

Capital Projects & Infrastructure Practice

# Control capital project duration—and cost—with schedule optimization

It is almost always possible to accelerate the completion of a capital project—even during construction. To do so, project owners should follow three best practices.

*by Tushita Garg, Piotr Pikul, Charlene Pretorius, and Rebecka Pritchard*



© Sornranison Prakitrakoon/Getty Images

When a large capital project takes longer than anticipated, costs can soar. But accurately estimating a project's completion date is not easy. Construction projects have many uncertainties, which are often exacerbated by insufficient up-front project planning and a limited understanding of site conditions at the time of final investment decision (FID). Involving multiple contractors and subcontractors creates a lot of interfaces to manage. And when creating schedules, project managers often underestimate the impact of site inefficiencies, work-front congestion, and labor issues.

These same challenges can make it difficult to accelerate a project that has fallen behind schedule during construction. While capital project owners know what they're supposed to do, in practice they often fail to follow a proper stage-gating process that allows ample opportunity to change course at key points, depending on what is best for the project. Adding to that strain is constant schedule pressure during project execution. This pressure creates an environment that is not conducive to following good processes and the principles of project value improvement (PVI), even though PVI could optimize a project schedule.<sup>1</sup>

In short, bad processes lead to bad outcomes in a vicious cycle. As capital project owners chase tight deadlines and rush through the front end of the process, they neglect several best-practice steps early in the project life cycle. This neglect often leads to delays—and higher costs—later.

However, there are ways to ensure a project meets its planned completion date or, better still, to accelerate a project to get cash flowing earlier. They begin with old-fashioned project discipline at each stage—from project approval to construction—combined with new techniques

such as modularization, standardization, and—yes—targeted use of digital technologies that reinforce these basics.

If project owners continue their current path of chronic schedule and budget overruns, much value is at stake. We estimate that between 2020 and 2025, global capital spending will total \$82 trillion. Assuming a 10 percent discount rate and a 15 percent initial internal rate of return (IRR), the delayed revenue associated with a one-year delay on this portfolio will result in a \$6 trillion, or a nearly 50 percent, drop in net present value (NPV). There is no time to lose on the path toward reliably finishing capital projects on time and on budget.

### **Accelerate a project schedule at any stage**

For decades, capital projects have been the backbone of our global economy. Yet schedule and budget overruns are still exceedingly common, and outcomes are not improving (Exhibit 1). A recent survey suggests that one out of every five capital projects goes over budget.<sup>2</sup>

Many industry experts have hung high expectations on digital tools as the solution to cost and schedule overruns. Capital project owners are learning the hard way, however, that these tools are insufficient on their own.

For project owners to improve schedule performance, they must first hit the “pause button” before using digital tools and ensure they have the schedule-management fundamentals in place. They should then adequately invest in PVI and continue to use PVI techniques all the way through the construction phase.

---

<sup>1</sup> For more on PVI, see Jeff Billows, Kevin Kroll, Piotr Pikul, and Charlene Pretorius, “Capital project value improvement in the 21st century: Trillions of dollars in the offing,” August 2018, McKinsey.com.

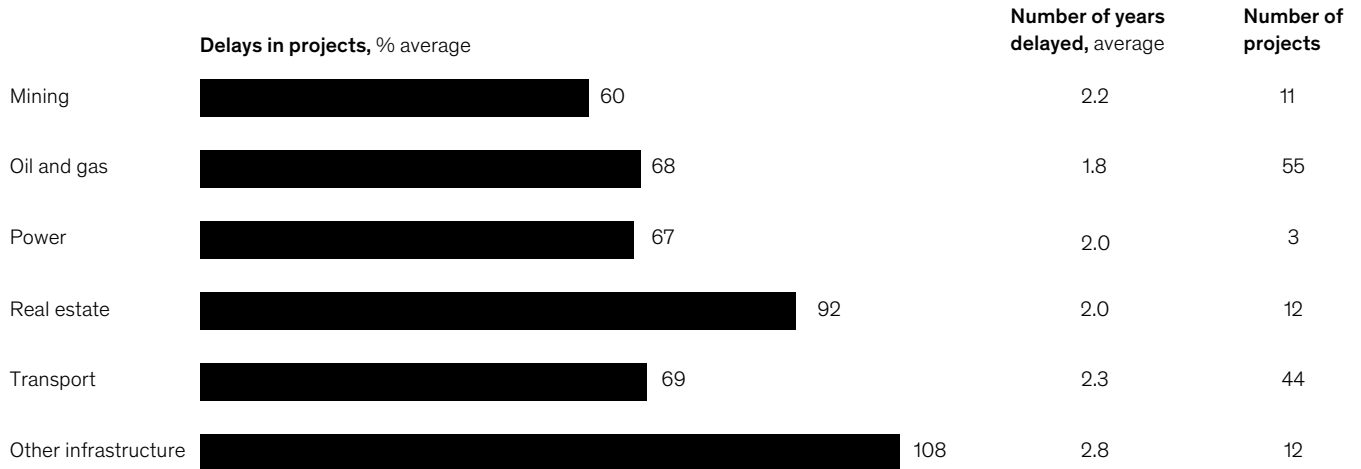
<sup>2</sup> Perry D. Wiggins, “Metric of the month: Percentage of approved capital projects considered within or on budget,” April 1, 2019, CFO.com.

Exhibit 1

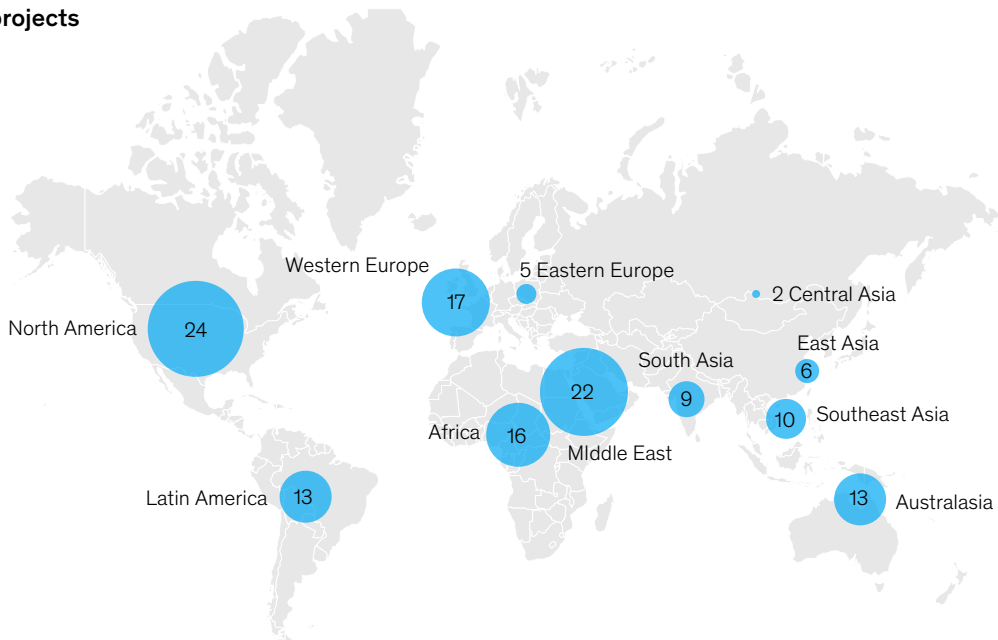
## Construction-heavy sectors struggle to deliver large investment projects on time.

### Projects per sector

n = 137



### Number of projects per region



Source: IHS Global Projects Database, McKinsey analysis

## **Remember the fundamentals before using digital tools**

Digital scheduling tools are becoming more sophisticated, providing new ways to create, update, and analyze schedules and collaborate with team members. These tools can add incredible value to a project—if there is adequate thought given to schedule development. However, a project team often uses these tools to offset a fundamentally flawed schedule or missing basic processes. Recently, one North American developer employed a single project scheduler to manage more than 500 detailed schedules, using only one visualization tool. The developer did not consider the quality of the schedules, which led to regular but unexpected overruns later in the project.

### **Ensure the basics are in place**

Scheduling and planning basics are fundamental to a successful project. A project team needs to ensure it has a realistic, well-structured baseline schedule with buy-in from all stakeholders. And the team should update that schedule regularly; if the schedule is not regularly updated with progress during construction, it quickly becomes disconnected from reality and simply becomes an administrative reporting tool. The team must also set up project controls to ensure transparency on project progress and completion date.

### **Employ advanced analytical tools**

When used correctly and combined with digital collaboration tools, integrated planning tools have proved successful in expediting critical milestones. There are also several simple, intuitive, and user-friendly apps available today for handheld mobile devices to enable real-time collaboration and communication among crews regarding constraints and progress. These digital collaboration tools offer the ability to synchronize with sensors, wearable devices, and desktop computers, assisting with productivity tracking, report generation, and document management.

Multiple tools can quickly assess the quality of a schedule. Cloud-based production planning tools,

using advanced analytics, can be used to control the day-to-day production activities on multiple work fronts. For example, as part of a new mining facility, a project owner was constructing a water dam and had to install multiple layers of lining on the dam walls and floor. By using a 3-D digital twin (created from drone footage twice a week) during the planning sessions, the layering works could be planned out in minute detail. Measurements could be done with the click of the mouse and used to set specific and feasible daily targets.

The foreman of each crew then received a personalized list of daily activities on his smartphone, accompanied by the 3-D image that clearly marked his work front. A collaboration tool also enabled foremen to quickly escalate constraints and get supervisor assistance. By selecting the root causes for delays from a drop-down menu, the foremen provided a digital record of recurring issues. In addition, the supervisors got real-time progress updates from the work front, as each foreman checked off his completed tasks throughout the day. The impact was staggering: a 300 percent improvement in workforce productivity and more than a month saved on the critical path milestone, worth over \$10 million in NPV.

## **There is time to invest in PVI**

How often do project teams say they do not have time to optimize a project because they are chasing a tight deadline, such as for an upcoming board meeting or first product shipment date? But spending time on PVI during up-front project planning will help ensure a project has a good business plan as well as a proper technical solution in place. This will expedite both the approvals process and the actual execution—especially when project pressures arise—and help ensure profitability down the road. Owners should take the following steps to achieve this.

### **Follow a stage-gate process to avoid delays during construction**

A stage-gate process is designed to systematically uncover and eliminate project risks and develop

an increasing level of certainty on the project cost, schedule, and financial value. It also helps identify areas where focused optimization initiatives can boost project value. While there are many publicly available stage-gate models to use as a guide, teams that are crunched for time are often tempted to skip preconstruction stage gates or to speed through developing an adequate level of detail for the gate deliverables. These shortcuts, however, can result in rework and costly delays during construction. For example, a brownfield expansion project in a petrochemical plant was delayed by several months when, during excavation, a construction team discovered underground piping and cables that had to be rerouted. Proper preproject planning would have found this obstacle during the engineering phase, and a cost- and time-effective solution could have been added to the construction schedule.

#### **Add rigor to the project approvals process**

Decision makers often have several questions about project plans, sometimes spurred by a lack of confidence in the underlying business case. Answers beget more questions, and the work can go on and on. To prevent endless iterations on the project plan, the project team must follow a rigorous process to develop the project business case. Ideally, there is a business analyst on the team who can, throughout the project life cycle, keep track of profitability and ensure that a project still makes economic sense. This process should take place in a dedicated war room where comprehensive analysis of each component is displayed visually, so the components may be challenged independently. This creates transparency on input data, assumptions, and risks, and provides a forum for joint problem-solving. Ultimately, it ensures the business case is robust and enables informed decision making when the project is presented for capital approval.

The owners of a major rail expansion project used to transport a commodity product successfully employed this approval process. Their project war room contained the global demand forecast for the relevant commodity, a view on feasible transport

tariffs, and the outcome of client interviews on probable commodity production volumes. Approvers could review and agree on the business assumptions, which expedited the capital approval process. By spending the time on the development of a robust business case, the project team shortened the approval cycle from three months to one month and improved the likelihood of good financial returns.

#### **Use standardization and modularization to shorten schedules**

The two PVI levers of standardization and modularization bring cost and schedule benefits.

***Standardization*** saves time by replicating proven designs, which reduces the need for engineering and troubleshooting during commissioning. Too often owners and contractors rely on custom solutions instead of proven and tested standardized approaches. A basic-materials company that was engineering and constructing between five and 15 plants each year, for example, achieved 70 percent standardization by using modular architecture, and the payoff was enormous. In addition to a 15 percent reduction in lead time, the company achieved 50 percent savings in engineering costs through standardized drawings, 7 percent savings on manufacturing the standardized modules, a 10 percent decrease in project management costs because of the routine nature of the work, and a 60 percent decrease in costs associated with rework and quality defects.

***Modularization*** has multiple schedule benefits. Because it requires increased up-front engineering, it cuts down on surprises and rework during construction. It allows for the prefabrication of modules in a controlled off-site environment with improved labor productivity. In addition, multiple modules can be prefabricated in parallel in different workshops, shortening the overall construction schedule. Moreover, off-site prefabrication cuts down on construction-site congestion, yielding safety and site productivity benefits. Modularization also allows pretesting prior to shipping, which

minimizes costly rework on site. In a recent case, a chemical company expedited its project schedule by five months, or by about 10 percent of the total project time. Ninety percent of the time savings came from its choice to modularize key components of the project.

Exhibit 2 shows the impact of modularization on an overall project schedule. To capitalize on these obvious schedule benefits, project teams must invest time and effort in PVI by identifying standardization and modularization opportunities.

### Continue using PVI techniques during construction

In our extensive experience, project professionals rarely employ PVI techniques during construction. Rather, they spend most of their efforts fighting fires and reactive problem-solving. Meanwhile, interface

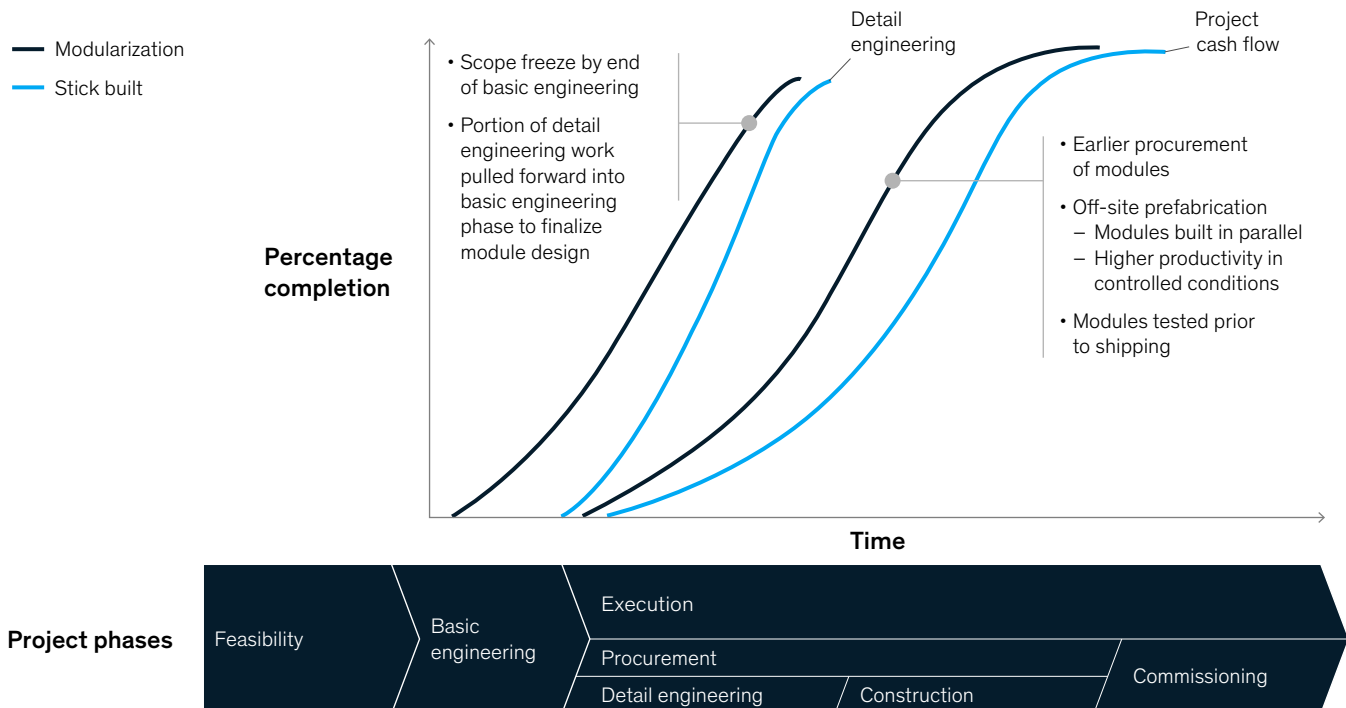
complexity, poor productivity driven by seemingly conflicting priorities, and heightened commercial tension among parties often result in substantial delays and cost blowouts.

The trick is to stay ahead of the construction curve and deploy PVI continuously through a project's life cycle—especially during construction. Doing so can significantly increase the odds of successful delivery and enhanced productivity. Regularly scheduled acceleration workshops can be extremely successful. For example, a travel company recently reduced its schedule by 10 percent (more than two months), resulting in a multimillion-dollar increase in earnings before interest, taxes, depreciation, and amortization (EBITDA)—all from a two-hour workshop.

Indeed, to continually optimize schedules, project owners must employ PVI techniques throughout the entire project. There are multiple techniques that

Exhibit 2

### Modularization can lead to faster and more profitable project completion.





may not come naturally to project professionals but that can help them get the most out of their projects in the execution phase.

### Integrate horizontal and vertical schedules

By nature, large capital projects are complex and need to be broken down into meaningful work packages for efficient management. Moreover, the involvement of contractors, subcontractors, and vendors creates multiple interfaces. Thus, the planning team must ensure the schedule is integrated horizontally along the project life cycle and vertically from owner to supervisor to crew. Inputs from commissioning and operations teams should be incorporated in the integrated schedule, allowing management to focus on the overall critical path and find optimization opportunities.

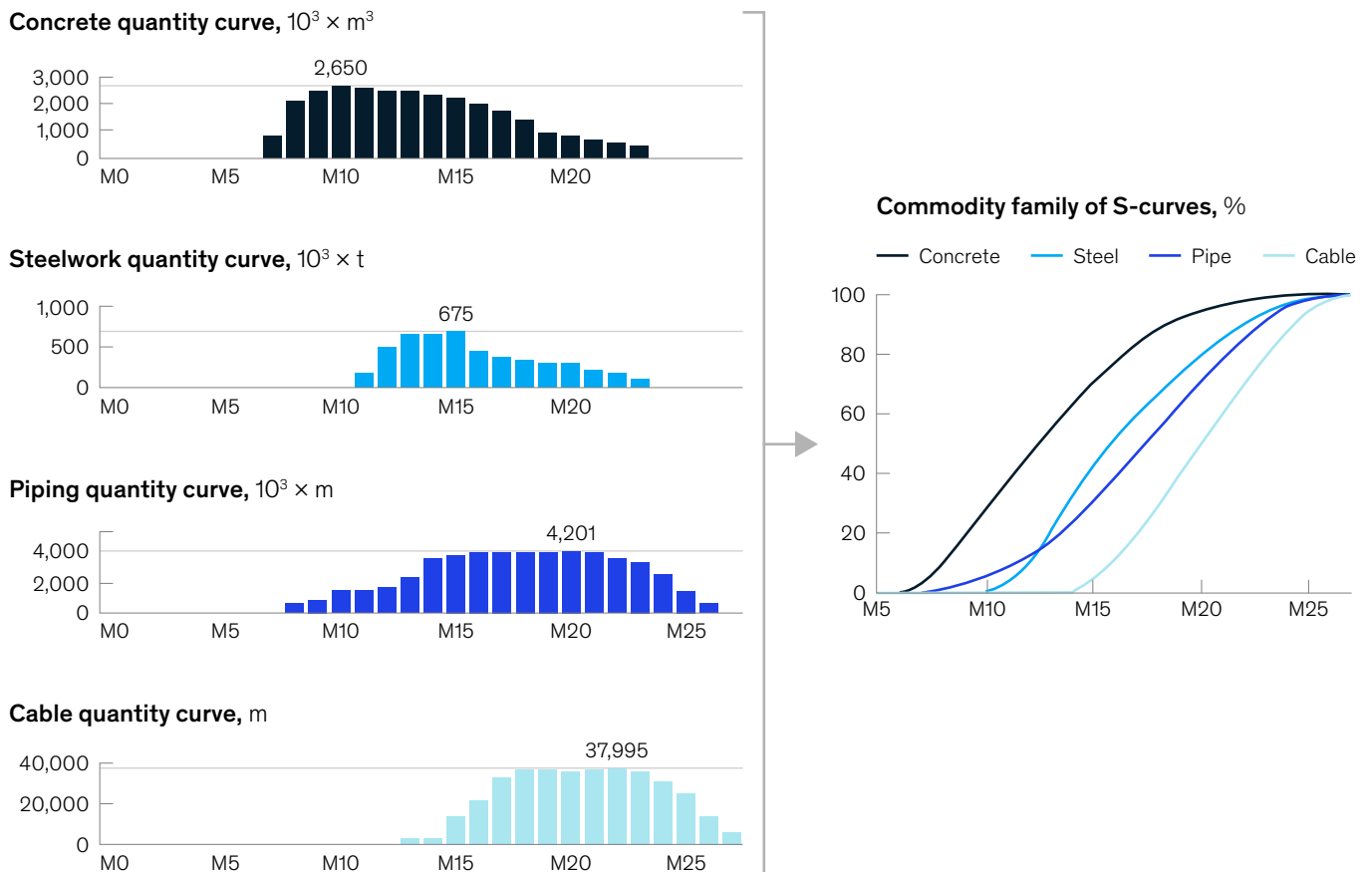
Exhibit 3 shows the construction commodity S-curves of respective trades must follow the construction execution sequence. In other words, the trades must follow each other in a logical order and slightly overlap. Concrete work must be followed by piping and civil engineering, which is then followed by electrical work—and contractors should be staggered in a way that allows them to follow each other as quickly as possible.

### Involve commissioning and operations teams early

The most successful project managers ensure the commissioning schedule drives project execution, and they encourage regular checkpoints with commissioning and operations teams throughout the construction phase. It is common to see only

Exhibit 3

**The typical commodity curves for any given project must follow a specific sequence.**



25 to 30 percent effective wrench time—that is, the share of tradesmen's time doing productive work—of construction crews in late-stage construction. Well-proven, lean construction techniques and routines can improve effective wrench time during precommissioning and commissioning stages. Driving process rigor and simple interventions for handover documentation can help mitigate delays in achieving milestones. Changing the equipment testing logic from sequential to parallel can accelerate the learning curve before integrated start-up. And project teams should regularly stress test and review the assumptions and granularity of their production ramp-up plans—the optimal frequency of these tests depends on the scale and duration of a project but should happen once a quarter for most large projects.

#### **Implement frontline coaching**

Best-in-class companies emphasize building frontline staff capabilities. Simple coaching cards can act as checklists and help supervisors and crews spend their time on value-adding tasks. In

the evolving world of construction, it is imperative for both owners and contractors to collaborate in upskilling their staffs and invest in the industry.<sup>3</sup>

---

While many project owners may think it is too late to make meaningful changes once the project reaches the execution phase, in our extensive experience that is not the case. Yes, it is important for project owners to ensure scheduling and planning basics are in place at the start of a project, and before implementing analytics. They must also spend time on PVI during up-front project planning.

But with few exceptions, capital projects owners can add rigor and discipline to their processes now, without hiring any additional contractors or spending extra resources. They will never correct cost and schedule overruns without first making some common-sense changes. And these changes can be made at any point in the life of a project, from the preplanning stage through construction.

---

<sup>3</sup> For more on meeting challenges during late stages of project execution, see Tom Brinded, Raja Sahulhameed, and Andy Thain, "Accelerating late-stage construction: Mastering the sprint finish," February 2019, McKinsey.com.

**Tushita Garg** is an alumnus of McKinsey's Toronto office, where **Piotr Pikul** is a partner; **Charlene Pretorius** is an alumnus of the Johannesburg office; and **Rebecka Pritchard** is a consultant in the Atlanta office.

Copyright © 2020 McKinsey & Company. All rights reserved.