

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We hosted our fourth GII Summit in Singapore on May 24–26, 2017. 211 global infrastructure leaders joined us from across the value chain, sectors, and geographies. Our agenda included discussions on rethinking the planning process, alternative funding frameworks, boosting construction productivity, and cybersecurity. We were impressed by the quality of these discussions—and particularly by the concrete ideas and recommendations that participants shared. Our 2017 GII Recap Report will cover these insights in detail but, for a sneak preview, explore the Summit's best ideas, videos, and photos.

Throughout the second half of the year, we have an exciting schedule of regional roundtables and innovation site visits lined up. In September, we will host a Johannesburg roundtable on reinventing construction, followed by a Stockholm roundtable on the future of mobility. Coinciding with the latter, we will visit Sweden's two electric road system pilots, a bold initiative to explore low-carbon transportation. Then in November we will visit the $100 billion King Abdullah Economic City (KAEC) in Saudi Arabia. Participants will learn what the KAEC team is doing to keep this massive project moving and what it takes to commercialize a city, from concept to masterplan to delivery and sales. For more details on upcoming events, visit our website.

Looking ahead, in October 2018 our fifth GII Summit will take place in Europe for the first time. Over the coming months, we will determine the city and core themes. If you would like to weigh in on which European city should host the Summit and why, please reach out to us.

The forthcoming September edition of *Voices* will focus on navigating big disruptions in transportation. It will feature a fascinating selection of articles and interviews exploring how to steer through the volatile environment caused by demand and supply-side disruptions, changing mobility patterns, and new technologies.

We welcome your thoughts on *Voices* and, if you would like to sign up for GII events, please contact us at info@giiconnect.com. Enjoy the June edition of *Voices*.

Photo courtesy of Katerra

Construction: The next great tech transformation

Mired by under-digitization and fragmentation, construction must find a new way to build.

Michael Marks

Executive chairman, Katerra

Imagine you want to buy a new car. You find the make and model you want, select your interior and finish details, and place the order. The car company starts building the car to meet your specifications, and promises to deliver it in a few weeks.

But a few weeks turn into a few months and the car never arrives. It's nearly impossible to get an answer as to why. When you ask you are referred to the person in charge of the chassis, who blames the engine guy, who in turn says the steel wasn't delivered on time. You're left trying to chase down multiple people over phone or email.

Finally, after nearly a year, you get your car. But it arrives with a bill for 30 percent higher than the original quoted price.

No one would buy a car this way. More to the point, no car maker or dealership would expect you to. But, somehow, we've come to accept this frustrating process as normal when it comes to construction.

Construction must embrace technology

While other industries have radically modernized their processes, construction remains one of the most stagnant major industries in the world, still using many of the same methods first deployed in the 19th century. As a result, productivity is falling, the construction workforce is shrinking,[1] and demand for housing continually outpaces supply.

There are many reasons behind the stagnation. Foremost among them is the lack of technology investment by construction firms. In 2016, 70 percent of construction firms dedicated 1 percent or less of their revenue to technology.[2] Outdated process management and low productivity contribute to the fact that a residential building with more than 20 units takes an average of 14.9 months to build—and that's after an entitlement process that often takes a year or more. The lack of technology is also pushing up construction prices worldwide, even amid falling commodity prices.

Furthermore, the vast majority of building projects are still treated as one-off prototypes. While design and construction are full of highly repeatable processes, there is still no scaled systems approach to building. Instead we start from scratch every time, sacrificing huge opportunities for time and cost efficiencies.

Fragmentation is another significant hurdle. The number of parties required to get something built is mind boggling, with property developers and owners having to assemble teams that include architects, general contractors, subcontractors, and materials suppliers. While everyone may do great work, each team member is set up to protect their own individual interests rather than champion those of the customer. They may have never worked together before and may not agree on certain aspects of the project.

The good news is that other industries have already figured out how to solve many of these problems. The automobile and electronics industries are two examples of successful models

1 David Randall, "Construction worker shortage weighs on hot U.S. housing market," *Reuters*, Sept 2016.
2 *The 5th Annual Construction Technology Report*, JB Knowledge, 2016.

that the construction sector should copy to create an entirely new way to build—a way that is technologically advanced, systematic, and vertically integrated.

A new way to build

In short, when the entire building process is owned by a single team from end to end—bringing design, manufacturing, material sourcing, and construction together into one streamlined system—it is possible to build high-quality, beautiful buildings, faster and at a lower cost.

The big challenge for the construction sector is to meet individual customer specifications without sacrificing assembly and material efficiency. The solution is to create a building design system that despite having a finite and controllable number of component parts—wall panels, floor panels, kitchens, balconies, and so on—still allows for a broad range of custom configurations.

The next step is to integrate design directly with manufacturing and the supply chain. Having a single, integrated team working from a standard kit of parts and products provides unprecedented transparency into material ordering, tracking, and delivery. Such integration provides the opportunity to aggregate demand for building materials, creating cost savings across multiple projects rather than having to buy key materials such lumber and steel project by project.

Shifting the construction sector to a modern manufacturing model will also transform the traditional construction job site and the skills required to run them. By shifting labor to controlled factory facilities, we can reduce waste and provide greater schedule and product quality assurance. Such a job site more closely mirrors a process of precision product assembly, fitting pieces together in a defined sequence.

This new model for construction presents an exciting opportunity and a big win for everyone in the industry. We can remove time and costs to the great benefit of consumers, create a new generation of skilled manufacturing jobs, and modernize an industry that is vitally important to our social fabric and to the planet.

And the housing shortage is a challenge that we must meet. In 2016, the United States was short more than 7 million affordable and available rental unit apartments.[3] A 2014 study found that by 2025, a third of the world's urban dwellers—1.6 billion people—could struggle to secure adequate housing.[4] Optimizing architecture and construction can get us there. I hope that other leaders across the built environment will join us on this journey and help us to break new ground.

3 *The gap: A shortage of affordable homes*, National Low Income Housing Coalition, March 2017.
4 "Tackling the world's affordable housing challenge," McKinsey Global Institute, October 2014.

Photo credit: Getty Images

Stopping the insanity: Three ways to improve contractor-owner relationships on capital projects

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Major capital projects are habitually beset by overruns and delays, but three solutions offer a path out of entrenched dysfunction and to increased profitability.

The definition of insanity is said to be doing the same things repeatedly while expecting different outcomes. Sadly, this is too often reflected in the delivery of major infrastructure and capital projects.

Time after time, our approach embraces the same contracting and construction techniques, the same relationships, and the same arguments. Yet we continue to be surprised when things go wrong.

Despite huge amounts of research and effort by construction professionals and project owners around the world, a disturbingly large percentage of projects still fail to complete on time or to budget, with 90 percent of megaprojects facing cost overruns, according to research from Oxford University. Whether in the public or private sector, the industry's reputation for predictable, consistent, and reliable delivery is uneven.

Numerous major publicly and privately funded projects in the transport, energy, and building sectors have grabbed media headlines and embarrassed public officials around the world as delivery and budget predictions have run off course.

Certainly the lessons are there, yet each new project starts with the same pronouncement: "This one will be different. It will be on time and on budget." But most of the time, that claim results in disappointment.

Two key questions emerge:

- What causes this insanity?
- What can be done to stop the insanity?

These are certainly not new questions, but it is time for the industry to consider a new perspective and find a better outcome.

What causes the insanity?

The root causes of project delay and cost overrun are well documented. Issues include poor project initiation, insufficient time spent on front-end design, the management of resource productivity rather than workflow productivity, and the use of contracts with inappropriate risk transfer.

But while these issues help us to understand why projects can go wrong, they do not explain why the sector consistently operates in the way it does. Understanding this behavior is more complex, and McKinsey research has identified two primary drivers.

First, research from McKinsey and industry experts shows that the number one cause of project overruns and delays is the poor procedures often adopted by project owners. To break from the cycle of repeated errors, these owners must take a stake in efforts to help drive the innovation that is vital to promoting change.

Of course, not all owners are equal. For many, major capital projects are a one-off, an exercise never to be repeated. To others, such projects are at the core of their business.

Some get too involved in the project, causing scope creep and costly and inappropriate rework. Many are not involved enough, causing delays due to slow decision making, design-review cycles, and last-minute, third-party interference.

Either way, when owners adopt poor delivery procedures no one wins. For the supply chain, any appetite for innovation quickly evaporates.

Second, this environment contributes to an important factor: the low underlying profitability of most companies involved in the delivery of large-scale capital projects. Most engineering, procurement, and construction (EPC) firms make 6 to 11 percent pretax margins and have relatively weak balance sheets. As such, they have no financial "shock absorber" to enable innovation.

On major projects, failure is usually very public and can lead some EPC firms to bankruptcy, a strong incentive to stick with the "tried and true."

By comparison, highly profitable companies in sectors such as high tech routinely invest to improve performance. Working in the privacy of their laboratories, they are free to experiment and fail with abandon.

What can be done to stop the insanity?

The best infrastructure-asset owners view their supply chain as a strategic partnership. They enter long-term, multi-project relationships when appropriate, and know enough to manage the critical matters over which they have control and influence. After that, they get out of the way.

This happens all too rarely. Yet, if the root cause of the insanity in large-scale capital projects is the ineffective interaction between owners and contractors, it would be logical to conclude that any intervention that enhances financial outcome should be embraced.

1. Relational contracting

There is clear evidence that better program and budget outcomes can be achieved by pooling delivery risk and sharing profits among the owner, engineer, and constructor.

Crucially, by procuring in this way financial returns for the engineer and EPC firm can be increased.

Effective relational contracts often also establish separate pools of money specifically to pilot new ideas across multiple team members. For example, Sutter Health in Northern California has a $7 billion capital plan and more than 255 active projects. Unreliable outcomes prompted the introduction of integrated forms of agreement, integrated project delivery, and lean construction.

As a result, Sutter delivered 15 capital projects with a value of $1.5 billion within schedule and budget.

2. Creative use of insurance

When owners require the general contractor to take sub-trade insurance, a large repayable premium is put at risk. This increased exposure typically prompts greater supply-chain oversight and engagement, consequently driving better performance.

Fewer claims against the insurance policy mean that a greater proportion of the premium can be returned to the general contractor to be taken as profit or distributed to the supply chain.

Some general contractors now expressly offer a performance bonus if the sub-trades work to avoid claims.

In response, insurance broker Aon has introduced subcontractor default insurance, a structure that better aligns the risks of the insurer with those of the general contractor. Under such agreements, the contractor carries a significant retention, which is most often funded via a retrospective agreement with the insurer or via a captive. The retention is exposed in the event of a claim. However, if there is no claim, the funded retention is returned to the general contractor and is often used to incentivize adoption of best practices within the organization.

According to the company, the use of these structures has significantly improved operational practices, particularly in supply-chain prequalification, procurement, and management. Aon is now working with insurance carriers to design similar retention structures to drive improvement in risk management and operational practices throughout all aspects of the construction process.

3. Project production management system

EPC firms are increasingly tempted to build large inventories of materials on site to reduce delays. However, this approach ties up capital in the mistaken belief that high productivity offsets any additional cost.

In reality, it does little to drive efficiency. Instead businesses focus disproportionately on issues such as measures of work progress and the variability of working capital rather than on the wider issues that affect delivery.

Using a true production-management system with lean construction tools enables decisions to be made collaboratively across the project. This shifts the focus on granular issues such as working capital and variability out of the system, speeding up execution and boosting profitability.

For example, Katerra has recently launched a global sourcing model to help the supply chain react to potential disruptions and market dynamics using predictive replenishment of supplies informed by Internet of Things–connected inventories.

Breaking from the insanity of repeating unreliable project-delivery practices is crucial if the sector is to raise productivity and deliver projects on time and to budget. Yet right now it is clear that we do not have the incentives or structures in place to drive this change.

But change is possible. The solutions highlighted here provide a clear route to fixing the often strained relationship between owners and the supply chain and to driving increased profitability across the sector.

These solutions provide a route toward a new environment in which owners and EPC businesses are willing to and financially capable of investing in innovative ideas that stop the insanity and transform major project delivery.

Photo courtesy of Kiewit

Out with the old: Why embracing new ideas can transform construction's poor delivery habits

Bruce Grewcock

Chairman and CEO,
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Construction lags behind other industries in its ability to manage complex projects, but two new approaches will help close the gap.

Cost overruns and schedule delays are inherent risks in large-scale projects across industries, but construction is particularly susceptible to these issues. A 2017 McKinsey Global Institute report on construction productivity found that nine out of ten infrastructure megaprojects face cost overruns that add, on average, 70 percent to the original budget. The research also indicated the industry does a poor job of completing projects on time, with 61 percent exceeding the original schedule.

The reasons behind these problems are as complicated as the types of projects being constructed today. Certainly, contractors are being asked to build highly complex projects, work in increasingly difficult environments, and operate with much higher levels of public scrutiny. However, old habits die hard, and the construction industry remains slow to embrace new ideas that might help it break out of this recurring problem—particularly when it comes to managing risk.

Owners and their legal advisers often focus on transferring project risk rather than identifying the most suitable party to carry specific elements of that risk, mitigating the risk or eliminating it altogether. Add to this the fact that we are now seeing the use of stricter contracts that push more and more risk onto builders. This practice can result in too little effort being put into identifying risks up front in the design phase, where, of course, many scheduling and budget problems can originate.

But construction's problems are not entirely at the feet of clients. Across the contracting community, stakeholders are still reluctant to embrace new ideas. Yet the reality is that in today's complex world of project delivery, the old-school contracting systems and approaches no longer work—and they haven't for some time. Two approaches—new contract models and technologies that support better decision making—can enable owners and contractors to make better decisions, reduce risk, and ultimately work more efficiently.

A new breed of collaboration contracts

A magnitude of problems can arise in complex infrastructure projects that follow a design-bid-build approach. Take Boston's Big Dig—one of the most public megaprojects that went sideways, taking a decade longer than expected to build as its budget ballooned from $2.6 billion to a jaw-dropping $14.8 billion (not including interest). Many factors, such as inflation and environmental review processes, contributed to the cost overruns and schedule delays, but one could argue that a project of such stature and complexity would have benefited from the greater involvement of contractors throughout the process—and particularly during the design phase.

To address this issue, a new breed of collaborative contracts such as the Construction Manager/General Contractor (CM/GC) structure—which shares many of the same characteristics and is often used interchangeably with the Construction Manager at Risk (CMAR) model—seeks to assess and deal with risk at the outset. Unlike a traditional design-bid-build contract, these models actively manage risk by engaging the contractor during the design phase to help spot problems before they happen, increasing the likelihood of bringing projects in on time and on budget.

Many construction projects are enjoying success with these models. At Kiewit, we have successfully delivered hundreds of projects over the past decade using these more flexible contract models when working across the transportation, building, and water and wastewater markets. Even with that documented success, clients are often unaware of or slow to embrace more flexible models with which they have no experience.

One example of success is the recent Fast Fix 8 bridge rehabilitation project in Nashville, Tennessee. Kiewit worked closely with the client and designer from the beginning to demolish and replace eight bridges within a series of 58-hour weekend windows. This early engagement led to the development of innovative solutions such as short-term road closures and round-the-clock work crews that ultimately brought the project in seven months ahead of schedule. Similarly, in Minnesota, use of the CM/GC model and early engagement of the contractor in the Highway 53 Relocation project, currently underway, has enabled the project team to reduce risk-related costs from $40 million to $6 million by the time the design was 90 percent complete. Identifying and anticipating risks prior to construction prevents unexpected cost increases which can blindside the client.

In the energy markets, the use of an Early Contractor Involvement (ECI) collaboration model featuring a pre-FEED and FEED (front-end engineering design) phase has achieved similar successes. In short, regardless of the sector, the earlier contractors are engaged, the better a project's risk profile for clients and everyone involved.

Technology and tools

The use of modern contract models is just one element in the journey toward greater risk awareness. Another solution to address cost and schedule overruns is literally at our fingertips: new technology and tools that track and organize data, enabling parties to make better business decisions, resulting in a positive impact on cost and schedule. For example, nearly a decade ago Kiewit recognized that the traditional way of running our business was not an option. We needed more connected, innovative technologies to support risk management and decision making—so we built them, investing heavily in the development and implementation of a new technology platform that would impact every aspect of our business.

Today, we're assigning new roles and deploying tools that measure data from estimating, scheduling, cost control, planning, safety, environmental, equipment management,

procurement, document control, and so much more. These fully integrated tools have helped us win bids, eliminate project losses, and make more data-driven decisions throughout the lifecycle of projects across our markets. Through greater visibility, our stakeholders, engineers, and project managers are empowered to manage risk more effectively, monitor progress, and communicate project success in real time.

The power of this technology can be seen, for example, at the Paradise Combined Cycle project in Kentucky, where we're integrating real-time data from six different mobile and web-based applications to assess progress from the estimating stage forward. By analyzing future resource requirements, we can make more informed decisions about work sequencing and scheduling.

We've seen the impact that these tools can have across our business and consequently on the industry as a whole. Our InEight business is helping to bring this suite of technology to market for the benefit of the wider industry—from our clients to joint-venture partners. With effective technology solutions, the entire industry can win through increased innovation, speed and accuracy.

To navigate risk and the root causes of cost and schedule overruns, owners, engineers, and builders have to evolve with the times. Modern solutions such as flexible, collaborative contract models and innovative technology are paving the way to overcome these common challenges.

The industry must embrace these new ideas. When we resist change, we overlook solutions and set our companies—our industry—up for failure. And that's a risk I'm sure none of us wants to take.

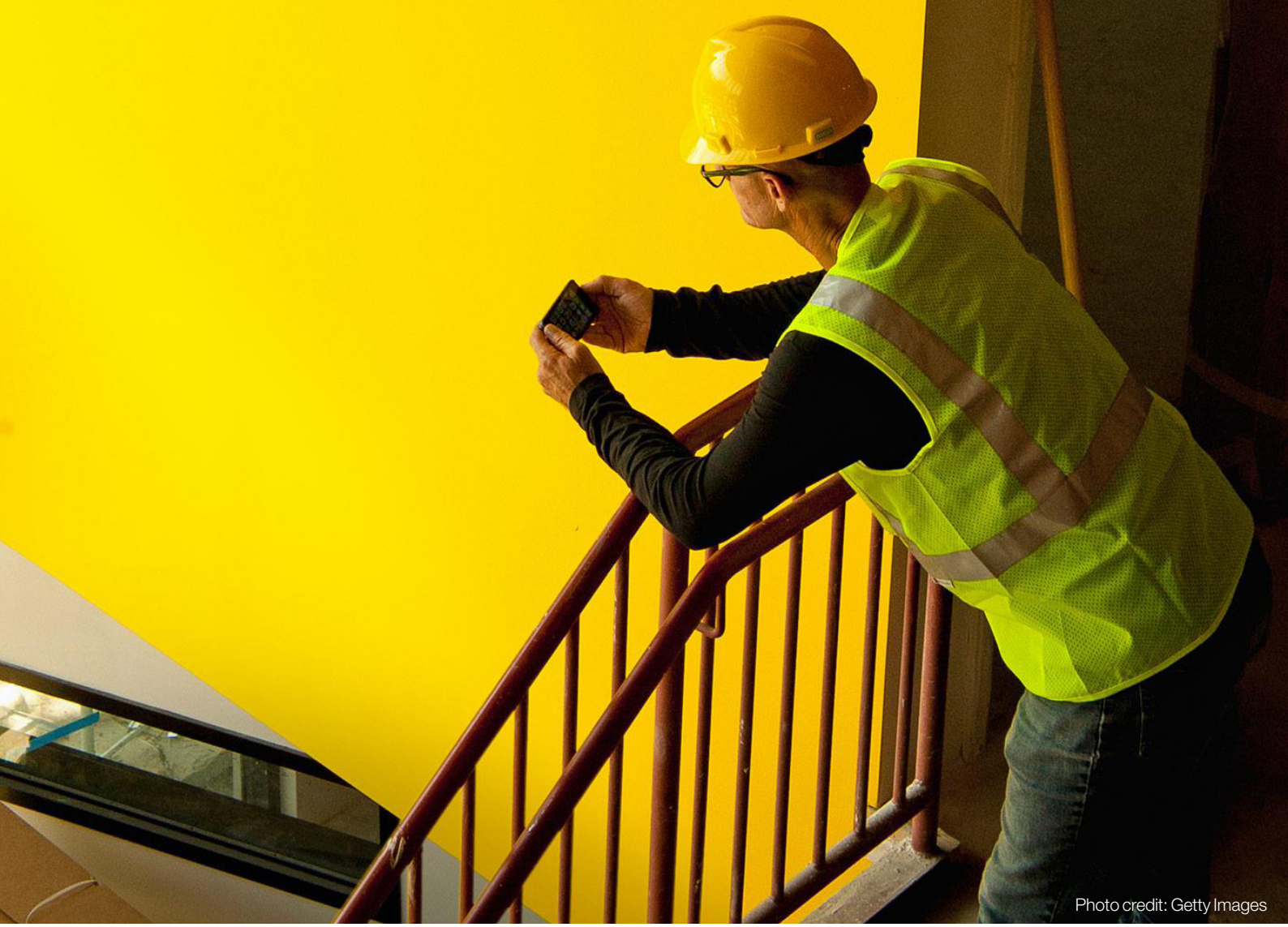

Photo credit: Getty Images

Improving construction productivity

McKinsey research finds seven levers can fix construction's productivity problem, but they require a new approach from all players. We heard from industry leaders about which barriers to change are most likely to fall first.

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The McKinsey Global Institute (MGI's) *Reinventing Construction* report, released in February 2017, found that the construction industry has an intractable productivity problem. While sectors such as retail and manufacturing have reinvented themselves, construction seems stuck in a time warp. Global labor-productivity growth in construction has averaged only 1 percent a year over the past two decades, compared with growth of 2.8 percent for the total world economy and 3.6 percent in manufacturing.

The report confirmed many reasons for this persistently poor performance, including stringent regulations and dependence on public-sector demand, informality and sometimes corruption, industry fragmentation, and mismatches in risk allocations and rewards. In addition, project owners reported that it can be hard to navigate the opaque construction marketplace—particularly when they do not frequently manage major projects. This struggle often results in subpar project management and execution, inadequate design processes, and underinvestment in skills development, R&D, and innovation.

Since February, we have discussed the findings with diverse stakeholders around the globe—in roundtables, our recent Global Infrastructure Initiative Summit, and more—and we have heard from nearly all that change is both needed and possible. There's a sense that the industry is on the verge of disruption, and industry players are actively working on new approaches. How organizations are preparing to deal with the disruption varies greatly—though most recognize that failure to adapt could result in being left behind. To cope with disruptive pressures, some have taken incremental approaches to adopting best practices by establishing small, discrete programs. Others have created transformational agendas designed to work within the current confines of the industry. Still others are making significant strategic bets to radically restructure the value chain or establish manufacturing-like systems of mass production. It is unclear which approach will win in a given market segment—but understanding the challenge and the opportunity to address it is a crucial first step.

The construction sector has much to do

To disrupt its own way of thinking, working, and building, the construction industry can learn from successes in other industries, as well as from pockets of excellence within subsectors of the construction industry and around the world. Change is underway, but many approaches that have been discussed for years have yet to be adopted at the scale needed to transform the industry.

Abundant gains are at stake. MGI's research found that if construction productivity were to catch up with that of the total economy—and it can—the sector's value added would increase by an estimated $1.6 trillion, adding about 2 percent to the global economy. Such a gain is equivalent to about half of the world's annual infrastructure need.

We identified seven ways that innovators are successfully addressing current market failures and improving productivity. With widespread adoption of all seven, we estimate that the sector's productivity could increase by up to 60 percent.

1. *Reshape regulation and raise transparency.* Too often, regulatory complexities hinder productivity. At one roundtable, a participant noted, "Rules and regulations are the scar tissue for past transgressions. Just like scar tissue, they eventually limit what you can do." Indeed, nontechnical risks, including political risks related to regulation and transparency, are often cited as proximate root causes behind poor outcomes, even more so than technical factors. Both government agencies and industrial companies can ensure robust nontechnical risk management programs are in place to help proactively manage nontechnical risks on their projects. Governments can help reshape regulatory environments by streamlining permitting and approvals processes, reducing informality and corruption, and encouraging transparency on cost and performance. Many governments also allocate grants for innovation and training.

   As project owners, government agencies can also help encourage innovation and new approaches by prescribing means and methods of delivery or requiring use of certain technologies.

2. *Rewire the contractual framework.* Many in the industry shared case studies demonstrating that when interests are aligned and aimed at well-defined outcomes, projects are more likely to meet schedule and cost targets. To align interests, the industry must move away from the hostile contracting environment that characterizes many construction projects to a system focused on collaboration and problem solving. For example, procurement can be based on best value and past performance rather than cost alone, and contracts can incorporate performance and alignment incentives. To move toward best practice, alternative contracting models such as integrated project delivery (IPD) help build long-term collaborative relationships.

   The issue of trust came up in many forums, and it will take time to build the level of trust needed to collaborate and transparently share data in a way needed for proper incentive structures. Yet owners were keen to start incorporating some aspects of IPD into their traditional models to increase focus on making the best choices for a project, encouraging innovation, and reducing variability. Managing those contracts will also require changes in behavior, attitudes, and skills.

   Many owners, particularly in the industrial space, have adopted contracting frameworks that aim to transfer financial risk to contractors under transactional lump-sum contracting frameworks. At their worst, these structures often provide incentives for structural failure in the multistakeholder collaboration process. Companies would be better served by considering the full spectrum of options from purely transactional contracting to purely relational contracting. This deliberation will go a long way to ensuring a collaborative working approach is established at project inception.

3. *Rethink design and engineering processes.* There is a major opportunity to improve productivity by institutionalizing value engineering into the design process and pushing for repeatable design elements. Only 50 percent of MGI Construction Productivity Survey respondents said their firms currently have a standard design library. In asset classes such as deepwater oil and gas for which standardization might not be the

panacea, the opportunity for parameter specification rather than individual company specifications is significant.

Nearly everyone we spoke with agreed that change will only be achieved if owners and contractors alike can shift mind-sets from custom scopes for each project to more standardization and repeatability. Building up libraries of optimized designs can support this undertaking.

4. *Improve procurement and supply-chain management.* The construction sector ranks in the lower range of sophistication in McKinsey's Global Purchasing Excellence Survey, suggesting ample room for improvement. A combination of best practices seen in other industries and innovative, digitally enabled approaches can improve reliability and predictability. Digitizing procurement and supply-chain workflows will enable more sophisticated logistics management and just-in-time delivery.

   More strategically, owners, contractors, and material suppliers are also exploring ways to learn from industries such as automotive and aerospace when it comes to building longer-term supplier and subcontractor relationships.

   In industrial companies, final investment decision (FID) is often a misnomer, as the decision tends to be a foregone conclusion given the incremental financial commitment that has already been made to procure long-lead-time stocks pre-FID. Supplier development programs that aim to reduce lead time through the application of lean supply techniques can help restore the integrity of FID and help owners avoid obsolescence issues.

5. *Improve on-site execution.* In our discussions, stakeholders voiced several challenges with on-site execution, including inconsistent use of best practices across all sites, projects, and staff, as well as difficulty finding and developing talented project managers. In addition, many struggled to identify and use hard data to baseline project (and project managers') performance rather than anecdotes about the difficulty of a project.

   To truly transform on-site execution, owners must implement change across all three aspects of a project: management systems, technical systems, and mind-sets. Four key approaches, though well known in the industry, have not been universally adopted. First, a rigorous planning process can help ensure activities are achieved on time and on budget. The use of integrated planning tools on a large-scale oil and gas project, for instance, achieved a 70 percent increase in the project's productivity. Second, companies should agree on key performance indicators (KPIs) and use them at regular performance meetings. It is critical to complement common KPIs with forward-looking metrics to identify, and subsequently reduce, variance. Third, project owners can improve project mobilization by ensuring all prework, such as approvals, is completed prior to starting on-site work. Fourth, careful planning and coordination of different disciplines on-site, along with the application of lean principles, can reduce waste and variability.

6. *Infuse digital technology, new materials, and advanced automation.* Construction lags significantly behind other sectors in its use of digital tools and is slow to adopt new materials, methods, and technology. Significant advances being deployed or prototyped today can transform the effectiveness and efficiency of construction in three areas: digital technologies, advanced materials, and construction automation. Digital technologies—from 5-D building information modeling to advanced analytics—have spread rapidly. Our survey revealed that more than 44 percent of respondents have adopted some type of digital technology, and planned adoption within the next three years is expected to reach 70 percent.

   In our discussions, stakeholders voiced several challenges in deriving more value from digital tools, such as maintaining accuracy in transitioning to virtual models: Today, frequently, there is no consistent "digital-twin" of a structure, but rather digital models are being printed for use with suppliers, who make changes and optimizations without feeding them back to the models, and there are substantial differences between as-built and plans that make optimizations in supply chains, work processes, and lifecycle management difficult to capture.

Read the biggest ideas that emerged from our roundtable discussions in Houston, London, Los Angeles, and Washington, DC.

   Given constrained R&D funds, industry players are using pilot programs to test innovations while minimizing risk. In a few leading cases, owners and contractors are pooling resources to overcome capital constraints. The Crossrail Innovate portal, where owners and contractors share ideas, is one example of effective cross-industry innovation.

   Technology alone will not address poor productivity. We heard nearly universally that a fundamental culture change is needed alongside adequate systems, processes, and buy-in from the field to embrace these solutions.

7. *Reskill the workforce.* Change cannot be achieved without investment in retooling a workforce that is undergoing major demographic shifts, from aging managers to increasing numbers of migrant laborers. Apprenticeship programs can train frontline workers in core skills that are currently underdeveloped and new technologies to help increase workforce stability by breaking seasonality and cyclicality.

   Collaboration is key; funders, educators, and public officials who run workforce-training programs should collaborate with contractors and trades to ensure skills programs match the industry's needs. Megaprojects should be seen as long-term catalysts to work with local workforce boards or nonprofits and develop regional training programs.

Beyond these seven ideas, parts of the industry could make a more radical change by moving toward a manufacturing-inspired mass-production system, in which the bulk of a construction

project is built from prefabricated standardized components off-site in a factory. Such a system would negate most of the market failures that are currently holding back productivity; the experience of firms that are shifting in this direction suggests that a productivity boost of five to ten times is possible.

While stakeholders have mixed views on the experience of precast building parts from the 1950s and 1960s in terms of cost and building quality, many are building up new capabilities today based on different, lighter-weight materials that are easier to ship and integrating more complex sustainability aspects into prefabricated components such as solar technology, rainwater harvesting, and high-quality building insulation.

The time to act is now

The pressure to act is rising. Demand is soaring. The scale of players and projects is increasing, making a more productive system more viable. The price of productivity-enhancing technology is falling, making it more accessible. There is increasing transparency in the market, and disruptive entrants are bringing a new wave of competition and increasing the urgency of digitization.

After decades of stasis, the industry appears to recognize the pressures bearing down on it, and these forces are motivating owners and contractors to change. As pioneering organizations transform, they will create best practices that can be emulated across the industry. Players that don't rethink their approaches may be left behind in what could be the world's next great productivity story.

We intend to continue to collect case studies and best practices from across the globe, and we hope to share them with the Global Infrastructure Initiative community. Please click here to share yours with us.

Photo courtesy of the Panama Canal Authority

Value plus efficiency: Where project delivery and execution matter most

Why understanding the client's view of value is critical for effective project outcomes.

Alan Krause

President,
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Whether you are a consultant, designer, contractor or operator, successful project delivery and execution is generally defined the same way; your goal is to complete projects on-time and on-budget, while also maximizing profit through efficient resource utilization.

But equally, success in the longer term is about maintaining satisfied and loyal clients. That means delivering value for their investment, thus ensuring that they come back to you with their next project.

Conventional wisdom would suggest that key to achieving client value is driving efficiency through project delivery and execution. And, of course, delivering this high value to the client should equate to higher fees to the consultant. But simply delivering a project on-time and within budget does not always result in the highest value for the client.

On the contrary, a relentless focus on efficiency during project delivery without reference to the actual desired outcome for the end user can significantly undermine the value delivered to the client.

The question for construction professionals, therefore, is how to translate this desire for efficient, cost effective project delivery into the all-important value for the client. How do we ensure that engineers really understand what drives value for the client and then continue to think out of the box beyond the project delivery phase.

Up-front investment is key, but real value can come later

Too often in project development and planning we inadequately assess the problem we need to solve. We commonly look at clients' problems in insulated technology-focused silos rather than from the wider, holistic, customer-focused perspective which could boost both the value and efficiency outcome.

The result is that clients are constantly reminded, quite correctly, that spending money and investing early in the planning stage has incrementally higher return on investment than spending in construction and operations. The message is that to deliver efficient project outcomes, up-front investment is essential on early planning, followed by careful monitoring of progress while making necessary corrections.

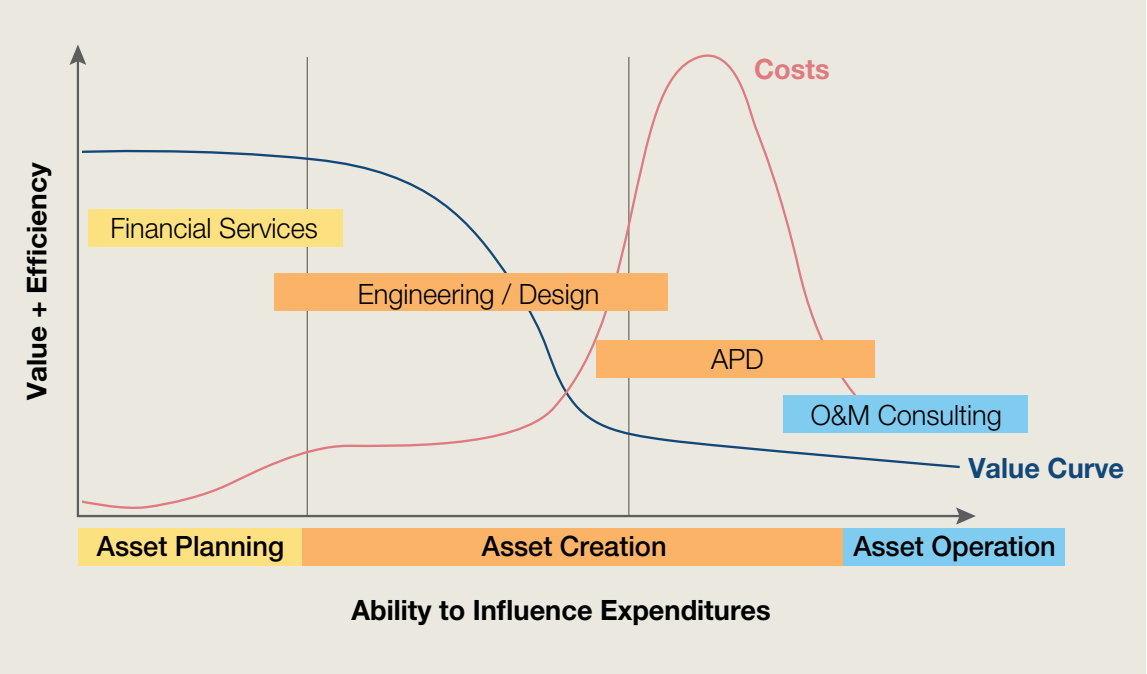
As such, the value proposition for clients is commonly defined simply by the success of the project delivery and execution process and leads to management consultants, engineers and planners arguing that the greatest value is always created in the early stages of development. This argument relies on the principle that planning is cheap when considered in the context of the entire project lifecycle, including construction and operations where investment capital is greatest.

However, if we assume a wider, holistic, customer-focused perspective, it is typically only after planning is complete that significant investment occurs. The project moves from concept to engineering design, asset creation actually starts, and real value begins to be

generated for the client. Unfortunately, under traditional delivery models, it is at this point that the ability to add value begins to diminish. As the project moves into construction and ultimately asset operation, the ability to bring further value is limited.

Exhibit

Asset/Project Life Cycle



MWH

The Exhibit above illustrates how the asset planning phase of a construction project presents the greatest opportunity to both generate value and influence expenditure. It also shows how the ability to create value falls away despite the actual rate of expenditure climbing rapidly throughout the asset creation phase.

Thus in reality, while we understand that value is very often created early in the lifecycle of a project, the greatest investment—and so the greatest potential for generating real client value—is always expended during the construction and long-term operation of the asset. And too often there is little consideration given to innovation or value in this phase.

This condition is emphasized in hard-bid contracts in which the client tenders to a prescribed specification and shifts risk to the contractor. Under these conditions there is little time, interest or ability for that contractor to embrace deviations from the design or contract terms

which may generate long-term value. In fact, the introduction of innovation will generally result in non-conforming bids that are ruled out by the client.

Innovation as a driver for true client value

So what is the solution? Project delivery and execution only drives value plus efficiency if the drive for innovation is religiously applied across the full spectrum of the project lifecycle. That means embracing a "blank sheet of paper" approach to identify not only the client's needs but also what actually constitutes value to them and for their customers.

This approach can present the client with an opportunity to reconsider their original scope and to rethink the longer-term implications or opportunities from the investment. Throughout such a process stakeholders should recognize that compromises are essential—however, these will be explicit rather than hidden, creating better opportunities for value across the lifecycle to be assessed by all.

Of course, the approach must start during the asset planning phase where costs are relatively low compared to later phases of construction and operations. The parameters around project delivery in this phase should be free-form and out-of-the-box with an emphasis on monetizing and commercializing innovation over the whole life of the asset.

It means investing in key knowledgeable and skilled staff such as program and project managers, project control specialists, schedulers, and technical leads. Among their primary strengths should be calculating earned value, developing accurate estimates to completion of a project, and assessing and quantifying risk exposure and how it ultimately impacts project delivery.

The process can be made more challenging by legacy assets, organizational blind spots, and the desire to maintain status quo, which can often constrain project definition and reduce the long-term value of a solution. The blind spots can even take the form of self-perpetuated myths about what might work and what might not.

But as the project moves into asset creation—from preliminary design to final design—the "blank sheet" project delivery and execution process can be redefined with more rigidity. Innovation is always encouraged but contained within the engineering "envelope" so that the engineering design is delivered to budget without spiraling out of scope. Most importantly, the whole supply chain must be engaged throughout to ensure efficient constructability.

Finally, as a project moves from asset creation to asset construction and operation, innovation shifts from engineering and design to delivery, which may include innovative approaches to supply chain management and offsite fabrication to create repeatable processes. These processes can improve quality and reduce flaws and introduce different approaches to risk management and risk transfer mechanisms including bonding, but must be discussed early in the project delivery.

Communication is crucial

Design engineers, contractors and system operators often communicate poorly. This early engagement of all stakeholders—internal and external—through a disciplined "gateway" process provides an opportunity for value to be constantly assessed and for customer expectations to be managed around what value will or will not be delivered. Too often the client is surprised about what value was intended at the end of the project.

Consultants, engineers, contractors, and operators commonly dwell exclusively on the need to boost efficiency in project delivery and execution when in fact, the client is really expecting value plus efficiency.

Achieving this combination is possible but made difficult if we do not first invest to understand precisely what the client is trying to achieve and then apply the sound project delivery and execution principles across the entire project lifecycle—all the time keeping efficiency plus value top of mind.

Photo credit: Getty Images

Taming scope creep to keep public sector projects on track

There's a monster that eats projects: scope creep. To keep the creep at bay, organizations need discipline, collaboration, and a relentless focus on real user needs.

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The tendency of projects to keep increasing in size and complexity—"scope creep"—is a threat whenever a bias toward optimism leads people to think that adding a bit more won't be too difficult or expensive. But in the public sector, with its large number of stakeholders pushing different agendas, the threat becomes much sharper.

A road-improvement or utility-upgrade program, for example, may involve a national transportation or energy ministry, a provincial or state-level agency, local and municipal authorities, specialized utility or land-use bodies, and an entire address book of other entities involved in the planning process. Each of those stakeholders will have an influence on project scope and funding decisions, and that can lead to lengthy planning processes and a tendency for project scope to grow over time.

Poor scope discipline can be exacerbated during the engineering phase. Without a clear understanding of the underlying business case for the project, engineering teams will attempt to find the best technical solution that addresses all the requirements identified by stakeholders. Nice-to-haves get mixed up with "must-haves," and cost, complexity, and delivery time continue to rise.

At one large US public-sector agency, poor scope discipline wasn't just adding extra cost. Some important projects were spending so long in planning, and becoming so expensive, that they were eventually deprioritized or abandoned. By aiming to address all the needs of stakeholders, the process ultimately addressed none of them.

Getting scope right

To address this challenge, the agency set about redesigning its project-delivery process from scratch. Its aim was a new way of working, one which kept the fundamental business case for every project in focus at all times, while also allowing stakeholders to have effective, fact-based conversations about the costs and benefits of different options and changes in scope.

To run the new process, the agency gave project managers a playbook—a collection of tools to improve project-scope management and quantify the costs and benefits of scope changes. Large projects would be divided into smaller chunks, for example, so the most urgent needs could be addressed first. Planners could then evaluate a range of options for each segment, including low–capital expenditure options or postponement of activity altogether if the need wasn't clear.

Crucially, the playbook addressed human factors as well as technical ones, providing guidance on how to plan and manage meetings with stakeholders, for example. Agency personnel were given training on the new methods, along with coaching and support as they applied them to real projects for the first time. As a result, the culture among managers changed from focusing on "solving an engineering problem" to "solving a transportation problem."

Keeping stakeholders aligned

One key objective of the new project-delivery process was improved stakeholder management. The aim was to get all stakeholders involved early, and ensure they all understood the end-user need, the range of options available to fulfil that need, and the costs and benefits of each option.

In the early stages of five new projects, for example, the agency led workshops whose 20+ participants included mayors, county personnel, and state and national officials. Together, they clarified the objectives of all five projects; in doing so, they identified engineering and other savings of $32 million. One relatively small project, for example, had been cancelled twice before, but the participants agreed to prioritize work at a few critical chokepoints. Focusing construction improvements on breaking through those bottlenecks cut costs by $10 million, and design and construction time by 30 percent—while achieving the same benefits.

From plan to delivery

With scope agreed, the playbook approach also brought new efficiency and rigor to subsequent planning and procurement activities—ensuring that project requirements were addressed in full and that parallel activities, like right-of-way purchases or utility relocation, were properly coordinated.

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Applying its new delivery approach in several pilot efforts has saved the agency between 15 to 20 percent in total project costs, through a combination of shorter development and construction schedules, scope control, and improved engineering. More important for the future, the playbook has given project managers new skills and tools that they can apply in subsequent projects, both new and ongoing.

Photo credit: Getty Images

Getting big mining projects right: Lessons from (and for) the industry

When major mining projects face trouble, leaders often find it hard to determine how or when to intervene. Six key strategies can help get projects back on track.

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More than 80 percent of mining construction projects come in late and over budget—and project leaders often find it hard to determine whether, when, or how to intervene. In our experience, their biggest regrets are waiting too long to act and not going far enough when they do. The sector's profit margins are already slim, and so is the room for error. Drawing on our global experience, we present the following six ways to help owners keep their projects on track and to intervene quickly and effectively when they don't.

1. Build a proven team. Companies often try to turn projects around by parachuting in individual experts. These individuals may be accomplished leaders, but they often work in silos when what's needed is an overall change in direction. At best, these individuals struggle to integrate their thinking as a team, and at worst they develop ineffectual plans after prolonged debate.

Instead, project owners should create teams of external and internal experts with turnaround experience, complementary skills, and a clear understanding of team missions. The team must operate as a unit, bringing integrated intelligence to focus on specific solutions for specific problems.

When a brownfield smelter project was bedeviled by cost overruns and delays, the company assembled a turnaround team of project veterans and younger professionals with deep analytical skills—all at the same location to ensure defined roles and easy information sharing. Equipped with project-control technology that tracked progress, costs, and schedules in real-time, the team established new communication channels and got the project back on track through quick identification and resolution of potential issues.

2. Create a comprehensive view. Distressed projects usually suffer from deep-rooted and interconnected issues ranging from contractual disputes to poor morale. Project owners often focus on one or two areas, convinced that fixing them will transform the project. But systemic problems need systemic solutions.

One way to develop a broad picture is to create a diagnostic framework that diagrams the organization of key construction activities, their supporting functions (for example, contracting and quality), and how they interact. This visualization of how issues are connected helps teams to better target where changes are needed and identify fixes likely to bring about the most significant benefits in the shortest time.

When a company's open-pit, copper-mine project was faltering, it developed a diagnostic framework that revealed a broad picture of interconnected problems and quantified costs and delays. It decided to address productivity issues rather than overhaul operations, sensibly choosing to focus on making the plant operational and learn for the future.

3. Address productivity. Productivity tends to deteriorate when problems accumulate and work becomes more complex. This decline often occurs near the end of a project, when tasks are congested and multiple trades are working in the same spaces. Improving productivity is thus a key lever in turning around a project and controlling costs.

For all projects, but particularly those in remote locations, every available work hour must be well used. Construction projects ought to resemble well-run factories, one trade finishing before the next one starts, with predictable schedules and no downtime. Disparate groups must collaboratively plan workflows, sequence tasks, facilitate access of materials and people to sites, and coordinate across disciplines to manage differently skilled personnel. But such planning rarely happens.

When one coal-mine project fell significantly behind schedule, the owner figured that catching up would require 1,000 additional people. However, a field-operations analysis found that construction crews were completing only half of the planned work—which meant hiring more people would probably only add costs without addressing core productivity problems. Instead, the company focused on improving productivity by overhauling its planning operations and installing mechanisms that would ensure crews implemented the plan correctly. The changes reduced the number of new workers needed, saved money, and improved outcomes.

4. Create an information infrastructure. One of the biggest challenges at today's mining sites is that despite technological advances, critical data such as cost and schedule metrics reside in separate systems that don't communicate with each other. Comprehensive dashboards that aggregate and analyze data can act as control towers that send crucial data to management and on-site teams. Readily accessible near work sites, these dashboards should contain up-to-date progress metrics, graphs, and drawings to drive better decisions.

But nothing replaces face-to-face conversations. While daily on-site meetings are often curtailed or eliminated when projects fall behind schedule, these meetings are vital to ensure trades, project managers, and superintendents all review daily work and address issues. To supplement daily meetings, a best-practice approach is to hold weekly meetings to cover progress and remaining problems and less frequent but regular meetings that address longer-term plans for future work.

5. Manage the transition from construction to operations. Mining companies tend to be fixated on meeting construction milestones and underestimate the effort of commissioning and start up. Often, those who build a facility focus on completing the work, while those who will operate it don't understand the design or what decisions were made along the way. It's a case of handing over the keys without an instruction manual—and it's a big reason why so many promising projects lurch toward disaster.

Transition planning must begin at the outset of every project and remain in the workflow until the end so the commissioning and operations teams learn about facilities as they are built. Construction and commissioning leaders must work closely to complete systems and subsystems safely. Contractors and operators need to collaborate to implement a structured system for testing each element.

While most teams agree with this approach in theory, execution often falters. Leadership should therefore establish a commissioning organization early to help plan for completion.

The owners of a new copper mine began building facilities without consulting the commissioning team, which eventually found that expensive equipment was going to be installed with no way to start it and nothing for it to do. In addition, critical tests were omitted and the people needed to begin operations weren't in place. Because of these misalignments, the mine opened on time but the plant didn't reach full production capacity until well after the intended start date.

6. Redefine success. When problems arise, large projects are often well into execution and contractors and managers are already invested in their decisions, practices, and actions. As a result, they encounter both momentum (ongoing activity) and inertia (resistance to change). To change the project's direction, an articulation of clear, ambitious, and achievable targets must come from the top of the company if employees are to believe in—and feel accountable for—reaching goals. Further, the revised plans must include a significant change-management program led by people skilled at driving cultural shifts.

One underground nickel-mining project, for example, seemed economically infeasible until the sponsor set a target expressed as an internal rate of return. The new goal energized the project team. Recovering ideas previously cast aside, the team identified an opportunity to double the rate of return.

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Executing complex and lengthy mining projects requires constant vigilance on the part of the project owner, from the first plans to the beginning of operations. Knowing when and how to intervene improves the likelihood of project success.

An expanded version of this article appears on McKinsey.com.

Photo courtesy of Aconex

Optimizing performance in infrastructure project delivery

To manage costs and schedules more effectively, a four-pronged strategy can identify and limit variability in process execution.

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"The bigger the project, the bigger the problems" is an apt description for infrastructure megaprojects, which have a history of failed delivery due to poor planning and execution. Their increasing size, complexity, and risk are frequently exacerbated by disconnected project teams, inefficient processes, and siloed data. The result is schedule delays, cost overruns, and quality issues: According to McKinsey research, large capital projects typically take 20 percent longer to finish and cost up to 80 percent more than expected.[1]

The global construction industry has attempted to respond to this recurring issue by introducing process innovation and standardization to boost consistency and quality of project delivery. With the benefit of historical data, projects are now more tightly scheduled to compress cycle times and contain costs. The critical path is tracked closely, to the point of process rigidity.

The premise behind these efforts is that more consistent process execution will result in improved project performance over time. In reality, execution for nearly all project processes still varies from plan, often significantly, resulting in still longer cycle times, higher costs, and lower quality.

Variability can occur in the execution of every process and needs to be carefully managed throughout the project lifecycle. For example, the duration of a structural drawing review with a planned turnaround of six days could vary from two to 12 days. If not managed properly, such variances could undermine project delivery.

To quantify the impact of variability, we analyzed 2,768 processes executed approximately 1.8 million times on global infrastructure projects using the Aconex platform. Our findings indicate the tremendous potential of strategies that can reduce variability.

Our analysis showed that actual process times vary by 12.5 days on average—nearly twice the planned process duration. Delays in each individual process can seriously affect overall project deadlines. Since many of these processes are predefined in the contract and baked into the schedule, this variability makes it difficult to meet delivery commitments. Understanding the root causes of variability is crucial to reducing process cycle times and improving delivery.

Four strategies to reduce variability

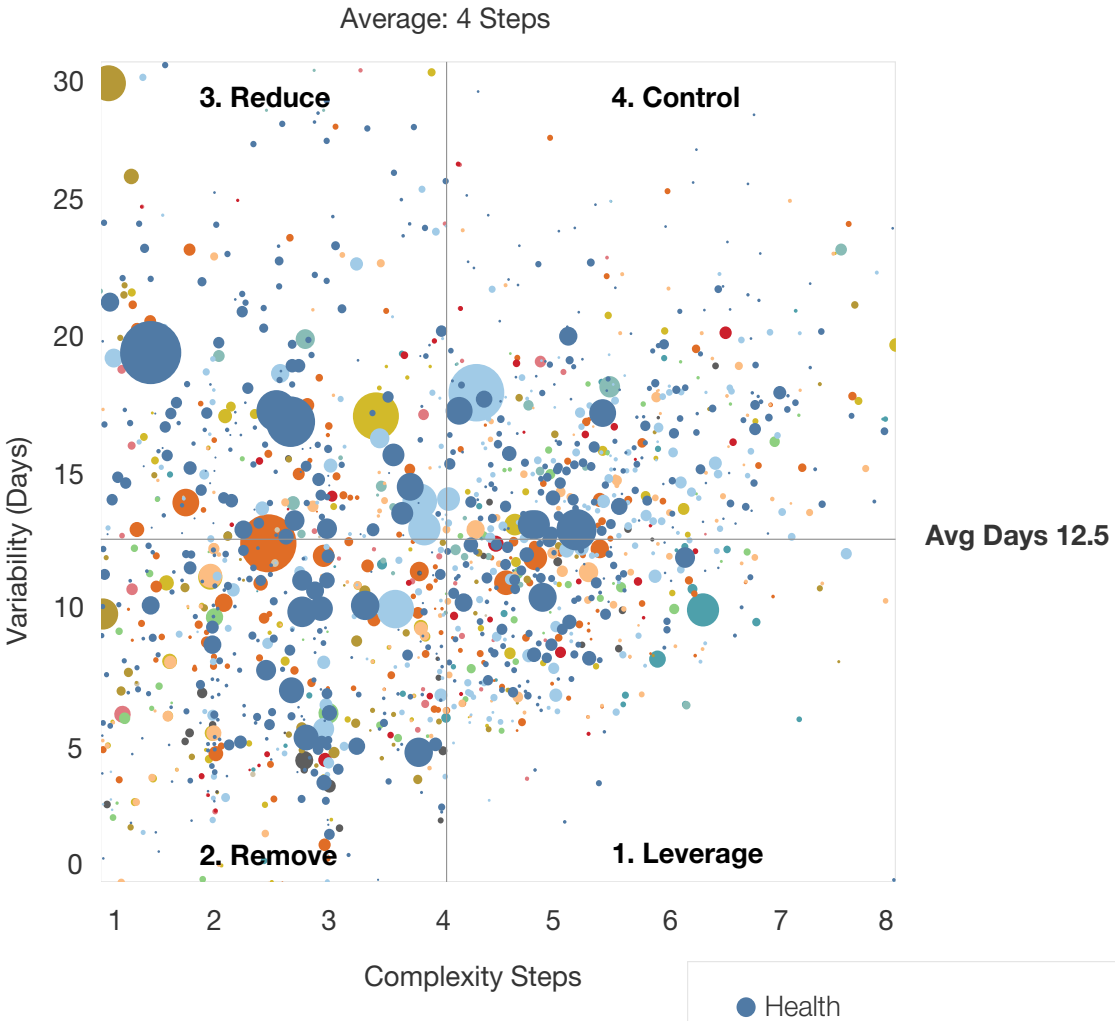
Complex processes are inherently prone to variability—and our analysis of data from real projects backs up this conclusion. Even simple processes such as interior design reviews show significant variability. We recommend a four-pronged approach to managing variability:

1. *Leverage.* When complex processes are standardized, they can be used as templates for other, more variable processes. However, complex processes differ from project to project. For example, on a hospital construction project, request for information (RFI) and site instruction processes are considerably less variable than they are on a power

1 "Imagining construction's digital future," McKinsey & Company, June 2016.

Exhibit 1

Process variability in large infrastructure projects



1. **Leverage –** Learn what is working from these processes and apply it more broadly for portflio-wide benefits.
2. **Remove –** Aim to eliminate variability in these simple processes.
3. **Reduce –** Minimize variability in these simple but highly variable processes.
4. **Control –** Expect variances in these complex processes but control them to avoid excessive time overruns.

The chart above illustrates processes executed on the Aconex platform for large infrastructure projects since 2013. The size of each circle represents the number of times the process has been executed. Variability is measured as the number of days required to complete the process, against baseline duration, and complexity is measured in the number of steps in the process.

engineering project. These differences should be factored into the adaptation of standardized process templates.

2. *Reduce.* The focus here is on processes where complexity is low—typically requiring just two to three steps—and yet variability is significantly high. An example would be structural and "as-built" documentation reviews on health projects, which we have seen vary by 16 to 19 days, on average. Clearly, delays in structural reviews can have an effect on construction. Yet by planning for handover early in the project, variability in as-built reviews can potentially be eliminated, with the output of these reviews feeding directly into asset operation and maintenance.

3. *Remove.* Many simple processes exhibit variability for no apparent reason. They go unnoticed and are often ignored because of their perceived minimal impact. But cumulatively, they can cause significant issues throughout the project. These processes, such as the simple reviews for facades or elevators in vertical construction projects, should be tackled before complex processes.

4. *Control.* Complex processes typically exhibit higher variability, but these should be tackled only after all the simpler processes have been addressed, as decreasing their variability may require considerable effort. Design reviews, contract administration, and change management, including variations, all fall into this category. These processes are intricate by nature because of contractual clauses, legal implications, risk impact, and financial considerations.

The next challenge is to reduce or remove variability in process execution. Although more commonly used in manufacturing, the DMAIC (define, measure, analyze, improve, and control) model can be a useful tool in the construction sector—provided a suitable project collaboration platform is in place to support the measurement of key process metrics such as duration, volume, and throughput.

Predictive analytic tools are also valuable in understanding the impact of performance against these metrics on project outcomes. Access to historical data and industry benchmarks makes measurement even more efficient, as it can form the basis for setting performance targets.

For infrastructure project managers, variability increases process cycle times and reduces quality, affecting schedules and budgets. Process execution should therefore be measured routinely during the project lifecycle and on practical completion.

If a specific process typically takes three days to complete, plus or minus one day, yet is trending toward more than six days, further analysis and corrective action can help reduce downstream schedule delays. Conversely, well-defined processes that are executed efficiently and consistently should be considered best practice and adopted for future projects.

Exhibit 2

Approach		Action
Define	Define the processes that you want to start tracking. Start with standardized processes because there is a pre-defined expectation of performance.	Process: • Request For information (RFI)
Measure	Set up measurement frameworks and start measuring the variability of the processes identified across multiple projects.	Process metrics: • RFI median = 7 days • RFI standard deviation = 8 days
Analyze	Analyze the variability data using standard root cause analysis tools to uncover reasons for the underlying variability.	• Fishbone analysis / cause & effect • Monte Carlo simulation & sensitivity analysis of RFIs to identify levers for reducing variability.
Improve	Improve the processes analyzed by making changes based on the analysis. For example, if variability is caused by differing contract types, consider standardizing contractual terms.	• Change RFI process based on analysis. • Change expected RFI close-out times on different projects / phases. • Measure change in turnaround times.
Control	Use a system to regularly and continuously monitor process performance across projects for at least a year. If deviations creep back into the processes, apply the model again.	• Run regular reports on RFI turn around times and volumes and the impact of changes.

The chart above describes the DMAIC approach to infrastructure projects, with a sample process.

Objective measurement of variability, coupled with close management of its longer-term effects, can drive successful delivery and continuous improvement across the project portfolio. With nearly $50 trillion in capital investment projected over the next 15 years, managing variability will be critical as the world builds new infrastructure to meet accelerating demand.[2]

2 *Fostering investment in infrastructure: Lessons learned from OECD Investment Policy Reviews*, OECD, January 2015

Photo credit: Gretchen Snyder

The rising advantage of public-private partnerships

In the United States, governments are increasingly turning to public-private partnerships (P3s) to implement public infrastructure works. Here's why the benefits of P3 project delivery, not just financing, will continue to shift the market in this direction.

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The World Economic Forum ranks US infrastructure behind that of most other comparable advanced nations such as Singapore, Germany, and the United Kingdom.[1] And it will get worse: from 2013 to 2020, cumulative US infrastructure needs are estimated to be nearly $3.5 trillion. Fiscal constraints limit how much governments can do on their own, and much has been written about how public-private partnerships (P3s) can be a viable option for filling this financing gap. But most overlook P3s' ability to address many of the nonfinancing pain points in infrastructure development and delivery.

A 2016 study by Syracuse University concluded through dozens of owner and concessionaire interviews for US-based projects that there is a significantly higher likelihood of meeting cost and schedule objectives under P3 models compared with traditional public sector project delivery where a project is owned, managed, and financed by government.[2] And yet when it comes to large, expensive public works projects, US elected officials have often struggled to develop and sustain the political will to partner with private investors on project delivery. The United States—which in 2015 accounted for roughly a quarter of nominal global GDP and 18 percent of global construction spending—accounted for just 9 percent of the world's nominal total costs of P3 infrastructure in the same time period.[3]

Elected officials' reasons for hesitance are varied but often boil down to misplaced perceptions about enabling a private entity to finance, construct, and manage the long-term operation of public assets. Those who are singularly focused on the finance and ownership debate, however, can miss other tangible benefits arising from a P3 delivery model. P3s can address some of the key structural and operational reasons why traditional large infrastructure project delivery so often fails.

The pain points that P3s can address

A strategic P3 approach can potentially mitigate the overruns and schedule delays that plague traditional infrastructure project delivery by clearly delineating governance, allocating shared risk, integrating resources, applying best practices, and establishing a lifecycle–long perspective of costs and accountability. In our experience, institutions face eight recurring challenges with their capital project portfolios, often unrelated to financing. P3s can potentially address each of these pain points to varying degrees depending on the project.

Unclear responsibilities. A lack of clarity about decision making and project governance often hinders effective project delivery. P3s address this challenge by requiring the owner to document and negotiate the performance standards, risk-allocation mechanisms, responsibilities, rewards, and penalties in a transparent and commercially realistic manner.

1 *The global competitiveness report 2016–2017*, World Economic Forum, 2016.
2 *Public-private partnerships: Benefits and opportunities for improvement within the United States*, Syracuse University, 2017.
3 Emilia Istrate and Robert Puentes, *Moving forward on public private partnerships: U.S. and international experience with PPP units*, Brookings-Rockefeller Project on State and Metropolitan Innovation, December 2011.

Poor alignment with strategy. Support can wane, or implementation can be delayed, when projects are not backed by a strategic and robust commitment. P3s, however, are thoroughly screened and vetted from a portfolio of potential investments with a high degree of public visibility, resulting in project commitments aligned with the strategy of the sponsor.

Insufficient optimization of project features. Sponsors are often constrained by existing standards, methodologies, and limited exposure to best practices under traditional approaches. But P3s encourage innovative problem solving by concessionaires during the bidding, design, construction, and long-term operational phases of the project.

Lack of an ownership mind-set in the delivery team. Traditional project delivery often results in poor alignment between the contractor and owner. In P3s, concessionaires adopt the perspective of owners, sponsors, or both because of the performance incentives and obligation to ultimately transfer assets in a state of good repair.

Lack of discipline in execution. Large infrastructure projects often suffer from competing objectives, time frames, and resource commitments. P3s achieve clarity of delivery and operational accountability by defining and aligning contractual obligations and integrating project delivery functions, such as design, procurement, and supply chain management.

Poor project controls. Multiple participants and different systems can result in competing versions of progress, differing views of the truth, wasted effort on reconciliation, and a strained relationship among participants. P3 concessionaires typically deploy project-wide systems and considerable resources to identify, manage, and mitigate deviations from plan, resulting in better contingency planning and faster response to changes.

Low initial cost mind-set. Traditional procurement approaches frequently award contracts to the lowest construction bid without a mechanism to consider the full cost of lifecycle operation and maintenance (O&M). P3s, by definition, focus on the long-term total cost of ownership, including O&M, at the time of contract award, thereby incentivizing the concessionaire to optimize not the minimum required capital, but the initial capital expenditure and ongoing operating expenditures that actually maximize value.

Poor resource optimization. Owners sometimes suffer from inadequate internal resources to ensure progress and daily decision making in a timely manner. P3s address this challenge by transferring delivery responsibility to highly capable and well-resourced teams incentivized to perform through the negotiated contract terms.

P3s consistently deliver better schedule and cost performance. Opinion or fact?

P3s will not tackle all of these challenges all the time—but a growing body of evidence supports the assertion that they can indeed solve many structural and operational problems that often cause budget and schedule overruns for large capital projects.

Based on published studies of the design, construction, and maintenance of social infrastructure projects, such as schools and clinics, in Europe, we find that the P3 approach

can reduce lifecycle cost up to 20 percent compared with the traditional approach. The UK Audit Office found a reduction of 70 percent of project budget overrun counts and 65 percent reduction in project schedule overruns deploying a P3 model.[4] An Australian study of 54 projects showed that only 1 percent went over budget; they also beat the schedule on average by 3 percent, while traditional approaches were on average 24 percent late.[5]

Like Australia, Canada boasts an impressive track record, with a mature P3 market that offers many lessons in best practices, including the establishment of an agency to oversee the growth and accountability of P3 opportunities to deliver infrastructure. A transparent procurement process and consistent approach drive Canada's success.

Success stories also exist in the United States. The largest availability payment–based social infrastructure project in US history, the George Deukmejian Courthouse in Long Beach, California, represents a successful P3 that accelerated replacement of an outdated and poorly functioning facility. The state of California awarded the project to a private consortium in a 35-year project agreement. The building was completed in 2013, on time and within budget, and it opened in May 2014.[6] For its part, the private consortium gained low-risk cash flow payments on the lease for the full duration, protected by the clause that the consortium can evict the state if availability payments are not made. Today, the state of California continues to occupy the award-winning courthouse, with dramatically improved facilities and amenities, room to expand, and a performance-based agreement with the concessionaire to ensure satisfactory long-term operations. Transportation success stories, such as the I-595 reversible managed lanes in Broward County Florida and the I-495 lanes in Virginia, have proven the ability of properly conceived and managed P3 projects to provide tangible transportation benefits.

Of course, the P3 approach isn't right for every project. In some cases, the advantages do not sufficiently offset the political, procurement, delivery, or revenue risks; value-for-money analyses clearly point out instances where this model is not applicable. Sophisticated financial investors place high hurdles on risk identification and mitigation before submitting proposals that satisfy their expected returns. And no matter the situation, a poorly executed contract can put a government in a risky position should the private partner fail to deliver.

However, public officials charged with shepherding the use of public funds are increasingly looking for better ways to deploy resources in the most efficient way possible. The P3 approache solves many root causes of poor project performance on

4 *PFI: Construction performance—Report by the comptroller and auditor general*, House of Commons, February 5, 2003; *Performance of PFI construction*, UK National Audit Office, October 2009.

5 Ibid. *Public-private partnerships*, Syracuse University, 2017; *Performance of PPPs and traditional procurement in Australia*, Allen Consulting Group and the University of Melbourne, November 30, 2007.

6 *Governor George Duekmejian Courthouse: Evaluation of cost-effectiveness*, California Administrative Office of the Courts, June 2014.

large capital investments. And indeed, the current market suggests strong momentum. As of January 2016, the Federal Highway Administration had identified that 35 states, the District of Columbia, and Puerto Rico have statutes that enable the use of various P3 approaches for the development of transportation infrastructure, to provide another arrow in the project delivery quiver.[7] And governments are validating this delivery approach through a documented portfolio of successful projects that offers many lessons about the circumstances, ingredients, and benefits of deploying a P3 approach that places project delivery excellence at the fore. We anticipate that as evidence of successful infrastructure P3s continues to mount, we'll see the pace of P3 deployment increasing in the US market.

7 Kevin Pula, *Public-private partnerships for transportation: Categorization and analysis of state statutes*, National Conference of State Legislatures, January 2016.

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