



Artificial Intelligence in Construction

How to Leverage the Power of Your Data with AI to Maximize Profits, Optimize Productivity, and Save Lives

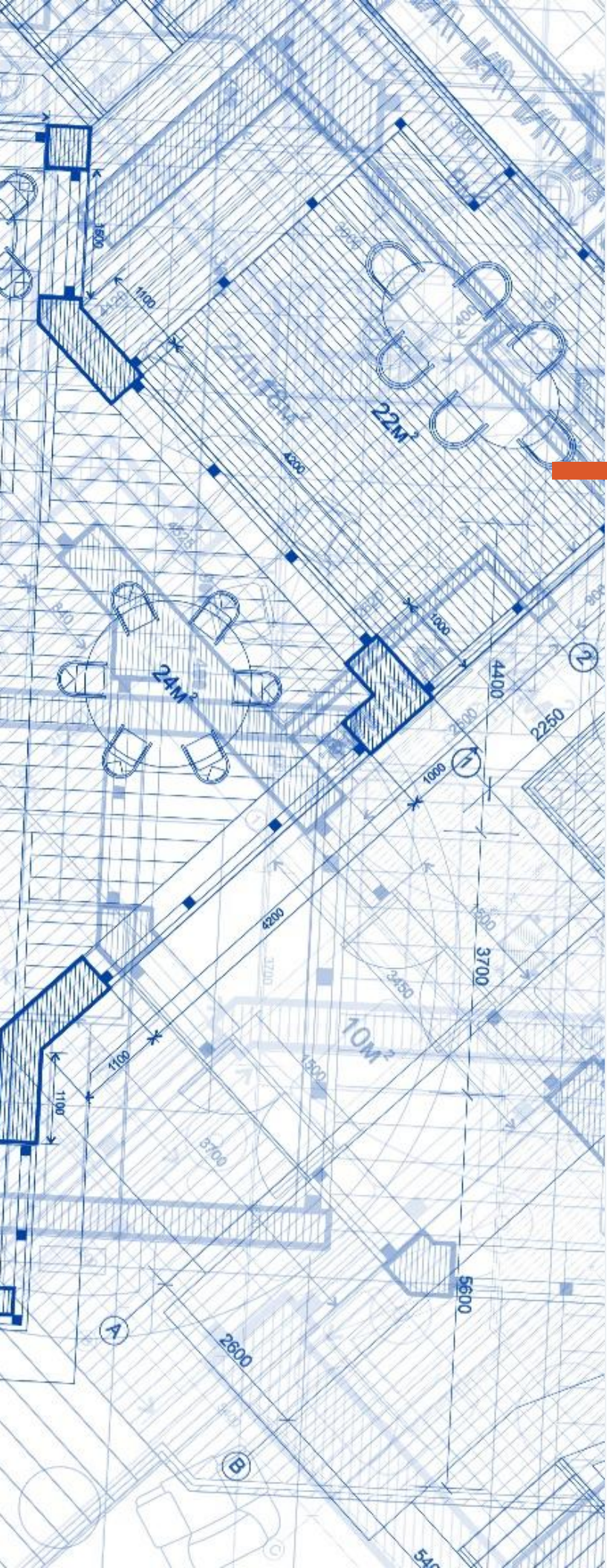


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Research Study Background

Overview

With over 75 clients in 20 industry sectors worldwide, Synaptiq aims to build a better world for future generations through novel machine learning and AI applications. We build human-centered AI solutions and products to solve any problem while upholding our firm commitment to ethics and transparency.

Our expert team is characterized by bold creativity, intellectual curiosity, passion for impact, and the audacity to innovate around obstacles previously thought impossible to overcome.

Since 2019, Synaptiq has been working with several large multinational construction companies to solve urgent challenges related to site safety and project cost modeling, which are key areas of focus industry-wide.

Our clients had “treasure troves” of data: images, videos, project costs, schedules – vast volumes accumulated over decades of leadership in the industry. Our clients aimed to leverage this data to their competitive advantage, and we worked closely with their internal teams to develop customized solutions that converted their data into actionable insights.

Throughout our engagements, Synaptiq became aware of the growing role of artificial intelligence in the construction industry, from the advent of drones to machine vision to even robotic dogs. On-site, we hypothesized potential new AI applications for use-cases in the industry.

To explore these ideas, Synaptiq launched a research effort to dive deeper into the industry and to achieve “on-the-pulse” awareness of what is happening now.





Our Methodology

Research Study

We invited a select group of innovation, technology, safety, design, preconstruction, and project management leaders from construction companies listed in the ENR 400.

Each participant had decades of industry experience in their respective specializations. We included experts in residential, commercial, and infrastructure construction.

Our interviews covered the following topics:

1. Top objectives for business operations, productivity, and cost management
2. Present and likely future pain points
3. Current investment in innovation and technology, especially AI
4. Unrealized areas of opportunity for innovation and technology, especially AI

This report provides a high-level summary of these interviews regarding the state of AI-enabled digital technology in the construction industry: what it looks like now, how it is changing, where it is going, why, and how we will get there.

We cover areas of focus and opportunities across the value chain including Design, Preconstruction, Construction, Operations and Management, and Project Retrospectives.

Finally, we include actionable insights for construction leaders, fusing together topics discussed during these interviews, our expertise in AI and applying it across a variety of industries, as well as our work in the construction space.

We conclude this report with key takeaways and recommended next steps for construction leaders.



Key Challenges and Areas of Opportunity

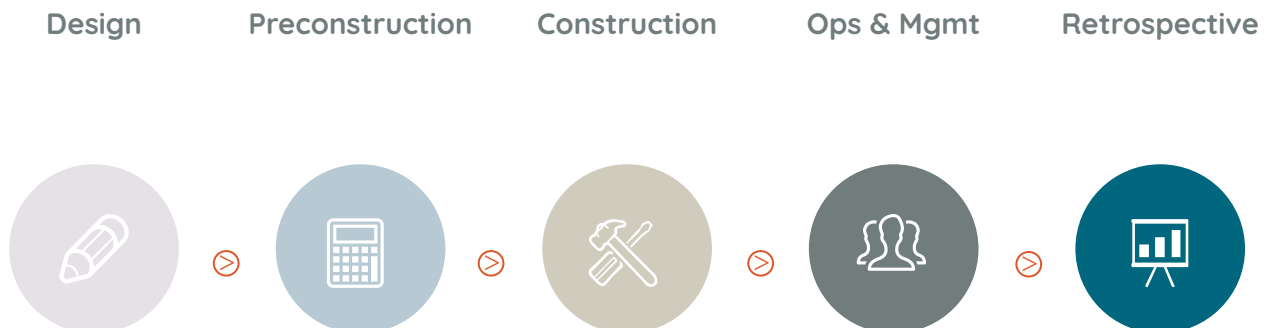
Summary of Findings

Construction industry leaders across all industry sectors, from residential, commercial, and industrial, are keenly focused on: 1) Project profitability; and 2) Health and safety. These two topics were emphasized in all of our conversations with industry leaders as “key challenges to solve” with new advancements in technology, including artificial intelligence.

Technology is moving rapidly in the construction industry, touching all areas of the ecosystem. From the digital transformation of the design process to new preconstruction estimation software, scheduling, predictive analytics, and asset management, new construction technology companies are shaking up the industry at an exciting pace. With these new technologies and industry-wide digital transformation comes data – and lots of it.

And with lots of data, opportunities for AI emerge across the entire project lifecycle:

Project Life Cycle





Summary of Findings (cont.)

From design to preconstruction, construction, and operations and management, the industry is at an exciting moment. Artificial intelligence as a whole is revolutionizing industries ranging from manufacturing to shipping and transportation – and construction leaders know their industry is extremely well-positioned to take advantage of these new innovations to boot.

Construction leaders at top companies are also confident that some of the industry’s biggest challenges can be solved by harnessing the power of their data with AI and in particular some of the newest advancements in machine vision and intelligent document processing.

Leadership also understands that without laying the necessary groundwork for AI, from data mastery to cultural transformation, the hurdles to achieve success are high. But, armed with a thorough understanding of current market drivers, identification of the biggest industry and organizational challenges to solve, getting the “fundamentals right” – such as data strategy and cultural transformation – construction companies will be enormously successful in their efforts.

The following report details: 1) Artificial intelligence overview and key definitions especially important for AI in construction; 2) Current market drivers; 3) Opportunities; 4) Key takeaways; and 5) Conclusions and recommended next steps.



Managing Costs: Artificial Intelligence technology can help give internal teams “superpowers” in keeping projects on time and on budget.

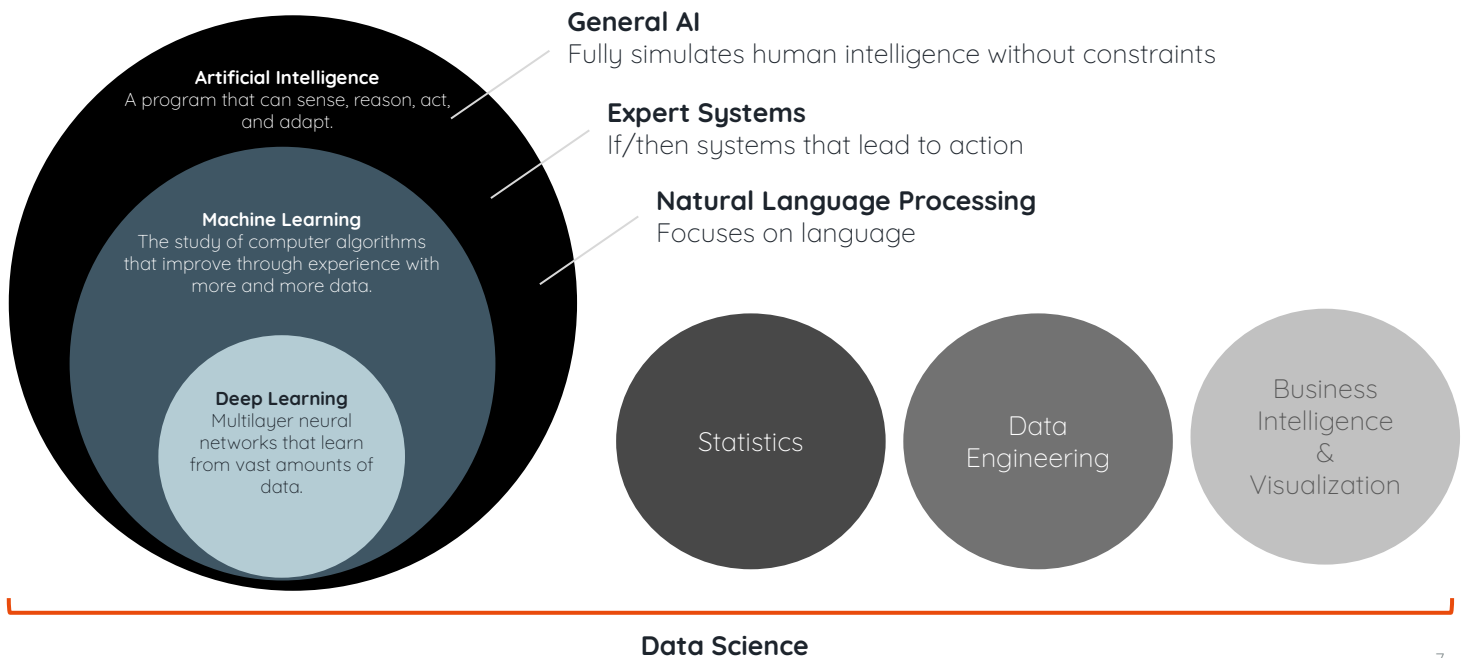


Artificial Intelligence and Machine Learning in a Nutshell

Artificial Intelligence: A Primer

Artificial intelligence (AI) leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind. It is a field that combines computer science, domain understanding, and robust datasets to enable problem solving.

Today, a lot of hype surrounds AI, especially as to how it relates to applications in industry – whether it is in construction, healthcare, or manufacturing. There is significant enthusiasm for its potential for impact across every sector, and right now construction leaders are at the forefront of imagining “what is possible.” As these discussions about imagining the possibilities for AI are occurring, there are critical questions industry leaders and data scientists are asking regarding ethical considerations as well, ranging from privacy concerns to building systems that benefit society as a whole.





Key Definitions


Within the AI space and applications for construction, three areas in particular are emerging as critically important to solving the industry's biggest challenges: Data Strategy, Machine Vision, and Intelligent Document Processing.

Data Strategy is vital to every organization as it helps identify highly valuable data and differentiate between structured and unstructured data sets, enabling business leaders to manage data more like valuable assets than byproducts of business activity.

Data strategy is based on three dimensions:

- 1) Core business strategy, including goals and objectives;
- 2) State of the business' data assets; and
- 3) Technology Architecture, including specific technology recommendations and blueprints for the system(s) informed by the vision and current state.

By understanding these three dimensions, a firm can devise a future state ("what success looks like") and roadmap for how to get there.



Key Definitions (*cont.*)

Machine Vision is the capability of a computer to visually perceive the environment. Machine vision leverages the latest technologies and methods to inspect and analyze visual data so they can be used in inquiries and controls, processes, and other applications reliant on accurate “sight.” This includes object detection, object tracking, and activity tracking in both real-time and retrospective capacities, for a variety of purposes, including: project management, scheduling, health & safety, audit & compliance, and more.

Intelligent Document Processing (IDP) is a new AI-driven approach to automating document classification, data extraction, and document creation. This solution is used to turn unstructured and semi-structured data into structured format for rapid and accurate processing and information retrieval and vice versa. An IDP model is tailored to the unique environment and document handling needs of a particular organization. IDP is actively applied to healthcare, financial services, insurance, supply chain, and legal industries today and has enormous potential for applications across the construction industry.



What's Behind the Rise of Artificial Intelligence in
Construction

Market Drivers

Perhaps the biggest surprise from our research interviews was that the “reputation” for construction being slow to implement digital technology transformation – was largely undeserved. We found that leadership was enthusiastic about innovation, educated in new technologies and software, and excited about possibilities for how AI will help shape the future of the industry.

It also became immediately clear to us that 2020 was a watershed year for the construction industry in terms of digital transformation. Companies not already well on their way with digital transformation realized quickly that the benefits of new technologies far outweighed the costs, thanks in part to the following market drivers:

COVID-19

One obvious driver in the push toward AI-led digital adoption in 2020 was the COVID-19 pandemic. The virus has forced huge changes across many industries. It has necessitated extraordinary, unplanned – and often unbudgeted – health and safety measures, including remote work and social distancing.

For many under-digitized construction companies, getting caught “flat-footed” in March 2020, without the digital solutions to facilitate fast changes and flexibility, was a wake-up call and an innovation catalyst.

It is evident that companies invested in digital technology pre-pandemic were more responsive to the rapidly changing regulatory environment. We learned through our conversations with industry leaders that those particular construction companies were able to use digital technology to react nimbly to respond on-site to rapidly evolving transmission rates, CDC recommendations, and local ordinances.

Consequently, these digitized companies were relatively unhindered by new COVID-related safety requirements. For these companies, their leadership’s ability to quickly adapt plans and protocols allowed the organizations to retain momentum during the pandemic, winning large projects while their undigitized peers struggled to catch up.



What's Behind the Rise of Artificial Intelligence in
Construction

Market Drivers

(cont.)

Consumer Preferences

Another driver for digital transformation in construction was actually digital adoption *in other* industries. 2020 marked record digital adoption rates worldwide across market sectors. We (as consumers) were already conditioned pre-pandemic to expect “smart” and responsive services from high-tech companies such as Netflix and Uber; this wave of digital adoption led us to further expect tech-competency from an even wider range of service providers. Online school, virtual appointments, remote work, and other everyday goods and services “gone virtual” shifted consumer preferences toward two values: convenience and efficiency. Gone are the days of exclusively brick-and-mortar, paper-heavy businesses. Today, marketability is largely focused on digitization. Construction has historically generated huge amounts of paperwork, from contracts to permits to blueprints. Now, some construction companies are responding to consumer demand for digital delivery by investing in AI-enabled solutions such as IDP that enable teams to work faster with more precision.

Competition

Finally, perhaps the most significant driver behind AI-led digital adoption in the construction industry is digital technology itself – or, more accurately, what it offers in terms of competitive advantage. For example, by having a predictive model which can anticipate which elements of a given construction project will have the most impact on the project's overall profitability, a construction company can stay ahead of the pack in profitability and client satisfaction. Beyond cost modeling, construction companies are also seeing safety benefits from AI-enabled digital technology. Machine vision solutions can aid EHS teams, providing 24/7 oversight to analyze risk factors and even predict – and potentially prevent – injuries and fatalities. They can detect situations that present immediate risks (for example, misuse of equipment or lack of PPE) far faster than the human eye, and send automated alerts to supervisors and EHS personnel. A demonstrated “care for life” is paramount within the country's top construction organizations, as outfits with clean safety records are preferred employers and contractors. As a result, AI-led digital technology offers a significant present *and* future competitive advantage: safety now, plus talent and revenue later. 1



Biggest Challenges to Solve with AI

Opportunities



Now that top construction companies are well on their way with digital transformation, construction leaders were eager to share their ideas for how to leverage their data with AI to solve specific challenges.

Several opportunities they highlighted included: document management across the entire project lifecycle, Design Management, Preconstruction, Prefabrication, Resource and Equipment Management, Schedule and Staffing Management, Health and Safety Compliance, and Project Retrospectives.

Document Management

The construction process – start to finish – typically generates a significant amount of paperwork, including: environmental documentation, blueprints, contracts, and permits, and external documents such as federal, state, and local building codes, OSHA regulations, union agreements, and more.

Document management is a top priority across the board – in all divisions of construction companies, from design to preconstruction to operations.

An Intelligent Document Processing (IDP) solution for contracts using a classifier to categorize documents according to their visual and language content, and a machine vision-based document extraction engine to pre-assemble document materials for expert drafting and review, dramatically improves accuracy and reduce manual document preparation time. This solution would be especially beneficial to teams managing contracts and tracking change orders.

A very near-term use case for IDP is to respond to the dramatic fluctuations in the cost of wood. If and when wood prices fall again, a massive amount of documentation will follow. IDP is the perfect solution to manage this.



Biggest Challenges to Solve with AI

Opportunities (cont.)



Design Management

“Design” is the process of developing: (1) Blueprints for a construction project; and (2) Instructions for those blueprints to be carried out. Quality assurance is crucial in this process, as even the most minor design mistakes can lead to inaccurate cost and schedule modeling in preconstruction, resource and staff shortages in construction, and structural instability in the finished project.

“Design management” describes an AI-enabled system used to automate and optimize the design process. To understand how it adds value, consider two construction companies: one with a team of architects and a second with a team that has an AI-enabled design management system. Both companies are tasked with designing a piping system for a project with given dimensions. Their goal is to minimize material costs without compromising efficiency. In this illustration, the first construction company directs its architects to manually draft and test piping configurations until they determine which configuration fits their stated goals. The second company, however, will use its intelligent design management system to automate the configuration-testing process. Consequently, the second company will likely arrive at the same conclusion as the first company much more quickly and at a lesser cost in labor and wages.

Preconstruction

“Preconstruction” encompasses tasks that must be completed between finalization of design and permits and when construction actually begins on-site. One of preconstruction’s most essential tasks is cost and scheduling modeling: the process of determining how much a project will cost and how long it will take to complete. Predictive AI solutions can improve cost and schedule modeling by analyzing historical data trends to make rapid and often more accurate predictions – for example, predicting the cost of steel one, five, or ten years from the present day. The more data a company inputs into a predictive model, the more accurate the output.



Biggest Challenges to Solve with AI

Opportunities (cont.)



Prefabrication

“Prefabrication” is the practice of manufacturing and pre-assembling parts of a construction project off-site, generally in a controlled factory environment. New advancements in robotics are enabling the automation of prefabrication manufacturing. Solutions such as machine vision are helping perform quality assurance and tracking. AI will help ensure prefabrication is more streamlined and efficient by automating processes, reducing errors with quality assurance, and improving logistics and transportation with data insights.

Resource and Equipment Management

Several construction industry leaders identified resource and equipment management as not only an important “challenge to solve” for the industry as a whole but also especially well-suited for AI solutions. Construction equipment is expensive, and there may be just *one* of a particular item onsite – but two different teams, physically located at different site locations, require the piece of equipment on a daily basis.

Knowing what resources and equipment are needed for a construction project is not always enough; managers also have to know where the high-demand equipment is located any given time – and who else needs it, and when. That is where “resource and equipment management” comes into play: an AI-enabled system to organize and track materials on site.

A resource and equipment management system can raise efficiency in the field by reducing “dead time” (paid hours spent waiting, searching, or otherwise not working on a productive task). It also allows for automatic, accurate usage-tracking, which provides helpful information for proactive equipment maintenance and an early warning when a given resource is running low.



Biggest Challenges to Solve with AI

Opportunities (cont.)



Project Retrospectives

Finally, at project completion, AI can help analyze project data to understand why specific project managers are *particularly excellent* at achieving profit margins: quantifying what they do, and how others can learn from them to establish best practices.

For example, a construction company could analyze project data with AI to understand the *why* behind critical questions such as: which subcontractors performed, which ones did not, what made money, and what lost money. Which milestones went off without a hitch, which ones had hiccups. Why was concrete poured late? What pre-existing conditions were present to ensure everything went smoothly – and how can we replicate these conditions in the future to achieve similar positive outcomes? This type of analysis is what an AI platform would enable.

Powerful AI Solutions Throughout Project Life Cycle

Design

Preconstruction

Construction

Ops & Mgmt

Retrospective





Two Key Takeaways for Construction Leaders

Getting Started

In this report we reviewed market drivers that are accelerating AI-led digital adoption as well as exciting opportunities for how AI can help construction companies solve big industry challenges.

Now we will take a step back and ask: if construction companies are so well-suited to invest in AI, and the “timing is right,” and there are big challenges to solve, why aren’t they yet?

This can be answered in two parts: first, many companies *are* already exploring and investing in AI-enabled digital technology – but have not launched their programs. We learned that not only are companies investing significant budget in some of the newest technologies, but some top companies have hired internal teams of data scientists to create customized proprietary software.

Secondly, other construction company leaders revealed that their respective organizations are not yet invested in AI, and it is *not* due to IT budget constraints. Rather, they face hurdles because they have not yet laid the necessary groundwork for AI: cultural transformation to data mastery.



Consider these Questions

How ready is your organization for AI? Are people slow to adopt new technologies, or are they just wary of how AI is going to change their day-to-day jobs?



Where are you focusing your technology efforts today?



How does your company think about investing in technology solutions, including new areas like AI?



What tools and products are you currently using or exploring?



Do you plan to use technology to achieve current business goals?



What do you need to be successful moving forward?



Two Key Takeaways for Construction Leaders

Getting Started (cont.)



Recommendation #1: *Lay the Groundwork for Cultural Readiness*

A company has “cultural readiness” when it:

- 1) Is open to change; and
- 2) Has the budget to invest in change.

Some construction companies are dominated by unions or in-house skeptics who fear that technology will replace human workers. We have found that our clients are most successful at achieving buy-in when they effectively communicate the game-changing advantages of human-AI collaboration – and especially how AI solutions can help employees focus on their specific expertise.

Robots will not replace humans and expert tradesmen: but they will help free up time to focus on what *they do best*. Looking ahead, this will be critically important as highly-skilled tradespeople are increasingly in high demand.

Furthermore, it is important for leaders and their respective teams to recognize that investment in AI-led digital transformation will not have an “overnight” return on investment. Sometimes it may take months or even years to realize the full effect on the organization.



Two Key Takeaways for Construction Leaders

Getting Started (cont.)



Recommendation #2: Establish Data Mastery

For many construction leaders we interviewed, cultural readiness was not the issue. Rather, “how to get the data we need, and what to do with the data” was the biggest blocker. Specifically, many construction companies do not know what data they even have. And, many times this data is redundant but named differently in other systems, or they have not defined a system of record for data.

Data governance refers to the collection of principles, practices, and systems a company uses to ensure that its data is high-quality and organized. A company has strong “data governance” when it knows *exactly* where its data is stored, who and what has access to it, and why. Since AI relies on data, data governance is a requirement for adopting AI-enabled digital technologies.

The reality of AI-enabled digital technology is that more data means better outcomes. Companies should start collecting data as soon as possible and treat it as a competitive advantage to avoid falling further behind the innovation curve.



Defining the Gap

What kind of data do you have, and how good is it?

We recommend conducting a brief current state assessment to gauge the time and effort required to fulfill your company’s vision and draw out a roadmap.

How do the following areas score against this simple maturity model below?



Organization structure, competencies, and hiring plans

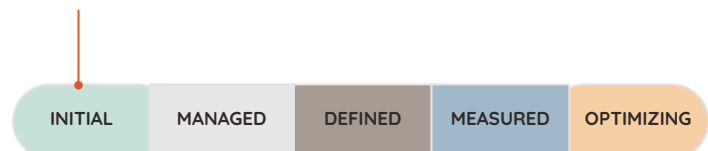


Data governance policies, processes and standards



Databases, schemas, and keys

CURRENT STATE
EVALUATION





Conclusions & Next Steps

The insights we gathered from this research project, combined with our recent work in the construction industry, has illuminated many opportunities for AI to help solve pressing challenges in construction.

We wish to thank the many participants who generously contributed their time to help us produce this report.

It is an exciting moment for construction, in every phase of the construction project lifecycle, from design, to preconstruction, construction, operations and management, and project retrospectives.

Many firms we spoke with are ramping up activities by building out their internal teams with data scientists or hiring external firms like Synaptiq to partner with and build solutions.

And, by first getting the “fundamentals” right – cultural readiness and data mastery – construction industry leaders will be well on their way to success in their AI-led digital transformation efforts.



For more information, feel free to reach out.

Contact



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