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Building More Value With Capital Projects

How to drive higher returns through data-driven digitization

Management Summary

Digital initiatives are no longer a novel concept. The construction industry has made impressive investments in digital programs—particularly among owner-operators and global engineering, procurement and construction companies (EPCs). To enable greater business transparency and agility throughout the value chain, companies today are implementing new architectures and approaches to harness technology innovations. These innovations are intended to improve key project indicators related to cost management, delivery cycle time and resource productivity, but our study found this is only happening a third of the time.

Data-driven insights play an integral role in creating various digital solutions (for example a 'digital twin'). Owner-operators are already using big data analytics to predict market trends, optimize commercial viability ahead of design as well as for predict project performance. In addition, EPCs are using data to build logistics control towers and digital twins that digitize asset and site layout designs.

Few executives would dispute the critical importance of having reliable and transparent data to enable a highly trusted, collaborative decision making process for project planning and execution—especially during the Covid-19 crisis.

Our latest Capital Projects research examines where owner-operators and EPCs are in their journey of data-driven digital transformation, their challenges, and the differentiated actions adopted by some of the most progressive companies during 2015-2019.

The insights, derived from over a million data-points, are based on:

Analysis of Accenture's Capital Projects 2020 survey of 570 executives from large owner-operators (exceeding revenues of USD1 billion), located across 20 countries, spanning asset-heavy industries such as Aerospace & Defense, Chemicals, Industrial Equipment, Metals & Mining and Oil & Gas, as well as the Public Infrastructure sector, amongst others. An additional 140 are responses from senior executives from global EPCs with combined 2019 revenues of over US$1 trillion.

In-depth discussions with nearly a dozen academic experts and senior industry experts representing owner-operators as well as EPCs.

Analysis of publicly available financial data of surveyed companies toward identifying progressive companies amongst the cohort of owner-operators and EPCs.

Regression analysis for determining the potential impact of differentiated actions being undertaken by progressive companies on financial performance of owner-operators and EPCs.
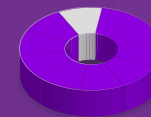
The Digital Transformation Value Gap

Clearly, owner-operators and EPCs are deeply committed to data-driven digital transformation. Nearly nine out of ten companies say they use average or good quality data and invest significantly in digital technologies. However, 2/3rds are not achieving the desired benefits.

From our perspective, the two biggest missteps include:

1 A strategic failure to build the right operating environment and incentives to create a data centric culture.

2 An inability to operationalize data and technology for more effective decision-making as well as completion of projects on time and within budgets.

How can owner-operators and EPCs create the right operating environment for each other to effectively realize the full benefit of their data-driven digital transformation initiatives?

9 out of 10 owner-operators and EPCs use average or good quality data for their recently executed capital projects

Only a third of the companies reported success around many of the key KPIs.
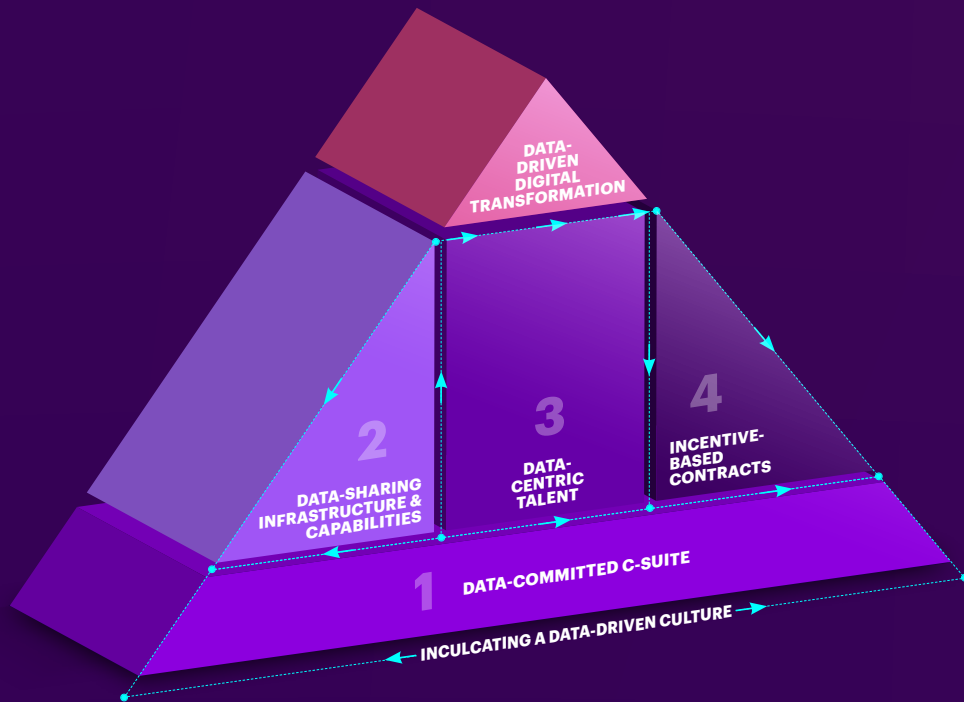
Prepare to reinvent collaboration

Data-driven digital transformation in capital projects is a journey, not a sprint. Our new framework for the industry—Capital Projects Strategic and Operating Network—CAPSTONE—helps owner-operators and EPCs reinvent collaboration to effectively use data and unlock the full value of their digital transformation. CAPSTONE works on the network effect—the larger the number of people using data and analytics in capital projects, the greater the value release for owner-operators and EPCs.

Our research shows that integrating elements of the CAPSTONE framework can grow the operating margin of EPCs by an additional 5.8 percent and can give owner-operators an incremental 6.6 percent return on their capital investment.

The CAPSTONE framework comprises four action-based elements:

1 Data-committed C-suite: With abundant data now being accessible, C-suite across owner-operators and EPCs must be committed to infusing a culture of data-ownership, data-sharing and data-driven decision-making with a focus on unlocking innovative and real-time value.

2 Data-sharing infrastructure and capabilities: Owner-operators and EPCs must align their investments across relevant technologies (such as drones, design automation, reality capture, IIoT), digital assets (such as data lakes and cloud-based platforms) and digital capabilities (such as intelligent estimation and cognitive supply analytics) for building contextual data-stacks and mutually beneficial solutions across the project lifecycle. For instance, building digital twins of capital projects can enable owner-operators and the EPCs to collaborate and detect problems early on to minimize defects and delays.

3 Data-centric talent: Data-stewards within owner-operators must facilitate timely and intelligent use of data-driven insights toward addressing schedule management, productivity and regulatory issues having the potential to distract EPCs from executing on the plan. EPCs, on the other hand, must engage data coaches to upskill the on-ground workforce and to extinguish resistance within the workforce to on-site data-use thereby driving improved project outcomes relevant to owner-operators.

4 Incentive-based contracts: Both owner-operators and EPCs must structure contracts that incentivize project stakeholders (suppliers, sub-contractors) to make collaborative use of data-based insights, toward achieving their financial as well as non-financial goals (such as lower climate footprint, inclusion and diversity).

We believe CAPSTONE will work, as its first three elements are based on the differentiated actions undertaken by a larger proportion of "Outperforming" owner-operators and EPCs. (A full explanation of the methodology followed to identify Outperformers is discussed in the section titled: About the Research). And the fourth element—incentive-based contracts—with a huge potential, has started gaining acceptance amongst Outperformers.

CAPSTONE is going to be a challenging experience. Yet, it signals a historic opportunity for owner-operators and EPCs to nurture symbiosis. Organizations that bravely orient with CAPSTONE will drive better data-driven engagement of their workforce and project stakeholders and increase shared rewards. And fortune favors the brave. Read this report to see how.

Capital Projects embrace 'Big Data'

Owner-operators and EPCs realize the integral role that data-driven insights play in the digital transformation of their capital projects. Nearly nine out of ten companies we surveyed used average or good quality data in recent projects. But that's not enough to get the most business value, especially in a Covid-19 scenario.

The capital projects industry is staring at a new set of challenges amid the Covid-19 pandemic. Loss of efficiencies due to sudden shutdowns and delays are forcing Owner-operators and EPCs to explore new methods of delivery.

Owner-operators would like their ongoing project to be commissioned on schedule, while keeping final investment decisions on hold for new projects. EPCs already exposed to cost-escalation and project scope-adjustments are being compelled to infuse high levels of productivity and business improvements to deliver projects on time and within costs.

Clearly, it is time for owner-operators and EPCs to reinvent their partnership to survive and thrive during this unprecedented crisis.

Data-driven insights—built and shared with the help of digital technologies—can come to their aid. Such insights can serve as a single source of truth and provide an integrated view to avoid mistakes or rework. They can enable better allocation of assets and talent for improved productivity, helping to complete projects on time and within budget. In short, data-driven insights can become the bridge of trust-based collaboration between owner-operators and EPCs.

To help build this bridge, Accenture's Capital Projects study of 710 global senior and C-level executives examined the data-driven digital transformation journeys of owner-operators and EPCs between 2015 and 2019. (More details about the survey can be found in About the Research section towards the end of this report).

Impact of Covid-19 on capital projects

61 percent of the owner-operators expect capital projects for which final investment decision was pending pre-Covid-19 to be delayed or put on hold.

34 percent of the EPCs expect escalation in costs and 35 percent expect project scope to be adjusted due to Covid-19.
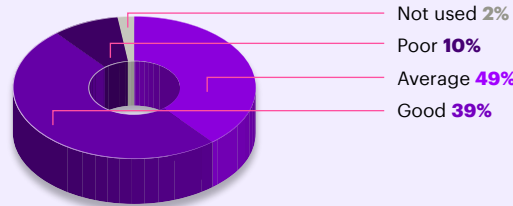
51 percent of the owner-operators and 55 percent of the EPCs expect their investment in business improvements (skills and processes) to get delayed as a result of Covid-19.

Our analysis shows that approximately 9 in 10 owner-operators claim to have used average or good quality data for their recently executed capital projects.

Figure 1a: Data construct

Extent of data usage by owner-operators

Not used **2%**
Poor **10%**
Average **49%**
Good **39%**

Executives also claim to be making data-driven insights an integral part of their digital initiatives. Seventy-five percent of the owner-operators use big data analytics to predict market trends and optimize commercial viability ahead of design, with data lakes from existing project portfolio for benchmarks. And 79 percent of the owner-operators build robust data analysis for predictive project performance forecasting and real-time project decision support.

A similar proportion of the owner-operators invest in a collaborative digital environment for robust data/document, configuration, engineering design and operational management.

What's more, this finding resonates with the academic literature, acknowledging extensive collection and usage of data by capital projects participants.

EPC companies also claim to be doing well when it comes to usage of data for improved efficiency at the site, as well as for better management of processes across the project value chain.

FIGURE 1b: Data-led project management and execution

Extent of data usage by EPCs

Not used **2%**
Poor **9%**
Average **50%**
Good **39%**

EPCs are especially good at deploying data-based insights for their logistics control tower and building digital twins. Seventy-nine percent of the EPCs are deploying logistics control tower for logistics tracking, materials management, warehousing and people logistics. In addition, 84 percent are digitizing asset and site layout designs early by investing to build, exercise and mature a digital twin and supporting data architecture.

Moreover, 81 percent of the EPCs are focused on building platforms that are accessible to all internal teams to collaboratively innovate with data. Take Royal BAM Group for instance. In 2019, BAM adopted a single approach to information management using a common data environment (CDE). This helped BAM significantly reduce the usage of paper and local storage of files, while enabling better collaboration and management of information across project teams.[2]

"Data volume in the construction industry is rising dramatically from diverse disciplines throughout the life cycle of construction projects. This vast accumulation of data has pushed the construction industry to the Big Data era."
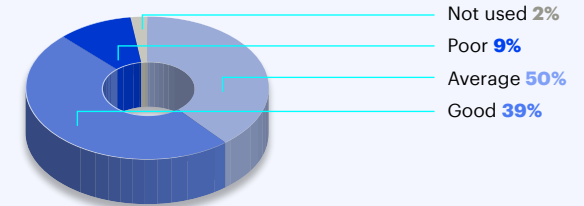
Prof. Hang Yan, School of Civil Engineering and Architecture, Wuhan University of Technology, Wuhan, China et. al[1]

Both owner-operators and EPC companies are facing challenges with creating data-driven value

Only a third of the owner-operators and EPC companies manage to improve their key performance indicators with data-driven digital transformation.

Although digital initiatives undertaken by owner-operators and EPCs underscores the rapidly growing importance of data-driven insights in the capital projects industry, much work remains. We asked executives participating in our survey about the impact these digital initiatives had on their most recently completed projects. A great majority of both owner-operators and EPCs admitted that they aren't experiencing success around key performance indicators linked to cost, delivery, risk, talent and financial management.

That led us to investigate why, despite so many years of experience managing such large projects, both owner-operators and the EPCs continue to struggle to execute and deliver their projects successfully.

Several challenges prevent companies from using big data analytics for projects within their organization:

| "Geek vs business mentality" where project professionals are averse to using data for project management and control.

| Lack of radical innovation in the way data is presented means that early 20th century graphical presentations of data (such as Gant charts) are used for project management.

| Lack of understanding around what data to use to run projects and how to use it for decision-making.

Prof. Naomi Brookes, Professor of Complex Programme Management, Warwick Manufacturing Group (WMG), University of Warwick

Owner-operators, who typically have a sizeable amount of investment parked in projects, are eager to ensure that their projects are up and running in a timely manner, meet the agreed standards, deliver the expected performance and are constructed with minimal accidents and incidents. But only slightly more than a third of the owner-operators are able to achieve these goals despite deploying digital.

A similar story persists for the EPCs. Just over a third of the companies report improvements in project and financial performance, despite their deployment of digital.

FIGURE 2a: Struggling for better outcomes

Impact of digital technologies/applications on the most recently completed capital project

Outcome	% achieving	% not achieving
Reduced operations & maintenance cost	34%	66%
Construction productivity	38%	62%
On-time completion rate	37%	63%
Improved returns on capital employed	36%	64%
Reduced construction accidents and HSE incidents	32%	68%
Better people retention	33%	67%

% achieving outcome ■   % not achieving outcome ▢

FIGURE 2b: Gains unrealized

Impact of digital technologies/applications on the most recently completed capital project

Outcome	% achieving	% not achieving
Reduced equipment & material cost	34%	66%
Construction productivity	44%	56%
Improved operating margin	38%	62%
Improved risk assessment capability	32%	68%
Ease of access to skilled labor	41%	59%

% achieving outcome ■   % not achieving outcome ▢

The stakes are high for some owner-operators. For a chemicals manufacturing company, persistent delays and cost overruns in one of its projects aggravated its debt situation, forcing it to accelerate asset sales. Against the backdrop of weak oil and chemicals prices and lower global demand due to Covid-19, the project woes have only served to worsen its financial strain, leading to an almost 80 percent drop in its market capitalization this year.

EPCs also face severe consequences due to their inability to improve project outcomes. Take, for instance, a major US-based EPC. Significant delays and changes in cost estimates in two to three major projects resulted in mounting losses for the EPC and ultimately forced the company to file for bankruptcy. Similarly, an Australian EPC was placed under voluntary administration after reporting significant losses from its solar projects.

So why is this happening?

As owner-operators belong to a specific industry and typically contract out the engineering and construction of their projects, we looked at the overall challenges that prevented them from getting the most value from digitally transforming their recently completed capital projects. Our analysis offered some striking results. Key among them was the unpreparedness at the strategic and operational level to build ownership and the operating environment for driving incisive use of data within and across their project stakeholders.

Owner-operators find EPC teams either lack the required skills or the interest to collaboratively generate data-driven insights. Moreover, owner-operators struggle to integrate freshly appointed 'data geeks' with the incumbent 'data-resistors'.

FIGURE 3a: Data-utilization gaps

Top 5 challenges that prevented owner-operators from digitally transforming their most recently completed capital projects

01 Limited interest and patience within on-ground project teams to drive data-driven digital transformation

02 Absence of a strategy and skills to build and deploy actionable insights with digital technologies

03 Siloed teams within and across project stakeholders

04 Poor understanding of how available data can be deployed for generating critical and operational business insights

05 Absence of a stakeholder-driven strategy to execute data-driven digital transformation across the project value chain

For the EPCs, we examined the challenges faced across the various project stages, as they work on projects for several industries and are engaged in most of the project stages. Key among them was their inability to operationalize data and technology for decision-making.

EPCs struggle with managing schedules and feedback and building systems that help them respond to change and integrate new technologies to drive KPIs relevant for owner-operators.

"Information flows reasonably well up and down functional silos like engineering and construction but does not flow across silos. So, one of the primary challenges is how do you set up a single collaboration tool, so that information is democratized and available to the right people at the right time. So, turn data into actionable insight."

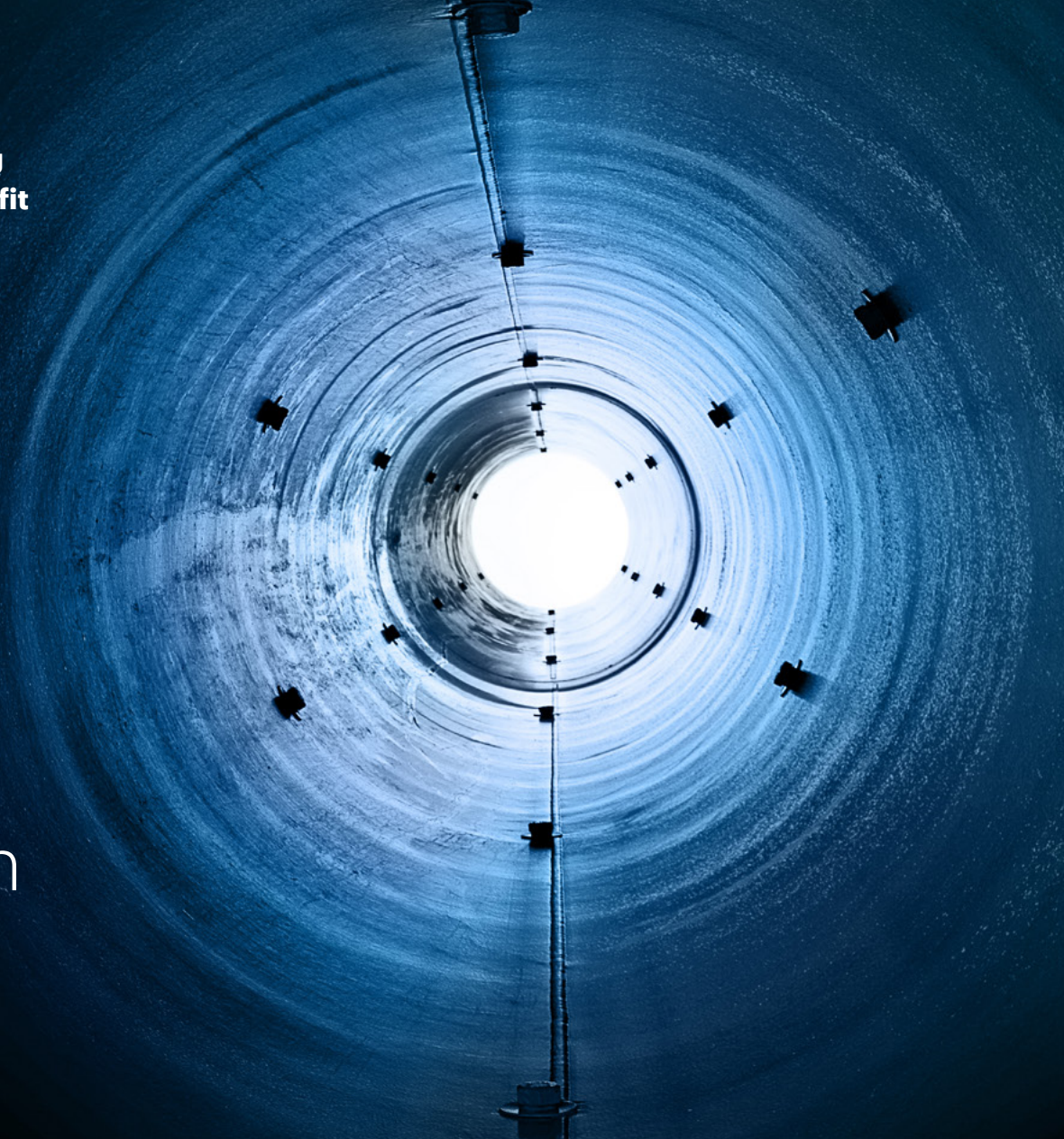Vaseem Khan, Global Vice President Engineering and Chief Engineering Officer at McDermott

FIGURE 3b: Data-integration gaps

Top challenges faced by EPCs while executing the most recently completed capital project (by project phase)

Project phase	Key challenges
Business Development	Creating accurate schedule, cost and benefit estimates
Project & Contract Mgmt	Inability to integrate sustainability agenda with project partners
Design & Engineering	Managing engineering change impacts across project supply chain
Procurement	Strategic and operational issues to pursue process automation robotization
Fabrication	Fabrication facility equipment availability issues
Construction & Commissioning	Limited ability to monitor productivity and verify time monitoring
Handover to Operations	Manually intensive process to manage data exchange, validation and loading into operational systems
Operations & Maintenance	Lack of feedback of asset performance back to design and engineering

How can owner-operators and EPCs create the right operating environment for each other, to effectively realize the full benefit of their data-driven digital transformation initiatives?

Deploy CAPSTONE:
A new, symbiotic approach
to reinvent collaboration

CAPSTONE stands for the "Capital Projects Strategic and Operating Network"

CAPSTONE is our framework to help owner-operators and EPCs reinvent their collaboration to cement greater trust and realize higher returns from data-driven digital transformation. It's built on our research and thinking about the benefits of combining the decision-making power of data and analytics with the ingenuity of human-collaboration. CAPSTONE works on the network effect—the larger the number of people using data and analytics in capital projects, the greater the value release for owner-operators, EPCs and other stakeholders.

Our research shows that integrating elements of the CAPSTONE framework can grow the operating margin of EPCs by an additional 5.8 percent and can give owner-operators an incremental 6.6 percent return on their capital investment.

To arrive at this proprietary framework, we identified progressive companies among the owner-operators and the EPCs, based on their financial performance over the period 2015-2019. We call this group the "Outperformers." We then analyzed our survey data to understand the differentiated actions undertaken by the Outperformers.

As owner-operators and EPCs embrace CAPSTONE, they create operating environments that stimulate data-driven collaboration at scale across a network of project stakeholders—resulting in significant improvement in KPIs.

(A full explanation of the methodology followed to identify Outperformers is discussed in the section titled: About the Research).

In the following sections, we discuss the action-based elements of the CAPSTONE framework and their impact on the project performance of owner-operators and EPCs.

01. Data-committed C-suite

With abundant data now accessible, C-suite across owner-operators and EPCs must commit to infusing a culture of data-ownership, data-sharing and data-driven decision-making, with a focus on unlocking innovative value.

Owner-Operators	EPC Companies

While C-Suite executives might not think of themselves as leaders of digital technology, they can make a big impact when it comes to adoption of data and analytics among the project rank and file. As pointed out by Denicol, Davies and Krystallis (2020)[3], "the main cause of poor performance associated with project leadership is an inappropriate definition of the project culture and sense of purpose, which lead to intra-and inter-organizational misalignments"

The top leadership of Outperformers address these issues. They create an environment for others to embrace change. How do they do it? By becoming role models on breaking 'data resistance' and embracing data-driven change through actions such as 'reverse-mentoring'.

C-suite and senior business unit leadership in 57 percent of the outperforming owner-operators take ownership of data-driven digital transformation of their capital projects.
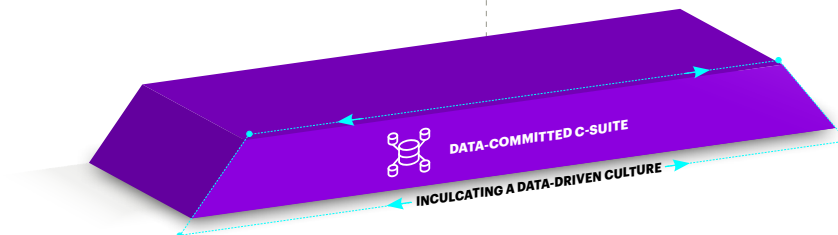
But simply enjoying top executive support from owner-operators does not work. EPCs must also have their CEOs or the COO push for data-driven transformation of the projects they undertake.

Sixty percent of the EPC Outperformers make their CEO or COO responsible for data-driven digital transformation of capital projects. Meanwhile, only 15 percent of the EPC "Others" (companies other than the Outperformers) adopt this approach.

Involvement of the C-suite ushers in compete overhaul of culture, processes and technology. Mechanisms are set up to allow teams absorb lessons about key issues, such as asset performance, which can then be used to improve design and engineering of their current projects. Through such collaborations within and across projects, Outperforming EPCs corner better margins from the projects they deliver.

DATA-COMMITTED C-SUITE

INCULCATING A DATA-DRIVEN CULTURE

"Given the fragmented nature of the industry, with a large proportion of systems and subsystems being delivered by SMEs, the digital strategy has to come from the client. Clients need to create the conditions and mechanisms to unlock the digital capability of the supply chain."

Prof. Andrew Davies, RM Phillips Freeman Chair and Professor of Innovation Management. University of Sussex and Dr. Juliano Denicol, The Bartlett School of Construction & Project Management, University College London, UK

With teams embracing collaboration for better leveraging data-driven insights, Outperforming owner-operators now stand equipped to dissolve silos within and across project stakeholders.

It is easy to see why the Outperforming owner-operators are increasingly warming up to such a top-down approach. Led by the data-driven mindset and decision-making, owner-operators manage to minimize wastages, limit design iterations and therefore rework across all project stages. Owner-operators are also able to maximize their returns from investments across the lifecycle of the project though smarter maintenance during operations.

Another interesting aspect of the C-suite involvement among the EPCs is that they view data-driven digital transformation beyond the lens of process and operational efficiency. These executives realize how their data accumulated over the years can be used to deliver services across the lifecycle of the asset, create greater value for their clients and drive their topline growth. With that in mind, EPC Outperformers prioritize innovation across the project value chain and initiatives that generate new revenue streams. These new revenue streams also align well with the greater lifetime value that owner-operators increasingly expect from their projects.

FIGURE 4: Topline focus
Key success indicators for EPCs in most recently completed capital projects

Key success indicator	Outperformers	Others
Accelerated innovation across the value chain	55%	34%
New revenues/deals due to market differentiation	55%	43%
Increased customer satisfaction levels	45%	50%

Case study: BP

Consider BP. With an aggressive data-push from the CEO's office, BP is steadily re-architecting itself for use of advanced digital technologies. Among the owner-operators, BP is widely seen as an "aggressive" and "early adopter" of digital twin and accompanying technologies, as well as being the furthest along in terms of cultural adaptation.[4]

BP leverages these technologies to maintain its existing facilities and design new projects in a more sustainable way. At one of its operational projects, the global energy giant set up a digital twin of the project to serve as a single point of information across the various project stages such as design, fabrication, and commissioning.[5] BP is also using the digital twin to build digital models of an asset before investing in its construction, to drive key project decisions and to facilitate better collaboration among the various project teams.

All of this is a part of the CEO's overall push toward putting digital at the heart of the company and infusing a data-centric culture across the company. The CEO's office itself hosts a large touchscreen, where data from all of BP's operations are streamed in real time to provide useful insights on performance and safety around the globe.[6] Such is the CEO's commitment toward data-related technologies that he engages with his digital 'reverse mentor' each month to discuss and understand the latest trends in data science.[7]

"Millions of data points emanate from our facilities every month. The stuff we do in the digital space is extraordinary."—Bernard Looney, CEO, BP plc[8]

02. Data-sharing infrastructure and capabilities

Owner-operators and EPCs must invest in relevant technologies, digital assets and capabilities to build contextual data stacks and mutually beneficial data-driven solutions across the life of the project.
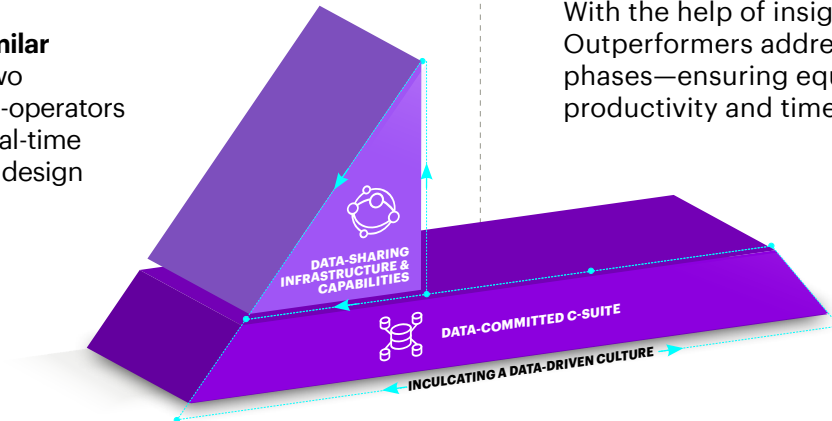
Owner-Operators

EPC Companies

Considering the inherent complexity of most capital projects, the sheer amount of data generated across the project stages and the multiple stakeholders involved, Outperforming owner-operators prioritize creation of an enabling technology environment, allowing their teams to operationalize data and technology for decision-making.

They do so by prioritizing investments in data lakes and cloud platform, which allow consolidated project data to be stored, converted into insights and easily made available to project teams for decision making. **Our survey found that data lakes and cloud platforms are among the top five technologies in which Outperforming owner-operators invested over US$10 million each, during the period 2015 to 2019.**

Outperforming owner-operators invested similar amounts in drones and reality capture. The two technologies, when combined, provide owner-operators and EPCs with on-ground pictorial data and real-time insights into the on-site activities and how the design will perform under certain conditions.

EPC Outperformers concentrate their investments in technologies that allow them to make the most of the data foundation put together by the owner-operators.

Consider, for instance, their **investments on Industrial Internet of Things (IIoT)/sensors.** It's among the top five technologies EPC Outperformers have invested over US$10 million, each during the period 2015 to 2019. By facilitating collection of on-ground data on equipment, materials and ground conditions (such as humidity and temperature), IIoT help EPCs effectively overlay on-ground data with the broader project data and respond in real time.

With the help of insights generated on cloud platforms, EPC Outperformers address key challenges in the fabrication and construction phases—ensuring equipment availability and monitoring project productivity and timeliness.

DATA-SHARING INFRASTRUCTURE & CAPABILITIES

DATA-COMMITTED C-SUITE

INCULCATING A DATA-DRIVEN CULTURE

Owner-Operators also heavily invest in 4D/5D visualization to determine design inconsistencies that would normally not be discovered until the construction phase and to continuously visualize the cash flows as well the project duration for each phase of construction.

What is more striking about the technology deployment of Outperforming owner-operators is how well they use their technology investments toward building advanced digital capabilities for improved decision-making across the project stages. Consider, for example, their deployment of estimation analytics, which is among the top two leading digital capabilities deployed by Outperforming owner-operators in the business planning stage.

FIGURE 5a: Capabilities to build on
Top 2 advanced digital capabilities deployed for executing capital projects by Outperforming owner-operators

Project phase	Top two digital capabilities deployed across project stages
Business Planning	LCOE optimization Intelligent estimating & estimation analytics
Engineering & Procurement	Supplier intelligence Software verification of design
Project & Contract Management	Prescriptive project analytics (e.g., next best action) Smart contracts
Construction & Handover to Operations	Reality capture & Augmented Reality Dynamic next best action scheduling

Another digital technology that Outperforming EPCs put their money in is design automation, with 100percent of the EPC Outperformers investing over US$10 million in design automation during the period 2015 to 2019. With owner-operators providing the technology foundation for collecting pictorial data and analyzing the designs, EPC Outperformers use design automation technology to explore a multitude of design options and optimize designs for the owner-operators in real-time. Similarly, EPC Outperformers deploy robotics process automation (RPA) to help them effectively tackle the manually intensive process of managing data exchange, validation and loading into operational systems ahead of handover to operations.

Similar to the Outperforming owner-operators, Outperforming EPCs also efficiently use their technology investments to build advanced digital capabilities. For instance, they use their investments in design automation to build advanced capabilities for software verification of design to be used in engineering and procurement. And they use their investments in RPA to build capabilities for automated period-end/close-out and automated progress detection. Meanwhile, their IIoT investments are channeled toward building cognitive supply analytics for predicting potential supply chain disruptions or assessing supplier performance. The result is much better margins from project executed.

"When executing projects, our focus is on delivering them on agreed cost and time. We place data at the core of this ambition and deploy technologies such as sensors and cloud data platforms to enable us to closely analyze various parts of processes. We are also using data in a big way to offer solutions to clients. Most important for our clients is to provide data solutions which ensure secure and safe handling of data."

Helmut Knauthe, Chief Technology Officer, thyssenkrupp Industrial Solutions AG

Based on the consolidated data stored in data lakes and the cloud platforms—often based on AI—this capability allows Outperforming owner-operators to make informed estimates around project cost, performance and value generation potential. Similarly, they build advanced digital capabilities based on reality capture for the construction and handover stage.

What truly differentiates Outperforming owner-operators from the Others is their balanced choice of technologies. As seen from our discussions above, Outperforming owner-operators choose technologies to help their on-ground and off-ground teams to work in a smarter and collaborative way to maximize the performance and the returns they expect from their projects.

The Others do not excel at striking such a balance. Our survey found that their deployment of technology is patchy and focused on getting the project executed, which is, in fact, a remit of their EPCs. Take, for instance, their investment in robots/AGVs and construction work packaging, which were among the top five technologies in which they invested over US$10 million each during the period 2015 to 2019. They, too, invest in data lakes, but do not follow it up with investments in cloud-based platforms that can help their cross-functional teams arrive at actionable insights for better decision-making.

FIGURE 5b: Capabilities for improved efficiency and visibility

Top 2 advanced digital capabilities deployed for executing capital projects by Outperforming EPCs

Project phase	Top two digital capabilities deployed across project stages
Business Origination	| LCOE optimization | Bidding & tendering automation
Engineering & Procurement	| Cognitive supply analytics | Software verification of design
Project & Contract Management	| 4D/5D planning & monitoring | Automated period-end/close-out
Construction & Handover to Operations	| Drone reality capture/automated progress detection | Material track & trace

Meanwhile, the EPC Others demonstrate little appetite to make such bold technology investments. For instance, only less than half of the EPC Others invested over US$10 million in design automation during the period 2015 to 2019, leaving most EPCs scrambling with managing design changes across the project supply chain. Similarly, only a third of the EPC Others invested in IIoT technology (compared with 60percent among the EPC Outperformers), severely restricting their ability to monitor site activity and therefore manage project timelines and costs.

Case study: European Rail Operator

One of Europe's largest rail operators is a prime example of how owner-operators can build shared digital infrastructure with a focus on KPIs, such as improved quality of projects, better managed cost and deadlines, as well as reduced workload for design, construction, operations and maintenance.

The operator extensively leverages Building Information Modeling (BIM) for the planning, design and construction of rail lines—along with all the bridges, tunnels, stations and technical equipment. Using BIM allows it to make information accessible to various project stakeholders and drive collaboration in all phases of a building's lifecycle.

The company also emphasizes supportive IT infrastructure. For one of its recent projects, the operator deployed helicopters, drones and laser cameras to collect data and make 3-D measurements of the ground and the topography. Together with existing project documentation, this data was used to create a digital twin of the project.

Project stakeholders working with this rail operator use the digital twin to collaborate and detect problems early on to minimize defects and delays. It has also built a shared common data environment (CDE), which serves as a central platform to host all the relevant project data.

Case study: Petrofac

Petrofac embeds several digital technologies across the engineering, procurement and construction project life cycle[9] to improve safety, productivity and efficiency at project sites during critical construction and commissioning phases.[10]

That goal guides shared initiatives such as the Connected Construction solution. Using an IoT solution-based on Edge analytics and PaaS cloud, Petrofac collects and transmits data from tags on workers and equipment. This site data is then integrated with project data to provide a live, one-stop dashboard. The live dashboard displays project KPIs, build progress, flags deviations schedule and planned production compliance. Petrofac also cuts down on repetitive workflows, often a hidden cost of inefficient collaboration. To reduce manual efforts in design changes, Petrofac uses replication technology, which takes a single design and automatically generates a full set of technical drawings for every subsequent variation.[11]

Case Study: Kiewit

US-based Kiewit focused on creating an integrated technology environment based on cloud-powered systems and data-driven insights to manage every part of its business and the entire lifecycle of a project.[12] The system is hosted on the cloud, to make sure that teams have end-to-end visibility into the full life cycle of construction projects. Its 300,000 users across 33 countries use the platform to derive prescriptive and predictive insights to quantify the risk and reward on each project, more efficiently distribute company resources and break down extensive timelines. Kiewit claims that this technology environment has helped improve equipment utilization by 18 percent, field productivity by 7 percent and estimating costs by 14 percent. As a result, the company now stands better equipped to consistently deliver projects on time and on budget.[13]

03. Data-centric talent

Owner-operators and EPCs must identify data stewards and data coaches across different levels to infuse a culture of timely and productive use of data-driven insights toward addressing key strategic and operational challenges impacting each other.

Owner-Operators

Outperforming owner-operators recognize how several strategic issues, that go beyond engineering and construction of projects, can affect project outcomes for them and for the EPCs. This group therefore focuses on identifying data stewards that are capable of productively using data-generated insights to iron out the foundational issues. These data stewards are already experts when it comes to project management.

These experts bring the patience and the skills to use data for informed decisions and are adept at leveraging all the available data for generating critical business insights, especially for tackling strategic and productivity issues.

EPC Companies

With the owner-operators deploying data stewards to tackle foundational issues, Outperforming-EPCs focus on readying an army of digital coaches who work closely with their on-the-ground workforce, to help them effectively deliver and execute the project efficiently with data-driven insights.

Appointed across different levels, these coaches are often a part of the core team that provides feedback on the technology solutions the teams require, how these solutions should be scaled and the changes that would entail. This engagement makes them well-positioned to serve as a bridge between the technology teams and the end users of these solutions. And once the solutions are implemented, these coaches work toward driving behavioral changes within their respective teams to encourage use of data-based insights on a continuous basis. The result is a shift in perception toward data among office-based and on-ground teams, which now view data-driven insights as a facilitator for intelligent decisions and enhanced productivity.
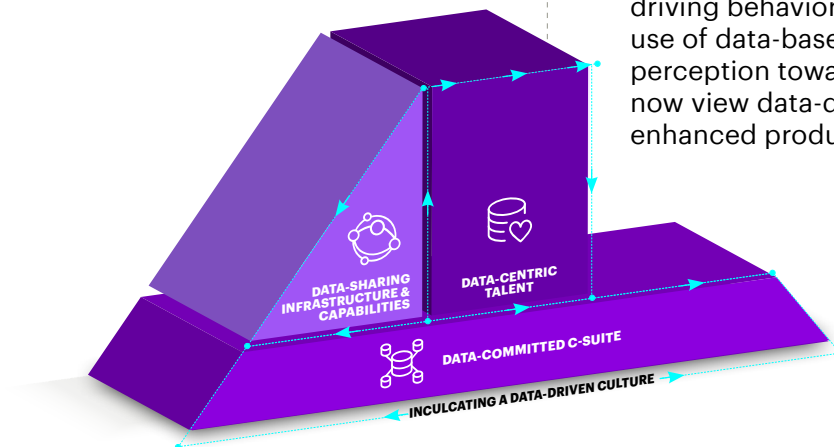

DATA-SHARING INFRASTRUCTURE & CAPABILITIES

DATA-CENTRIC TALENT

DATA-COMMITTED C-SUITE

INCULCATING A DATA-DRIVEN CULTURE

FIGURE 6a: Tackling strategic issues using data-driven insights

Top 2 types of data leveraged by project teams from Outperforming owner-operators

Project phase	Data types used to generate insights
Business Planning	| Project financing | Regulatory data
Engineering & Procurement	| Historical reliability | Procurement category intelligence
Project & Contract Management	| Disputes | Schedule management
Construction & Handover to Operations	| Site security | Productivity

Our survey shows that the top two types of data leveraged by data stewards among Outperforming owner-operators in the business planning stage pertain to project financing and regulations. They also leverage data to effectively manage project schedules and productivity issues, as well as disputes and site security throughout all phases and workstreams (i.e., during project management, construction and handover).

FIGURE 6b: Tackling operational issues using data-driven insights

Top 2 types of data leveraged by project teams from Outperforming EPCs

Project phase	Data types used to generate insights
Business Origination	| Cost | Skills
Engineering & Procurement	| Historical reliability | Equipment specs
Project & Contract Management	| Schedule management | Lessons learned
Construction & Handover to Operations	| Cybersecurity incidents | Productivity

Our survey shows that in the engineering and procurement stage, for example, office-based project teams at Outperforming EPCs use data related to equipment specifications and historical reliability of suppliers and sub-contractors to make informed procurement decisions. Meanwhile, the on-ground teams use data pertaining to productivity to monitor progress during the construction stage.

For owner-operators, such an approach helps significantly minimize potential disruptions to the project. EPCs also benefit because they are not distracted by the wider project issues and can instead focus on delivering the project within the expected timelines and outcomes.

In contrast, Others deploy data primarily to drive decisions in areas that typically fall in the remit of the EPCs. For instance, they prioritize use of data related to cost management in the project management stage and equipment reliability in the construction phase. No wonder regulatory concerns and disputes keep cropping up as the project progresses, contributing to project delays, cost overruns and a build that does not yield them optimum returns.

Another interesting aspect of the talent strategy among EPC Outperformers is their choice of data coaches for upskilling the on-ground workforce. **Our survey also shows that as many as 60 percent of the EPC Outperformers entrust their contract managers with this responsibility** and nearly 45 percent give this responsibility to their project managers.

The close involvement of contract and project managers in various project stages, their understanding of the project requirements and interaction with teams from the owner-operators make them the best on-site data-driven mentors. They therefore guide on-ground teams on the type of data they should be leveraging and how insights based on this data should be deployed for better project outcomes.

This action also bodes well for owner-operators keen on data-driven digital transformation of their capital projects. Working with Outperforming EPCs gives them access to talent pools that have the patience and the potential to drive value with data on the field—their topmost challenge.

On the other hand, EPCs Others fail to identify mentors who could be entrusted with the responsibility of managing and upskilling their on-ground workforce. Access to digitally skilled labor therefore remains an ongoing challenge with EPC Others. **Only 38 percent of the EPC Others report ease of access to digitally skilled labor, compared with 65 percent among the EPC Outperformers.**

04. Incentive-based contracts

Owner-operators and EPCs must structure contracts that incentivize project stakeholders to collaboratively use data-driven insights toward achieving their financial and non-financial KPIs.

In a traditional construct of a capital project, cost for an owner-operator is revenue for an EPC. But surely, this cannot be a 'win-win' strategy for both parties. Incentive contracts fill this gap. Incentive-based contracts with mutually agreed-on KPIs, build compensation or rewards with a goal to enhance trust-based collaboration and unlock innovative sources of mutually beneficial value. With such mechanisms, owner-operators can incentivize all the ecosystem partners within the capital project network to work toward the project goals.

Incentive-based contracts become particularly critical as owner-operators make global pledges in the domains of environmental and social responsibility. Let's take the example of sustainability. The capital projects industry is responsible for 39 percent of all carbon emissions in the world, with operational emissions (from energy used to heat, cool and light buildings) accounting for 28 percent. The remaining 11 percent comes from "upfront" carbon that is associated with materials and construction processes throughout the lifecycle of a facility.[14] For owner-operators keen on enhancing their sustainability credentials, it is imperative that they provide incentives to EPCs and the other project stakeholders to collaborate from the early stages of the projects, using climate friendly construction materials and innovating ways to reduce the carbon footprint of construction as well as the asset being built.

Adoption of incentive-based contracts has started gaining acceptance among Outperforming owner-operators and EPCs. **Our survey shows that over a fifth of the Outperformers currently engage in incentive-based contracts.**
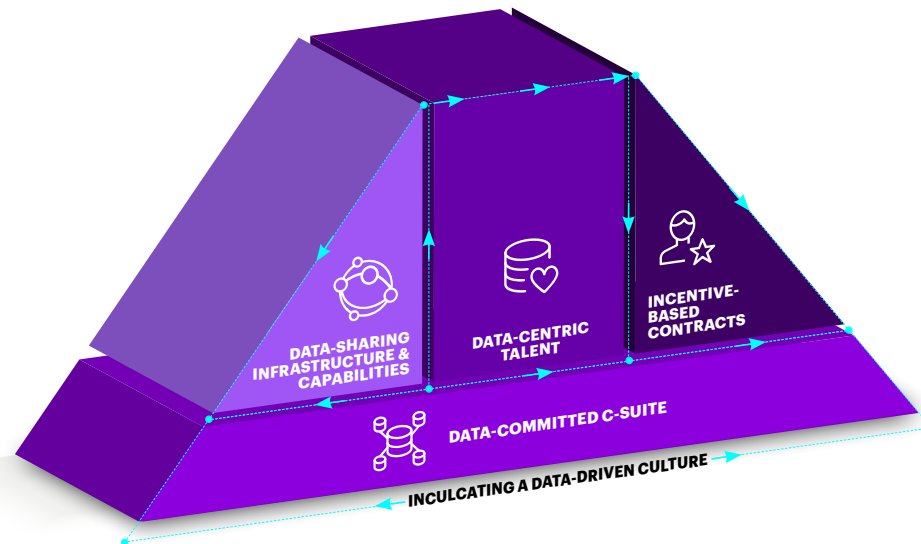
So how can they structure such incentives into their contracts?

Owner-operators could include considerations, such as adopting a total cost of ownership approach rather than a low-cost bid process. This can make owner-operators commit EPCs to schedule rather than costs, which gives EPCs a greater bandwidth to innovate, requiring them to adopt a more data-driven approach of engagement with their sub-contractors and suppliers.

Having decided on the incentives, owner-operators can bring stakeholders together to form an integrated network during a pre-defined planning period. This enables the network to collaboratively develop project design, scope, schedule and budget with data-driven insights. This can usher in data-driven alignment from stage zero of project creation.

What's in it for the EPCs? The incentives and the reasonable amount of risks transferred to the EPCs under these contracts encourage them to experiment with technology. Given that these contracts require EPCs to get on board early in the project, they can start identifying and cementing data-driven partnerships with suppliers and sub-contractors aligned to the project goals. EPCs can form a focused and aligned project network, committed toward delivering the financial KPIs of the project, and the broader environmental or societal goals to be achieved by the owner-operator.

DATA-SHARING INFRASTRUCTURE & CAPABILITIES

DATA-CENTRIC TALENT

INCENTIVE-BASED CONTRACTS

DATA-COMMITTED C-SUITE

INCULCATING A DATA-DRIVEN CULTURE

Case Study: Sutter Health California Pacific Medical Center

Sutter Health California Pacific Medical Center (CPMC) crafted a three-way, incentive-based contract that motivated all parties to successfully deliver on its projects. The not-for-profit Northern California healthcare system, which owns 24 acute care hospitals, brought together architectural company SmithGroup and contractor HerreroBoldt to form an integrated project delivery team. The team was assigned two projects simultaneously: the flagship $2.1 billion Van Ness Campus hospital and the smaller Mission Bernal Campus. Their size and complexity meant 240 design professionals would be working closely over the 10-year duration of the project.[15]

The team agreed to deliver the projects within CPMC's target cost or the "Estimated Maximum Price" (EMP). The team built into the EMP the cost of work, a contingency pool and the Risk/Reward pool. Seventeen "Risk/Reward" members agreed to put 100 percent of their profit at risk in the Risk/Reward pool. The contingency pool was to fund any rework or fix, if required.[16]

Representatives of the 240 professionals, along with CPMC's project managers, got together in "weekly big-room meetings" to report on progress toward commitments and alert others if there were any constraint. Focus was on sharing information, enhancing communication and increasing accountability across the entire team. Additionally, the construction trades, architects and engineers were mandated to design and model in BIM, enabling the entire team to observe each other's work and adjust virtually to avoid real-world clashes.[17]

The results were impressive. Claims paid due to injuries at the job site stood at only 15 cents, compared with the typical $1.10 per man hour payment made for similar projects. The project ended with a contingency balance of more than $20 million, a portion of which was shared with the Risk/Reward members as per the contract. Last, but not the least, the project was delivered on time and $150 million under the original project budget.
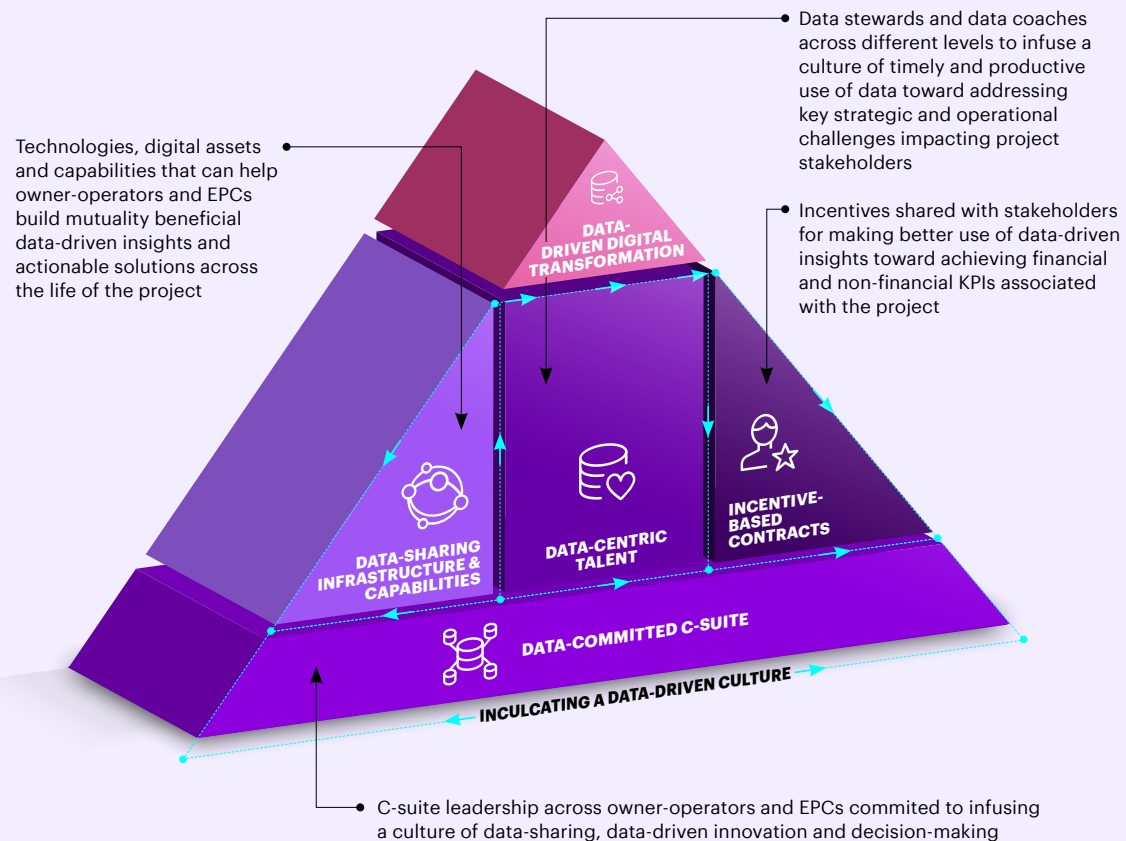
Reaching the apex

Buying and deploying data and analytics tools is not hard, but changing behaviors is.

By embracing the four elements—enlisting the C-suite to infuse a data culture, aligning the data and technology architecture with project KPIs, upskilling and empowering talent across different levels, and modeling contracts to incentivize the right behavior—businesses can reach CAPSTONE's apex that holds outperformers.

Organizations will have to work hard to reach the apex. But once they do, we are confident that over the long run they will see the full benefits of a data-driven digital transformation.

FIGURE 7: The CAPSTONE framework

Reinventing collaboration to unlock value with data-driven digital transformation

Data stewards and data coaches across different levels to infuse a culture of timely and productive use of data toward addressing key strategic and operational challenges impacting project stakeholders

Technologies, digital assets and capabilities that can help owner-operators and EPCs build mutuality beneficial data-driven insights and actionable solutions across the life of the project

Incentives shared with stakeholders for making better use of data-driven insights toward achieving financial and non-financial KPIs associated with the project

DATA-DRIVEN DIGITAL TRANSFORMATION

DATA-SHARING INFRASTRUCTURE & CAPABILITIES

DATA-CENTRIC TALENT

INCENTIVE-BASED CONTRACTS

DATA-COMMITTED C-SUITE

INCULCATING A DATA-DRIVEN CULTURE

C-suite leadership across owner-operators and EPCs commited to infusing a culture of data-sharing, data-driven innovation and decision-making

Value release from embracing the CAPSTONE framework

Using an econometric model, we quantify the contribution of each of the four elements of the CAPSTONE framework toward improving the return on capital employed (ROCE) for owner-operators and the operating margins for EPCs.

This exercise involved estimating the correlation between the actions taken by companies for data-driven digital transformation and the potential impacts on the operating margin for EPCs and the ROCE for owner-operators. (More details on our econometric modelling methodology can be found in the "About the Research" section.)
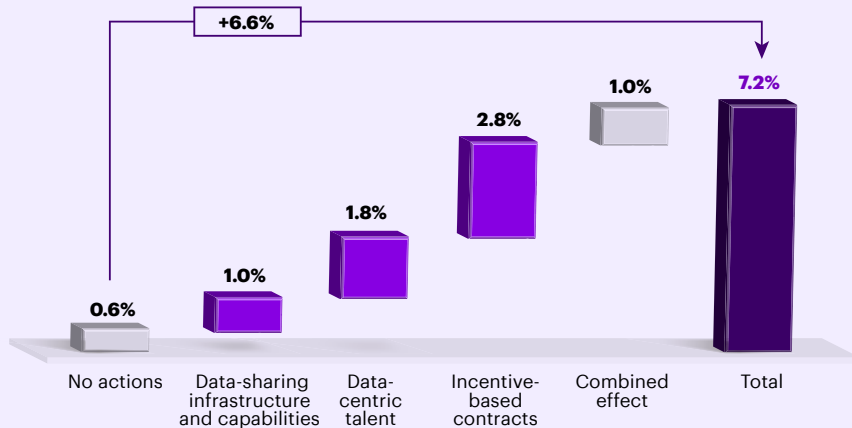
For owner-operators, the biggest gains are to come from engagement in incentive-based contracts. This is not surprising, considering that these contracts remain an unexplored territory for the owners. More importantly, this highlights how incentivizing larger number of project stakeholders to make better use of data can help release more value through efficient use of resources and adoption of innovative process and methods.

Meanwhile, for the EPCs, the biggest gains are to come from the commitment of the C-suite toward data-driven innovation and decision-making. This commitment ushers in an environment of information sharing and data use across different project stages.

FIGURE 8a: Building the gains brick by brick

Impact of data-driven digital transformation on the ROCE for owner-operators

FIGURE 8b: Building the gains brick by brick

Impact of data-driven digital transformation on operating margin for EPCs

How can owner-operators and EPCs begin their CAPSTONE journey?

Start reflecting on these 10 questions related to the four CAPSTONE elements:

Data-Committed C-Suite

1 Are you making your C-suite responsible for data-driven digital transformation of capital projects?

2 How does your C-suite work toward building value with data-driven insights and creating a culture of collaboration across teams and project partners?

Data-Sharing Infrastructure and Capabilities

3 Have you developed secure platforms and tools that can be collectively accessed by relevant teams across all project stakeholders to innovate data-driven solutions?

4 Does your technology allow you to automate repetitive tasks in the project lifecycle to accelerate project cycle time?

5 How advanced are your digital capabilities in the areas of design automation?

Data-Centric Talent

6 What are the top areas where your teams are deploying good quality data for planning, management and execution of capital projects?

7 How are you empowering your on-ground workforce to efficiently use data-driven insights for capital projects execution?

8 Who in your company is responsible for managing and upskilling the on-ground workforce?

Incentive-Based Contracts

9 How often do you manage to bring an integrated team together during a pre-defined planning period?

10 Do you get stakeholders and counterparties to agree to contractual models that spur project innovation and encourage collaboration with other partners?

Reinvent collaboration to unlock data-driven responsible value

Ensuring your capital project is completed on time and on budget is more critical now than ever before. Despite widespread agreement that data-driven insights are critical to achieving those business outcomes, owner-operators and EPCs have largely been unable to effectively generate and use them. Too often, they are stymied by organizational inertia, sliding into disengagement among employees as well as mismatched technology and business goals.

The CAPSTONE framework allows owner-operators and EPCs to understand how they can create a mutually beneficial and collaborative environment to effectively use data. This reinvented collaboration approach combines the decision-making power of data and technology with the ingenuity of human collaboration.

But the CAPSTONE journey isn't easy; each step rests on a deep commitment to accepting and collectively managing change—both within and across stakeholders. Only those who boldly do so see the full benefit of their data-driven digital transformation.

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About the research

Step One:
Conducting A Sample Survey

Between June—August 2020, we surveyed 710 senior executives from EPC companies and the owner-operators (spanning 13 different industries) spread across 20 countries with annual sales exceeding $1 billion. In the survey, we asked executives to report their company names, the investments they had made towards digitally transforming their capital projects and about their usage and practices for data-driven transformation of capital projects. We also collected data on the impact these investments had on their projects and financial performance.

Step Two:
Classifying The Outperformers

Using publicly available financial data, we identified a small group of Outperformers among the EPCs and the owner-operators that exceeded their industry peers both in terms of Productivity and Efficiency for the five-year period between 2015 and 2019. Given the nature of business at hand and

through intensive consultation with experts, we decided to adopt the following metrics as measures for efficiency and productivity.

For owner-operators:
Returns on Invested Capital (defined as Net Operating Profit Adjusted for Taxes/Average Invested Capital), as a measure of efficiency, given that owner-operators are seen to be making significant and recurrent digital investments;

Asset Turnover ratio (Revenue/Average Total Assets), as a measure of productivity, given that capital projects account for some of the largest assets owner-operators build and operate.

This exercise resulted in only 24 percent of the owner-operators from our survey emerging as Outperformers.

For EPCs:
Operating Margin (Operating Income/Revenue), as a measure of efficiency, because it depicts how efficiently the EPCs use their resources, including the digital ones, to accomplish their core business.

Revenue per Head (Revenue/Total Employees), as a measure of productivity, because it shows how well do they combine their human and machine workforce (e.g., robots) to unlock new sources of value and growth. Only 14 percent of the EPCs from our survey emerged as Outperformers.

Step Three:
Measuring The Impact Of Key Action Elements On The Financial Performance

Having identified the Outperformers, we analyzed our survey data to investigate the differentiated actions undertaken by these groups among the EPCs and the owner-operators.

An econometric approach was then used to estimate the correlation between the actions taken by companies regarding data-driven digital transformation and their potential impacts on operating margin for EPCs and return on capital employed (ROCE) for owner-operators.

About the research (continued)

Why ROCE in the case of owner-operators? Management of financial resources across the life-cycle of a capital project is key. Owner-operators use a mix of debt and equity to finance capital projects. From a predictive standpoint, it therefore becomes important to understand the extent of internal rate of return, owner-operators can generate above the cost of capital during life of a capital project. ROCE helps us build that perspective. Owner-operators generating a ROCE, higher than the cost of the capital (both debt and equity less short-term liabilities) can be considered as making effective use of their deployed capital.

The four-key action-based elements included were:

1. Data-committed C-suite: CEO or COO having the overall responsibility for data-driven digital transformation of capital projects

2. Data-sharing infrastructure and capabilities: Digital technologies and assets relevant to data-sharing attracting investment in excess of $10 million

3. Data-centric talent: Talent (on-ground/managerial talent) with data expertise

4. Incentive-based contracts: Owner-operators and EPCs structuring (at most 70 percent) of their projects with incentive-based contracts

$$Logit[P(Y<=j)] = \beta_1 * Key\_actions + \beta_2 * Controls + \varepsilon$$

An ordered logit regression is used to estimate the impact of key actions on the probability (P) of the impact of data-driven digital transformation on capital projects (Y, ROCE for owner-operators, operating margin for EPCs) resulting in a certain category (j). Industry type, region and company size are used as control factors. ε is the error term of the regression.

Average expected value is then calculated for both owner-operators and EPCs by multiplying the probabilities of multiple categories with average value for each interval of the financial performance indicators.

The model provides insights on the sensitivity of the key action elements on the impact of data-driven digital transformation on capital projects, thereby helping us estimate the potential value associated with the same for both EPCs and owner-operators.

Survey Demographics

Revenue Size	Owner-operators (%)	EPC Companies(%)
$1 - $4.9 billion	58%	87%
$5 - $9.9 billion	15%	6%
$10 - $29.9 billion	17%	6%
$30 - $49.9 billion	5%	1%
$50 billion or more	5%	0%
Total	**100%**	**100%**

Company Type	Count	%
Owner-operators	570	80%
EPC Companies	140	20%
Total	**710**	**100%**

Role	Owner-operators %	EPC Companies %
Chairman/Vice Chairman - Executive Committee	4%	3%
C-suite	44%	29%
Project Director/Manager	14%	23%
Senior VP/EVP	15%	20%
VP/Director	23%	25%
	100%	**100%**

Survey Demographics

Industry (for Owner-operators)	%
Aerospace & Defense	6%
Automotive	6%
Consumer Goods & Services	6%
Chemicals	14%
Industrial Equipment	5%
High Tech	6%
Life Sciences	6%
Metals & Mining	9%
Oil & Gas	11%
Public Infrastructure	6%
Telecommunication	10%
Utilities	15%
Total	**100%**

Geography	Owner-operators (%)	EPC Companies(%)
Australia	6%	9%
Austria	1%	2%
Brazil	7%	0%
Canada	4%	2%
China	10%	14%
France	5%	3%
Germany	10%	1%
India	2%	3%
Ireland	1%	1%
Italy	4%	4%
Japan	12%	9%
New Zealand	1%	2%
Saudi Arabia	1%	0%
South Korea	0%	4%
Spain	4%	4%
Sweden	0%	2%
Switzerland	1%	1%
United Arab Emirates	1%	0%
United Kingdom	7%	13%
United States	23%	26%
Total	**100%**	**100%**

Authors

Tracey Countryman
Strategy & Consulting,
Industry X Europe and Digital
Manufacturing & Operations Lead

Raghav Narsalay
Accenture Research, Industry X
Global Research Lead

Andy Webster
Strategy & Consulting,
Industry X Capital Projects Global Lead

Preeti Bajla
Accenture Research,
Industry X Associate Principal

Franz-Josef Pohle
Strategy & Consulting,
Industry X Capital Projects ASGR Lead

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| Vaseem Khan, Global Vice President Engineering and Chief Engineering Officer at McDermott

Project Team

Aarohi Sen, Adriaan Raaijmakers, Ajay Garg, Aoife McEvoy, Barbara Ciocca, Florian Heinrichs, Himanshu Patney, Ida Nair Sharma, Jens Derksen, Julia Bierwirth, Konstantinos Trantopoulos, Magda Zaslona, Paddy Lynch, Ruth Keane, Sachin Guddad, Sinead Kennedy, Surbhi Mehta, Taya Vernon, Yuhui Xiong.

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