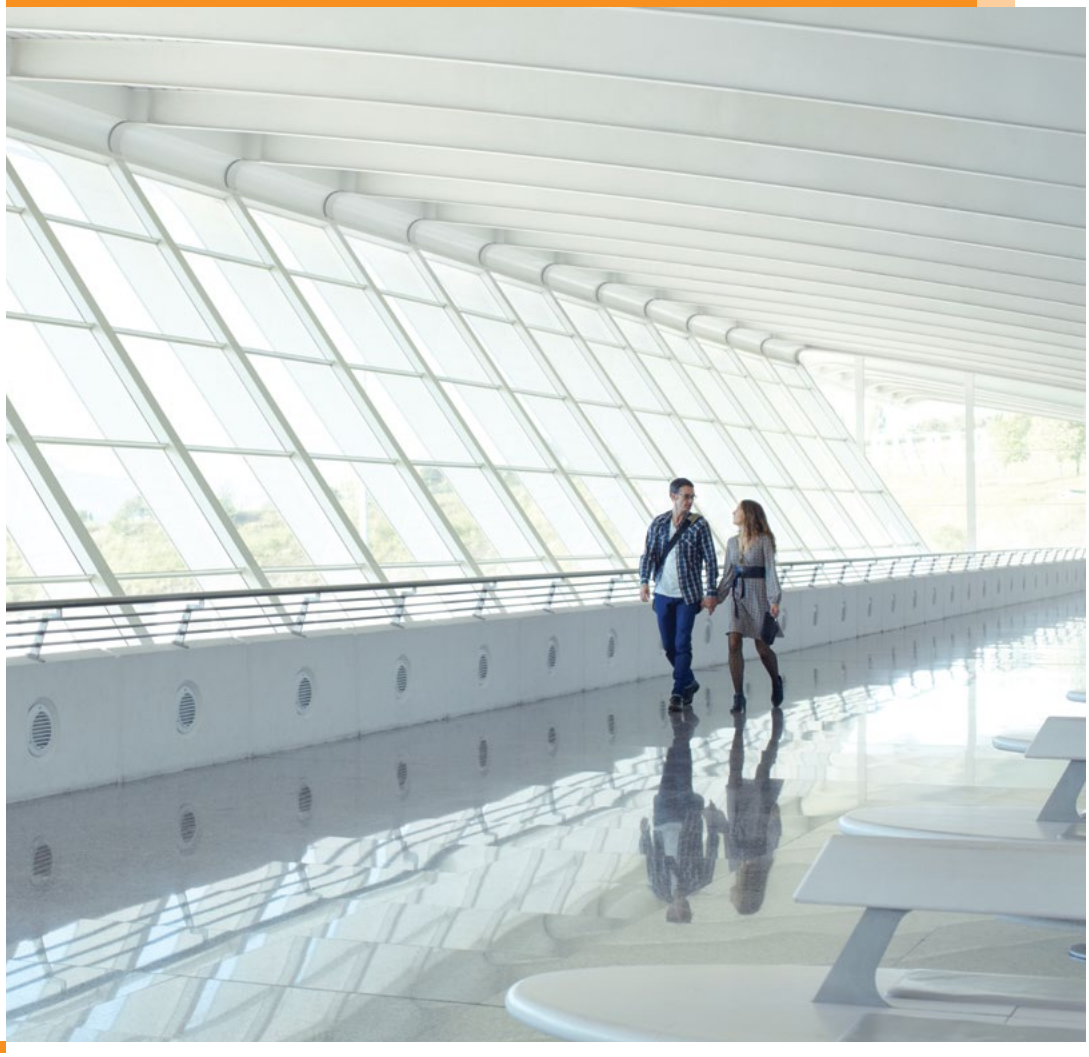
Risk management and schedule control on mega-projects



pwc

Schedule analytics and risk management

What is at risk

Construction projects are inherently risky. Managing this risk is essential and, like any other important management or oversight function, it is either done well or it is a wasted effort that can risk everything.

What the engineering and construction (E&C) firm can't always know is every unique risk you will face with any given project as the design complexities, geographical influences, and stakeholder forces come into play. This can involve many parties, risks and challenges, such as technology development, skills shortages, cost and time uncertainties, governance and accountability issues. These risk areas are in addition to increasing regulatory focus.

E&C firms have focused on improving governance structures in recent years, yet too many projects still fail to deliver on cost, schedule or quality commitments. The consequences of failure can be public embarrassment and disappointed owners as well as financial, so getting an independent view on how to manage risks can be critical.

What you can do

Exposure to risk cannot be avoided, but it can be managed. Many E&C firms that have been exposed to the consequences were not fundamentally reckless. They simply had not taken effective measures to protect themselves, by implementing a proactive and comprehensive program that considers a company's culture, training, policies and controls.

If you accept that risk management is a top success factor in construction, then you should prioritize the investment you make in independent internal or external project oversight. Also, consider that the risk you face is multi-dimensional and shifting, requiring an agile, multi-disciplinary management and oversight plan.

Helping your project deliver on its promise

Establishing systematic controls and processes is made difficult by the nature of large-scale and mega-projects. Essentially they are hybrids in terms of financing, procurement, delivery, management, operation and ownership. As a result, unique systems and controls are required for each project to enable E&C firms to deliver the promised short- and long-term value to owners.

Effective monitoring and decision making on mega-projects requires institutional systems, governance and procedures that promote accountability and transparency at all stages of reporting and control. And, while accurate and timely information is essential to controlling risk, it cannot be achieved without open and transparent systems and oversight that flesh out human factors such as optimism bias, systematic underestimation of costs and durations, and overestimation of benefits and opportunities. Schedule analytics and risk management systems address these concerns and assist in ensuring that projects deliver as promised.

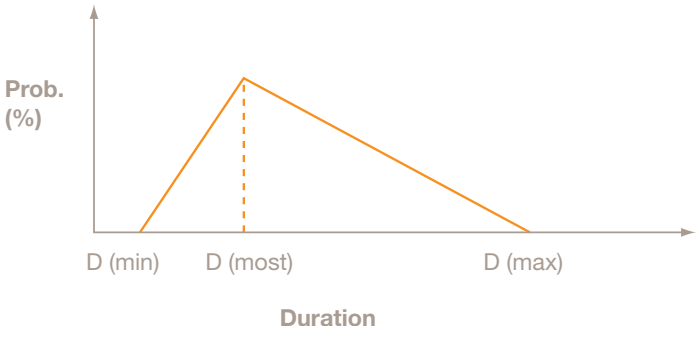
Taking effective measures

To identify and manage risks, PwC recommends the use of proven risk management, project management and dispute avoidance strategies during the project development, design and construction phases from a third-party point of view. These systematic processes assist in making informed decisions while breaking down boundaries between the owner, designer and contractor teams to proactively reduce the threat of delays and events which cause disruption, cost overruns and disputes. PwC combines our experience with analytic tools to provide clients thorough risk management services. The success or failure of a project depends on aligning a client's appetite for risk with their risk management and project governance policies and procedures. Traditionally, engineering procurement and construction (EPC) project management staff have applied risk management instinctively, with risks remaining implicit and managed by judgment informed only by experience.

Systematic risk management, combined with analytic Critical Path Method (CPM) scheduling tools, explicitly and formally identifies risks and provides a management tool that supports objective, fact-based decision making and informs one's instinctive judgment.

We work with our E&C clients to apply proven risk analysis techniques, employing appropriate quantitative modeling tools customized for each project and/or client. Our pragmatic, hands-on approach to risk management and the associated technology allows us to effectively communicate the potential outcome of projects, and their most influential risks that need to be managed or eliminated at the earliest opportunity.

When risks or delays are being experienced, PwC can perform root cause analysis.



This analysis uncovers hidden risks inherent in procedures, processes, contract terms, or performance that often lead to cost and time impacts. Once identified, risk management plans and processes are developed, along with actions to remove or reduce any threats to a successful project. Additionally, risk and opportunity go hand-in-hand and systematic risk management often results in the identification of opportunities for adding value to a project.

Typical risks in large-scale or mega-projects include:

- Changes in project scope and requirements
- Overcoming regulatory concerns
- Design delays, errors and omissions
- Inadequately defined roles and responsibilities
- Insufficient skilled labor
- Financial stability of subcontractors and suppliers
- Inadequate management experience
- Unstable relationships among project participants
- New technology or novel construction techniques
- Unfamiliarity with the local cultures or conditions
- Uncontrollable events / force majeure

Given the unique requirements of large-scale and mega-projects, the benefits of early formal risk management are many; a few more tangible benefits are listed below:

- Selection of most appropriate contract form
- Establish optimum contingency strategy
- Establish most appropriate risk distribution
- Reduced premium for insured risks
- Reduced disputes
- Increased owner awareness
- Increased potential of successful projects

Getting started

PwC has developed a methodology and a set of tools that help us move easily from risk assessment to controls to reporting and remediation. These principles can be tailored to any size E&C firm or project and any size exposure.

Our experienced construction and controls professionals have advised numerous clients undertaking major projects with all aspects of the control environment. Using the risk management framework illustrated below, we separate the project or project portfolio into a number of elements.

- **Organizational framework**—including the project organizational framework and structure, oversight, roles and responsibilities of key members of the project management team and skills gaps.
- **Systems and technology**—the tools used to support project control and management functions, relevant enterprise-wide and corporate systems.
- **Procurement and contract management**—including contracting strategy and procurement methods for vendor contracts. Evaluate vendor and contract management practices and processes.
- **Scope and change control**—evaluate how changes to scope are managed, controlled and approved including the methods of costing change; analyze how the changes are monitored against budget.
- **Financial management**—including estimating, budgeting, forecasting, monitoring actual spend against budgets and payment application approval process.
- **Schedule management**—assess what control processes and procedures are in place to guarantee schedule accuracy and completeness, what methods are used for progress measurement, and how schedule issues are managed.
- **Issue and risk management**—including identification, analysis, mitigation planning and monitoring/control, as well as the tools utilized to manage risk.
- **Communication and reporting**—including internal and external communication tools, reports, status updates, project issue tracking and reporting methods. This element includes the quality of reports provided to the regulator.

Project elements	Project life cycle					
	Planning	Design	Implementation	Testing	Turn-over	M&O
Organization design & HR management	Project management plan and staffing			Staff reductions/ transfers	Operations staff planning	Ongoing requirements/ skills review
Procurement & contract management	External contracting options	Vendor qualification RFP process EPC contract evaluation	Vendor selection contracting	Contract compliance review	Trouble-shoot & punch list	Vendor qualification/ selection
Scope & change management	Definition of project elements and benefits	Design project components (phase 1 transition plan)	Change control process		User acceptance process	Operations acceptance process
Cost management	Capital budgeting and ratemaking approach	Cost & schedule forecast	Cost control		Final payment/ retention release	M&O budget process
Schedule management	Project schedule requirements	Baseline project schedule (WBS & pre-deployment schedule)	Detailed schedule management		Schedule completion check list	Ongoing maintenance schedule
Business systems & technology	Project purpose funding & approval	Business needs assessment & technology framework	Integration & executive oversight		Continuous improvement and reasonableness reviews	
Risk & issues management	Project risk & issue management planning	Risk & issue tracking & resolution			Confirm issue resolution	Ongoing issue management process
Communication, reporting & regulatory requirements	Project reporting requirements (project communication strategy)	Project status and regulatory filings	Project cost, schedule & budget variance	Project quality performance	Project close-out performance	Financial reporting

Schedule analytics

To achieve quality and transparent reporting, schedule analytics should be employed and balanced with hands-on experience. Quantitative schedule analysis is used in mega-project management and assessment to evaluate the integrity, nature and compliance of the active schedules produced by the project team. Qualitative schedule analysis provides us, and our clients, insight into the E&C firm's ability to comply with schedule provisions, accurately model the contractual scope, and transparently report intentions, critical tasks, interface dates and milestones. In short, it provides timely reporting of progress actually achieved.

Generally, over-the-counter software compares two schedules or updates and provides diagnostic and integrity reports based on changes made between them.

PwC uses a proprietary tool to extract data from third-party, industry-accepted software databases and organize it into a manageable, transparent reporting format.

Results of the analysis provide an indication of:

- The underlying schedule design and integrity;
- The dynamic nature of the project and supporting schedules; a comparison of any individual schedule against the entire schedule catalogue; and
- A comparison of the schedule catalogue and trends against a number of relevant industry standard metrics.

A quantitative analysis should not be considered in isolation and should form part of an overall schedule assessment that includes an evaluation of the general control environment, the nature of the schedules and the underlying processes and procedures.

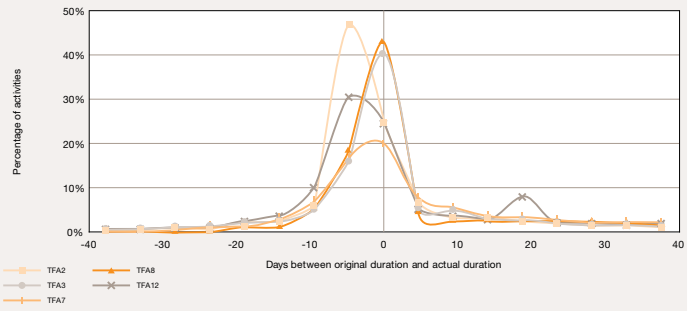
PwC's analytics track parameters, such as duration variance, (see top right) as well as several other integrity and performance indicators:

- Constraint analysis
- Mandatory constraint analysis
- Free float constraint analysis
- Open end analysis
- Criticality summary
- Float density analysis
- Duration variance

When combined with our qualitative analysis, our schedule analytics provides our E&C clients with the transparency and information needed to determine if the information provided by their schedules is accurate, reliable and credible for the purposes of critical decision making.

Duration variance

Description	Observations	Recommendation
This chart illustrates the difference between Actual Durations and Original Durations for a number of schedules.	The curves generally illustrate lower actual durations than planned. This is a good indication that schedules are not overly aggressive and may be achievable. However, it may also indicate embedded activity contingency.	Duration variances should be monitored. The TFA2 and TFA8 schedules show high variability in original and actual durations and should be further investigated.



Notes	This analysis is performed on activities (Task Dependent), with an Actual Duration greater than 0 and with a "Completed" activity status.

Often, projects require re-baselining. Too often, E&C firms attempt to use re-baselining as a technique for sequestering float, or preventing comparison of actual performance against original baseline, or intended performance.

Criticality summary provides visibility into which areas of a project or program have float. Float is an integral part of critical path method scheduling and project management, and is a relative, quantifiable value which can and should be treated as a resource, like money. Time is a finite resource, which can be used to:

- identify slippage that is occurring to an activity or sequence of activities;
- identify critical paths, sub-critical paths or concurrent critical paths;
- allow re-sequencing of activities to mitigate pre-existing delay;
- identify areas where acceleration will most efficiently benefit the project; and
- allow re-sequencing of activities to reduce or avoid disruption due to discontinuity of work, adverse weather or seasonal conditions.

Constraint analysis allows our team to identify manipulation of the schedule and systematic optimism bias by project teams that are preventing true critical paths to emerge and be managed by the project team. Float can easily be manipulated to enhance a project team's ability to gain an extension of time for completion through the use of various float suppression techniques, for example:

- Preferential logic;
- Excessive lead/lags;
- Excessive use of date constraints;
- Zero total or free float constraints; and
- Extended activity durations.

Altering activity durations or historic as-built start/finish dates is the simplest method of float sequestering. It is also the simplest to detect, but requires diligent adherence to schedule management and review procedures.

The PwC difference

PwC has the skills and experience to provide **independent** advisory services on, and the assessment of, large-scale and mega-projects.

Our E&C and Capital Projects & Infrastructure (CP&I) professionals provide services related to the full value chain of acquiring, financing, investing in, planning, designing, procuring, constructing/implementing, commissioning, operating and maintaining complex, medium- to large-scale greenfield or brownfield capital assets, programs or portfolios.

We bring our clients:

- Independent and objective insight;
- A strong foundation of knowledge of leading practices for mega-project governance structure and control environments;
- Bench strength that allows us to provide continuity of our core professional team;
- An outstanding team of experienced resources comprising engineers, nuclear engineers, accountants, project management professionals, and IT and other professionals who provide advisory services to regulated utilities;
- Direct experience working with clients, such as E&C firms, public utilities and private companies, as an independent advisor on major capital projects subject to reasonableness review, oversight and governance legislation;
- Specific, deep regulatory experience supporting E&C firms and utility clients on rate cases and regulatory proceedings related to nuclear plant construction and other major capital projects, including providing fact and expert witness testimony before public utility commissions;
- An extensive network of external technical professionals that we can employ, internally, with specific technical skills if and when needed; and
- An unwavering commitment to our clients to plan and manage our work at the appropriate level of professional standards with a consistent focus on cost control, timely product delivery and overall efficiency.

Additionally, using experience and lessons learned from our extensive claims, dispute avoidance and resolution services, (i.e., knowledge of how things go wrong), we apply proven strategies and systematic processes to identify and monitor risks to the project, and specifically to the schedule.

PwC can address a wide scope of project risks as needed through our global network of E&C and CP&I professionals.

Program governance, fraud, and ethics

Project management and project controls

Risk management, security and safety

Managing cost and schedule

Technology design and implementation

Public-private partnerships

Country-specific risk

Impact of government stimulus funds

Regulatory requirements

Environmentally safe construction

Serving a variety of stakeholders

To bring value, your advisors must have an extensive and full range of experience across risk areas, disciplines, industries and geographies as well as the perspective born from working for many types of project stakeholders.

This multi-dimensional concept is at the heart of the PwC difference.

For our E&C clients, this means PwC's perspective and experience will extend beyond the members we assign to your immediate engagement team to include not only construction advisors, but also a wide variety of seasoned industry professionals with expertise in all types of capital projects.

Below are some examples of construction advisory and risk management services we have provided to government entities, owners, developers and E&C firms:

- Assessments of project risks from concept development through project close-out;
- Compliance audits and forensic accounting at interim and close-out milestones;
- Cost variance analyses, schedule reviews, and change order analyses;
- Claims management, analysis, and resolution (including early assessments of filed claims to determine information requirements and options for risk mitigation);
- Assessments of project management control tools and procedures, with an emphasis on accountability, transparency and audit trail;
- Project accounting and controls for jobs in progress;
- Assessments of document and data management procedures and protocols including integration with project collaboration systems and other applications to address contract performance (e.g., cost, schedule and labor/equipment productivity);
- Developing uniform global policy protocol for project management and document/data control procedures;
- Strategic consulting for commercial negotiations or other forms of alternate dispute resolution; and
- Litigation support and expert testimony.

PwC can address a wide scope of project risks as needed through our global network of E&C and CP&I professionals:

PwC's approach to managing risk is focused on assisting E&C clients to establish cost-effective management of their projects, improving their financial performance and avoiding or settling contract disputes. Seasoned professionals with hands-on experience bring to each engagement the practical knowledge gained as contractors, engineers, planners, accountants, estimators, subject matter experts and project managers.

Advice to assess the planning, management and delivery of large-scale projects for the engineering, procurement and construction sectors

Program design

Project structuring & financing, including:

- Specification
- Risk analysis
- Contract structuring
- Financial structuring
- Procurement strategy
- Advising on debt/equity, restructuring and tax advice.

Independent and ongoing evaluation of risk, project governance and control structure

- Monitor and assess project risk and controls structure on a periodic basis.
- Evaluate risk management processes.
- Perform ongoing metrics evaluation and trend analysis focusing on project completion.
- Provide observations to senior management regarding the strengths and weaknesses of the project governance as compared with leading industry practices.
- Identify control gaps and assist in development of recovery plans.
- Serve in an ongoing advisory role to senior project management to identify issues, trends, and potential mitigating actions.
- Provide periodic reports to document observations and mitigating actions taken by the project management team.

Contract administration support

- Review control structure to monitor and evaluate data supplied by vendors for completeness, accuracy, and compliance with contract terms.
- Provide outside expertise to support dispute identification and resolution process. Provide specific contract audit support. Research industry operating experience and provide subject matter expertise.

Regulatory support

- Review and advise on monthly status and semi-annual construction monitoring filings (consistency, completeness).
- Evaluation of decision support criteria available for regulatory review.
- Review control processes to help ensure adequate information is gathered to support required audit trail and validation.
- Provide support on discovery requests from owners.

Project execution support

- Provide subject matter expertise to monitor and advise in the area of vendor/subcontractor quality oversight such as prototype testing, acceptance criteria, documentation requirements, etc.
- Provide subject matter expertise to monitor and assess the schedule performance of the project.
- Monitor and evaluate the logistics plan for the project.
- Contract reviews
- Regulatory support
- Internal audit support/ advice
- Asset management and benefit realization
- Disputes and investigations

PwC's E&C and CP&I practitioners have a broad base of experience in domestic and international capital projects including:

Airports

Power plants

Pipelines

Processing plants

Manufacturing facilities

Transportation projects

Medical facilities

Mining (exploration and production)

IT system development and implementation

Oil refineries and off-shore platforms

Dams

Office and retail buildings

Sewage and water treatment plants

Electric transmission and distribution

Refineries

Sport complexes

Correctional facilities

Examples of our experience

Project experience

The strongest demonstration of our abilities is to provide examples of work performed for other clients and other projects that are similar in scope, approach, and deliverables. We have provided internal audit and capital projects advisory services to several utility clients and other industry clients with similar issues. Provided below are examples of our credentials, presented in terms of the specific work performed for other clients.

Major LNG facility constructor
Evaluation of global LNG facility construction program

PwC provided continuous external project assessment services to a major LNG facility constructor in relation to its LNG construction program. To date, PwC has completed project assessments on projects in China, United Kingdom, Peru and Angola. The project assessments have involved detailed assessment of the project control tools implemented on projects related to cost, time and change control to identify areas of risk, and advised on opportunities for performance improvement.

Representative project experience

Below are additional examples of our direct experience supporting our clients in a variety of engagements. Further client experience can be provided upon request.

Company	Project type	Description	Summary
A company specializing in the engineering and construction of large steel structures	Engineering & construction	Project assessment and recommendations to enhance and/or standardize processes and procedures	PwC provided continuous external project assessment services to this company in relation to its construction operations. These assessments involved detailed evaluation of the controls in order to identify areas of risk and opportunities for performance improvement. PwC also helped evaluate their global project management functions, including global project controls assessing the functions' effectiveness and providing recommendations for performance improvement. The global engineering review included assessing performance and effectiveness of global engineering capabilities related to large-scale engineering procurement and construction programs. Policies, processes and procedures associated with engineering management were assessed. PwC presented recommendations to enhance and/or standardize process and procedures to help engender consistently high performance across all global engineering offices.
A major US utility company	Energy/utilities	Governance readiness review	A major US utility was finalizing its plans to construct new plants costing several billion dollars. Working in a highly regulated environment, the client recognized the importance of a strong control environment to manage the project. The client requested a governance readiness review to determine whether its systems and controls could support a project of this magnitude and complexity. The PwC team delivered a comprehensive picture of the project's risks and controls throughout different stages of the project's life cycle. We also worked with the client to set up the control environment, which involved leveraging data management specialists to develop a system to track the project estimate to complete. We helped our client build a risk and issue management system, develop a master schedule of all project work, and establish a reporting framework for communicating the status of key project metrics to management and regulators.
A biotech real estate developer	Real estate investment trusts	Project management	The client's rapid growth had led to a lack of consistency in how it managed development real estate projects. Based on PwC's review and recommended solutions, the client is now benefiting from additional efficiencies due to increased visibility and improved information flow throughout the company. Regional offices are better aligned under a cohesive, consistent project management governance framework, and new reporting metrics give executives real-time insight into their operations. As a result the company has improved control of projects and is better equipped to foster further growth under a new, more structured approach to project management.

Company	Project type	Description	Summary
An integrated energy company	Energy/utilities	Project delivery model, contract requirements and construction management	PwC worked with this utility company during the initial stages of a major engineering and construction project, to repower a gas-fired power station. PwC helped the company address and craft the project delivery model and assisted in drafting the details of contract requirements and setting the proper expectations and terms. PwC also assisted this client with two other major capital engineering and construction projects from a project management and governance perspective, which included providing detailed recommendations for performance improvement in the areas of organization, people, policy and procedures and systems. Further, PwC assisted with the strategy and development of standardized approaches to the execution of large-scale engineering and construction projects at the portfolio level.
A major oil company	Energy/utilities	Capital project advisory services	PwC provided capital project advisory services to a major down-stream oil and gas client who is undertaking a multi-billion-dollar project to increase its production capacity. The project is high profile and a similar such undertaking has not occurred in North America in the past 30 years. PwC was retained to provide subject matter expertise on project management control tools and procedures for large-scale capital projects.

www.pwc.com/us/capitalprojects

The PwC difference

We believe PwC is uniquely positioned to provide independent advisory services on, and the assessment of, large-scale and mega-projects. Our Engineering and Construction practice comprises nearly 5,300 professionals who serve more than 20,000 engineering & construction companies around the world. Our Capital Projects & Infrastructure specialists provide services related to the full value chain. This includes acquiring, financing, investing in, planning, designing, procuring, constructing, commissioning, operating, and maintaining complex programs or portfolios.

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