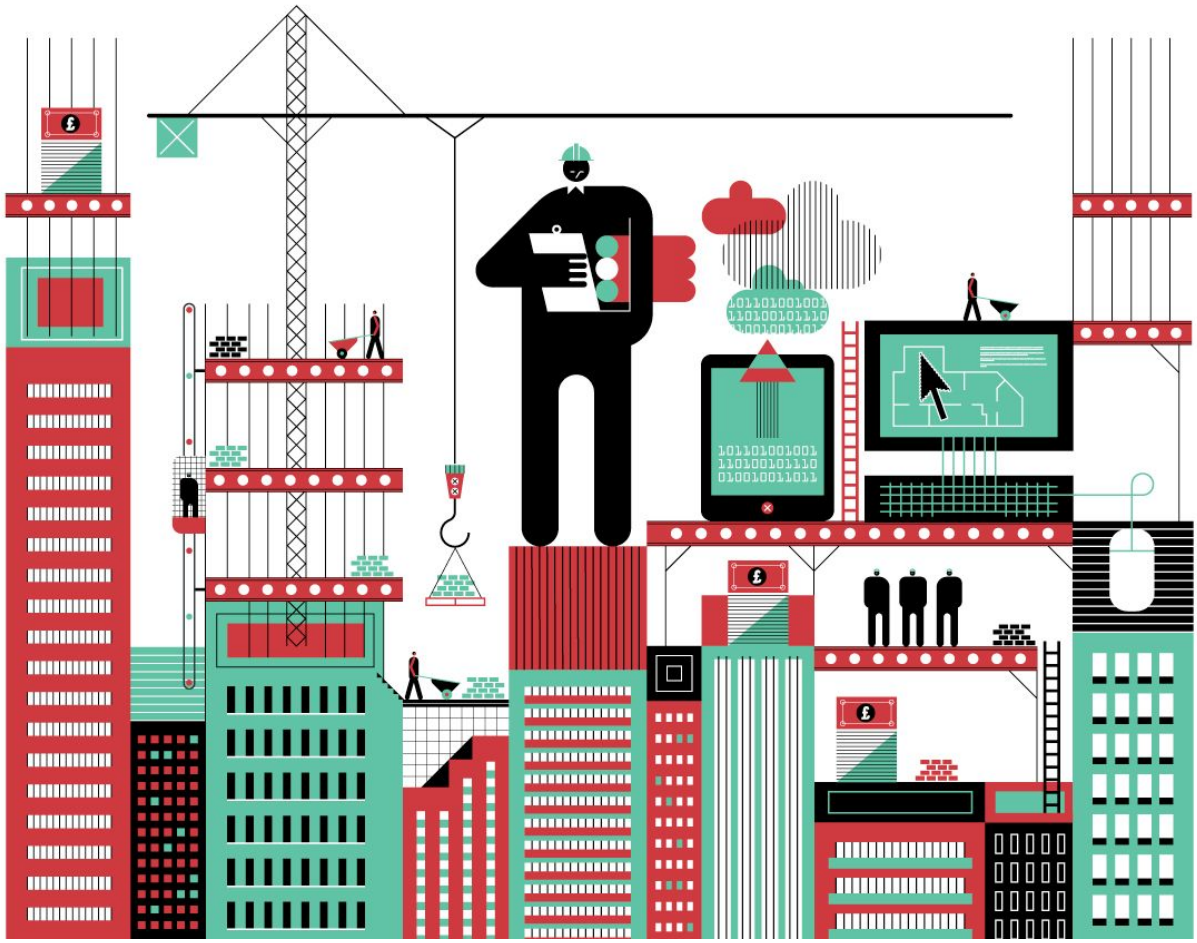
AUTODESK UNIVERSITY

CS21082

BIM 360 Data Insights: Performance-Based Supply Chain Analysis for Construction



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Learning Objectives

- Learn how the digitization of construction that we're currently witnessing will lead to the digital transformation of the industry
- Learn how best-value procurement moves away from low-bid selection by considering multiple performance indicators
- Learn how to incorporate data from BIM 360 into a series of performance dashboards and supply chain selection tools
- Learn from peers and see real examples of how contractors and owners already use these insights to make informed decisions

Class Description

Traditionally, price has been the sole factor considered when selecting construction contractors. The digitization of construction information is creating opportunities for new procurement models, where decisions to award contracts can be based on business intelligence techniques which analyze performance in key project risk areas.

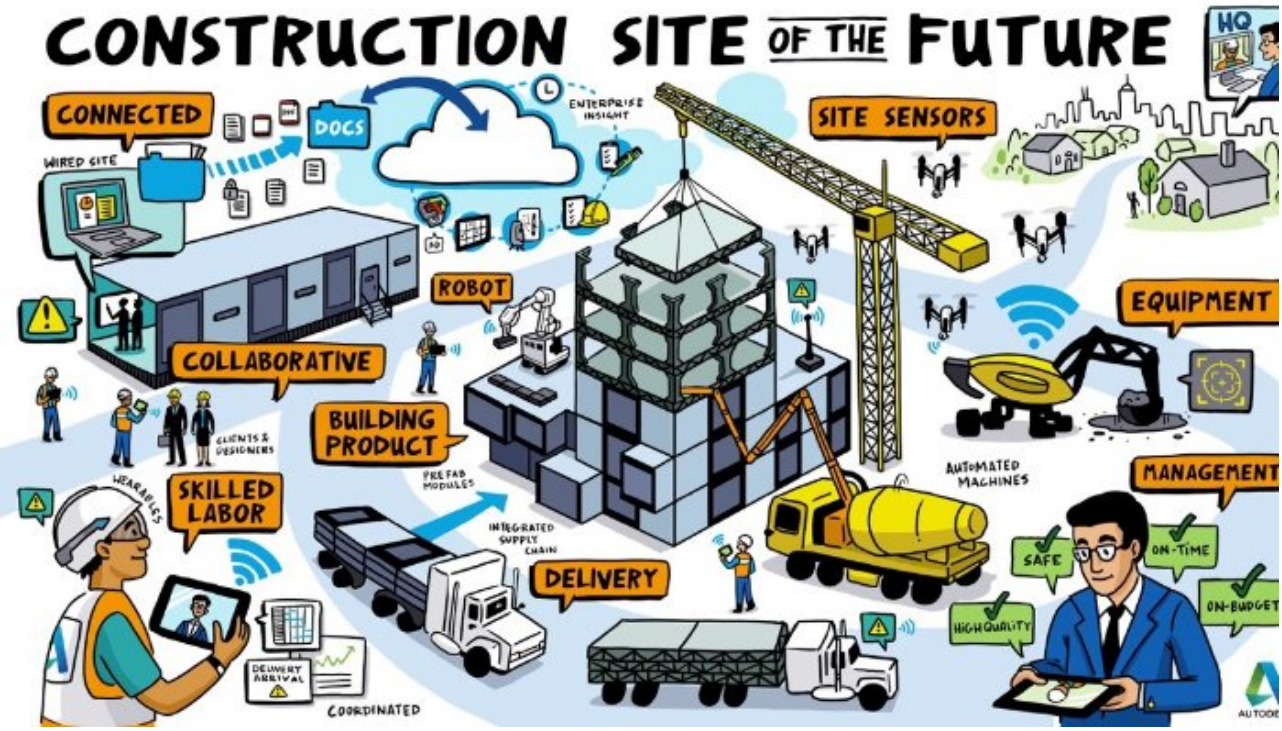
Your AU Expert(s)

Michael Moran is a construction consultant at Autodesk, Inc., helping customers optimize their construction processes through adoption of cloud-based BIM 360 tools, with a focus on design review, production planning, scheduling, field management, layout, and project handover to owner/operator. His master's thesis in construction management at the Delft University of Technology assessed productivity gains from using Building Information Modeling (BIM) tools on Skanska U.S. Building projects. Moran has taught 5 previous Autodesk University classes and has spoken multiple times about the benefits of cloud-based BIM.

Mark Taylor is responsible for implementing new technologies and construction tools in BAM Construct UK to meet their digital construction strategy. He is also responsible for leading development and implementation of information management standards and procedures to meet the U.K. Government Level 2 BIM mandate. He supports project teams in preconstruction, construction, and through to handover. He works closely with clients and facilities management teams to deliver digital assets and ensure operational requirements are met. He also delivers education and training modules for construction teams, supply chain, and design teams on digital transformation (BIM) to ensure change is effectively managed and new ways of working are fully adopted.

The construction site of the (near) future

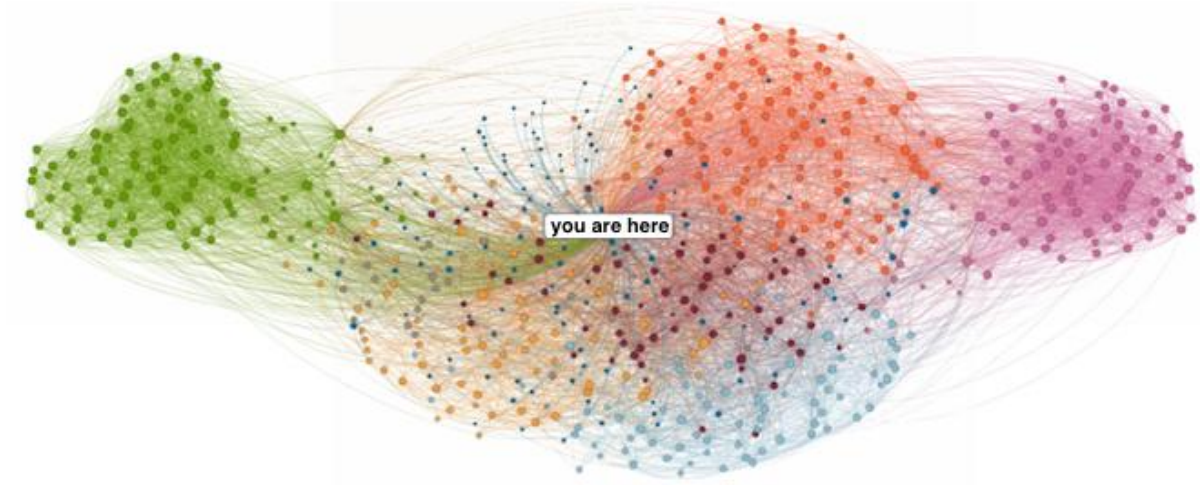
Picture the scene: as you walk onto the construction site, a drone buzzes overhead. Lasers bounce off every surface. You pull a device out of your pocket to view the latest drawings and fully coordinated 3D models, and record a video to capture progress. As you upload it to the cloud, the objects in the video are automatically recognized and tagged to let other project members quickly find what they need. Nearby, an engineer wearing a smart helmet performs a complex task with the aid of real time information beamed straight onto his field of vision. A few years ago, this scene would have seemed straight out of science-fiction, but it's fast becoming a reality.



And yet, as fantastic as some of this technological progress is, we've only begun to scratch the surface of digization in construction. These outwardly visible, tangible manifestations of gadgetry on jobsites represent the first distant rumblings of the potential of digital transformation which the construction industry will begin to realize in the coming years.

Digitization vs Digital Transformation

Digitization is the trend turning aspects of our life into digital data, and transforming this data into new forms of value.



The image above is an example of an ever increasing amount of real-world objects and activities for which a digital replica is recorded and stored. Throughout human history we've had complex webs of interpersonal connections. But in the last decade, simply by having hundreds of digitally recorded connections on online social networks like Facebook, we can visually map the mutual links within our professional or social circles.

Digital Transformation is when business activities, processes and models are restructured to fully leverage the opportunities of digital technologies and their impact across society in a strategic and prioritized way.

The digitization of construction

In construction, site management activities have relied heavily on paper until very recently. BIM and project management software have allowed designers and contractors to coordinate complex designs and simulate construction tasks. But there was always a gap in transferring digital information between site and office. Now, thanks to cloud and mobile tools such as Autodesk BIM 360, a growing number of these tasks are being performed in a fully digital workflow, tracked in centralized cloud databases. The information gap between the site and office is

starting to close. But, despite the exciting early signs of technological progress, construction is still in its digital infancy:

We've begun to realize some early benefits of digital construction through adoption of BIM, project management and mobile collaboration software. Change orders and design errors have been significantly reduced on many projects. But the change we've seen so far has been incremental, not transformational. Projects still overrun deadlines. Project managers still lose sleep. They still yell and swear a lot (ok, maybe that's part of the fun). Site workers are still inefficient, and get injured and killed more than in just about any other industry. Contract structures are still combative and litigious. Waste and rework still standard, projects (when profitable) still have razor-thin margins, clients are still often unsatisfied, and the public still views construction as a wasteful, polluting nuisance. And it still is.

Digital transformation in construction.

Construction will be transformed when we connect the digital dots. A real step-change in performance will happen once the exponentially-growing digital data streams generated during design, construction and operations start to become interconnected in a meaningful way. The terabytes of images and photogrammetric models captured by drones, mobile devices and scanners. The millions of data points on suppliers', designers' and subcontractors' performance, stored in 3D models and project management software. Ubiquitous data-streams from cheap sensors being embedded in building components and wearable technology.

Just as manufacturing was transformed when PLM, ERP and CRM created systems of integrated applications to manage production, logistics and demand, construction will see significant improvement as BIM becomes the true information backbone of the jobsite. Data will be analyzed in a way that reveals actionable insights. New types of contracts, procurement models and methods of managing supply chains will develop to facilitate, rather than hinder, adoption of collaborative construction technology and meet clients needs. Autodesk broadly refers to this as the Construction in the Era of Connection. In the UK, the term Level 3 BIM is used. In Germany, they refer to Building 4.0.

This change will be good for some and painful for others. Many small, hitherto unknown contractors and construction managers who successfully recognize how to get value out of the "I" in BIM will have distinct early-mover advantages. Large, established companies who fail to react, rehire and

restructure will be hurt. What's more, other industries have already begun undergoing this revolution, which could accelerate the rate of change in construction, since we wont need to reinvent the wheel. How can we predict future needs to ship materials to site before they've even been ordered? Ask Amazon. How can humans and robots build something together? Ask Audi.

Best Value Procurement

It should come as no surprise that construction contracts have traditionally been awarded on price. Price and costs are easy to measure, can be exactly defined in a contract, and can be evaluated during project execution (usually in the form of huge overruns!).

Some complex projects consider a variety of other performance indicators when awarding contracts, including:

- Previous Qualifications
- Quality
- Schedule
- Safety

The goal of using this selection process, sometimes referred to as the "Best Value Model" is to minimize project risks and to enhance long term performance and value of the built facility. A client will invite qualified vendors to bid. Once selected, the vendor(s) will create a project specific risk plan. Then, during the project, the client will track performance according to the risk plan and require regular reports. This performance can be logged and consulted again when awarding future contracts.

One big challenge when awarding contracts based on this approach is that the additional performance dimensions are much harder to objectively measure than price. How do you track past schedule compliance? What indicates a contractor's relative safety record? During execution, a client may doubt the reliability of progress reporting from the vendor.

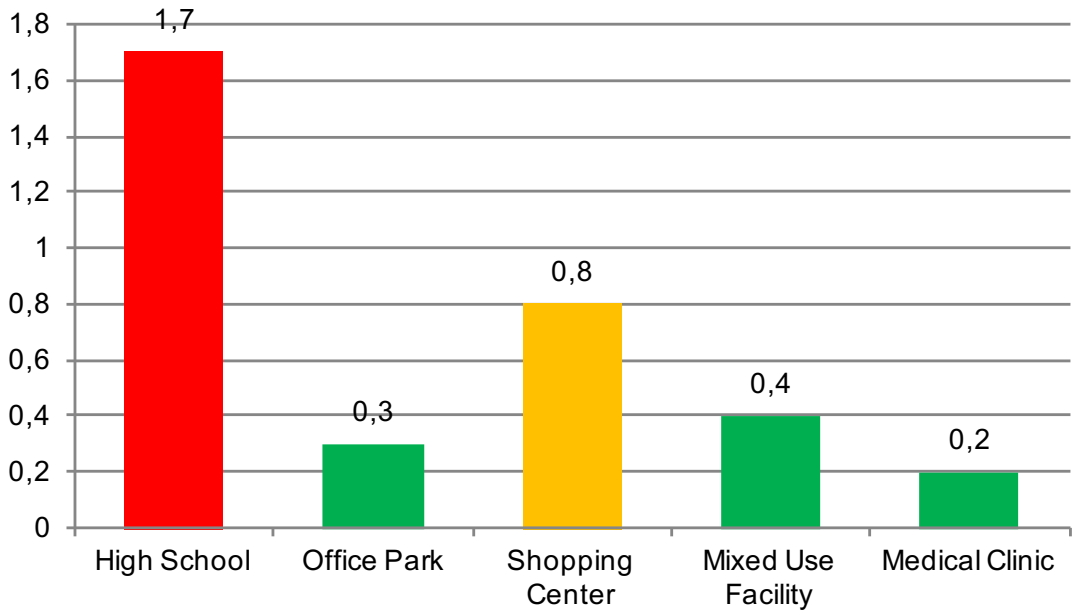
Luckily, the digitization of construction information is beginning to give us objective indicators of supply-chain performance. Lets focus on a few construction management workflows which are being digitized, and how as a result, they can

begin to provide reliable Key Performance Indicators (KPIs) of subcontractor performance:

Quality: Resolution of Design Coordination and On-Site Issues. When a clash between a structural element and service duct is identified in a 3D model environment it can be assigned to a responsible party and tracked through to resolution. The total number of such clashes, RFIs, errors, and the average time taken to satisfactorily close them out can be measured and analyzed per engineering firm working on a project. Likewise, the number of issues and observations occurring onsite can be quantified per million $ of contract value, and similar subcontractors can be ranked against each other, resulting in a measure of quality compliance.

Schedule Adherence: Short Term Planning and Coordination Reliability. In projects using the Last Planner System® of lean production planning, subcontractors are required to commit to a detailed series of tasks which they will complete in the coming week. If they do not deliver the work by the promised date, the committed activity will be recorded as incomplete. Planned Percent Complete (PPC) is a score measuring the percentage of completed activities out of the total committed activities, and is tracked as a measure of planning reliability.

Safety. As structured, checklist based safety inspections are recorded digitally, measures of compliant vs. non-compliant observations associated with particular subcontractors can be analyzed. On a growing number of sites with biometric access control, this can be further measured per man-hour per subcontractor.



EXAMPLE SUBCONTRACTOR DASHBOARD SHOWING SAFETY OBSERVATIONS PER 1000 MANHOURS WORKED

How to Incorporate KPIs into a Subcontractor Selection Process

The data sets which provide the above KPIs can be analyzed to surface insights into performance of subcontractors. The results of this analysis can be used to make informed decisions during the process of awarding bids, and while tracking progress.

A business intelligence dashboard is a data visualization tool which consolidates KPIs and scorecards on a single display. In a subcontractor management context, it is vital that these have customizable interfaces which can be tailored for a specific role or persona within an organization:

- Project managers who want to track, monitor and report on subcontractor adherence to cost/schedule/quality/safety within a single current project
- Supply chain procurement managers and executives who want to analyze current and past subcontractor performance in various dimensions when awarding bids
- Subcontractors who want to evaluate and improve their own performance across projects

	Company	Safety Overall	Safety Issues/$M	Safety Issues/Man-hour	Time to fix safety issues	Schedule adherence	Quality Overall	Overdue Quality issues	Quality issues per $/M	Total Weighted Score
1	Anderson Wall Systems	**5**	4	5	5	**3**	**4**	5	3	**4**
2	Plastertech	**1**	2	1	1	**3**	**2**	2	3	**2**
3	Mitchell Ltd	**4**	4	4	4	**3**	**4**	3	4	**4**
4	Gypsum Company	**2**	2	2	2	**2**	**4**	4	3	**3**

EXAMPLE EXECUTIVE SCORECARD ACROSS MULTIPLE KPIS FOR DRYWALL CONTRACTORS IN A REGION

The Importance of Data Quality

Remember the adage: garbage in, garbage out. Incomplete, imprecise or faulty data inputs can potentially be presented in series of slick, convincing looking BI dashboards, at the risk of supporting catastrophic failures in human decision making. To ensure that any insights offered by these data sets are reliable, we need structured quality assurance at all phases of data collection and analysis. This includes:

- Large enough data sets to draw statistically meaningful conclusions
- Consistent adoption of the construction management tools (our sources of data) across the supply chain
- Filtering of data to remove anomalies and inconsistencies
- Standardized operating procedures within a general contractor across projects

Creating a Framework for Performance Evaluation

Once we can ensure that quality data is being reliably collected and analyzed, we need to agree on the dimensions of subcontractor performance evaluation. The importance of carefully defining these KPIs cannot be overstated – they affect the supply chain management, strategic and operational planning of a company.

There must also be a clear process in place for interpreting the results of KPIs at all levels within an organization. Consider, for example, a seasoned project manager who consults the results displayed on dashboards to conduct monthly reporting on supplier performance in adherence to quality, safety, schedule and cost. How can this PM's report, which is after all an aggregation of insights offered by the BI tools combined with the knowledge derived from years of experience on multiple projects, be filtered up into a cross project scorecard that can be presented to a supply chain manager?

Some other important questions to consider: What is the consequence of a score below a certain threshold in a critical area? Do subcontractors have regular score reviews, after which they can are promoted to or demoted from a "top league" of vendors who can be invited to tender on high risk projects? Is the overall pool of potential vendors examined on a project specific basis, based on the performance criteria deemed critical for that project's needs?

Where Do We Go From Here?

This class outlines a roadmap for data driven supply chain analysis and selection in construction, outlining some of the KPIs currently available for analysis as well as highlighting some of the key data quality assurance areas that need to be addressed in order to surface truly useful to useful insights to contractors. It is still early days for contractors and clients as they incorporate BI into their procurement processes. But as data sets grow larger and more comprehensive, we can expect that data driven decision making will be more commonplace in project procurement strategies, and that BI analysis techniques will become more sophisticated, and begin to include techniques for identifying correlations of key risk factors based on machine learning and predictive analytics.