The construction productivity imperative

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Sriram Changali
Azam Mohammad
Mark van Nieuwland

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The construction productivity imperative

How to build megaprojects better.

Around the world, ever-larger capital projects are being undertaken. Better project management and technological innovation can improve the chances of success.

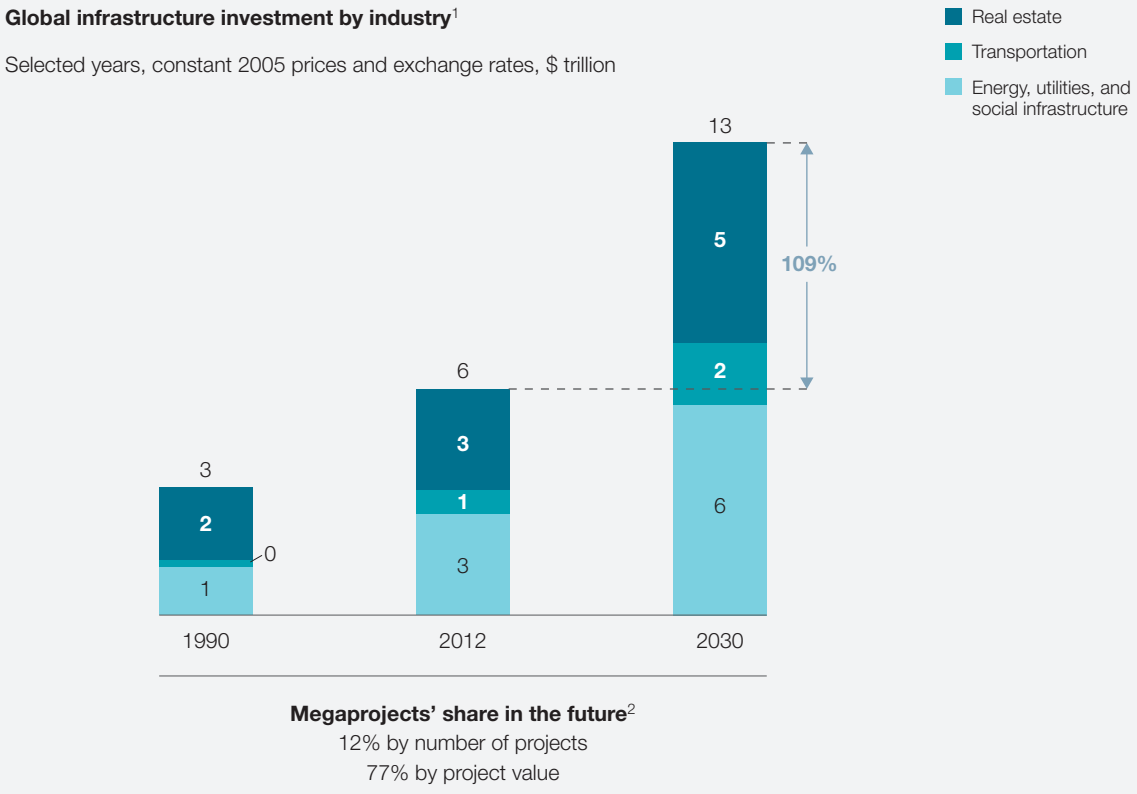
Three factors are defining the future of large-scale capital projects. First, investment is growing fast. In 2013, global investment in energy, infrastructure, mining, and real-estate-related projects was about $6 trillion; by 2030, that, could be $13 trillion, according to McKinsey research (Exhibit 1). Second, billion-dollar-plus megaprojects will account for a greater share of these developments. Third, the industry does poorly completing megaprojects on time, on budget, and to specifications. Our research estimates that 98 percent of megaprojects suffer cost overruns of more than 30 percent; 77 percent are at least 40 percent late (Exhibit 2).

There are many reasons for this poor record. Start with productivity—or, rather, lack of it. Construction productivity has been flat for decades, according to McKinsey research. In manufacturing, by contrast, productivity has nearly doubled over the same period, and continuous improvement has been the norm (Exhibit 3).

A variety of factors account for poor productivity and cost outcomes. Among them are the following:

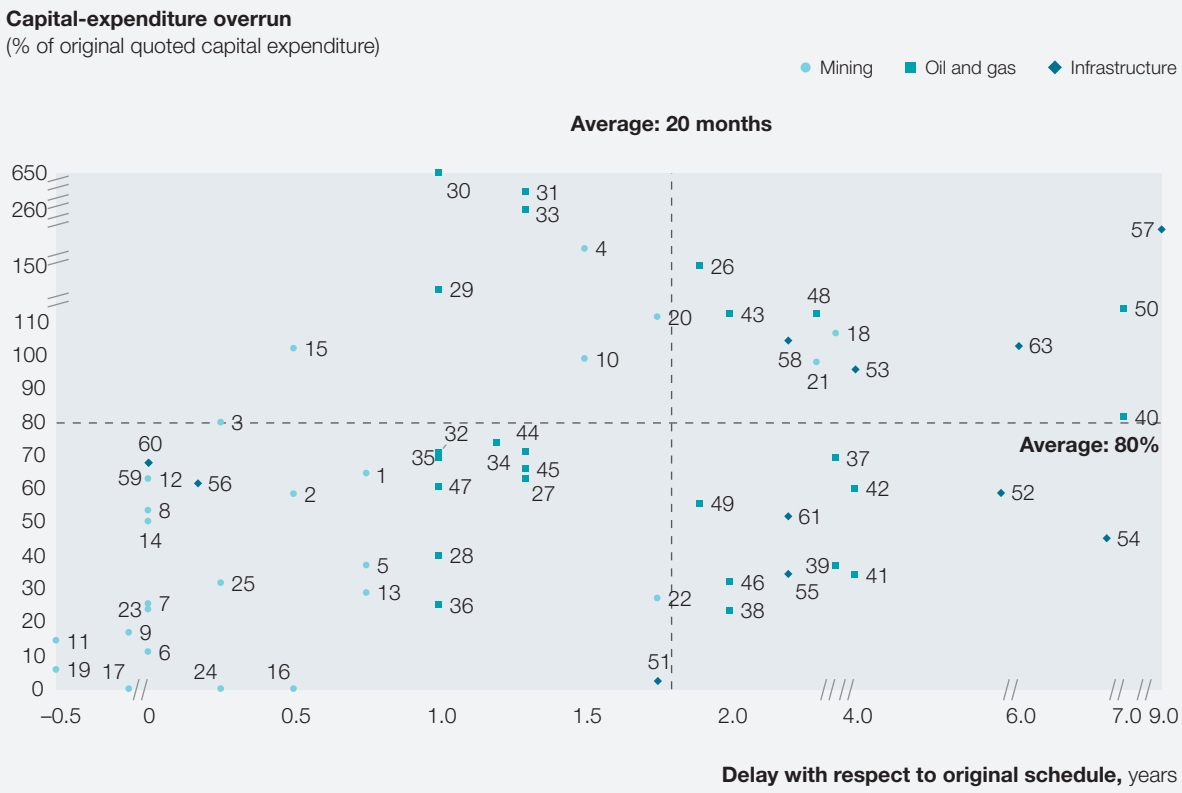
- **Poor organization.** Decision-making and procurement processes do not have the speed and scale required.
- **Inadequate communication.** Inconsistencies in reporting mean that subcontractors, contractors, and owners do not have a common understanding of how the project is faring at any given time.

Exhibit 1 **Infrastructure investment will double in the next 15 years.**



[1]Forecast assumes price of capital goods increases at same rate as other goods and assumes no change in inventory.
[2]Project award date 2015 and beyond.
Source: McKinsey analysis

Exhibit 2 **Ninety-eight percent of megaprojects face cost overruns or delays.**



- **98% of projects** incur cost overruns or delays.
- The average **cost increase is 80%** of original value.
- The average **slippage is 20 months** behind original schedule.

Source: Companies' public annual reports; IHS Herold Global Projects Database, November 19, 2013; press releases

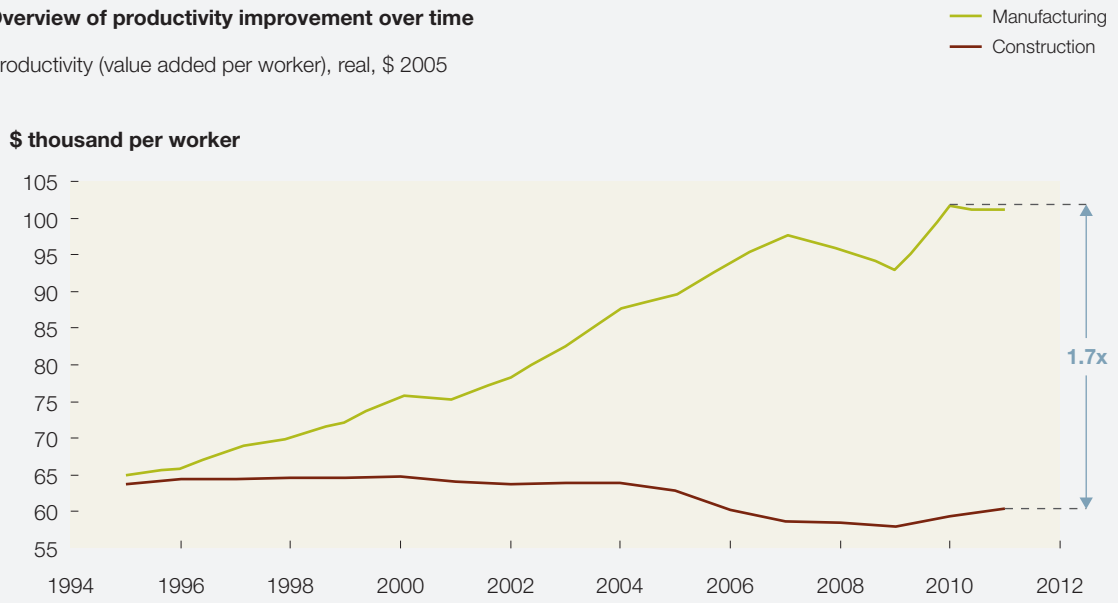
- **Flawed performance management.** Unresolved issues stack up because of lack of communication and accountability.
- **Contractual misunderstandings.** The procurement team typically negotiates the contract, and this is almost always dense and complicated. When a problem comes up, project managers may not understand how to proceed.
- **Missed connections.** There are different levels of planning, from high-end preparation to day-by-day programs. If the daily work is not finished, schedulers need to know—but often don't—so that they can update priorities in real time.
- **Poor short-term planning.** Companies are generally good at understanding what needs to happen in the next two to three months, but not nearly so much at grasping the next week or two. The result is that necessary equipment may not be in place.
- **Insufficient risk management.** Long-term risks get considerable consideration; the kinds that crop up on the job not nearly as much.
- **Limited talent management.** Companies defer to familiar people and teams rather than asking where they can find the best people for each job.

These problems are serious, systemic, and all too common. Still, some companies do manage

Exhibit 3 **Productivity in manufacturing has nearly doubled, whereas in construction it has remained flat.**

Overview of productivity improvement over time

Productivity (value added per worker), real, $ 2005



Source: Expert interviews; IHS Global Insight (Belgium, France, Germany, Italy, Spain, United Kingdom, United States); World Input-Output Database

to succeed. Through our analysis of more than $1 trillion worth of capital projects over the past five years, we have found that improving "basic" project-management skills offers the most potential to improving site performance. This article discusses 15 practices that can help to improve productivity in the three phases of project delivery—concept and design, contracting and procurement, and execution.

Concept and design

The concept-and-design phase is where the most project value can be gained (or lost). These seven principles offer the most promising ways to improve performance, and therefore financial returns.

Build only what is needed.

Design-to-value (that is, design based on understanding and minimizing the elements that drive up costs) and the minimal technical solution (MTS, design to deliver only the necessary value-added requirements) are two concepts that can be used to reduce capital investments to what is required—no more, no less. Consider the example of two utility companies who needed to build a similar substation building. One spent substantial time and money building a full shell, including floors, walls, a roof, and so on; this required many approvals, followed by a long and difficult construction schedule. The other utility defined the MTS to be "protection against the weather, while retaining ease of access during maintenance;" on that basis, it built a retractable roofing structure with pillars. This latter option required much less time and money to build.

Maintain a life-cycle perspective.

Companies typically observe a certain rigor in managing up-front capital costs; less often, however, do they consider the full life-cycle costs of construction and operations. Ensuring that design engineers and project managers are familiar with life-cycle metrics, such as net present value (NPV), could help. So could linking incentive structures to NPV improvement. One approach that is gaining traction is competitive front-end engineering and design, where companies invite multiple

engineering, procurement, and construction companies to apply. Bidders win by coming up with designs to optimize overall project costs. It's important for procurement specialists (see next section) to keep life-cycle costs in mind as well, evaluating not only the acquistion price but also efficiency, maintenance, and disposal.

Strengthen scenario planning.

Developing options under various scenarios reduces risk and enhances predictability of project returns. The plans for many infrastructure, real estate, and energy projects are based on estimated capacity, such as airport passenger loads, or on production profiles, such as those for oil-and-gas developments. Companies pay a great deal of attention to developing this base case. Less often, however, do they put in the same effort in evaluating alternative scenarios that could affect the success of the asset or require expensive modifications. If developers thought harder about the worst-case scenarios, they would do a better job ensuring that they had the flexibility to cope with the unexpected.

Optimize around site constraints.

This seems obvious, but unfortunately it is not practiced consistently enough. Too many companies work out the design in the office and therefore do not take into consideration actual site conditions, such as climate conditions, soil characteristics, terrain, and weather. It's usually easier (and cheaper) to tweak a building design than a landscape. One example of good practice would be the Olympic Stadium in London; the designers planned the structure around a natural slope to minimize the need for excavations.

Think modular design and standardization.

Standardizing and modularizing components can save costs and time. Nevertheless, a significant number of companies do not apply this principle; exploration-and-production companies, for example, often use different specifications for their wellhead platforms. India's Reliance Industries shows what can be achieved through standardization. When Reliance built a second refinery in Jamnagar, it was almost an exact replica of the first one, with some updates to accommodate new technologies. The decision to replicate shaved six months off the engineering schedule. On a smaller scale, utility companies are increasingly using standard design for new substations. This also improves life-cycle costs, because spare parts can be used across assets. The use of standard designs should be considered on a case-by-case basis, taking into account local conditions or the latest technologies, to avoid using suboptimal design. However, it is typically more efficient to start with the last design and adjust, rather than to start from scratch.

Consult construction and procurement teams, beginning in the design phase.

Construction and procurement teams bring different expertise to the table; it makes sense to bring them in from the start to evaluate concepts and designs. A construction expert, for example, might notice that a design choice will have costly ripple effects down the line; procurement managers can suggest new ways to minimize costs. In short, sometimes great design ideas can come from outside the design team. T-REX, a highway/light-rail project in Denver, Colorado, finished almost two years ahead of schedule, in part because contractors developed a way to do certain tasks at the same time, rather than sequentially. That would not have happened if they had not been in the room from the beginning.

Optimize engineering processes and choices.

Companies are usually stringent about managing time lines during construction. But often they do not pay the same attention during the preconstruction phases, even though the work done during this period can have a disproportionate effect on the project value. There is substantial room for improvement in engineering productivity, with respect to time and quality of output, to prevent rework in the construction phase. For example, during a recent refinery project, the owner ordered the engineering firm to set up a 24-hour global "engineering factory." This enabled the company to save several months in the engineering phase. In another example, a company with an engineering team based in

a number of different places analyzed the data analytics associated with its e-mail traffic. This helped the company optimize locations, team sizes, and work flows, and resulted in productivity improvements of up to 25 percent.

The use of Building Information Modeling (BIM) helps improve productivity as projects progress, because all information is contained in a single location. BIM tools are based on 3-D models, and they help planners avoid design clashes. Some companies are exploring adding dimensions, such as cost, time, and resources, in order to smooth project management in the execution phase and facilitate maintenance during operations.

The use of aerial, laser, and radar technology can rapidly improve surveying productivity. For example, in the design of transmission lines, the ground survey can be conducted with helicopter-mounted radars rather than having ground crews do manual surveys.

Contracting and procurement

It is important to define a contracting-and-procurement approach that minimizes cost and risks—and to think this through for each project. It's awkward but true: practices that worked well on one project may not be suited to another. Companies cannot always do things the same way. Here are some best practices that can help companies avoid delays and save money.

Integrate risk allocation into the contract.

It is tempting for those paying for construction to try to transfer all risks to the contractors—even when the latter lacks the required financial capacity. A more balanced approach that assigns contractors only those risks that they can influence may be preferable, not only for good relations but also for economic reasons. When contractors are forced to assume risks that aren't naturally theirs, then they wind up paying higher insurance premiums; these costs, of course, are passed on to the customer. T-REX again provides an example of better practice. During the bidding period, the different government agencies involved allowed the contractors to indicate which risks they would assume, and at what cost. This allowed for a clear demarcation of risk and a better understanding of associated costs.

Set up an efficient process for claims and change-order management.

During construction, substantial time can be lost in claims and change-order management, particularly if processes and contracts are ill defined. Creating a stringent process for change-order management and an efficient one for claims management can minimize time lost in disputes during construction. Delay in decisions on claims leads to delays in construction—and could also lead to a breakdown of trust between the owner and contractor. One successful company installed a board for change-order and claims management as part of leadership's "war room"—the place where everything is monitored and major decisions are made.

Align the interests of owners and contractors.

It is important to see contractors as partners in the effort to complete a megaproject, not hirelings who just execute the terms. Most contracts penalize contractors for delays; these penalties can be draconian, even punitive. The better approach is to base contracts on a set of common interests, with a well-defined payment structure and a balanced mix of incentives and penalties.

Incentives for early completion, or for benefit sharing (when the contractor suggests ways to improve project NPV), can help ensure that the owner and contractor are working with each other as allies. Some companies create a contingency budget and will pay a bonus if the project comes in on time and on budget. The design of the payment structure can also help to align incentives—in the form of mobilization fees paid when the site office is ready, main equipment quotes/contracts are in place, and a workforce is present—versus the more traditional approach of paying when the contract is signed. A payment system based on completing milestones rather than end-of-month payments also motivates teams to finish early.

Develop the owner's perspective on costs.
Too often, owners rely on third parties or the engineering department for cost estimates. Strong performers maintain an in-house cost database that incorporates quotes from new construction and existing facilities. In addition, these owners have a clear understanding of what factors affect costs, and they use this information to their advantage in design and negotiations. For example, they scrutinize the factors behind equipment costs, such as steel prices, and constantly update their databases accordingly; they also perform bottom-up cost estimates for core equipment.

Project execution

There are four practices that set the strong performers apart from the weaker ones during the execution phase.

Overinvest in planning.
Unforeseen events are inevitable; creating a continuous work flow means construction workers need to be able to anticipate and react quickly. Many companies use 30-, 60-, and 90-day plans, but they overlook the importance of microplans that look at what needs to happen the next day or the next week. Strong performers know what is happening day by day at the work site and adjust their microplans accordingly. They assess whether drawings, equipment, materials, and people are available and troubleshoot before the actual due date. Companies are exploring how to incorporate these elements into planning software and to make this a routine step in the planning process. This reduces idle time and is the most promising way to improve site productivity.

Companies are also beginning to manage multiple critical paths. To put it simply, some activities have to happen in a specific sequence—no putting up a wall until the foundation is done. Strong performers go a step further. They plan what to do if the foundation is running late and get other activities going on a parallel critical path.

Use prefabrication and preassembly methods.
Strong performers design a specific supply chain for prefabrication and assembly. In one case, this translated into building a 30-story structure in just 360 hours; on-site construction work amounted to only 7 percent of the construction work. Substantial prefabrication also helps to minimize waste.

Although it is early days yet, universities and companies are exploring the use of additive manufacturing techniques, such as 3-D printing, as a next stage of innovation in building. The use of select design elements and fixtures could pick up rapidly, as 3-D technology allows for new shapes and forms to be efficiently constructed.

Build structures to cooperate on project performance.
To encourage an environment in which problems are addressed head-on, it's important to have timely and consistent feedback. All too often, though, the area supervisor, the project manager, the planner, and the owner have different views on what is going on and where the problems are. Usually, this is because they are not getting the right information in a timely manner; sometimes, they are not getting the same information. In effect, they are operating from different versions of the truth. The better approach is to agree on a standard reporting system and then to devise ways to ensure timely feedback, such as daily discussions with on-site staff and weekly reviews on project status, pace of progress, and risk management. The underlying purpose is not to create more paperwork but to create a transparent environment that fosters quick issue resolution. Some companies are exploring how to track performance using handheld devices that report completion levels on a daily basis to planners.

Minimize waste.
The same lean principles that apply in manufacturing could work for construction. Actively seeking opportunities to reduce inventories, overproduction, rework, transportation, and waiting times can substantially improve productivity. For example, one company reviewed the placement of a boiler; in the original plan, this would have required more than 1,000

serpentine tubes and ten full-time workers to install. Instead, through preassembly (attaching the serpentines during the fabrication process), parallel processing, and setting up a flexible team, the firm cut labor costs in half and completed installation 43 percent faster than estimated.

Organizational skills

These practices apply to specific moments in project delivery. There are also ways to set up the entire organization for success. Again, the analogy to manufacturing is pertinent. Manufacturers have learned to keep value creation and efficiency in mind all the time, which is one reason that the sector has seen sustained productivity gains. When it comes to megaprojects, though, it is common to concentrate on just finishing the job—and not to consider how value can be enhanced along the way and how to transfer knowledge between project teams. High-performing megaproject teams, on the other hand, review project NPV every three to six months and think through the most important risks and how to mitigate them. Once a project is done, they have structured meetings to discuss what lessons to learn.

These kinds of issues, related to governance and processes, are rife. For example, in operations, the site manager might have a signing limit of $100,000; that could be far too low for a megaproject and could end up wasting management time as people run after signatures. The same can apply to decision making. The key is to look at the scale of the job and assign responsibility to suit.

One way to devise and institute these capabilities on a company-wide scale is to set up an in-house project management academy, as a number of companies with large project portfolios are doing. Good project managers are a rare breed. It is no easy task to manage the contractors, engineers, lawyers, procurement specialists, and public-relations experts any big project needs. The best approach is to combine structured training, including certification in specific modules, with on-the-job coaching, so that people can apply the skills they learn.

As with every other economic sector, technology will also play a role in improving construction productivity. Specifically, there are innovations in areas as diverse as 3-D printing, computer-aided design, laser and radar technology, and pipe laying that could make for faster, less mistake-ridden construction. But technology is only a tool. The bigger priority—and opportunity—is in improved project management from design to execution.

The best practices and innovations outlined in this paper are only a starting point for discussion. The larger point is that these conversations are worth having. A healthy, productive construction industry benefits the whole world. ■

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Sriram Changali is an associate principal in Singapore, where **Azam Mohammad** is a principal; **Mark van Nieuwland** is an associate principal in Bangkok.

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