

# Addressing Uncertainty in Construction Projects

Value Realisation Using Project Controls Systems to Effectively Manage and Operate Assets across the Project Life Cycle

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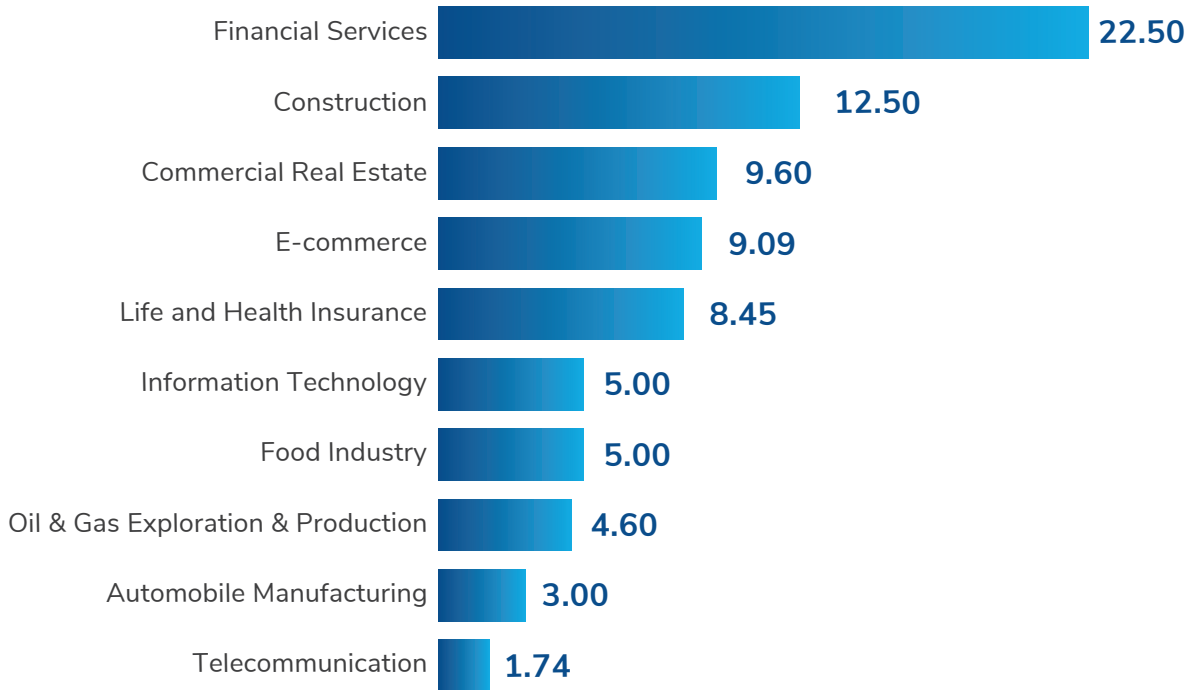
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## Introduction

Construction—one of the largest industries in the world—plays a crucial role in the global economy. Accounting for nearly 13.0% of global gross domestic product (GDP) in 2020, it facilitates the growth of other industries by providing relevant enabling infrastructure. In 2020, the global construction industry registered output of approximately \$10.7 trillion, and it will likely reach \$15.2 trillion by 2030. Growth in construction output will average 3.6% per annum until 2030—higher than both the manufacturing and services sectors.<sup>1</sup>

FIGURE 1.1: Top 10 Industries by Market Value (US\$ Trillion), Global, 2021



Source: "10 Biggest Industries in the World," Yahoo Finance, 21 March 2021

Prior to the COVID-19 pandemic, the global construction industry employed about 250 million workers, accounting for 7.7% of global employment in 2019.<sup>2</sup> Looking ahead, this industry will continue to provide large-scale employment to workers worldwide.

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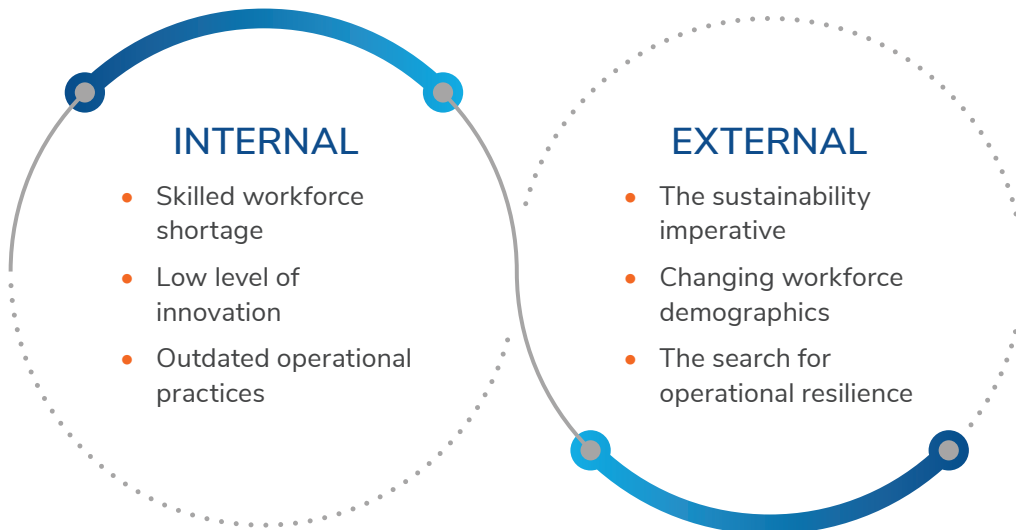
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until 2030—higher than both the manufacturing  
and services sectors.**

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## Key Trends Impacting the Construction Industry

Significant transformation is occurring across all aspects of construction—including building materials, construction processes, and outcomes—and both internal and external trends drive these transformations (see figure 1.2).

FIGURE 1.2: Internal and External Trends Transforming the Construction Industry



Source: Frost & Sullivan

Moreover, project owners commonly adopt digital technology **to aid this transformation and improve certainty in capital-intensive infrastructure project delivery.**

### The Sustainability Imperative

In 2020, the buildings and construction sector accounted for 36% of global final energy consumption and 37% of energy-related carbon dioxide (CO<sub>2</sub>) emissions.<sup>3</sup> The construction industry generates significant amounts of waste, which adversely affects the environment. Currently, the industry recovers less than one-third (20–30%) of construction and demolition waste.<sup>4</sup> As a result, project owners are exploring efficient ways to incorporate sustainability and minimize waste. Technology can support owners' sustainability efforts without negatively impacting project timelines and budgets. With advanced modelling technology enabling scalability and standardisation, sustainable construction approaches will significantly **improve productivity and achieve low-cost execution.**

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**Technology can support owners' sustainability efforts without negatively impacting project timelines and budgets.**

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## Changing Workforce Demographics

The global construction industry contends with an ageing labour demographic, with approximately 21% of the workforce aged more than 55 years old and only 9% of in the 24-year-old-and-below category.<sup>5</sup> The following statistics offer a glimpse of the global scenario:

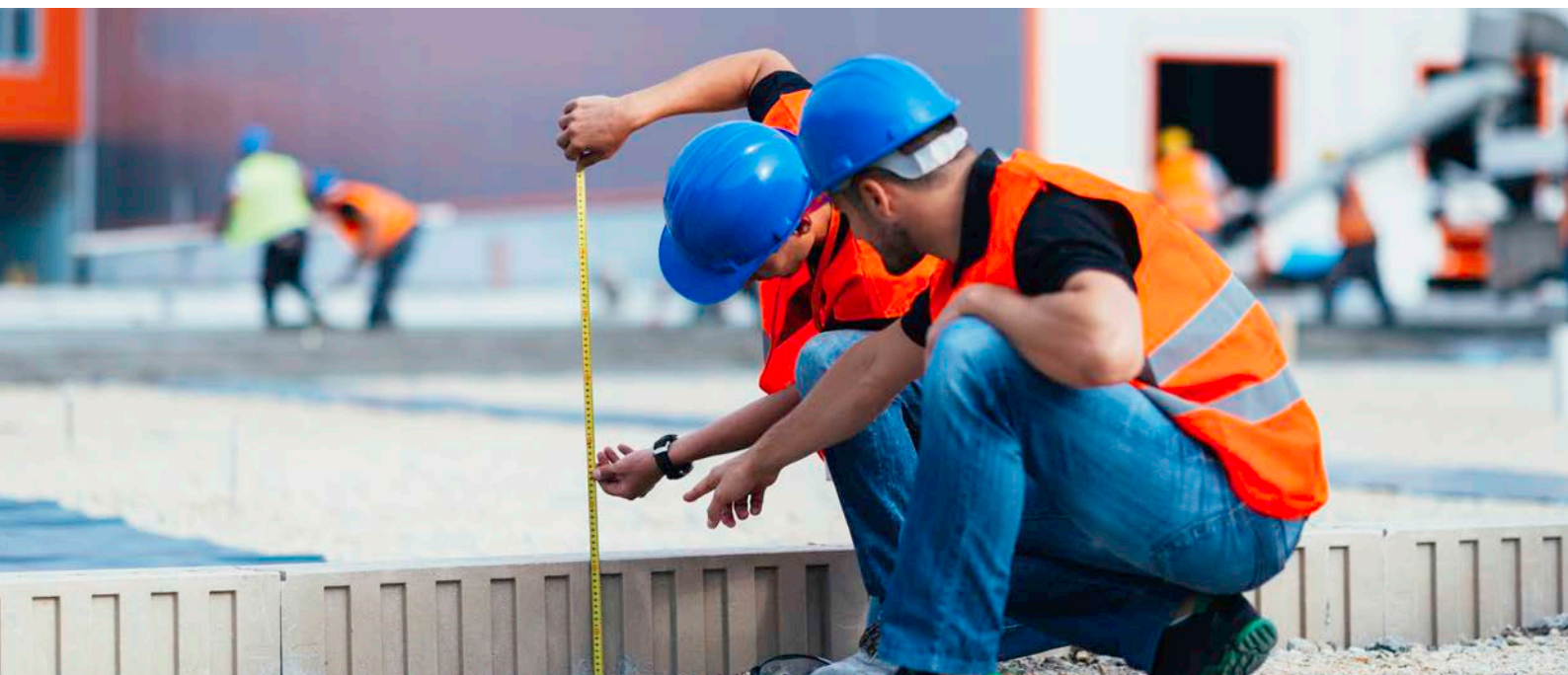
- A survey by the Associated General Contractors of America shows that **80% of US construction companies encounter difficulties locating qualified employees.**
- The construction industry will **need more than 2 million workers in the next 3 years** to keep pace with housing demand amid the labour shortage, according to the Home Builder Institute.
- By 2025, **the Japanese construction workforce will have two-thirds** of the number of workers it had in 2014. Also, a quarter of the Japanese construction workforce will be aged 60 years or older in 2025.<sup>6</sup>

The industry-wide challenge is to reduce labour shortages through various strategies, such as leveraging automation and digital technologies. Smart solutions that help improve project **staff utilization and reduce the time to complete tasks** (searching for documents/updating or analysing data) will gain considerable traction.

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**“We need to start designing a better environment  
for our own employees.”** –Project Owner

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## The Search for Operational Resilience

The uptake of modern construction methods, such as **offsite (prefab/modular) construction** (promising shortened construction periods and net savings of up to 7%),<sup>7</sup> will improve productivity and profitability. Still, this trend and the overall globalization of supply chains, make the construction industry vulnerable to external disruptions, such as the COVID-19 pandemic, US-China trade war, and various geopolitical risks. For example, reports from several markets worldwide suggest that pandemic-induced movement restrictions and supply chain disruptions resulted in the fastest growth in construction costs seen in decades. Moreover, the pandemic forced both the private sector and public institutions to speed up the adoption of new work practices and digital technologies.

Considering the large amounts of data generated across a construction project's value chain, the current focus is to gather this data into a single platform to derive actionable insights.

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In a recent survey of organizations involved in capital-related projects, about 71% of the respondents acknowledge digital transformation as the most significant growth enabler in the coming years. Further, 96% of the organizations admit they could do more with the data they capture.<sup>8</sup>

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“Tech is not making us faster because we are swimming in data.” –Project Owner

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## The Paradigm Shift to Outcome-driven Processes

The combined impact of the major external and internal trends transforming the construction industry results in a **long-awaited paradigm shift to outcome-driven processes** (see figure 1.3). This transformation has implications for every construction phase (including the concept or pre-planning, design and construction, and start-up and operations phases) and **redefines success** for the industry.

FIGURE 1.3: Long-term Shifts to Business Processes



CAPEX = capital expenditures; OPEX = operating expenditures Source: Frost & Sullivan

## The Project Owners' Evolving Role

As financiers for the project, owners or representatives increasingly involve themselves in all project phases, especially for significant infrastructure projects. Owners often adopt a supervisory role or may participate directly, depending on the chosen project delivery model. Whatever the approach, the **owners' increasing need for expanded visibility and control requires more comprehensive and connected digital solutions to enable collaboration and agile decision-making** that is needed to manage and mitigate project risk.

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**“We have to assess risk in a new way and are very concerned with unpredictability.”** –Project Owner
 

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With the arrival of improved data capture tools and digital project controls, owners can anticipate issues before they occur. They can establish more realistic plans and accurately account for and mitigate risks, becoming data-driven organizations that bring operational assets online with more predictability and certainty.

## Project Management Information Systems (PMIS)

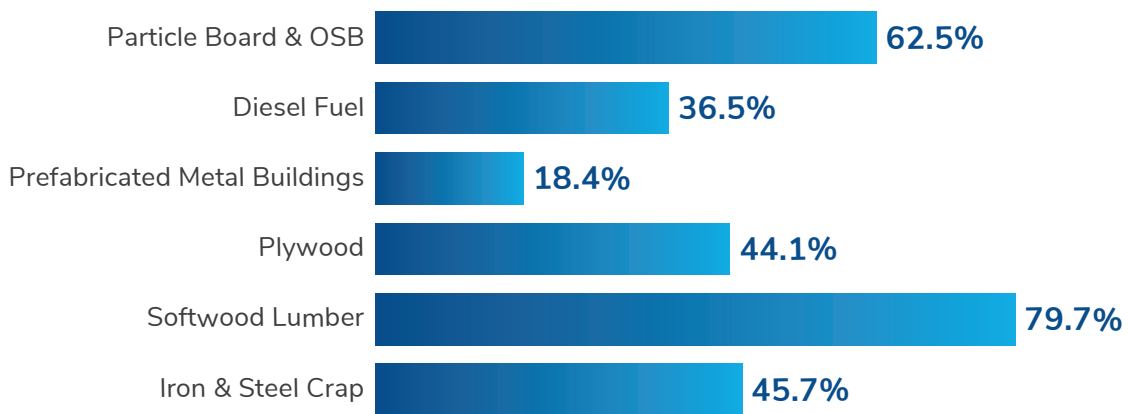
PMIS, also referred to as **project controls systems**, streamlines workflows by integrating all necessary project controls and management processes into a single platform. As a result, PMIS helps owners gain access to information across project phases and facilitates better monitoring and execution.

### Why PMIS?

During the pre-planning phase, PMIS **connects across disciplines** and combines estimate/bid/tender information with the schedule while also drawing insights from **past project performance for risk analysis**. It also helps enhance engineering management, whereby owners see real-time design changes and understand impacts on the project schedule and cost to decide whether to keep the design or look for alternatives.

As figure 1.4 shows, the cost of essential construction materials rose sharply between 2019 and 2020. This highlights the importance of **close monitoring and management of cost and schedule** during the design and construction phase. PMIS provides centralised and linked execution tools that track planned-versus-actual progress from the field to create performance reporting for owners to access across their capital development programs.

FIGURE 1.4: Key Construction Material Cost Changes from Producer Price Index Series, US, 2019–2020



OSB = oriented strand board

Source: Bureau of Labour Statistics (BLS)

Moreover, PMIS pools all documentation, inspections, and models during the start-up and operations phase. Owners document a project's **complete historical record**, which is accessible **through a digital twin**. A digital twin provides the owner valuable insights through unique visualization of information throughout the asset's lifetime, with all construction and commissioning data available for the operations and maintenance teams.



A PMIS solution also addresses the challenge of operating **disconnected point solutions**. While point solutions may be highly efficient in niche functions, regular introduction of new point solutions can result in a medley of products from different vendors, causing **compatibility and integration issues**. Also, projects commonly run into data-sharing challenges because of a **lack of data standardisation** and a consistent framework across various disparate point solutions.

Adopting an integrated platform, such as PMIS, makes **corresponding data available in real time**, allowing owners to understand the past context and as-built state, which provides a single-sourced truth for more accurate forecasting.

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These fully enriched, time-sensitive perspectives enable more impactful decision-making that greatly mitigates risk and improves outcomes.

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## Pre-planning Phase

A construction project's pre-planning phase encompasses tasks that support project approval before moving on to significant engineering and design work. Major activities during this stage include project-scope identification, feasibility and constructability analysis, and high-level (or conceptual) budget and schedule development. In addition, any vital information the project captures during this phase will serve as a solid foundation for subsequent detailed design and construction work. In this phase, three vital aspects for owners are cost estimates, realistic schedule estimates, and good contractor engagement.

### Key Challenges

**Defining the Project Objectives, Budget, and Schedule:** Poorly defined scope and undefined goals resulting from poor communication between project stakeholders are the biggest challenges in this phase. If the project aim, scope, budget requirements, and schedules are unclear, then project execution loses its effectiveness.

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**“It starts with price realism.”** –Project Owner

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**Timely Risk Identification:** Risk management is vital during this phase. Identifying potential risks must happen at the earliest opportunity, even before developing a detailed design. Similar completed projects which lack historical data lead to weak risk management practices.

**“I think there is struggle with a lack of conceptual budget estimates and schedules for early-stage projects. Planners plan, but the discipline of project management is something that often goes missing. In planning, you think about something in a bubble.”**

–Mark Simister, Head of Program Delivery,  
Sydney Water



## Leveraging PMIS during the Pre-planning Phase

High risk-sharing in the private sector through diverse project delivery models (public-private partnerships or build-operate-transfer) results in a lack of alignment and conflicting interests amongst project stakeholders. **From 2019 to 2020, the global average value of construction disputes reached \$54.26 million.**<sup>9</sup>

Risk identification cannot be effective without inputs from all stakeholders. Further, assessing the risk impact on schedules and costs requires strong expertise from multiple domains. Referring to and **benchmarking actual expenses from similar past projects** can establish a more reliable estimate.

- PMIS solutions allow **benchmarking, enabling users to identify known risks** from historical projects to **create what-if scenarios** for estimating both **real-time and future impact on schedule and cost**. Such effects can happen even when the work scope changes, giving owners the confidence to proactively develop risk mitigation strategies that emerge earlier in the project or during project execution.
- All **centralised project-related data** are available for stakeholders, enabling informed decision-making.
- **Integrating cost, schedule, and scope into a single solution platform helps owners track project performance in real time**. Monitoring real-time metrics allows the platform to tag deviations beyond the acceptable range of outcomes as risks requiring the owners' attention.

Artificial intelligence (AI) and machine learning (ML) now make project risk assessment more effective for owners. AI/ML reduces the overhead and complexity of risk analysis by allowing an inference engine to make suggestions to owners based on the voluminous historical data gathered from previous projects. Further, AI can leverage historical data and generate most-likely scenarios along with best or worst case scenarios that traditional methods used to develop for risk assessments. **Both AI and ML can augment human intelligence, combining suggestions from historical data with the planner's experience and intuition.**



In this early project phase, owners need to shift from thinking solely about cost to outcome-based objectives. Equally essential, owners must follow a progressive contracting approach that is open and transparent for prospective contractors to understand their capabilities and derive the best intellectual property from them in the pre-planning phase.

## Design and Construction Phase

The design and construction phase involves detailed planning, procurement, and project execution. Architects and engineers complete detailed schematic designs to ensure the construction process will meet owner objectives while remaining workable and compliant. Contract documents containing final drawings and specifications enable the placement of bids for selecting subcontractors to work on the project. Owners receive regular updates on the project's progress. Stakeholders need to receive all documented incidents at the project site that include workplace health and safety. Ideally, they would have access to progress dashboards and reports that provide visibility and transparency across planned and actuals.

### Key Challenges

**Ineffective Time Management:** The critical path method involves performing traditional project scheduling, defining activities, assigning time durations, and sequencing activities. This scheduling method is only as effective as the accuracy of activity duration estimations. Errors or variances in an area can have a **ripple effect on other schedule areas**. Project planners assign these activity durations, typically leveraging a select personnel pool or, at best, organisational experience. During this phase, the estimated time to complete inspection (quality control), test plans, and finish other quality-related activities is often optimistic and significantly affects the project's schedule when jobsite realities become clear.

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**“We didn’t make decisions in time.”**—Project Owner

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**Inconsistent Project Management Practices:** The time frame for the infrastructure project's design and construction phase typically varies between 3 and 10 years, which is long enough for an organisation to undergo considerable restructuring internally. Robust project management practices are vital to ensure **business continuity**.

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**“We need streamlined and consistent business processes.”**—Project Owner

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**Weak Documentation Practices:** Construction projects involve thousands of documents related to scope, project design, permits, and building codes. Hence, **finding the correct document and accurately capturing data is time-consuming and prone to error.** On average, construction professionals spend 5.5 hours a week searching project documents.<sup>10</sup>

**Managing Appropriate Access Levels:** Throughout the design and construction phase of the project, the number of collaborating parties expands significantly. **Managing appropriate access for all team members** to the relevant documents will help avoid task delays, disputes, and rework. In addition, **revision control** and referencing the latest construction drawings are essential to document control.

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**“We are seeing spikes in our pricing, and our contingencies aren’t adequate.” –Project Owner**

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**Limited Visibility on Procurement Practices:** Procurement has a massive impact on project outcomes. If the correct materials are not available on-site, it can have significant implications for **time delays and cost overruns** (far more than the material costs alone).

**“When it comes to execution, there’s quite often a gap in terms of budget, timescale, and outcomes that can be delivered. Prioritization is a tough task because there’s a whole range of different desires, needs, wishes, and wants within an organization. Trying to pull together all the appropriate levels of information and data that are needed, to go and get the right product at the right time at the right cost can be complicated.”**

*–Project Owner*



## Leveraging PMIS during the Design and Construction Phase

The value of deploying PMIS during this phase yields considerable time, cost, administration, and communication benefits.

- PMIS solutions aid project stakeholders in developing **better designs that leverage historical data** available from previous projects.
- PMIS **eliminates human bias** and overly optimistic scenarios and accommodates the variables based on facts. The system derives or guides task duration by referencing productivity rates and quantities from similar historical projects. This enables **objectivity in data-backed schedules**.
- PMIS ensures the incorporation of various **quality control activities** into the plan, including the **percentage completion** calculation **and earned value as the project progresses through construction**.
- PMIS offers **effective project document control that can reduce the time the company spends on document capture by 75%**.<sup>11</sup> PMIS supports owners through effective project monitoring, budget and schedule managing, and reliable progress reporting. It delivers **reports and dashboards** for owners that **provide high visibility on project status and performance**. As change occurs across design and construction, owners know that updated designs, plans, and progress align with desired outcomes and within a risk threshold.
- **A centralized and comprehensive procurement solution by PMIS** makes the process manageable. As a result, should unexpected costs or changes occur, the budget and forecast automatically update, making the **whole process more transparent and accurate**. All relevant stakeholders receive updates with information relating to contract documents and spending data. Seeing the relationship between material procurement status and the forward-looking project schedule is essential when potentially thousands of material line items, trades, and specialist machinery need coordination.

As the construction phase is generally the project life cycle's riskiest stage, real-time and efficient collaboration between owner, contractor, and subcontractor is critical, as is the implementation of well-defined rules for measuring progress.

## Start-up and Operations Phase

The start-up and operations phase marks the completion of physical construction. However, project completion occurs only when the asset becomes operational and is handed over to the owner.

### Key Challenges

#### Smooth Documentation Handover Is

**Imperative:** Owners must validate that all project-related documents are the correct or latest versions. The non-validation of submitted documents, such as design drawings or site survey results, may necessitate re-doing the survey work when the project becomes operational. These challenges become substantial if project stakeholders have used paper-based or poorly managed digital document management tools, which may lead to errors and gaps in documentation. In many instances, these discrepancies add to overall project costs, and the resulting process delays can aggravate the financial burden for owners. Likewise, it is the owners' responsibility to ensure they receive warranty documents, certifications, and all relevant regulatory compliance documentation.



**Limited Collaboration between Specialist Teams:** Starting up (commissioning) an asset can be highly risky. When the general public uses infrastructure or when material or power flows through a facility or plant, it is vital for owners to ensure that **start-up performance accords with a well-considered plan, including relevant approvals and inspections**. Collaboration between specialist teams responsible for start-up activities is, therefore, vital to overall start-up phase success.

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“In the project commissioning phase, we have embedded commissioning teams who work as an integrated team with our suppliers. Designers, construction, and maintenance staff are all integrated. They work together but also have their particular tasks to do... Software solutions for project and program management should have the best ability to interconnect.”

–Mark Simister, Head of Program Delivery, Sydney Water

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“During handover, the requirement was for the delivery to be in the form of a database that included documents related to drawings, warranties, anything to do with information about the terminal. It had the capability of visualising the entire terminal and associating the document and the data requirements defined in the contract for every piece of the building. For example, you could click the door, and it would tell you who installed that, the reference, or any pertinent data associated with the door.... It is more traditional to have contractors use their own systems to deliver information through it, and then we (owners) get an output from their system. That has never been a formula that works well for us... the data we receive ends up being almost useless. **We want context in the creation of data. That’s where InEight (PMIS) plays a big role.**”

–Frank Peters, central Building Information Management (cBIM)  
Program Manager, Los Angeles World Airports

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## Leveraging PMIS during the Start-up and Operations Phase

Active deployment of PMIS during this phase benefits project owners in terms of traceability, visibility, and seamless operation.

- Owners realize better document control and management through PMIS solutions. It **brings all related project items into a centralised location**, providing a single source for sharing and ensuring that all appropriate stakeholders can access the same documents. Further, **automating and tracking document collection increases accountability and reduces risk** for owners.
- The **start-up team needs to be aware of vital installation processes and task completion** to execute commissioning on time. **Ensured visibility through PMIS solutions** will facilitate the construction team's checklist creation and completion for review at start-up so that the asset is ready for operation.
- PMIS enables smooth operations because necessary warranty and repair information is available via the asset's digital twin.

Collaboration between the specialist teams responsible for commissioning an asset is vital for a successful start-up. Empowering the commissioning team with project data will resolve pending issues and take construction to completion.



## Conclusion

The construction industry's contribution to the global economy will increase with **massive planned infrastructure investments** from the public and private sectors. Significant trends, such as demand for sustainable construction, changing workforce profiles, and operational disruptions, will force the industry to radically transform. In this context, the COVID-19 pandemic has exposed the industry's vulnerability, which is that it has been slow to innovate.

In these unprecedented circumstances, the need for visibility and collaboration between major stakeholders to improve certainty in completing capital projects per plan is more evident than ever. Project developers and asset owners, whose stakes are the highest, are increasingly looking to adopt tools and solutions to monitor and assess project progress independently, without relying on other stakeholders. Owners will look to leverage tools, such as PMIS, to perform significant tasks such as risk assessments and associated contingency plan developments, with minimal support from contractors.

With industry trends moving towards expansive and more complex capital projects, owners have a low-risk tolerance, even as expectations from different stakeholders, such as investors, communities, and end users, remain high.

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**This low-risk tolerance makes it even more critical for owners to have accurate visibility of cost and schedule, undertake proactive risk management, and carry out real-time decision-making across the project life cycle.**

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When owners use solutions such as PMIS as integrated platforms, it substantially helps them meet their strategic objectives and manage risks effectively. Corresponding data made available through platforms that integrate the various workflows and a project's processes allow owners to gain better visibility across the asset's entire life cycle, ensuring successful project outcomes.

Leveraging AI and ML tools to analyse and derive actionable insights in the construction industry improves productivity and helps stakeholders realise value throughout the project life cycle. As the construction industry evolves and advances by treading the digital transformation path, it will also become more data-driven, creating new opportunities across the project life cycle to incorporate advancements in the manufacturing, retail, and transportation sectors. In the future, industries that leverage data-driven insights will retain their competitive edge and thrive, while those that lag to capture, use, and understand that data may become obsolete.

## Endnotes

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## About InEight

InEight provides field-tested project management software for the owners, contractors, engineers, and architects who are building the world around us. Over 575,000 users and more than 850 customers worldwide rely on InEight for real-time insights that help manage risk and keep projects on schedule and under budget across the entire life cycle. From pre-planning to design, from estimating to scheduling, and from field execution to turnover, InEight has powered more than \$1 trillion in projects globally across the infrastructure, public sector, energy and power, oil and gas, chemical, mining, and commercial spaces.

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