GLOBAL INFRASTRUCTURE INITIATIVE
By McKinsey & Company

Voices on Infrastructure

Major projects: Improving the odds of success

June 2018

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Introduction

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Welcome to the June issue of *Voices on Infrastructure*, a collection of insights on improving the odds of success for major projects.

Major projects—those defined as having a value of more than $1 billion—account for an increasing share of global construction spending. In 2014, major projects accounted for 21 percent of global construction spending, up from just 4 percent in 2005. However, major projects are especially challenging. They are multilayered, nonlinear, frequently in remote locations, and often highly regulated. As a result of these conditions, their productivity tends to suffer.

This issue of *Voices* explores how to buck this trend. We look across sectors at the key enablers of success for major projects and ask big questions: As major infrastructure needs continue shifting to developed markets, how can we connect these projects to much-needed private sector financing? What is the role of government in supporting and scaling notable major project outcomes?

We hear from CEOs on the bets they're placing for long-term success, such as pursuing new commercial strategies, prioritizing culture and talent development, and investing in digital innovation.

In addition, we explore critical levers for improving project delivery. As major projects continue to grow in number, size, and complexity, owners and contractors who wish to see long-term success must embrace more collaborative contractual structures, apply digital tools throughout the process, and define clear road maps for recovering distressed projects.

We hope the insights collected here help spur new ideas about major project innovation and scale best practices in your own organizations and geographies.

News from the Global Infrastructure Initiative

Tony Hansen

Director of the Global Infrastructure Initiative, McKinsey & Company

Welcome to our 12th edition of *Voices*, which compiles insights on improving the odds of success on major projects. Such projects, often referred to as megaprojects, are continuously buffeted by strong forces, including cost overruns, politics, regulations, and civic protests. Therefore, it is essential to structure major projects to be resilient to these inevitable stressors by clearly allocating risks and roles. We hope that the perspectives collected here will engage readers in some of the global best practices in developing and delivering similar projects.

In just four months, the 5th Global Infrastructure Initiative Summit, which takes place in London on October 29–31, is shaping up well. We are fully subscribed with a strong list of participants and a robust agenda that focuses on major project delivery and digital transformation. Additionally, we are delighted to announce our partners for the 2018 GII Summit: Bentley Systems, Clifford Chance, Spencer Stuart, Trimble, and our host partner, the UK Infrastructure and Projects Authority. The best ideas from the summit will be shared with the GII community in our December edition of *Voices*.

In May, we hosted a roundtable in Sydney on technology in transport, and in Dubai we hosted a roundtable on construction productivity in the digital era. We also cohosted a fascinating series of site visits in Moscow, exploring the city's major projects. These visits allowed us to better understand how the territory of Moscow has more than doubled in geographical size since 2011, based on the launch of the largest construction program in the history of modern Russia. On June 12, we ran our first of three scheduled roundtables on infrastructure investing. The Toronto roundtable focused on the implications of disruptive technologies for infrastructure investors. A recap of these events can be found by visiting globalinfrastructureinitiative.com.

Looking ahead, in September GII will be hosting a roundtable in Zurich on managing risk in a digitized infrastructure environment. With AECOM we will also cohost what promises to be a fascinating site visit to New York's supertall towers (defined as structures equal to or taller than 300 meters), focusing on the innovations that have enabled a boom in their construction since 2014. Please contact us at info@giiconnect.com if you would like to attend any of our forthcoming events or subscribe a colleague to *Voices*.

We hope you enjoy this edition of *Voices* and that it stimulates discussion of what needs to change to ensure a greater percentage of major projects are successful. Our September issue will address the important topic of resilience and future-proofing infrastructure in a fast-changing world. We look forward to sharing it with you, and we welcome your thoughts on *Voices* at any time.

The new Crossrail station at Custom House built off-site in Derbyshire

Smarter infrastructure: A solution to the productivity puzzle?

What elements lay the groundwork for “smart infrastructure,” and how can the public sector drive them?

Tony Meggs

Chief executive
UK Infrastructure and Projects Authority

Infrastructure has the ability to change lives. It helps us travel, communicate, and prosper. It powers our homes and businesses, supporting growth, boosting productivity, and improving our competitiveness. But is our infrastructure smart? Are we embracing the manifold opportunities presented by technology in how we plan, deliver, and operate our infrastructure systems and networks? Are we learning fast enough from innovation and best practice at home and internationally? Can we articulate clearly what we mean by smarter infrastructure and can we describe what high-performing infrastructure looks like?

The short answer to these questions is *"Not yet – but we do have a plan."*

Building on previous efforts, this past December the Infrastructure and Projects Authority (IPA) published an ambitious ten-year plan—*Transforming Infrastructure Performance (TIP)*—aimed at improving the delivery of economic and social infrastructure. The plan defines how the government will work with the construction industry to design, build, and operate our transport, energy networks, schools, prisons, hospitals, and other public works. By focusing on effectiveness rather than volume, we aim to close the construction productivity gap, representing an opportunity of £15 billion a year, and ensure our infrastructure serves our communities in both the near and long term. We believe this plan can serve as an example to other nations seeking to improve efficiency and return on the massive investment we make each year on infrastructure.

The state of infrastructure

Like many other developed nations, the United Kingdom has mature construction systems and networks. The public and private sectors together invest around £60 billion per year (2.5 to 3 percent of GDP—similar to spending levels in the United States, Canada, and Western Europe) in projects and programs across economic and social infrastructure. This is a huge commitment both in scale and ambition, but we need to invest not just to create but also to improve.

A significant share of this investment is devoted to major projects—Government's largest and most complex. Construction and infrastructure projects represent the largest growth area in the Government Major Projects Portfolio (GMPP); in 2016–17 alone, the government was engaged in 37 infrastructure and construction projects with a whole-life cost exceeding £222.5 billion—almost half of the GMPP total of £455.5 billion.[1]

And like other nations, our approach to infrastructure needs to evolve. This is not simply about delivering the same projects more efficiently; it's about delivering more ambitious social, economic, and environmental outcomes. It is about building skills, driving growth, supporting decarbonization, improving performance, and boosting productivity. It is about making smart infrastructure investments.

Of course, making these investments can be difficult. Construction as a sector is characterized by low profitability and productivity compared with other sectors. With low margins, it's not possible to compete to deliver cheaper solutions. This is where technology will play an increasingly crucial role—not only helping us build smarter new infrastructure but also improving how our current operational assets perform.

The elements of smarter infrastructure

TIP is intended to improve the way the United Kingdom's infrastructure is planned, procured, delivered, and operated, thus boosting national productivity. Other sectors have made similar transformative changes and have seen huge productivity leaps as a result. For example, auto manufacturing has made large investments in a

standard, automated manufacturing platform that can be used across vehicle types but that also enables user mass customization. Applied to infrastructure, such standardization could enable designs that are useful in a variety of contexts. For example, hospital and school buildings both need functional spaces, which require similar building pieces. If we could standardize these parts, we could use them time and again. Such innovations are not yet endemic, and technology is not used widely nor consistently.

To this end, rather than focusing on capital efficiency of individual projects, TIP encourages government departments and leaders in the industry to take a higher-level, portfolio view of projects, prioritizing the whole life of the asset as well as the performance of the entire system. By working together, they can better benchmark performance, choose the right projects, improve planning across sectors, support commercial relationships, and increase use of new technologies—ultimately leading to an increase in the sector's efficiency.

Before beginning this change program, we have to envision what harnessing smarter infrastructure will look like across the sector. We see opportunities in five specific areas.

Data

Data will drive effective decisions, prioritizing investment in schemes that meet the needs of users and maximize the wider socioeconomic and environmental outcomes for society. Benchmarks will measure whole-life costs, schedule, in-service performance, and the delivery of benefits.

Commercial models

These models will be collaborative, supporting innovation and boosting the competitiveness of UK supply chains to deliver safely and predictably. Procurement will focus on whole-life outcomes, and contracting strategies will deliver rapid payment to all levels of the supply chain.

Delivery

Delivery will be more productive, exploiting digital technology in design to enable smarter manufacturing and construction techniques that speed delivery, minimize disruption, and maximize efficiency, helping to build new skills in the economy.

Infrastructure assets

These assets will be intelligent, producing and using data to perform measurably better through their whole life, meeting exacting standards of sustainability, resilience, and availability.

Productivity and competitiveness

Both the infrastructure industry's and the wider economy's productivity and competitiveness will be boosted with investment delivering better services and driving growth. Both qualitative and quantitative measures would place UK infrastructure at the top of international rankings.

Making smarter strides

So how do we get there? With these goals in mind, the UK has made moves to improve its infrastructure. Certain projects and programs, leaning on innovation and best practice, are starting to make a difference. Some parts of our networks are already intelligent—for example, Highways England's smart motorways program—but overall we could be smarter.

The TIP program is under way, and helping us reach these goals in diverse ways.

Benchmarks

We are developing benchmarks that measure not just cost but also performance. With these benchmarks, we can gauge performance at a network level, in how it reduces congestion, and at the system level, in terms of how productive the economy is. Thus, these benchmarks enable us to look beyond just a single project and to map operational success.

International collaborations

We are collaborating internationally to ensure world-leading best practice helps to shape our strategies. We will be using these benchmarks to make investment decisions, inform procurement choices, and measure performance.

Innovative incentives

The construction industry has long been fragmented, underinvested in, and operated on wafer-thin margins. These are not the conditions that support innovation and enable productive growth. We are looking at new commercial models that incentivize industry to innovate, invest in more productive skills, such as digital and manufacturing, and deliver value in the long term.

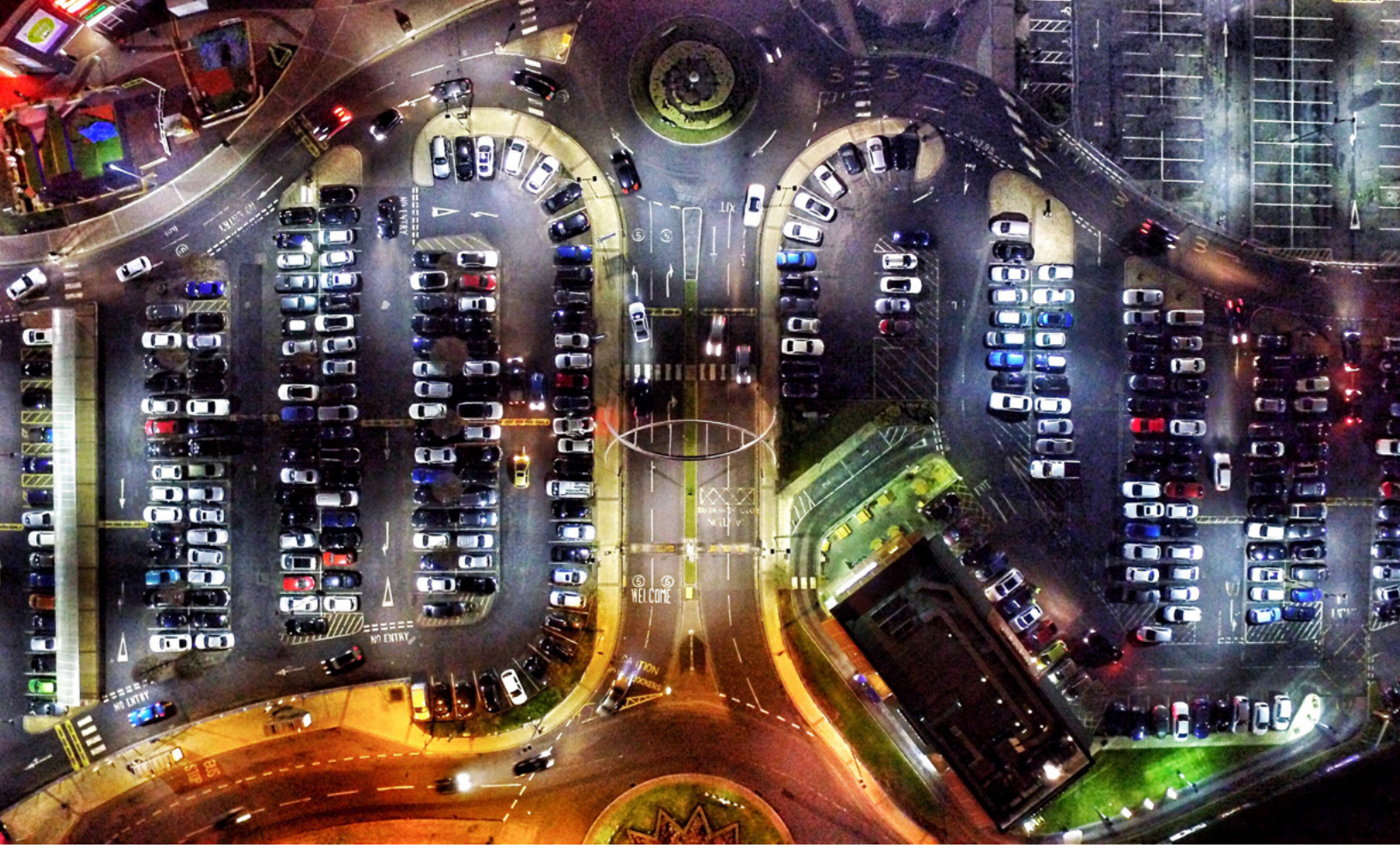
Government participation

As the largest client to the construction sector, government must also play a key role. How we specify, produce, and contract must create the right conditions for transformative change. Within the Autumn Budget 2017, the government announced that five of its departments—the Department for Transport, the Department of Health and Social Care, the Department for Education, the Ministry of Justice, and the Ministry of Defense—would adopt a presumption in favor of off-site construction by 2019. We believe bringing manufacturing processes off-site will drive huge productivity gains into construction. By working together, these departments, which are responsible for £20 billion per year in building and transportation projects, can drive scale and standardization in manufacturing. This collaboration also stimulates demand, because the collective, larger-sum budget is attractive to investors.

We must remember that TIP is a change program, not a magic switch, and that the IPA cannot deliver this alone. Only by continuing to work with innovation leaders across the public and private sectors will we be able to make the transformational change to smarter infrastructure and boost our nation's productivity. As we start on this journey, I will always welcome the input from innovators who can support us on this path to smarter infrastructure.

[1] *Annual report on major projects 2016–17*, Infrastructure and Projects Authority, July 18, 2017, gov.uk/IPA.

Voices highlights a range of perspectives by infrastructure and capital project leaders from across geographies and value chains. McKinsey & Company does not endorse the organizations who contribute to Voices or their views.



High stakes: How investors can manage risk in the new infrastructure environment

Technology is disrupting construction on multiple fronts. What are the consequences for infrastructure-investment managers?

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With technology transforming how we live and work, infrastructure investing is becoming more complicated. Self-driving cars, now undergoing on-road testing, could reduce the need for passenger railways or metros. As 3-D printing gains traction and manufacturing becomes distributed, ports may require fewer storage terminals. And electronic monitoring systems, which are already available on many roads, could render toll booths obsolete. For general partners raising investment funds or direct infrastructure investors, such as pension plans and sovereign-wealth funds, such changes could affect returns on the power, water, transportation, and telecom assets that were expected to provide predictable cash flows for many years.

In tandem with these shifts, technology is opening many important opportunities for investors by stimulating the need for infrastructure that wasn't on the radar a decade ago. The potential for drone deliveries, for example, could stimulate construction of docking stations, while the growth of electric vehicles (EVs) could ultimately make charging facilities as common as today's gas stations. What's more, technology is improving how construction gets done. New digital tools are emerging, including 3-D-mapping applications, virtual reality, and real-time performance dashboards. More companies are also using advanced analytics to improve performance and boost productivity, making it easier to stick to the original budget and time lines for capital projects.

These technologic shifts come at a time when many new investors are entering the infrastructure market, increasing competition for assets. The key to success involves understanding how technology is influencing the way assets are built and operated. It's also crucial to take a long-term view of technology's potential impact, since many infrastructure assets have a lifespan of 50 or more years. Any investment decisions made today will have lasting repercussions.

To help investors deal with disruption, we explored recent developments in the infrastructure-investment landscape, with a focus on technological advances that are changing both asset value and how assets are delivered.[1] Since there is still much uncertainty about how certain trends will play out, we also propose a structured approach for evaluating the risks and opportunities in specific asset classes as technology influences the market.

How is the infrastructure-investment landscape changing?

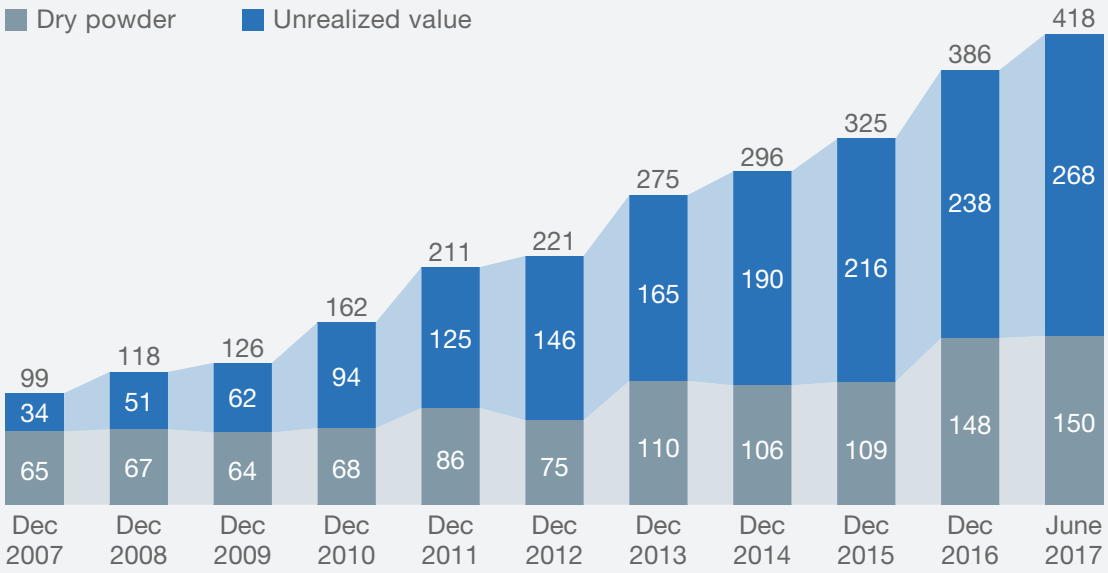
Infrastructure has been a rock of stability for investors, generating consistent inflation-indexed returns even during tough economic times. With construction soaring in both emerging markets and developed economies, the value of privately owned infrastructure assets—those not traded on public exchanges—rose from approximately $99 billion in 2007 to about $418 billion by June 2017 (Exhibit 1). Fundraising was remarkably fast and successful in 2017, with the average fund closing more rapidly than any year since 2009. Many funds also exceeded their target size by a large margin.

A more active role for investors

The surging infrastructure market has attracted new players who want to capture value, including private-equity managers that want to expand their fund offerings and pension-fund managers that formerly limited their investments to infrastructure funds. While the potential for good returns still exists, the increased competition for traditional brownfield infrastructure assets is leading to higher entry multiples and lower overall returns.

In this competitive market, infrastructure investors are broadening their focus. Traditionally, they concentrated on core assets—those that are highly regulated in terms of pricing and access, such as water utilities or power generation. Now, their investing targets increasingly include noncore assets, such as port operations or rolling stock,

Exhibit 1 **Privately owned infrastructure assets reached a value of about $418 billion by June 2017.**



McKinsey&Company | **Source:** Preqin

which may not be regulated. Investors look for noncore assets with higher barriers to entry, in the form of capital intensity, long contracts, and very robust client needs at specific physical-access points.

The management approach for core and noncore assets is a study in contrasts. With core assets, investors typically look at potential deals, estimate their returns, and fund those that promise to produce free-cash flow annually and appreciate over time—a traditional buy-and-hold approach. For noncore assets, investors have the potential for higher returns, but also more volatility. They can maximize return by taking an active role in strategy, operations, risk management, organization, and capital planning—an opportunity that they should seize but which will require new capabilities.

The growing impact of technology

In addition to the forces just discussed, many other factors are reshaping infrastructure investment, but technological advances are potentially the most important (see sidebar, "Beyond technology: Other shifts that could affect infrastructure investment"). Although it is difficult to single out the most important technologic shifts, we have identified several that may have a particularly dramatic impact. First, companies across industries are increasingly relying on big data and advanced analytics during the construction process, which

significantly decreases costs and timelines. Similar benefits come from automating manual tasks or using robots. Other technologic stand-outs include the development of fully autonomous vehicles, also called self-driving cars or level-five vehicles, which could alter demand for transportation-related assets, and the increased interest in distributed renewable energy, which could change the infrastructure needed to generate and store power.

But how will these changes, as well as other technologic advances, affect infrastructure investment? To get the most complete view, we looked at technology from two angles: its influence on asset value and its ability to improve the construction process.

How is technology changing asset value?

Many long-term investors, including the most experienced players, haven't yet determined how technologic advances will affect demand for infrastructure—both traditional assets like railway stations and innovative structures that weren't on the radar ten years ago, such as vertiports for drones. Here's what they need to know about both categories.

Rethinking traditional infrastructure assets

Even if investors have long received reliable returns from traditional infrastructure assets, technology could upend these expectations. Take parking garages. These structures have typically been a solid investment, but a combination of two trends could reduce their appeal: the growth of ridesharing

Beyond technology: Other shifts that could affect infrastructure investment

Technology isn't the only force bringing big changes to infrastructure. Investors must heed the following trends, which are altering both geographic demand patterns and the types of assets being built:

- **The growth of emerging markets.** Through 2030, emerging markets are expected to account for about 60 percent of demand for infrastructure.[1]
- **Urbanization.** McKinsey Global Institute estimates that large cities generate about 75 percent of global GDP today, and that figure could rise to 86 percent by 2030, increasing capital projects in these areas.
- **Increased brownfield investment in developed markets.** Many developed countries are now confronting major infrastructure issues after years of underinvestment and poor maintenance, prompting governments to increase funding.
- **Consumer preferences.** Members of the millennial generation often prefer to borrow assets rather than making a purchase. This trend could eventually influence infrastructure and construction trends if they seem disinclined to purchase homes.

[1] For more information, see "Bridging global infrastructure gaps," McKinsey Global Institute, June 2016.

services and advances in autonomous vehicles. If fully autonomous cars become a reality within the next 15 to 20 years, ridesharing services might rely on them. After dropping off their passengers, the cars would immediately leave to pick up their next fare, potentially reducing, or even eliminating, the need for parking in some areas.

But this potential trend doesn't mean that infrastructure investors should entirely write off parking garages—they just need to take a more nuanced view of the risks and opportunities. For instance, infrastructure investors have typically forecast demand for parking garages and other assets based on factors like population size, economic growth, local industrial activity, the number of available parking spaces, and a few other variables. Now they'll need to go much further than a rudimentary supply-and-demand analysis by examining additional variables, including those from new data sources, such as vehicle-tracking data that show the typical routes for local journeys or information about new government policies designed to support use of autonomous vehicles.

The new algorithms must also account for factors that could be disruptive over the long term, including the projected growth rate for self-driving cars or ride-sharing services on a location-by-location basis. Investors might also need to consider whether other technology trends could affect demand or revenues. For instance, the rise of parking apps could direct drivers to garages with capacity. And garage owners could potentially see a big jump in margins if they use software programs that allow them to predict demand and adjust prices accordingly.

After their analysis, investors might determine that demand for parking is so low that their garages should be repurposed or provide a broader set of services. As one example, garages that have off-curb parking could be transformed into service centers for e-commerce package delivery or turned into vertiports for delivery drones.

Evaluating new infrastructure assets

An even more difficult puzzle involves determining how technology trends will increase demand for—or affect the value of—unconventional assets. Consider charging stations for EVs. In an age where most cars use gas, demand for these facilities is relatively low. But EVs are becoming more popular in many major markets, with registration increasing 70 percent in China and 37 percent in the United States from 2015 to 2016.[2] Over the long term, farsighted private-management firms that invested early in charging stations could receive greater returns than those that focused on traditional infrastructure.

With so much uncertainty ahead, investment firms should consider a range of scenarios when estimating the value of unconventional assets. For instance, the market for renewable energy, including wind and solar power, is increasing. But there are still many uncertainties regarding the extent of their growth and the amount and type of infrastructure assets required to support them.

Consider one recent innovation related to renewables—the development of liquid-air storage. Using this technology, energy-storage plants use off-peak or excess energy to clean and chill air until it becomes liquid. It can be stored in large tanks until needed.[3] Such plants might be critical to the success of renewables like solar and wind power, which have supply peaks and troughs. These facilities are in their early stages, and it's not yet clear how popular they will become or how their infrastructure needs might change as the technology advances. Investors will need to manage these uncertainties by developing scenarios in which technology, market growth, and infrastructure requirements evolve in different ways.

How is technology changing the construction process?

In addition to affecting asset value, technology is also transforming basic construction processes. Construction-technology firms received $10 billion in funding from 2011 through early 2017, and they've used this capital to develop and scale a host of innovative technologies to assist with tasks ranging from off-site fabrication to portfolio management to yard inspection. Automation is streamlining multiple manual processes, such as productivity monitoring, just as it has in many other industries. And companies have improved decision making by applying advanced analytics to a much broader range of data than they did in the past. For instance, project leaders that want to determine the most efficient time, location, and strategy for land moving can now analyze geologic surveys, equipment-demand projections, and forecasts about when they'll meet project milestones.

When experimenting with new, untested tools, companies may sometimes be disappointed, since it is difficult to predict which ones will succeed. The cost outlays for each tool can be significant, and a bad choice could reduce the bottom line for years. What's essential for success is an expert view of digital tools and their potential—one that helps investors sort through the confusion and focus their investment in the most promising areas.

To develop this perspective, investment firms must replace speculation about a tool's potential with a fact-based analysis. They'll need to conduct extensive research that cuts through the hype regarding tools and realistically consider risks, such as the potential for hackers to seize control through cyberattacks. For companies that make the right investment decisions, the rewards can be great. McKinsey research shows that capital-project leaders that select a strong assortment of digital tools can reduce project costs by up to 45 percent. Even greater benefits may be possible when the tools are applied across all projects—and this will further widen the divide between digital adopters and those who stick with traditional processes.

Although all infrastructure projects face unique challenges, certain ideas and solutions offer universal benefits. For example, 5-D building information modeling (BIM)—the combination of 3-D physical models of buildings with cost, design, and scheduling data—is now sophisticated enough to be applied to most projects, and has proven results for improving execution. Digital twins—virtual models of a process, product, or service—allow teams to address problems before they escalate, identify opportunities to reduce costs or timeline, and conduct simulations that assist with planning. Drones and virtual-reality tools are fundamentally altering traditional inspection and surveying methods on construction sites. Other solutions, such as artificial intelligence or 3-D printing, could have radical implications if deployed at scale.

With so many tools on the market, some investors may be uncertain where to begin, especially if they have multiple problems that digital tools could potentially improve. In those cases, they should consider applying tools to three areas in which they have extensively demonstrated their value: risk management and project planning; field productivity; and collaboration and decision making.

How can infrastructure investors truly estimate the impact of technology?

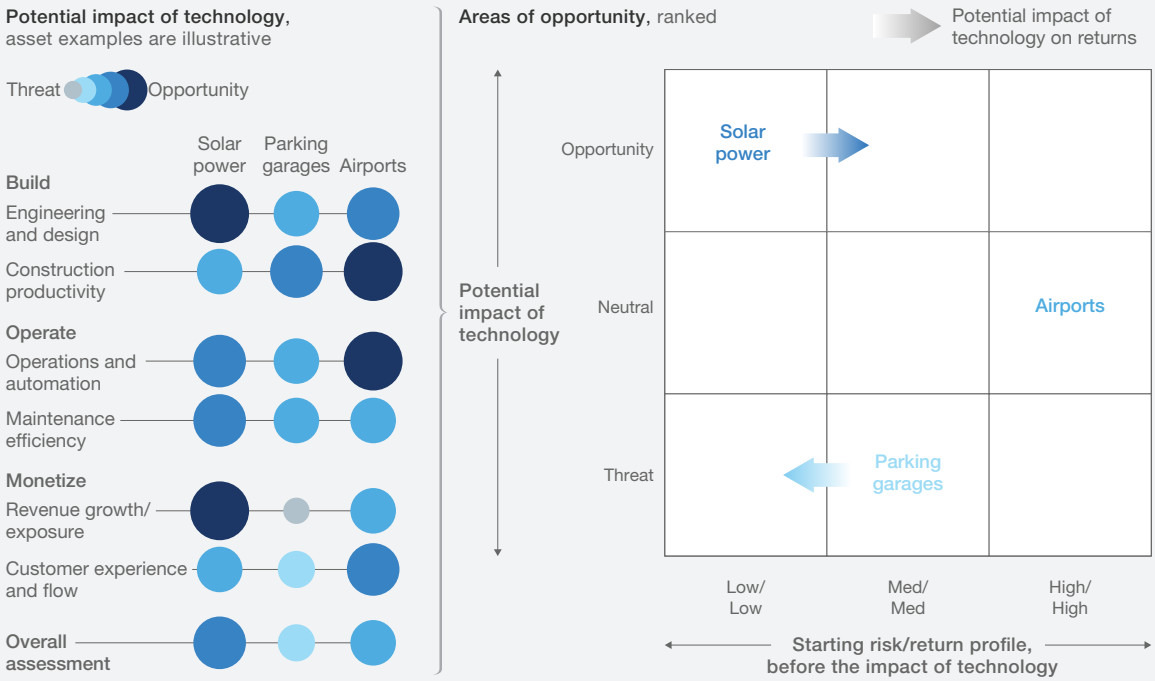
Many private-investment infrastructure firms have leaders whose backgrounds have given them relatively little exposure to technology, such as engineering or construction. To fill in their knowledge gaps, many are now working with an ecosystem of partners, including companies with specific technology expertise. When we analyzed how investors have capitalized on recent technology

trends thus far, a mixed picture emerged. While some have enhanced value creation, others are still in the early stages of exploring opportunities.

As investors venture forward, they should take a more structured approach when evaluating technology's impact to ensure that they don't overlook any risks or benefits. One possible framework, shown in a simplified example in Exhibit 2, examines two variables. First, it considers the original risk/return profile for each asset, or what investors could expect to achieve in the absence of technological advances, either inside or outside of construction. Next, the framework quantifies technology's potential impact on the building, operation, and monetization of assets. Within building, for instance, investors would have to determine if new technologies could cut costs and timelines for engineering and design, or if they could improve construction productivity. For monetization, investors would have to determine if new technologies, such as drones, could increase an asset's revenues by stimulating demand.

Using the framework, we classified solar-power assets as an important opportunity for multiple reasons. For instance, technologic improvements will create new opportunities for localized generation and distribution of energy, which could increase demand. Improvements in grid balancing—the ability to match energy supply with demand—are also increasing revenue growth for solar-power assets. By contrast, airports received a neutral rating. Although advanced analytics and greater

Exhibit 2 **Leaders should evaluate technology's impact on projects through a more structured approach.**



automation could support more efficient operations, it's not yet clear whether this will have a significant impact on revenue generation. We also determined that technology would have a negative impact on parking garages, because autonomous vehicles might decrease demand.

Since the framework only looks at technology issues, investors would have to assess the impact of other trends separately to determine the best path forward, and that could alter their perspective. Let's return to the parking-garage example. These assets might seem relatively unattractive if viewed solely through a technology lens, but investors might still see some potential if they consider how increased urbanization could stimulate demand.

For this framework to be valuable, leaders will have to increase their investment in data collection and analytics. Otherwise, they risk over- or underestimating technology's impact. Their investment will pay off, however, since investors with the best knowledge might become the "go to" groups for certain asset classes. Government agencies might be particularly interested in hearing their perspectives, which could increase the potential for public–private partnerships.

Of course, investment firms need to apply the framework using the most current data, and their perspective may change as new information becomes available. If they fail to make updates, they may overinvest in tools or systems that soon become outdated, just as the telecommunications industry did with 3G connectivity back in the early 2000s, when no one predicted that it would be eclipsed by later generations in fewer than 20 years.

Investors may be frustrated by the uncertainty ahead. But in selecting their investments, they must consider the inevitability that technology will alter the investment landscape. Likewise, they need to understand how technology is fundamentally changing every phase of construction, from planning through completion. A solid in-house view of digital change won't guarantee success, but it's a major step in the right direction. ■

[1] Most infrastructure investment comes from direct investors. We use the term "investors" to refer to both general partners and direct investors.

[2] Patrick Hertzke, Nicolai Müller, and Stephanie Schenk, "Dynamics in the global electric-vehicle market," July 2017, McKinsey.com.

[3] Katia Moskvitch, "Tesla's lithium ion battery tech gets a cool rival: Frozen liquid air," *Wired*, June 7, 2018, wired.com; Adam Vaughan, "Pioneering 'liquid air' project can help store excess electricity," *Guardian*, June 5, 2018, theguardian.com.

Rendering courtesy of Lifestyle Architecture

How to thrive in the engineering and construction sector:

A conversation with Steve Demetriou

In an era fraught with change, senior partner Robert Lewis and partner Jose Luis Blanco spoke with Jacobs chairman and CEO Steve Demetriou about how E&C companies can set themselves up for success.

Steve Demetriou

Chairman and CEO
Jacobs

McKinsey: *What are some of the biggest trends in the E&C industry today?*

Steve Demetriou: In the United States, everyone knows that our aging infrastructure is an issue. Everybody wants to improve it, especially our government—yet we are in a logjam while our government figures out how to unleash funding. We have a very partisan environment, and both parties know that we need to address the infrastructure spending gap, but they can't agree on how. Even so, we are seeing plenty of opportunity and view the eventual influx of federal funding as "upside."

Some of the most impactful trends are happening outside of Europe and the United States. There is a growing demand for water and energy as well as for new innovations around resilience to climate effects, resource recovery, and zero emissions. We are also seeing urban migration and the creation of megacities. Add on top of that security threats—not just physical terrorism but also, increasingly, a more insidious and pervasive variety of threats such as cyber warfare, data piracy, and phishing scams—and it's clear the landscape is changing.

Then we have the overlay of technology with the rise of digital, artificial intelligence, and automation technologies, which have us racing to upgrade our skill base and increase productivity. This shift is causing a major war on talent since we are all competing for a new breed of skilled workers. At the same time, we are navigating significant demographic differences in our workforce. For example, younger generations expect new and different benefits from their employers, including those related to health and wellness.

McKinsey: *In light of these trends, what must E&C companies do to be successful?*

Steve: First, companies need to shift from a "billable hours" mind-set to one focused on being a solutions provider, effectively becoming thought partners for clients rather than focusing on pushing services and submitting bids.

Second, the companies that leverage global capabilities and delivery platforms are going to be winners because most of the big opportunities out there are in translating proven experiences across the globe to deliver projects locally.

Third, portfolio management is going to be key because companies can't do everything. You have to articulate what you are going to focus on and what you're not—and then be relentless on staying true to that strategy. We launched our portfolio strategy in 2016, communicated it externally, and for the past 18 months have worked hard to deliver against it.

And finally, we need to take a different approach to culture and talent. We have been talking about this as an industry for years. But it starts by taking culture as seriously as we take our financial performance priorities.

McKinsey: *E&C players have faced a tradition of performance challenges—big write-offs, low total return to shareholders. What are you seeing successful companies doing that others are not?*

Steve: In the past, our industry seemed to believe that it was acceptable to deliver revenue growth without ensuring profitability, and that driving volume without the necessary delivery capabilities and disciplines was okay. I believe successful companies will be the ones who look at the bigger picture and change their mind-set about what matters. At Jacobs, that means focusing on higher returns, stronger cash flows, and better margins, and reinvesting back in our business.

The other outcome of chasing volume is write-offs. The industry has a long history of taking write-offs, which clearly erodes the collective bottom line. At Jacobs, we were right there with the rest,

with record high write-offs in 2015. So, we took the difficult steps required to correct course. We shut down offices. We restructured our cost base. We established new processes to deliver projects, and we installed IT systems to improve enterprise resource planning across our supply chain. We are now totally focused on execution excellence, and I am very pleased with the progress.

McKinsey: *A lot of E&C companies are undertaking significant M&A—including Jacobs, which recently acquired CH2M, a global engineering firm. What do you see as the keys to a successful merger?*

Steve: The E&C industry has struggled when it comes to merging big companies together. The keys to success as I see them are strategic fit, aligning cultures, and achieving costs and revenue synergies that are visible in the P&L statements.

The more a merger can be complementary, rather than overlapping, the better. Two-thirds of CH2M's business exactly complemented areas where Jacobs was not strong and satisfied many of the strategic priorities we set—like their leadership in environmental services, Tier-1 nuclear capabilities, and track record delivering water solutions.

Second, we looked at where acquisitions through the years failed, and one of the common themes was cultural fit. Failed mergers generally have one set of employees who become demoralized and frustrated. They feel like everything they had been working on for decades was torn up, stripping them of their legacy and identity and are at the mercy of a conquering acquirer and its culture. That is a recipe for failure. Positive culture fit and purposeful culture integration—where a new inspirational culture emerges—takes the conversation of "winners and losers" off the table.

Delivering cost synergies is another place where a lot of mergers fail. Companies have all these quoted synergies starting at the announcement date, and then in the next 12 to 18 months, you don't see them delivering improvements in operating profit or EBITDA. They seem too focused on claiming synergies with too little focus on controlling other cost segments. Before long, shareholders recognize the smoke-and-mirror tactics and take their investments elsewhere.

Finally, once we have delivered the cost improvements, our challenge will be to turn the company to the more exciting aspects of our combination—realizing profitable growth synergies that arise from the complementary capabilities of both legacy companies. This will help employees get excited about the future.

McKinsey: *You mentioned culture fit; why is culture so important in this industry and for Jacobs specifically?*

Steve: Culture is important for every industry, but one distinguishing characteristic of the E&C industry is that it's driven by people who are trained in engineering, science, and analytics—the backbone of the industry's success. But, in many cases, these individuals are underprepared for how to lead people and build a culture that engages and inspires.

I have always believed that in any company, including ours, the most important thing is to inspire employees. So many companies fail because they don't truly know their people, how to engage them, how to communicate, and ultimately, how to win hearts and minds. Employees want to feel a sense of belonging in the workplace and know that they're making a positive difference in their work. I have never met anybody who didn't respond to that. And even if you gain clear cultural benefits and success at the top levels of the company, real success is only going to occur when we have a full cascading of this culture down through the organization—meaning that all leaders behave the same way and demonstrate these same attributes.

As a starting point, it's helpful to have a mechanism to assess and measure culture. You need to have a baseline and benchmarks to diagnose strengths and weaknesses. In our case, we discovered a number of broken internal management practices that stood in the way of our aspirations of an accountable culture. Our cultural journey has involved identifying and addressing the elements that threaten a culture of accountability.

McKinsey: *What are your thoughts about the E&C industry's approach to the role of diversity and inclusion (D&I)? And how do you think about it at Jacobs?*

Steve: The data show that the E&C sector is behind the curve when it comes to D&I. To start, I choose to define D&I more broadly, as spanning cultures, genders, generations, geographies, politics, socioeconomics, and even business units—all of the differences that reflect the population. This broadens the view and supports both innovation and equitable leadership to ensure employees on every team feel equally included.

Of course, one of the major opportunities is gender diversity. We understand that our approach and mind-set has to be comprehensive. It's not enough for us to hire more women and call it a success. It's not acceptable if most female professionals are consigned to lower-level positions. We can only claim success when we have authentic equality across all levels of our organizations.

To make this real, we need to rewire our processes, people, and systems to effect and sustain the change. As an example, we have improved our talent management and development processes to ensure we're affording equal opportunities in training and development to position people for success and advancement. Along with this, we're improving mentoring and sponsorship efforts to more effectively support that whole system.

Successfully executing our strategy means that we accept our responsibility to lead on this front, to sustain an inclusive culture that consistently enables us to attract, develop, and retain a truly diverse population. And being visible starts with me, so I am now the executive sponsor for the Jacobs Women's Network, an employee network that strives to address the unique challenges women face in the E&C industry. They help me think differently about how we could change to improve our performance surrounding diversity and inclusion. I believe this will differentiate us and elevate our capacity to innovate, grow, and create higher shareholder value. ■

How financial products can attract infrastructure capital from institutional investors

By mitigating key risks of investing in major infrastructure projects in emerging markets, banks, governments, and international financial institutions can close the funding gap in developing Asia.

Sir Danny Alexander

Vice president and corporate secretary
Asian Infrastructure Investment Bank

Developing Asia is facing a serious infrastructure shortfall. Currently, the region invests about $881 billion in infrastructure annually. But to keep pace with growing populations and developed economies around the globe, the region will need to increase that investment to $1.7 trillion per year.[1] Currently, developing economies get 70 percent of infrastructure funding from government budgets, 20 percent from private players, and 10 percent from multilateral development banks (MDBs). This mix differs significantly from that of developed economies, where just 40 percent of infrastructure is funded by governments, with the private sector and MDBs contributing 55 and 5 percent, respectively.[2] Mobilizing private capital, then, represents an untapped opportunity to bridge the funding gap in developing Asia.

The Asian Infrastructure Investment Bank (AIIB), an international financial institution (IFI) comprising 86 member countries, was set up three years ago to help address this challenge. Mobilizing private capital is one of the AIIB's thematic areas of focus, in addition to building sustainable infrastructure and enhancing cross-border connectivity. To date, AIIB has provided more than $4.5 billion of financing for projects across Asia and beyond.

Looking to the future of major infrastructure projects in Asia, we see institutional investors as an important and largely untapped source of vast amounts of private sector funds. The Organisation for Economic Co-operation and Development (OECD) estimates that as of 2013, the funds managed by institutional investors in OECD countries amounted to nearly $100 trillion.[3] However, institutional investors' current allocation to emerging-market infrastructure assets is insignificant compared with the potential. Despite historically low interest rates and an unprecedented low yield in developed markets—a result of the post–global financial crisis environment—these investors still tend to see investments in developing markets as too risky. Such investors are accustomed to the low but certain return of investments such as government bonds. But in fact, infrastructure assets—even those in developing markets—should be appealing to these investors for a number of reasons. And a handful of financial products can help appeal to these critical investors and work toward solving the Asian investment gap.

The lure of infrastructure assets for institutional investors

Infrastructure assets have several characteristics that make them well-suited to institutional investors' needs.

First, infrastructure projects by nature are long-term investments: once an infrastructure project is completed, it lasts decades, providing a steady revenue stream. In this way, they match the long-dated exposure of pension payouts and insurance policies that have traditionally appealed to institutional investors.

Second, infrastructure investments tend to be less volatile because project revenues are defined by a long-term contract provided by the government, which sees infrastructure as critical to economic growth. Governments prioritize these revenue payments, which can provide institutional investors peace of mind.

Finally, in many cases, these contracts from governments offer returns that exceed inflation. As such, these contracts can be attractive to institutional investors who, for example, may need to count on a certain level of return to meet pension payments.

Barriers to investment

So why don't more institutional investors finance major infrastructure projects in emerging markets? Several factors currently limit institutional investors' and other private sector actors' investments in infrastructure across the globe.

These factors are compounded in emerging markets, which have a higher baseline level of risk than other economies.

The j-curve of infrastructure assets

The profit profile of infrastructure assets exhibits a "j-curve." This means that investors must endure several years of absorbing investment funds before operations begin and cash flows are generated. In emerging markets, because of project delays and other common complications, the j-curve is even deeper—meaning it takes more years of spending before investors start to see returns. This profile is not attractive for those needing to demonstrate a more immediate, if modest, return from the start of an investment.

Transactional costs

Large, complex infrastructure projects in emerging markets often require unique financing structures and processes to make the projects bankable. For instance, project leaders often have to bring in specialists from outside the country because of skills shortages, or they might need to jump through excess bureaucratic hurdles. These factors increase the costs of completing deals and can drive away investors with limited resources, time, and expertise, who may find it difficult to assess projects when standards are fragmented and markets undeveloped.

Lack of tradability

Investments in infrastructure assets are usually not easily tradable. Investment structures and revenue contracts are often bespoke and have a degree of opaqueness that could deter would-be investors. The lack of a ready secondary market to sell and refinance infrastructure investments can make it difficult for investors to shift their portfolios.

Monetization

By their very nature, infrastructure benefits can be harder to monetize or turn into cash flows for investors, as social returns are often greater than the benefits to individual paying users. For instance, a rural road network connecting villages may have greater economic benefits for the region than the sum of benefits to individual road users.

Financial products to mobilize private capital

Our research and discussions with investors and those seeking investment revealed the kinds of financial products that could correct for these barriers and the overall risk profile of emerging-market infrastructure projects, ultimately helping to direct more private capital to these investments across developing Asia.

Long-term loans and financing

Infrastructure assets need long, large loans—and providing the entirety of that amount can be daunting to any single investor. To mitigate this risk, IFIs can offer long-term loans for part of the project and allow private sector actors to make short-term investments for the remainder. These arrangements help investors overcome the j-curve because revenue streams from the infrastructure assets can be allocated to investors when they need returns while the IFIs wait out the investment.

Bundling assets

One way to decrease the overall risk of an infrastructure investment in this environment and therefore appeal to institutional investors is to securitize operational infrastructure assets through bundling. For example, infrastructure assets with different risk profiles could be bundled together so that the resulting financial asset carries less risk. Then institutional investors can invest in the bundle, which has an overall lower risk profile than some of its individual components.

Refinancing

As mentioned above, the lack of a secondary market or tradability for infrastructure assets can dissuade institutional investors from investing in the asset in the first place. IFIs can reduce the risk of investors' capital being tied up in infrastructure

by buying those assets off of investors—in other words, refinancing the infrastructure assets. Such refinancing frees up funds for investment in new brown or greenfield projects.

Public-private partnerships and guarantees

Public-private partnerships (PPPs) usually involve a nongovernment entity agreeing to finance, build, and operate an infrastructure asset, such as a power plant, in return for the government promising a stream of payments for a set amount of time. Offering guarantees or viability gap financing is another way to make investing in infrastructure assets more palatable. In this case, if the infrastructure provider—for instance, a rail operating company—was unable to make its loan repayments to lenders, the guarantor would pay out instead, thus ensuring the investors receive their returns.

Of course, these products alone won't solve Asia's financing challenges. However, these solutions are a requirement to overcoming obstacles to private capital investment in Asian infrastructure and are steps on the path to support the standardization that would allow infrastructure in Asia to emerge as an asset class.

Closing the infrastructure financing gap will require all players, including IFIs, national governments, and private sector specialists, to work together. It is only through acknowledging the need for collaboration and supporting the free flow of knowledge that we can hope to make a difference in meeting Asia's infrastructure requirements, thereby creating a better tomorrow for billions of people.

[1] *Meeting Asia's infrastructure needs*, Asian Development Bank, February 2017, adb.org.

[2] *Closing the financing gap: Infrastructure project bankability in Asia*, Marsh & McLennan Companies, 2017, marsh.com.

[3] "Institutional investors: The unfulfilled $100 trillion promise," The World Bank, June 18, 2015, worldbank.org.

Voices highlights a range of perspectives by infrastructure and capital project leaders from across geographies and value chains. McKinsey & Company does not endorse the organizations who contribute to Voices or their views.

Collaborative contracting: Making it happen

Full implementation of integrated project delivery (IPD) or other forms of alliance contracting isn't for everyone. But everyone can and should implement collaborative contracting practices today to improve project outcomes.

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Alliance contracting, also called integrated project delivery (IPD) in the United States—in which owners, contractors, and engineers are integrated into a single contract—has been heralded as the cure for what ails contracting. Indeed, many large firms in other industries, such as retail, healthcare, and financial services, have had great success with IPD.

But for many major construction projects around the world, full-blown IPD implementation may not be feasible. When a major project owner is bound by public procurement rules, for example, it is nearly impossible to award contracts to any party but the lowest bidder. In many other cases, corporate governance functions and the banks that finance projects restrict owners' ability to completely rewire contractual frameworks and limit their options for recourse when a contractor performs poorly.

Fortunately, this is not an all-or-nothing type of dilemma. There are many collaborative practices—some borrowed from the IPD playbook, others created as innovations in traditional contracting—that construction project owners and contractors can implement today to better align the objectives of all parties and boost productivity.

Collaborative contracting, like IPD, treats projects as mutual enterprises. But in the collaborative approach, parties work within the boundaries of traditional contracts—and their agreements rest on a fundamental belief that both owners and contractors want the best possible outcome and that each party brings unique strengths and capabilities to the table. Only if participants hold these beliefs—and implement a number of simple but important collaborative practices—can collaborative contracting lead to better project outcomes.

Each stage of a project life cycle presents multiple opportunities for collaborative practices, and in many cases these practices will have a meaningful impact on delivery times and costs and improve project performance on other metrics, such as safety and quality. To achieve these benefits, owners must be open to incorporate contractor input early in the process, select the right contractors, clearly articulate the potential incentives, and then work collaboratively with those contractors to develop, apply, and standardize best practices.

Where collaborative contracting falls on the IPD continuum

For the vast majority of construction project owners and contractors today, the default mode of interaction is adversarial. Both parties fiercely guard their perceived commercial interests and protect against inequitably allocated risks. This misalignment results in cost inflation, project delays, and shortcomings in quality, safety, and performance.

In IPD-style contracting, the parties seek to better align incentives by replacing individual transactional contracts—such as those between owners and prime contractors, or between a prime contractor and its subcontractors—with a single agreement signed by all parties. Collaborative contracting is also geared toward building better relationships, but it lies within the fold of traditional contracting. It encourages more cooperative relationships along a project's contracting life cycle, which of course is a central tenet of IPD, by offering incentives for various cooperative practices and behaviors. And it achieves this collaboration without completely overhauling the way the contractual relationships work.

The incentives to collaborate are based on four key principles:

- Everyone involved in a project—from the owner to the primary contractor to the subcontractors—should work to articulate a common vision, which involves agreement on target cost and schedule and defining what constitutes success for the project and for the individual companies involved.

- Contractors must have the expertise to steer a project toward efficient delivery and positive outcomes; owners must use this expertise to help encourage specific behaviors that lead to better project outcomes. This takes the form of early contractor involvement in site selection, design constructability reviews, locking a scope at the appropriate time, and long-lead procurement support.

- Contractors must be allowed to earn a reasonable return on the work, and both risk and reward should be shared.

- Performance management and production planning must be done collaboratively and at a systemic level.

To some degree, market forces have made this type of collaborative approach a sheer necessity in contracting. For example, on the Gulf Coast of the United States, modularization and prefabrication have led to the replacement of on-site, "stick-built" LNG liquefaction plants with plants built from multiple mid- and small-scale process units. This shift has already begun to dilute some of the power of the large construction contractors by forcing them to collaborate with the process-module fabricators, which are fast becoming significant players in this new model.

As always, such major changes to convention pose formidable challenges. Participants that cling to the old ways of maximizing their own profit will exacerbate these challenges. When major-project owners seize the opportunity to bring diverse interests together under the umbrella of collaborative contracts, on the other hand, they can drastically boost their chances of success.

Getting started

Common misconceptions notwithstanding, collaborative contracting is feasible in many different industries in both the private and public sectors. Based on our experience, we've identified a series of practices built on the four principles above that owners can initiate to spur a more collaborative approach.

- *Get contractor input early.* During the contracting-strategy phase of a project, when owners are deciding on scope and delivery models for each phase of the project—such as engineering, procurement, and construction (EPC) or engineering, procurement, and construction management (EPCm)—they would benefit from contractors' input on their capacity and appetite for financial risk. By soliciting contractor input early in the process, one large oil and gas company was able to design a smart contracting strategy for a technologically and geographically challenging project. It also reduced the duration of the tendering process and improved contract terms for both sides since the company already knew the capacity and risk appetites of its potential contractors.

- *Cocreate the scope and schedule.* Before releasing a request for proposal, contractors eager to help shape a project can work with owners to cocreate the scope and schedule. For example, when a European utility engaged in a structured process of consulting on the impact of schedule requirements on bid value with multiple contractors, it was able to reduce the cost of an EPC package for a gas-fired power plant by 27 percent compared with the first tender, run traditionally just a few years earlier.

- *Choose the right contractors.* When evaluating proposals, owners need to make sure that potential contractors have what it takes to get the job done well. A rigorous process begins with screening a full list of general contractors for basic attributes such as financial strength, compliance and safety, team experience, and

performance history. Then owners can assess proposals for strengths and weaknesses among the people and processes, including a judgment on whether a given contractor is committed to a better contracting model and is open to sharing cost and other information. When contracting for a portfolio of plant projects executed over an extended period, owners should ensure that contractors prioritize long-term relationships over short-term profits. For example, when a metals smelter in Europe needed to select three general contractors for a large project, the owner first conducted quick financial due diligence on all bidders to minimize the risk of selecting a weak contractor. The owner then designed a multifactor selection formula which rewarded contractors' experience on similar projects and their ability to assemble a strong team with experience working together.

- *Design win-win incentives.* During the tender process, owners should design—and discuss with potential contractors—a win-win incentive scheme that can be linked to and propel the value that's actually delivered. This scheme might align contractor incentives with key operational milestones, such as the production of the first salable product in the case of a manufacturing plant, or the first product "in tank" in the case of a refinery or chemical plant. The amount of the incentive should be commensurate with value added. For instance, a European utility building a conventional power plant found ways to offer its EPC contractor incentives for improved boiler efficiency, a key quality parameter that had enormous implications for the net present value of the project. The incentive resulted in the parties improving efficiency by nearly a percentage point, and the contractor received part of those savings.

- *Define processes that help capture value.* Unfortunately, even the best-designed incentives won't generate value by themselves. Throughout the project, owners must also create processes that encourage contractors to be aware of those incentives and take advantage of them. For example, owners can continuously find ways to encourage contractors to innovate and improve performance by implementing advanced production planning and lean processes. A North American utility-scale renewable energy developer used this approach to form an alliance of preferred contractors. These contractors shared ideas for shrinking costs, such as reducing manpower and improving designs, with the owner in return for a portion of any savings generated. Over the course of two years, the approach saved 3 to 5 percent per project.

In our experience, owners that follow these steps to creating more collaborative partnerships attract contractors that are better partners. Contractors that respond to concepts such as collaboration and win-win incentives are more likely to enter into partnerships with an open-minded approach. Of course, for collaborative contracting to work, contractors must be willing to provide clear visibility into project cost drivers, including subcontractor costs—not always a comfortable concept. Contractors must also agree to remain responsible for cost and productivity performance within its assigned scope. In return, owners must be willing to cover all of the contractor's reasonable costs if conditions outside the contractor's direct control affect project schedule and cost. When these conditions are met, we have seen significant and continuous improvement in project outcomes.

Conclusion

Owners may fear that collaborative contracting will be difficult and time consuming. But done

right, it should never be overwhelming. For a simple one-year project, piloting a collaborative contracting agreement shouldn't take more than 18 weeks from start to finish—it takes weeks, not months, for owners to identify key goals and months, not years, to reach them. As with most business transformations, however, while all parties will enjoy some of the benefits of partnership right away, it could take several months to achieve the full benefit.

Across all sectors and asset classes worldwide, we have seen some project owners reap the full benefits of collaborative contracting. But to facilitate the effective delivery of large and complex projects, and to break the construction productivity curse, more owners must embrace true collaboration in contracting.

Moving from an adversarial approach to a collaborative model means taking into account the many construction value drivers beyond up-front bid price. It also requires both owners and contractors to believe that they can indeed share and apply best practices, continuously learn, correct errors, and better plan to reduce management complexity and cost. But in the end, our experience suggests owners must lead the charge toward collaborative contracting, and that they will find willing partners with their most motivated contractors. ■

Digitizing an E&C Company

Larsen & Toubro CEO SN Subrahmanyan sheds light on how he's seen digital technologies, particularly sensors, evolve the major projects industry.

SN Subrahmanyan

Chief executive officer
Larsen & Toubro

As projects increase in size and complexity, digital technologies are becoming a critical tool in every stage of project delivery. Larsen & Toubro CEO and Managing Director SN Subrahmanyan sat down with McKinsey senior partner Subbu Narayanswamy to discuss how he has seen digital technologies improve productivity, decision-making, and talent attraction throughout the life cycle of a project—ultimately improving the infrastructure asset owner's experience.

McKinsey: *Across the engineering and construction industry, how are projects changing in size and complexity?*

SN Subrahmanyan: Across sectors, the size of projects is definitely going up. At L&T, for example, in the road sector we bid for projects above $120 million in value—and we are considering raising this threshold. In commercial buildings, we bid for projects above $75 million in value, and so on. Even with these standards in place, we're busy; L&T's construction business has about 850 projects running at any point in time, across geographies.

While complexity typically increases as project sizes go up, project complexity is not always related to size. India is going through a development phase, and the country has many ongoing complex projects of various sizes. At least 20 of our projects in India today are technically challenging and risky enough to keep anyone in the world up at night; for example, for the Mumbai Trans Harbour Link, we have to construct complex structures in deep water while preserving the environment.

It is an exciting, challenging phase. A lot of our time is spent on mobilizing resources, overcoming technical challenges, and ensuring customer satisfaction. But working to accommodate large, complex projects is better than not having projects to work on.

McKinsey: *Everybody in the global projects and construction industry is talking about digital technology. To what extent has L&T embraced digital solutions?*

SNS: Five or six years ago, digital solutions were much less prevalent in the construction space than they are today. From 2012 to 2017 when I oversaw L&T's construction division, which forms the bulk of the company, we set out on a mission to change that lack of digital solutions. Our digital team identified about 35,000 pieces of equipment in use across our sites globally, of which 15,000 were suitable for installing data-collection sensors. This effort spanned equipment such as transit mixers, cranes, motor graders, and wheel loaders.

We began connecting this equipment with Internet of Things (IoT) sensors. We integrated these sensors with an IoT platform, implemented a Mosaic platform to collect information and process and analyze data, and put that data on a real-time dashboard. In the past year and a half, we have connected about 6,000 pieces of equipment.

McKinsey: *Have you encountered any challenges throughout the process of implementing digital solutions?*

SNS: It's not been easy. Installing the sensors can be difficult because some of the equipment is more than a decade old, which means it was simply not designed with today's technology—and IoT—in mind. Older equipment was designed to transfer minimal data at relatively slow update rates, whereas IoT and big data hinge upon large volumes of data being transmitted in near real time.

Gateways—that is, centralized equipment that collects data from multiple sensors—were also a problem because construction sites are often remote, and Wi-Fi networks are not always available. We had to identify specific ways of transmitting the pulse to a gateway and find a

software partner to work with our platform, and all of this took time.

Still, we did start collecting data—initially just on fuel and spare parts consumption, as well as GPS locations. We were keen to collect data on productivity, such as how much weight an excavator or tower crane is lifting, but this proved difficult because these types of equipment see a lot of wear and tear.

Consider an excavator: every time the hand scoops up earth or rock, the sensors can get damaged. We eventually discovered a way to gauge weight by measuring the tension on the steel wire that does the lifting, and now we have a display in each operator's cabin that shows the lifted weight.

McKinsey: *What impact have you seen as a result of using digital tools on major projects, and what are some planned initiatives?*

SNS: Digital solutions improve transparency, bring objectivity into decision-making, and boost operational efficiency and productivity. We can work faster to complete projects ahead of schedule—which of course greatly benefits the infrastructure asset owner. Just by using digital technologies—such as sensors, building information modelling (BIM) software, and virtual-reality glasses—at our sites, we hope to increase productivity by 10 percent, which translates to significant annual savings. Our digital centers in Chennai and Mumbai receive a constant stream of objective data to support decision-making—such as how many workers have been deployed and where.

Another benefit has been improved talent attraction. Our expanding use of digital technology has helped us in recruiting the next generation of employees, who are excited about working in a digitally enabled construction atmosphere.

One upcoming effort is to map out our storehouses, which are dispersed across about 850 sites. We are hoping to catalog our ecosystem of vendors and tag all of our parts and materials so we know what is being stored and where. This visibility will allow us to allocate supplies among sites, manage inventory, and cut waste. We are also increasing our use of tools such as LiDAR and drones to map out our sites and measure materials.

McKinsey: *Did you receive any pushback to implementing digital solutions?*

SNS: When we began implementing technology, we received lots of questions: Why are you spending money on this? What is going to come out of it? We knew there were lot of drawbacks. Nobody had done it before, and in an ecosystem where the network or the Wi-Fi is not well-developed you don't get reliable data. While the business case wasn't clear from the start, we knew we had to move in this direction. So we made the decision to push forward, and we're starting to see the return on this investment.

Also, while our methods and processes have necessarily evolved over the years, being an 80-year-old company means that many in the organization are not in tune with the latest digitization efforts. As such, we've identified ambassadors of change in key positions who are charged with breaking us out of our tendency toward the familiar. These individuals have been hugely helpful in converting more believers in digital technologies and helping to fan the flame of support.

Today it's a pleasure seeing our digitization efforts working. Recently, I was at one of our major sites, the Motera stadium at Ahmedabad. When I asked about digital, at least 15 people took out their devices to show me what they were doing.

McKinsey: *Where do you see the future of digital E&C technologies going?*

SNS: We envision the use of digital solutions growing, of course, such as through the increased use of BIM on new projects. We anticipate greater use of virtual-reality tools and drones to monitor projects, and the development of new tools that integrate with location data to track progress. We will also see more analytics and digital procurement platforms being deployed. All of this technology will fundamentally change the way we work, in India and around the world.

Keeping up with training and education will be critical. It is simple: we have to adapt if we are to grow. ■

Realizing the full potential of BIM technology

By understanding the full suite of potential BIM benefits and hiring the right people to oversee project-wide implementation, engineering and construction players can better leverage this nearly ubiquitous tool in major projects.

Doug Brent

Vice president of technology innovation, Trimble

Dennis Sheldon

Associate professor and Director of the Digital Building Laboratory, Georgia Institute of Technology

Chris Shephard

Vice president of construction solutions, Trimble

Few would argue that building information modeling (BIM) has become a crucial tool in the modern construction industry. In fact, in some ways it represents the primary technology that has broken through the shell of the industry's aversion to new technologies, particularly during the conception phase of a new project as contractors, owners, and other players build and adjust their initial model.

However, while many would nod their heads in agreement that BIM is a valuable information system, in practice many players see it still as primarily a means to that conception phase—that is, to build a model. In fact, BIM can be used for so much more across the life of a project: to create shared documentation, facilitate connections between contractors, and build a library of information—a truly connected network that can streamline processes, prevent errors, and speed up work. Moreover, the data produced by BIM can be used to institute repeatable processes based on the cost, performance, and installation techniques of previous projects. Even tasks that are bespoke to a given project, such as earthmoving and steelwork, can benefit from a data-centric approach that can more accurately spell out desired outcomes based on previous experience.

The potential to improve productivity using a tool with which many players are already familiar is an opportunity too big to pass up; one McKinsey report 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."[1] By informing their projects with data early in the process, contractors can discover issues faster and solve those issues before they manifest into hard costs, accurately predict outcomes, and set aggressive schedules—resulting in better yield and reduced rework. The best way to get started on creating the requisite predictable, repeatable processes is to ensure that your company's culture and talent pool can support skilled workers' efforts to incorporate data into their workflows, from the back office to the field.

Moving toward a new interpretation and use case for BIM

BIM has been around for years, but only in the past decade has it evolved into almost universal use. According to McGraw-Hill Construction, in North America "the percentage of companies using BIM jumped from 28% in 2007, to 49% in 2009, and to 71% in 2012."[2] Today, many in the industry are quick to point out their use of BIM to visualize projects. However, visualization is actually a limited usage of BIM—one that fails to take advantage of its potential role as an information hub that can drive real efficiency gains throughout the life cycle of a project, including engineering, estimating, project planning, construction, and documentation. Our analysis indicates that contractors actually estimate the highest value of BIM can be realized in the latest stages of a project—but that's where adoption is currently lowest (see exhibit).

Indeed, in most cases architectural models are of limited value for the actual construction process because they lack the detail needed to build from. This is because in a typical major project, each trade partner will produce and maintain individual sets of drawings or models that do not include direct links to shared source data. Amid potentially thousands of change orders throughout the life of the project, for which construction can last years or even decades, each change can result in hundreds of adjustments by project stakeholders—which compound at later stages of a project.

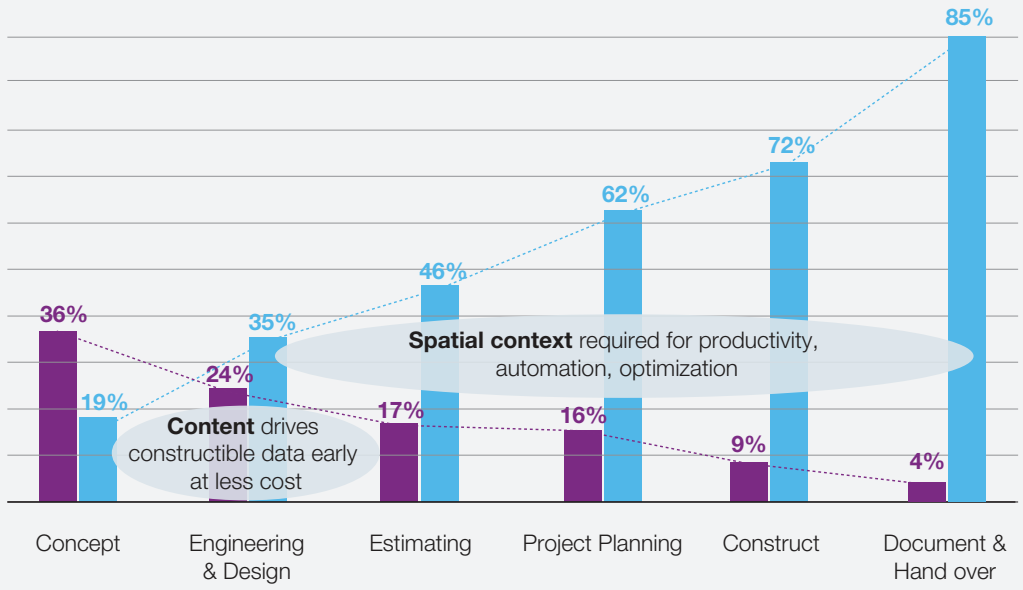
A better way is to include design detail in models that directly tie to a master to avoid potential costly errors or omissions. As such, a new interpretation of BIM views it as an information ecosystem that first

Exhibit

Productivity driven from constructibility

Constructible data will increase productivity, reduce waste and increase safety

% of contractor adoption of BIM by Phase
% of where contractors believe BIM provides ROI



Source: (1) 2014 McGraw-Hill Smart Market Report; The Business Value of BOM for Construction in Major Global Markets, (2) Internal Trimble market estimate

advises on constructability—that is, determining whether a design and its components are buildable—and then helps build that design in the most efficient way.[3]

The benefits of expanding the interpretation of BIM

Detailed constructible models facilitate more than just the design; they can drive the actual workflow of a project. Project scheduling, fabrication, and installation of components can all be driven by a shared and coordinated set of digital construction documentation. Cost estimating can be transformed from the manual process of counting the number of doors, the linear feet of steel, and the volumes of concrete to a streamlined and repeatable takeoff from the digital record. The complex relationship between mechanical, electrical, and plumbing systems is fully coordinated before installation starts, then precisely placed on-site to avoid clashes due to the smallest errors in execution by one of the trades. If contractors at later stages of the project can access an ever-evolving BIM information system that details not only the design but how that design has evolved—for example, changes to the constructed airflow that better take into account the pressure changes caused by wind—you can adapt later in the project, for example by making utility decisions based on what the airflow tells you about how quickly you can heat or cool the space.

Putting the data to work can also help mitigate the risks of one of the most unpredictable elements of a large infrastructure project: the people on the ground performing the work. If the BIM system can tell you where each bolt goes, you can feed that information to a robot on-site that can automatically drill the holes in exactly the right spots. With no interpretation required, there is much less room for error—and more ability to automate. In our experience, using precision instruments in the field to lay out foundations and floor plans can cut layout times by 50 percent or more over using manpower alone.

Major projects tend to involve a very large number of stakeholders—contractors, subcontractors, government agencies, etc. In addition to better aligning the workflows and decision-making of each, centralizing communications also makes it easier to trace decisions and changes—a huge benefit in today's construction landscape, where the threat of litigation can stymie fast, confident action.

Finally, in recent years we've seen a rise in availability of pre-existing content that project stakeholders can draw from—everything from the faucets and furniture an architect uses to render an interior space to the chillers, ducts, and fans the mechanical team uses behind the scenes. Major projects tend to be undertaken with an approach of reinventing the wheel; we've never built this airport before, so we need to start from scratch. In reality, a more robust use of BIM can help build a digital content library across projects. Access to good content saves design time, but also improves understanding of the expected performance of the systems and how various components will work together to meet the requirements of the occupants.

Moving toward full adoption of BIM

To realize the full benefits of BIM, major project owners, contractors, and other industry players need to prepare their organizations for both cultural and operational shifts that put data in the center of all they do. Such shifts will likely require hiring new talent at the highest levels of the organization as well as on the front lines. While there are many others, major-project players that are just starting the process of getting the most out of BIM should focus on three important considerations:

1. Create a top-down culture for data-centric workflows

Businesses that want to change their ways are putting people in influential positions to help create a data-centric culture. For example, instituting a role such as chief data officer makes data a business imperative and can help facilitate a culture shift by demonstrating investment at the highest levels. A chief data officer also has the knowledge and the authority to affect real changes that cut across functions in the business and allow various groups and systems to gather and share data.

2. Trust and embrace results of data-driven practice

It's a good sign that over the past decade, many contractors have added roles such as virtual design and construction (VDC) managers, adding BIM expertise to support their key projects on a broad range of construction tasks. In practice, though, simply having a VDC manager is not enough. VDC managers often struggle with job-satisfaction because project teams are resistant to the potential of data-driven practices to fundamentally transform their workflows, rather than simply augment the status quo. Executives can navigate this challenge by working with their project teams to help them embrace the idea that a major change is warranted. By testing data-driven practices and demonstrating meaningful improvements in predictability and breakout productivity gains, executives can win over skeptics and position their VDC managers to succeed.

3. Push the data into the field

The value of constructible data and models is not limited to virtual construction – it is capable of directly automating physical construction as well. The same data and models are fully capable of directly controlling robotic instruments for on-site placement of structural construction components and interior layout, as well as driving computer numerical control (CNC) machines for off-site fabrication of construction components. Leaders should leverage "blue-collar BIM," in which data models are taken out to the field and applied to fabrication, assembly, and location-based scheduling of labor and equipment to ensure assets are available exactly when and where they are needed.

Conclusion

Expanding our understanding of BIM as a true information system is an important step in better embracing technology in major projects. Improving productivity in major projects requires evaluation and scrutiny across the entire supply chain—not just the discrete links of the chain. The owners and builders embracing the idea of repeatable processes are seeing the greatest improvements today and positioning themselves for the greatest returns tomorrow. ■

[1] Filipe Barbosa, Jan Mischke, and Matthew Parsons, "Improving construction productivity," July 2017, McKinsey.com.

[2] "The business value of BIM in North America: Multi-year trend analysis and user ratings (2007–2012)," McGraw Hill Construction, 2012, bimforum.org.

[3] For more on building a connected data environment, see Greg Bentley, "Going digital to advance infrastructure delivery: The open information project," Voices on Infrastructure, March 2018, McKinsey.com.

Voices highlights a range of perspectives by infrastructure and capital project leaders from across geographies and value chains. McKinsey & Company does not endorse the organizations who contribute to Voices or their views.

Leading the world's largest capital projects: Where science meets art

Through history, from the Great Wall of China to today's transport and energy infrastructure, major projects have set themselves apart—but what are the keys to success with leading the very largest projects?

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The impact of major projects—those with values of over $1 billion—is immense. Their sheer scale sets them apart. Today's large capital projects have an impact beyond the organizations engaged in running them; they can also influence wider industry dynamics, the regulatory landscape, and even geopolitical relations. Significantly, as a project's size rises, its complexity in terms of strategy, design, financing, procurement and, ultimately, project execution, skyrockets. Inevitably, such projects are not without complications: on average, they are delivered one year behind schedule, and run 30 percent over budget. If this trend continues, $5 trillion in value will be destroyed in the projects currently announced around the world.

The majority of research into failure in large capital projects concentrates on flaws in project management processes, standards, systems, tools, and technical mastery—the "science" of project management. While these topics are important, we find that insufficient attention is paid to the "soft" organizational and leadership elements of project delivery: we refer to these as the "art of project leadership." Today's successful major project leaders are perhaps defined by their ability to master a combination of practical judgment, political ability, and wisdom—in addition to their thorough grasp of technicalities, core project management systems, and processes.

Our report, *The art of project leadership: Delivering the world's largest projects*, focuses on the largest and most complex of capital projects, with budgets over US $5 billion, and timeframes exceeding five years. Such characteristics bring unique complexities associated with project scale: multiple complex interfaces with stakeholders such as local communities and government bodies, new regulatory and environmental requirements, and often unique technological challenges.

Our research set out to answer two fundamental questions: 1) Why do such projects continue to fall short of expectations despite so much experience, learning, discussion, and analysis? 2) What are the unique success factors deployed by those who have managed to avoid significant time and cost deviations? We asked experts in ultra-large project delivery for their insights; in-depth interviews with 27 practitioners tapped into over 500 years of collective project delivery experience.

We found that leaders tend to take the science part for granted—companies attempting large capital investment are often already implementing best-practice standards and processes. Instead, the practitioners we interviewed kept coming back to the importance of the right mindsets, practices, attitudes, behaviors, leadership capabilities, and organizational culture. As Jack Futcher, president and chief operating officer of Bechtel Group, told us in the 2017 report: "Process does not deliver projects; leadership does, and has to trump process." These interviews also supported our hypothesis that such factors gain importance with increasing project size and complexity. Further, despite being branded "soft," the reality is that these factors can be the most difficult elements to embed within the organization.

Based on our research and interviews, we synthesized the critical elements of this art into four distinct mindsets and eight practices, four of which are relevant to the project setup phase and four to project delivery.

Mindsets

Mindsets play a critical role in the development of ultra-large projects. Good systems and processes will positively influence team behavior to a certain extent, but success or failure is largely determined by how well a team works together. Team mindsets inform the multitude of decisions and interpersonal interactions that occur on a project. Constructive mindsets lead to good decisions and strong trust-based relationships, which in turn lead to high team morale and excellent performance.

We identified four mindsets that should underpin the development of the project from start to finish:

- Lead as a business, not as a project. An ultra-large project is more akin to building a business than executing a construction project, requiring CEO-level leadership and judgment to address a broad range of organizational issues.
- Take full ownership of outcomes. The project owner needs to maintain full accountability for delivery, remaining well informed throughout and ready to step in to make tough decisions in a timely manner.
- Make your contractor successful. Owners and contractors work best as a business partnership with a mindset of "we win together or lose together". Productive contractor-owner relationships are based on mutual trust and joint problem solving.
- Trust your processes, but know that leadership is required. Processes alone will not resolve every challenge on an ultra-large project. Leaders should trust and enforce the appropriate process, but recognize their benefits and limitations.

These mindsets need to be adopted across the project organization and the broader owners' team, not just the top management of the project itself. Owners and project directors should create an environment in which these mindsets shape the way the team approaches its day-to-day work and how members interact with one another, with contractors, and other stakeholders.

Setup

Unsurprisingly, the project setup phase is fundamental to establishing healthy management practices that deliver successful project outcomes. "The way you start is the way you finish," one of our report interviewees noted. Another, Grant King, former managing director and CEO of Origin Energy, added: "I don't think anything avoids the need to think deeply about how you set these projects up, how you get the right people in the ventures, and how you get the right behaviors between the partners and through the contractors. I think it's all about the beginning." There are four setup practices that leaders should uphold as crucial:

- Define purpose, identity, and culture. Effective project teams should have a unique shared identity, and create a culture of mutual trust and collaboration. Project leaders should articulate purpose, role model behaviors, and nourish the desired culture.
- Assemble the right team. Owner and contractor team members need the appropriate blend of leadership qualities, cultural and local awareness for the task ahead, complementing the requisite technical skills and experience.
- Carefully allocate risk and align incentives. Successful owners thoughtfully delegate only those risks that the contractor is better positioned to manage. Leaders should establish and maintain relationships—not only contracts—to facilitate ongoing alignment of incentives.
- Work hard on relationships with stakeholders. Strong and transparent trust-based relationships with stakeholders enable prevention and rapid resolution of problems. Invest in stakeholder management as a core activity. Setup needs a strong focus on building constructive relationships—especially trust—internally and externally, to resolve issues early in the project timeline that would otherwise impede delivery. Trust is also critical to productively addressing the inevitable crises that arise in projects of this size and complexity. Done right, this phase sets up the project as you mean to go on for its full operating life.

Delivery

By the time a project reaches the delivery phase, many of the key decisions have been made, yet unexpected challenges inevitably arise. Our research indicates that project leaders should focus on four practices throughout this phase.

- Invest in your team. Delivering an ultra-large project requires continual investment in the effectiveness of the team. Leaders must think deeply about how to develop and challenge their people throughout.

- Ensure timely decision making. This depends on the delegation of decisions to the lowest appropriate level, so leaders must have confidence and trust in their systems and people. They are then free to anticipate and resolve critical issues.

- Adopt forward-looking performance management. Effective project leaders use fact-based performance dialogues to strengthen trusting relationships and instill accountability. This allows for early problem resolution and opportunity identification.

- Drive desired behaviors consistently. Effective leaders inspire their teams—especially in challenging times. They define, communicate, and role model expected attitudes and behaviors. Leaders should take the time to connect with team members on a personal level.

We believe that by embracing these mindsets and practices, project leaders can dramatically increase the chance of successful delivery of large projects. ■

Getting capital projects back on track: Six elements of a successful turnaround

Leaders don't want their projects to be in a turnaround situation, but that often happens. Here are some tactics for resolving problems quickly.

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The first signs of a distressed project are clear. Cost begins to creep and the project rapidly consumes the float that planners built into the schedule. As work progresses, important milestone dates continue to slip and each forecast of projected expenses is higher than the last. Team meetings are less productive and people become skeptical that progress reports truly reflect realities in the field. As frustration builds, enthusiasm wanes.

Even the most seasoned managers may miss early signals that their project is in trouble because of cognitive bias. Some convince themselves that things aren't as bad as they seem, or simply don't see that a turnaround is imminent. Others blame factors beyond their control, such as poor weather. When managers do intervene, their response is typically muted—often a series of isolated initiatives that have little impact. By the time they take more decisive action, the project has veered into dangerous territory.

With capital projects becoming more expensive and complicated each year, managers can't afford to repeat these mistakes. So how can they improve? There's no secret formula that will work in every instance, since each project faces unique challenges. But our research on distressed projects, combined with interviews with internal and external experts, suggests that leaders of successful turnarounds implement some common tactics.[1] Here are the main elements.

Develop a recovery plan and realign stakeholders

When setting a new course for a troubled project, many companies don't know where to begin. A good first step involves determining where the project truly stands with respect to milestones, budget, and scheduling. In the process, they'll have to ask difficult questions to learn from past mistakes and avoid repeating them. What went wrong and how do we change things? How can we make better and more timely decisions? The main goal is to identify the exact reasons the project went south, rather than just making a general claim that teams were underperforming. Often, it's very effective to have fresh eyes independently review a project's status, diagnose problems, and make forecasts about the outlook. An in-house team that hasn't been intimately associated with the project, or external experts in the construction or capital-projects sectors, might be a good choice for this task. As outsiders who don't have a stake in the game, they won't hesitate to speak up if they see that the project doesn't measure up to the vision in the original project plan.

Once stakeholders have an accurate picture of a project, including the areas where it is broken and dysfunctional, they can craft a recovery strategy that identifies major problems, their root causes, and possible solutions. In many cases, companies revisit the ambitious goals in the original project plan. As they establish a new baseline to create a challenging but achievable vision for success, they should focus on schedule, cost, and quality. They will also need to manage commercial aspects of the project—for instance, by developing strategies for quickly processing change orders. Recovery plans will always include safety targets, especially for construction sites where employees have been injured or narrowly escaped danger.

In addition to defining new targets and milestones, the project-recovery strategy should outline the execution approach and key enablers. That might include a new system for bonuses and incentives, or major changes in the project's organizational structure. For instance, a construction team that has responsibility for an entire site is sometimes tasked with managing both processing plants and utilities. Usually, the original organization for such projects is purely functional—a single construction or engineering team covering all facilities, for example. If multiple problems arise, these teams

will be spread so thin that the most critical facilities won't receive the attention they deserve. In cases like that, companies should consider creating a new organizational plan in which each critical or near-critical facility has its own teams dedicated to implementing effective solutions, as needed.

Once the strategy is defined, companies must align all project stakeholders and win their buy-in. In some cases, they'll need to create incentives for stakeholders to increase their commitment to the project. If a contractor is behind, for instance, leaders might need to revise the incentives outlined in the project-recovery strategy to encourage more rapid work. At one $750 million energy project, leaders created a new retention-bonus program for welders to combat high attrition rates that were at the heart of some schedule slippage. The subsequent increase in retention boosted productivity.

When developing a recovery plan, the most difficult conversations invariably focus on costs and schedule. But our interview panelists stressed that it was extremely important to put all facts and benchmarks on the table. Without that information, critical stakeholders will question the details within the plan and withhold their support. Some discussions will relate to project leadership and will frequently result in new appointments or a shift in responsibilities.

Install new leadership to encourage progress

On distressed projects, top executives must often acknowledge that the original project leaders are ineffective—a serious problem that necessitates immediate change. According to our interview panelists, even very experienced leaders may lack one or more critical skills. Their main weaknesses might include indecisiveness, failure to maintain the trust of important project stakeholders, approximation in planning activities and following through, and the inability to get people to work as a team. Others withhold information, or aren't entirely candid when asked about the project's status. And some don't adhere to standard processes. Such problems can interfere with progress and create a toxic culture in which line managers and others follow their example.

The implications of these findings are clear: executives must install new leadership, rather than trying to protect managers or shield them from criticism. This shift is the only way to drive progress, interject needed enthusiasm, and help the team implement the changes that it has struggled to make.

Since team members may be disillusioned, the new leaders face a tough situation. They must quickly connect with critical staff, from functional managers to crew foremen and line supervisors, through one-on-one conversations or group meetings. To make these discussions count, leaders should focus on facts—where the project is, why targets are not being met, obstacles encountered, and other difficult topics.

Above all, leaders must convey a new vision and aspirations for the project, as well as concrete solutions that show they won't repeat past mistakes. If they only make vague statements about the need for alignment or avoid discussions about major problems, they'll rapidly lose the battle. New leaders should also focus on the future, including the project's goal. This positive outlook can go a long way when trying to reenergize jaded teams.

Stabilize the project

After establishing new leadership and creating a recovery strategy, teams may take months to stabilize a large project in distress. Consider the case of a turnaround at a large refinery. The project leader had a detailed recovery plan that required extensive groundwork. One major goal involved restructuring the engineering, procurement, and construction-management teams, as well as the owner's team, to increase the focus on the critical

path for priority facilities. As a first step, the project leader negotiated for approximately 60 new staff, assigned them responsibilities, and set them to work. These activities, which included the identification and mobilization of new resources, required two months.

The recovery plan also called for improved governance, since leaders wanted to reduce bureaucracy and encourage more rapid and effective decision-making. The project leader spent the first three months adjusting the new agenda and shifting the composition of key meetings before they were satisfactory. To improve interactions with stakeholders—another major goal—he worked with the team to evaluate and implement new performance-management tools. These solutions, in combination with the improved governance system, increased transparency and facilitated decision making.

As in most projects, the recovery plan included some activities designed to score quick wins and mitigate short-term risks, including those related to the supply chain, fabrication, and contractor management. Almost immediately, the project leader created a list of 20 critical solutions and implemented them within the first 30 days of the stabilization process. For example, he rebalanced the scope of work to eliminate bottlenecks for contractors and arranged to airfreight some critical materials.

Finally, the recovery strategy called for creating a new schedule sequence that would help compensate for lost time on critical tasks. The project leader brought in a new construction manager to lead a team review of the three most critical facilities. The team's main goal was to determine the optimal construction methods. It evaluated different cranes and lifting techniques to increase the number of work fronts. The team also identified more efficient methods for erecting steel and piping. In many cases, it also pointed out skill and process gaps that subcontractors had to address if they wanted to increase field productivity. By identifying these opportunities, the team created more than 12 weeks of new schedule float.

The stabilization phase is of utmost importance in turnarounds. If new leaders demonstrate that they're willing to make big changes, tackle problems, and work with contractors within their first few weeks, they'll help the project gain momentum. But if they can't report any major accomplishments or progress after 30 days, companies will know that they have a new—and larger—problem to fix.

Install an operating model with a dual focus

Strong project leaders can manage the unexpected problems that usually pop up each week. These problems may involve trouble-shooting the late delivery of equipment or materials, resolving an engineering problem, or resolving a quality problem. But the best project leaders will also dedicate significant time and resources to capture float or buffers—elements that will make the project more robust and protect against unforeseen events.

Most project leaders recognize the importance of being strategic, rather than just tactical, since they know that new opportunities to cut costs and reduce timelines always arise as the project transitions from early construction to bulk construction and again from late-stage construction into pre-commissioning and commissioning. But leaders often become so focused on their day-to-day work that strategy takes a back seat. They can overcome this bias by establishing an operating model with a dual focus. In addition to optimizing day-to-day performance management and capturing short-term value, they must engage in medium- to long-term strategy development.

For this operating model to work, project leaders should establish a full-time team of highly skilled

staff who can recognize and capture strategic opportunities. Team members should have the right mix of operations, construction, engineering, and planning skills. For best results, they should report to the project leader, who can provide rapid access to the information and resources required to implement their recommended strategies.

In one case, the project leader dedicated a team of four highly experienced staff to identify opportunities to reduce costs and timelines. The team analyzed activities that needed to occur about 6 to 12 months out, as well as those that were in no-man's land because they didn't fall under a line manager's responsibilities. The leader spent about one or two hours with the team each day to discuss their findings. For example, the project plans for construction and commissioning were originally separate, since they were contracted to different parties. The team realized that it might be able to reduce the project timeline dramatically if it created an integrated plan. By considering construction and commissioning together, the team significantly reduced the schedule. The team also recognized that it could capture long-term savings and reduce rework if it set up a boot camp to help contractors improve welding productivity.

Take active ownership of the turnaround

As they monitor performance, leaders will inevitably discover that some contractors are missing their targets. All too often, however, they'll just silently acknowledge the failings because they think that interventions will create more chaos or because they fear potential liabilities, such as penalties imposed for missing deadlines. Later, leaders regret not taking more decisive action.

If a contractor is struggling, leaders won't make progress by pointing fingers or assigning blame. A much better solution involves serving as an active partner in the problem-solving process and mobilizing additional resources when necessary. Such cooperation may be the most difficult and delicate part of any turnaround. Managed poorly, they could alienate critical contractors. But if managed well, they could be one of the primary improvement levers.

On one project, a contractor failed to meet earth-movement targets for reasons beyond its control, including poor soil conditions, bad weather, and untrained staff. Rather than issuing penalties, managers on the owner's team collaborated with the contractor to develop solutions. The owner's team agreed to purchase more equipment to alleviate bottlenecks, changed the strategy for disposing of unusable earth as spoil, and searched for alternative sources of competent material. These efforts helped double the quantity of earth moved—even tripling it on some days—allowing the contractor to reach its established goals. When the construction team saw these results, it agreed to new earth-moving targets that were more ambitious than the original goals.

In more extreme cases, project leaders might have to take more interventionist measures, such as descoping a contractor's work by reassigning some responsibilities to another one. They might also ask contractors to replace their project leaders or supervisors, or second resources into the contractors' organization to bolster performance.

Ensure transparency

The same scene often plays out in progress-review meetings on troubled projects. Instead of reaching alignment on future milestones and resolving the issues that impede performance, participants hold long debates about which group has the best or most recent information. Then they spend time reconciling their progress reports or providing rationales to explain why they're lagging on performance metrics.

The only way to avoid this morass is by creating a common report that describes progress on major performance metrics, with a special focus on those essential to project success. While common reports can benefit any project, they are especially critical for turnarounds, where struggling teams tend to rely on intuition when making difficult choices.

In one schedule-driven turnaround, the team had to complete work on eight critical and near-critical facilities. To track progress, it created a simple report that showed the weekly and cumulative progress, both actual and target, for major trades at each facility. This report helped the team focus on priority activities.

Teams can also increase transparency by establishing very clear metrics. On one pipeline project, leaders originally relied on a "stoplight" system to assess progress. They didn't look at facts to see if the project was on track—they simply made a qualitative assessment for each goal. If they felt they were behind schedule, they'd put an icon of a yellow light next to the task; missed goals were supposed to get a red light. But few tasks received these warning symbols, since managers were inclined to be overly optimistic or rationalize missed deadlines. To increase the rigor of their assessments, the team switched to more quantified metrics. For instance, they assigned red lights to any milestones that the team missed by more than two weeks. This shift changed meeting dynamics, since the data-driven metrics eliminated endless debates over whose progress reports were most accurate.

That said, ensuring transparency is not just a matter of tools—it's first and foremost a matter of choice. In too many instances, project leaders consciously avoid raising difficult issues with key stakeholders, often because they fear overreaction. Some leaders also hope that they can buy more time to improve the project's outlook, but this strategy is rarely effective. In our interview panel, not a single project leader regretted surfacing issues early. Time is a scarce resource in any project, and rapid action is fundamental to success. Almost all the seasoned leaders we interviewed said that the best communication strategies involved fearlessly exposing a project's weaknesses. By bringing the issues to light, they were more likely to find solutions and deliver the desired outcomes.

Project plans aren't written in stone. If the original strategy isn't working, top executives must intervene by staging an intensive turnaround. But it's not enough to set new objectives and declare a break with the past. Project leaders should also ensure that their turnarounds contain the basic elements essential for success, from a clear recovery strategy to full transparency. Without this structured approach, they'll inevitably repeat past mistakes.

[1] We interviewed over ten experts, internal and external, who were current or former senior managers or executives with more than 25 years of experience within the capital-projects industry. They had experience in a variety of capital-projects and infrastructure asset classes.

Innovation Site Visit: Major projects in Moscow

Since launching modern Russia's largest construction program in 2011, Moscow has more than doubled its territory. To catalyze the full potential of this rapidly-growing metropolitan area of 19.5 million people, the City of Moscow's government pays significant attention to infrastructure as one of the key pillars of urban development—with a current focus on projects that create livable and comfortable urban spaces for both citizens and tourists.

Following its first five years of projects, Moscow was given special recognition for "demonstrating outstanding strategic commitment and ambition" by the International Association of Public Transport (UITP). That period saw 50 million square meters of real estate developed, 370 social infrastructure objects built, and the metro expanded by 30 percent—including 101 kilometers of metro lines and 55 new stations. Innovative finance solutions, necessitated by the city government's debt-free approach to development, enabled all this whilst maintaining a budget surplus and remaining a net donor region within Russia.

On 30-31 May 2018, the City of Moscow and Mosinzhproekt—a large Russian engineering, construction and project management company—hosted an Innovation Site Visit to showcase Moscow's major projects to the Global Infrastructure Initiative (GII) community. Through roundtable discussions and site visits with project executives, participants explored where innovation and technology have enabled the step-changes that have allowed Moscow to deliver major projects on a short timeline – and how to apply these lessons to other cities and major projects.

The following insights emerged during GII's Innovation Site Visit in Moscow:

- *Establish a structure for citizen involvement.* Major urban infrastructure projects are an extremely visible expenditure of taxpayer funds while also often being large disruptors of daily life. A foundation of citizen support is essential for success and requires a thoughtful engagement program. In Moscow, citizens are encouraged to participate in the planning process by steering major initiatives through the "Active Citizen" application – a portal for online referendums on topics appropriate for democratic decision-making. To date, almost 2 million citizens have cast more than 90 million votes on over 3,000 issues through the platform. The purpose of this structure is to increase the opportunity for citizen engagement and involvement with their city's major investments.

- *Manage the disruption 'cost'.* Major urban projects cannot be delivered without disrupting daily life. While citizens can be enrolled to accept the disruption as a necessary investment for a better outcome, equal attention needs to be given to managing the disruption 'cost' as to managing real expenditures. For example, MyStreets, a project to upgrade and enhance Moscow's urban environment through reconstruction of streets and building façades, was disruptive to many citizens and commuters. However, through staging and swift execution, the disruption was minimized and the intended lifestyle improvements were quickly delivered to Muscovites and tourists who traverse newly styled pedestrian streets every day.

- *Invest in technology to optimize sequencing.* Moscow's cohesive vision for urban transformation has allowed early investments in technology to assist future delivery. One of the first projects completed was the centrally-controlled traffic management system which can monitor traffic conditions and urban movement through more than 2,000 traffic cameras and 160,000 CCTV cameras installed across the city. Data collected on current conditions, and knowledge of planned activities, allows real-time rerouting of traffic through the city's dynamic signage. It also allowed identification and analysis of permanent traffic flow changes that could further ease disruptions like those created by the major construction projects.

- *Maximize utility of brownfield sites.* A key reason the Moscow Central Circle (MCC), a new light-rail system integrated into the Moscow Metro, was completed in a record four-year period was the repurposing of existing brownfield networks which allowed the installation of modern technology on existing rail transport routes. The MCC's 31 new stations will revitalize formerly abandoned industrial areas when its next stage of development builds an expected 300,000+ square meters of hotels, 250,000+ square meters of retail, and 200,000+ square meters of offices. This will give districts with historically poor infrastructure access a chance to develop at the same pace as the rest of the city.

- *Leverage PPPs to enhance basic services.* To manage public cost and investment while delivering world-class infrastructure, municipalities need access to additional financing tools. Based on a structure that took an act of federal legislation, the MCC is an example of enhancing publicly developed foundations with private services. The tracks and land are owned by the Moscow Metro, with the rolling stock subcontracted to Russian Railways under a life cycle contract with a guaranteed buyback. The innovation is that Moscow Metro is licensing the development rights of its individual stations to private investors. Though all stations will exist under the same covenants, individual investors will assume their station's construction cost and operational risk and rewards.

- *Create citizen-centric spaces.* In addition to serving as open spaces, today's city residents expect their parks to provide for entertainment and consumer services too. Many modern parks offer architectural features, charismatic vistas, and social, educational, and artistic spaces for all ages. When Zaryadye Park, an area of prime real estate next to the Kremlin was converted to parkland, an international contest resulted in 10 hectares being densely designed for this multi-function purpose. The outcome was two concert venues, restaurants, a parking garage, an entertainment complex, and a biological education center, all neatly camouflaged into a natural landscape that represents Russia's ecological diversity.

- *Innovate where needed but not excessively.* Moscow's planners and builders did not shy away from technological innovation. The MCC used weldless joint rails to create a smoother and quieter system that is easier on riders and less disruptive to residents living near the railway tracks. The retrofit designs for Luzhniki Stadium were fully modeled in building information management (BIM) – a step which identified more than 100,000 conflict points before they could escalate into project delays. However, the project teams were also careful not to force innovation where it could create unnecessary risk and complications. Instead, they delivered the massive project portfolio by tactically melding innovations with highly-proficient execution of well-known and proven methods. ■

Video

Construction projects have traditionally been founded on risk, not collaboration—a root cause of the sector's low productivity. At the 2017 GII Summit, McKinsey partner Michael Della Rocca joined leaders from Atkins, Bentley Systems, and King Abdullah Economic City to discuss how relational contracting and shared incentives can create better outcomes for infrastructure and capital projects.

Rewiring contracts for collaboration →

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Over the past five years, we have delivered impact in more than 3,000 engagements, including work on 150 megaprojects collectively valued at more than $1 trillion. Our unique ability to partner with our clients and drive fundamental change is rooted in our independent perspective, alignment with client goals, a deep commitment to innovation and impact, and the depth and breadth of our expertise and experience.

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Global Infrastructure Initiative

Since 2012, McKinsey & Company's Global Infrastructure Initiative (GII) has convened many of the world's most senior leaders in infrastructure and capital projects to identify ways to improve the delivery of new infrastructure and to get more out of existing assets. Our approach has been to stimulate change by building a community of global leaders who can exchange ideas and find practical solutions to improve how we plan, finance, build, and operate infrastructure and large capital projects.

GII consists of a global summit, regional roundtables, innovation site visits, and a quarterly digital publication, Voices. The fifth GII Summit will take place in London on October 29-31, 2018, and will focus on major project delivery and digital transformation.

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