



HEXAGON
PPM

WHITE PAPER

DIGITALLY TRANSFORMING CONSTRUCTION EXECUTION ON SITE

HOW A DIGITAL TECHNOLOGY REVOLUTION ENABLES CONSTRUCTION STAKEHOLDERS TO OPTIMIZE PLANNING WHILE MAXIMIZING PROFITS



CONTENTS

1. Abstract	2
2. The Need for Significant Productivity Improvement.....	2
3. Use Cases of Transforming Construction Execution On Site	3
3.1. Digital Engineering and Construction Integration.....	3
3.1.1. Real-time Decision Making	4
3.1.2. More Accurate Planning	4
3.1.3. Enhanced Engineering Efficiency	5
3.2. Digital Supply Chain to Construction Integration.....	5
3.3. Master Project Planning to Construction Integration.....	6
4. Benefits of Digitalizing Construction	7
4.1. Increased Labor Productivity	7
4.2. Enhanced Visibility	8
4.3. Safer Execution	8
5. Conclusion	8

1. ABSTRACT

Digital Transformation is the latest 21st Century business buzz; it is impacting every industry and reshaping the way stakeholders interact with each other. The construction industry is no exception and is deeply impacted by the changes digitalization brings. However, simply digitally transforming a business does not automatically ensure success. As always when business and mission critical decisions are made, there is a need for industry best practices to ensure a positive outcome.

This white paper will describe the possibilities current technologies offer and feature real-life use cases for digitalization of construction sites.

We will also discuss the most common pain points in the construction industry and showcase why an integrated information management platform - that spans engineering and design, supply chain, planning, and detail operations execution - is needed, as well as the key benefits of such a solution.

2. THE NEED FOR SIGNIFICANT PRODUCTIVITY IMPROVEMENT

Despite computers and IT technology being deployed on construction sites over the past decades, productivity has not significantly increased. In fact, productivity reports show a significant embarrassing gap in comparison to other industries, for example manufacturing, where progressive deployment of technology has enabled parallel increase of output per worker.

There are some key reasons for this lack of productivity improvement in construction:

- Construction typically is a multi-tier sub-contracting business, which often means difficult and ineffective communication between different stakeholders.
- Having multiple, independent organizations working on the same project regularly involves working with numerous different and siloed IT systems, making it challenging to integrate data flows and all the relevant input/output data.
- Lack of transparency around the overall impact of the changes in a project leads to waste and cost overruns.
- Poor consistency and lack of automation between long-term and short-term planning generates a need to continuously plan operations on site, generating more waste and idle time during the execution.
- Misunderstanding of contractual obligations prior to litigation creates delays and lowered execution quality. This in turn leads to rework, delays, and more budget overruns.

As a consequence, all the above has a negative impact on decision making processes on site, reducing output and lowering productivity.

This level of inefficiency has become accepted at construction sites and therefore almost a part of the business. It has become a normal procedure to include additional budget to cover what is seen as an unavoidable budget overrun. This process is so inbuilt in the industry that resistance to change can be high, even though new technology would significantly improve planning and efficiency.

However, the pressure to improve productivity is ever increasing as the industry needs to enhance profitability. Besides the few pioneers that have embraced digital technology for site planning and execution management years ago, more and more forward-looking construction companies are now investigating their options to digitalize.

The main drivers for digitalization of construction sites is not only the need to transform the way construction business is done, but also to ensure that construction companies will be part of the digital revolution that is changing the way we work, live, and travel. The whole industry will be shaped by digital transformation, and only the ones participating will stay in business.

3. USE CASES OF TRANSFORMING CONSTRUCTION EXECUTION ON SITE

Digital transformation will impact each and every aspect of the construction industry. How this will happen is a decision that each company will need to make independently.

The digital technology is already available, and companies can either look at the implementation as a holistic process or phase the actual deployment by priority. Either way, it is important to highlight that digitally transforming a site requires more than just deploying some technology or software here and there.

Digital transformation will deeply impact each organization, it will reshape typical relationships among contractors, change best practices, habits, culture and methods, whilst setting the next level of standards that will drive the industry for decades.

This chapter will review what technology is available today as a starting point and consider the use cases for digitalizing construction execution.

3.1. DIGITAL ENGINEERING AND CONSTRUCTION INTEGRATION

Construction has always been the strongest internal client of engineering and design. Construction stakeholders typically receive results and deliverables from engineers, the most important information being the so-called construction quantities, also known as Bill of Quantities (BoQ). Construction reuses BoQs for multiple purposes: from estimating execution efforts or evaluating sub-contractors' bids to set relevant contracts and define the scope of fabrication, erection, and installation. In addition, cooperation between engineering and construction enables addressing clashes, design changes and as-built situation on site.

In the last ten years, engineering and design have benefitted from becoming progressively "digitally executed." This happened through a slow, progressive and independent process before digital transformation became the buzz word that it is today.

Digitalizing engineering and design started already when systems – either 3D modeling or 2D and schematics systems – adopted an open and commercially available database management system. These systems were used to record and store design data in all formats, including information to shape objects either in 3D or 2D, therefore decreasing traditional utilization of the CAD technology that had been developed since the 1980s.

Adoption of digital database technology to support engineering and design delivered three key benefits that have dramatically contributed in increasing both the quality and the productivity of engineering and design work processes:

- Objects to objects correlation, which solves key consistency issues and design changes related to execution
- Work sharing for real-time collaboration
- Rules based design for automation, and quality assurance and quality control

What does this mean for the construction industry today? Often, all the typical construction information is digitally available in engineering database. However, because of the limits, constraints and inadequate functionality among the different systems, this information has not been digitally delivered to construction stakeholders.

Without a digital platform bridging the gap between engineering and construction, the digital data sets are not transferred to the construction system where the data is consumed. This usually produces the following issues that non-digitalized construction site suffers from:

- Extensive manual re-work on data
- Delays in receiving design change notifications and processing them
- No data integrity, therefore, time wasted in bringing the right information, and double checking for its reliability.

Once digital technology is deployed on-site, engineering and design deliverables, and 3D models will flow smoothly from engineering to construction stakeholders. They can then timely and efficiently reuse the data sets for constructability reviews, construction planning, effective sequence management and accurate progress recognition, as well as quick short-term planning revision if more flexibility is requested.

A key feature of digitalized engineering deliverables is that all the properties and values are embedded into both the digital 3D modeling and the 2D deliverables, which can be exchanged between the different departments and accessed by all the relevant stakeholders.

This provides significant benefits, as described below.

3.1.1. Real-time Decision Making

Receiving accurate and timely information from engineering, without any need for re-entering or manipulating the data, is a clear improvement which becomes especially important in case of any design changes. Beyond the fact that a digitalized system supports notifications to construction upon revised deliverables and data, the real key benefit is that the information addressing the change will always be available in a timely manner to improve decision-making process at the construction site.

3.1.2. More Accurate Planning

By having accurate engineering information available, rules can be created to process design data and receive automatic calculations of the planned man-hours. This boosts the planning process while making it more accurate and reliable. Engineering deliverables become easily available due to the improved connectivity, either via desktop or mobile devices. The deliverables can be accessed by using typical plant design properties and related indexes, such as EWP, unit, area, system or sub-system. This means that the users will have no need to look around for files or to download a local copy.

3.1.3. Enhanced Engineering Efficiency

From an engineering perspective, providing digital engineering data and deliverables to construction means that there is no further need to spend time creating construction specific deliverables. Construction will be able to reuse all available engineering deliverables and data so the task such as “create construction quantities” will disappear from engineering planning and schedule, delivering more efficiency and cost reduction.

3.2. DIGITAL SUPPLY CHAIN TO CONSTRUCTION INTEGRATION

Supply chain and procurement are key stakeholders in the construction process, as they provide the construction site with all the materials and components required to deliver the scope of the project.

As well as engineering and design, supply chain work processes have already been extensively digitalized. Significant benefits are available to companies that adopt a digital supply chain management system. According to McKinsey¹, overall supply chain management costs can be reduced by up to 30 percent by digitalization.

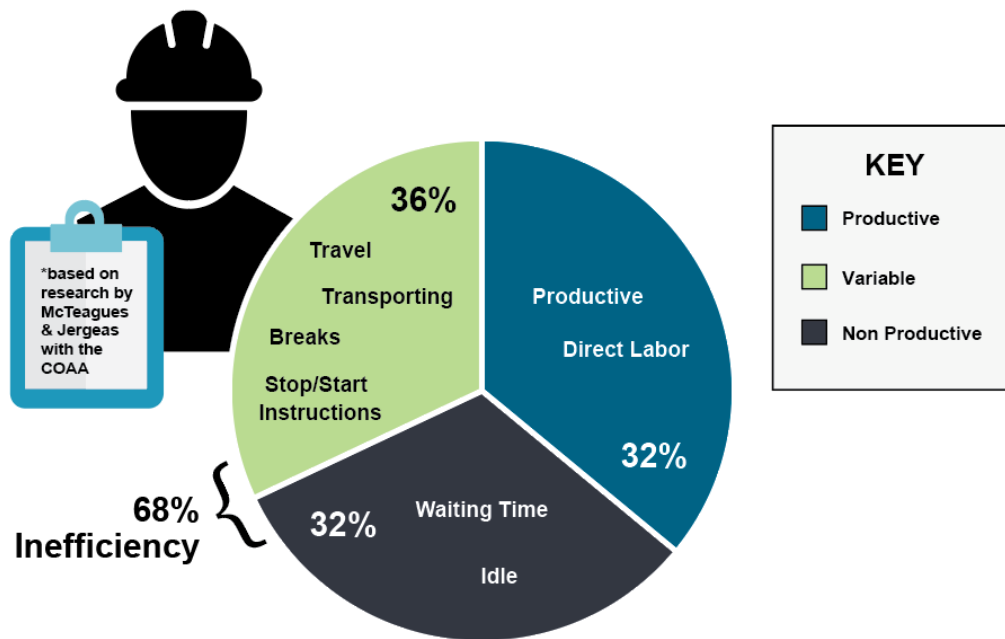


Figure 1: Inefficiency gap in the construction industry.

¹ Supply Chain 4.0 – the next-generation digital supply chain ©McKinsey & Company 2016.

Digital execution of supply chain work processes triggers the following benefits:

- Faster delivery due to more efficient inquiry and awarding processes, coordinated follow-up and more efficient logistic
- Enhanced planning and increased flexibility to quickly react in case of production and logistic issues
- Increased granularity enabling full tracking of each and any part of the supply
- Accuracy and reliability, since digital technologies such as barcoding, QR coding and RFID secure identification of components throughout the supply chain and make data more reliable

Enabling a construction stakeholder to easily access the supply chain information becomes a must. Furthermore, a digitalized construction site will use connectivity to access supply chain information that has been digitally recorded into the procurement platform. This way users can see the most up-to-date information about goods Expected Time of Arrival (ETA) on site so that construction planning will be digitally validated against real-time material availability.

3.3. MASTER PROJECT PLANNING TO CONSTRUCTION INTEGRATION

The ability to digitally bring the construction master schedule – as a part of the whole project schedule into the construction planning system – is key for preventing misunderstandings. It also validates high level and front-end constructability. It is crucial for detecting inconsistencies and identifying constraints and risks for potential pitfalls in the execution.

Overall, accessing planning and master schedule information relies on connectivity. As soon as connectivity is available, technology enables the stakeholders to read the data from the master schedule and seamlessly deliver the information to the construction platform.

This means the data addressing tasks assigned in the project Work Breakdown Structure (WBS) will be digitally retrieved in the construction planning system. It also facilitates creating a detailed construction plan (figure 2).

This is a significant improvement that allows construction stakeholders to focus on business-critical information instead of wasting time engaging in low-value tasks such as finding, downloading or uploading planning information manually.

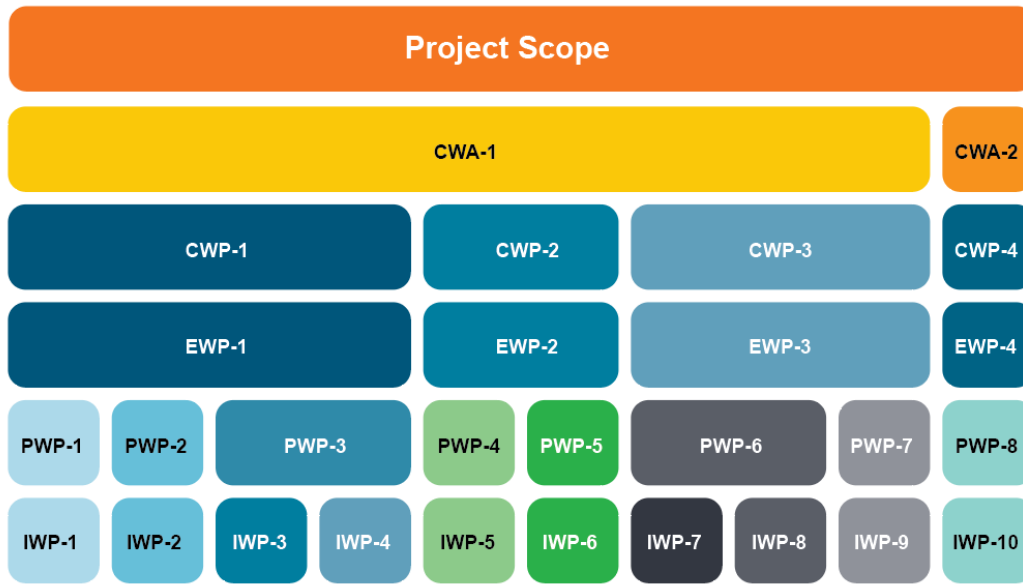


Figure 2: Suggested image from our BD. Description??

Since project planning typically works by defining an incremental level of detail, a construction master schedule has been established to include a few nodes, such as plants, areas, units or disciplines. In the next step, the detailed construction planning develops granularity, including additional information such as engineering and procurement work packages, installation work packages, components and relevant construction work steps.

4. BENEFITS OF DIGITALIZING CONSTRUCTION

After decades of consolidated practices and stakeholders’ inertia, the time has come to introduce changes that reshape both the way stakeholders interact among each other and the way construction is executed. Connectivity and the ability to access and consume data has never been available at this level before, making this the perfect time to digitally transform construction execution.

In this chapter, we will discuss in more detail the overall benefits that digitalization delivers to all the key players in the construction sectors.

4.1. INCREASED LABOR PRODUCTIVITY

As already observed in other business sectors, digital transformation in the construction industry will drive the productivity transformation that all stakeholders are looking for. From the construction perspective, productivity deals with two operational parameters wait-and-idle time and so-called “Time on Tools.”

Reducing wait-and-idle time has an immediate correlation to increase Time on Tools, which then boosts the overall labor productivity. As a real-life example, one of Hexagon PPM’s clients, a leading

engineering, procurement and construction company, has reported a 20 percent increase on Time on Tools on a digitalized construction site when compared to a site with no digitalization.

4.2. ENHANCED VISIBILITY

The overall efficiency of large capital project execution increases as project readiness gets higher. Constructability and supply chain integration play key roles in anticipating inconsistencies and preventing construction pitfalls at the earliest stages of the project, when the impact to budget is limited, and corrective action can be taken in time

During construction, 4D animation and the ability to access all relevant information has proven to ensure smoother execution and cooperation between all parties. This occurs in engineering deliverables, design properties, supply chain status information, and when resources availability / constraints are in one integrated environment.

By enabling this, a digitalized construction site helps stakeholders identify inconsistencies and issues at an earlier stage. From the contractors' perspective, this prevents overruns and keeps costs closer to agreed budget, while from the owners' perspective it prevents changes and litigations – and therefore delays – while keeping CAPEX and expected revenue closer to forecast.

4.3. SAFER EXECUTION

Digitalization is not only about productivity and CAPEX; high safety standards are important for any construction site. The level of safety is improved when execution is carefully planned to avoid labor issues and complaints from the workers.

In a digitalized construction environment, digitally-available information, documents and regulations can be easily deployed and shared with all relevant teams. This prevents an unsafe environment and tasks being executed in wrong sequences.

Furthermore, sensor data is available to monitor workers' movements onsite to ensure that the employees do not enter any prohibited areas. This information can also be added to the construction management dashboard for enhanced visibility.

5. CONCLUSION

A fully digital construction platform that is truly integrated with procurement, engineering and master planning data becomes the backbone of overall construction management. It provides all construction stakeholders with integrated access to all project data, ensuring the following benefits:

- Data is reliable as all the information is up-to-date
- The system identifies and highlights if any of the data has been superseded
- The system supports integrated cross-discipline visualization, such as using 3D to:
 - Animate components according to review multi-disciplines / multi-sub-contractors' sequences and to double check constraints and clashes
 - Show materials availability and relevant impact to constructability

- Navigate through engineering deliverables, 2D to 3D correlation and relevant component properties
- Review costs, constraints and resources by accessing any relevant digitally available data.

All of this is in one digital construction platform.

Having a consistent level of digitalization across the engineering, procurement and construction processes is the only approach to improve labor productivity on site. This is only possible when there are no gaps in digitalization, as it is no longer acceptable to compromise the digital integrity of project execution.

Boosting productivity provides additional benefits for the owner of the site since it increases contractors' profitability and makes project completion reliable. This also enables ensuring Time to Market and keeping CAPEX and ROCE as close as possible to what was originally forecasted.

This process has already started as the leading global contractors are embracing digital technology, while digital construction execution becomes a necessity for success. The technology is available for both the pioneers and for the companies who are now embarking on their digitalization journey to overcome the persistent need for productivity improvement.

Interested to know more about what digitalization of construction sites can require? [Contact us](#) for a free consultation with an industry expert.



About Hexagon

Hexagon is a global leader in digital solutions that create Autonomous Connected Ecosystems (ACE). Our industry-specific solutions create smart digital realities that improve productivity and quality across manufacturing, infrastructure, safety and mobility applications.

Hexagon's PPM division empowers its clients to transform unstructured information into a smart digital asset to visualize, build and manage structures and facilities of all complexities, ensuring safe and efficient operation throughout the entire lifecycle.

Hexagon (Nasdaq Stockholm: HEXA B) has approximately 20,000 employees in 50 countries and net sales of approximately 3.8bn EUR. Learn more at [hexagon.com](https://www.hexagon.com) and follow us @HexagonAB.

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