How analytics can drive smarter engineering and construction decisions

Three applications illustrate how companies are beginning to embrace data-driven solutions while establishing a foundation for future initiatives.

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The construction business faces a major productivity challenge. While labor productivity in the global economy has increased by an average of 2.8 percent a year over the past two decades, and in manufacturing by an impressive 3.6 percent, the construction sector has registered a mere 1-percent annual improvement. As the capital-project partners responsible for execution, engineering and construction (E&C) firms are well positioned to drive changes that can help close this troubling gap.

To do so, some are turning to data-driven solutions that have already revolutionized many other corners of the economy. These techniques are emerging as vital tools for improving capital project outcomes and reducing risk. By enabling E&C companies to leverage the vast amounts of data they already collect, analytics can uncover critical insights that both speed up and improve the quality of management decisions. In particular, they can help project teams assess market conditions, portfolio composition, and individual project performance.

Admittedly, adopting analytics tools may pose challenges for project-driven businesses in the construction sector. Unlike manufacturers, for example, which tend to follow predictable and repeatable processes, E&C firms face high variability. Progress-tracking systems sometimes change mid-project, causing incompatibilities and inconsistencies in the collected data. Parameters such as scale, materials, and subcontractors involved also vary significantly from project to project, making it difficult to establish benchmarks.

The cultures and processes within E&C organizations can pose additional barriers. The industry tends to put trust in individual experience and expertise over empirics, and few companies have data analysts on staff who can take ownership of advanced analytics initiatives.

In time, predictive analytics, machine learning and artificial intelligence solutions will likely usher in bigger changes to the ways E&C firms bid on and deliver projects. For now, three applications illustrate how companies are beginning to embrace data solutions while establishing a foundation for more ambitious initiatives in the future.

1. "Should we bid on this project, and if so, how much?"

Usually, E&C firms must decide whether to bid on a project based on incomplete information. Major construction projects often have a five- or 10-year timeline, if not longer, which makes it difficult to accurately define the scope and predict likely complexities or complications up front. What's more, bidders don't know how market shifts may affect their costs between the time of the bid and the project's start. Companies rely on staff experience to weigh potential risks and profitability, but those judgments are subject to inherent biases and may be affected by ambitious growth targets or individual incentives.

Misjudging risks and underestimating costs can prove disastrous. In a business with typical margins of 5 to 7 percent, underestimating a bid by 10 percent without the ability to recover the extra costs can make the project an expensive money-loser for the E&C firm. Conversely, overpricing a project by building in too big a contingency cushion will likely mean the loss of the contract—something a firm can ill afford in an industry with win rates of merely 15 to 25 percent.

Data modelling can replace cognitive bias and flawed assumptions with fact-based insights about a project's statistical chances of success. By analyzing historical information such as types of labor and contract arrangements, regional spending trends, and project size, analytics can assess the

probabilities of project outcomes. Those, in turn, will enable teams to better evaluate the attractiveness of a given project, re-balance the portfolio away from jobs that tend to underperform, and calculate the right level of contingency to include in a bid.

One company, for example, leveraged data from more than 100 of its past projects. It combined internal data on project locations, asset classes, contract structures, and profit margins with external information such as total spending in a given sector or geography and statistics on local workforce size and unionization. Analyzing these factors in aggregate, the company uncovered project characteristics that influenced profit margins in ways that conventional analysis could not illuminate. For example, while companies often look to factors like region or project type to predict profitability, those variables may be merely correlated with more influential factors such as contracting strategies, craft unionization, or regional public sector budgets.

Using the insights from this analysis, the organization developed a dashboard of risk variables that could affect project margins. The system creates a scorecard that identifies potential risks based on past patterns—for example, if the venture is in a region with a history of low-margin projects, or if it entails working with a public-sector owner with different requirements than typical private-sector partners.

During pre-bid meetings, teams rely on this information to help them decide whether the project is sufficiently attractive to make a bid, estimate the costs, and calibrate the size of the contingency to assign to the bid.

2. "Are the subcontractor bids reasonable?"

When E&C firms receive bids from subcontractors, they turn to procurement specialists to assess the quotes. These individuals often rely on parametric estimates to evaluate the quoted costs and tap the expertise of project managers, slowing down the process. Complex estimates pass through multiple reviewers, with each one adjusting the estimate based on his or her own experience and judgement (as well as potential bias).

Despite these extensive consultations, the lack of an empirical foundation makes it hard for engineering companies to credibly challenge a subcontractor's estimates beyond relying on generalized rules of thumb. In addition, while many companies maintain (and subscribe to) databases of parametric cost factors for bidding, they rarely follow up with the actual costs at the end of their projects to gauge the accuracy of those estimates.

Analytics can provide a solution to these problems. By analyzing individual drivers of past project costs, such tools can enable E&C companies to rapidly assess a realistic level of effort and cost for a project and compare those figures to subcontractor quotes.

One large U.S. infrastructure owner took the initial contracts from 17,000 past projects, incorporated amendments and adjustments, and created a comprehensive database of all final costs by work breakdown structure, both in time and materials. It then built a multi-variate statistical model to determine the factors that would most accurately predict final project costs, such as the likely number of structural engineering hours required for a bridge replacement, or projected materials cost for an additional lane along a four-mile strip of rural arterial highway. The result is a procurement tool that benchmarks a project's final cost. When bids come in, managers immediately know if these are

within the expected range for that type of work. Today, leaders can gauge an accurate price for procured contracts within an average of two days, down from an average of 60 days often spent in labor-intensive negotiations.

3. "Is the project about to run into trouble?"

Traditional project controls often lag the incurrence of costs by days or weeks, which makes them an effective tool for retrospective reporting but not for managing ongoing projects. The controls also don't account for the interconnectivity of different metrics and the unique combinations that may have outsized effects on performance. For example, lagging crew productivity can often be recovered through special planning activities; but late material delivery or multiple days of adverse weather might exacerbate crew productivity losses and require a different intervention from management.

Unable to continually track and grapple with all the data a project generates, managers tend to follow a few key performance indicators. The resulting incomplete picture of the project's daily progress can lead to flawed decisions on the ground.

Analytical tools can deliver a significant improvement on this front by allowing companies to quickly and continuously analyze project data and assess progress, enabling managers to react faster to potential problems. With real-time or near-real-time project controls in place, an E&C firm can track events or problems known to correlate with the erosion of bid margins, such as a one-day weather delay or three consecutive days of a subcontractor's failure to complete designated tasks.

Industry leaders have created an approach, statistically correlated with erosion of margins, to monitor their project performance. On a daily basis, the analytics model crunches the day's project data and looks for these red flags; if enough of them appear, management is alerted immediately to intervene before the problem even materializes.

As we have written elsewhere, engineering and construction firms wishing to prepare for the digital age will need to establish a new operating model. Such a shift requires treating digital initiatives as part of the core strategy, adapting processes and organizational structures, and ensuring staff have the necessary training to deploy, troubleshoot, and lead digital initiatives. But the first step in such transformations is applying analytics to assess current operations and performance.

Often, the greatest hurdle to implementing such solutions is the one-time backward reconciliation of data. Most firms have collected lots of information over the years, but it's stored in disparate systems and inconsistent formats. As such, the first step should be to take stock of what they have—many companies will find they have a lot more data than they realize, such as accounting records and purchase order history—and put it into a form they can digitally analyze. This may be a tedious and resource-intensive process, but it will set the foundation for more sophisticated data collection and analytical techniques down the line. What's more, this one-time work will create a foundation for structuring data—into data lakes, for example—that will make future analytics initiatives easier.

Companies also need to establish standards for the data they collect in the future. Whether it's a full-fledged data management system or simply a standard way of tagging and collecting information, standards for what you want to collect and how you collect it are critical to a long-term analytics strategy.

As digitization penetrates all parts of the economy, including engineering and construction, capitalizing on the insights hidden in data will become essential. E&C companies reluctant to invest in the systems and skills needed to harness what they have collected should remember that competitors who have successfully made the move are already reaping significant benefits. Firms that embrace analytics can make sharper bids, thus avoiding unprofitable projects and increasing their win rates on those with strong margin potential. They conduct savvier negotiations with subcontractors, reducing costs and increasing decision speed. And they anticipate problems with ongoing projects, allowing managers to intervene before potential delays and cost overruns turn into real ones. As the industry increasingly deploys these tools, the companies that get in early will likely emerge as leaders. ■

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