

BIM-Based Integrated Project Management System

An Integrated Approach Against Delays, Waste, and Uncertainties in the Construction Industry

Senato Project Management

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Abstract. An integrated system where workflows within the Project Management knowledge areas of Project Schedule Management, Project Resource Management, and Project Cost Management mutually feed Building Information Modeling (BIM) processes. By transforming BIM models from mere deliverables of the design phase into primary data sources that remain alive, processed, updated throughout the project lifecycle, and actively participate in decision-support processes, this integrated system creates a dynamic, data-driven digital framework specifically for the Planning, Executing, Monitoring, and Controlling process groups of Project Management.

Building this unified structure is made possible by basing it on the applications of Data Engineering, Data Analytics, and Business Intelligence. By integrating BIM models with Primavera-based schedules, operational field data, contract details, accounting software, progress payment reports, and other project management tools, all data generated throughout the project lifecycle is gathered via ETL (Extract, Transform, Load) processes, transformed, and subjected to automated computations to generate outputs.

This approach aims to establish a data-driven, transparent, and traceable management culture in today's construction industry, where conventional project management practices fall short of digitalization requirements and delays and cost overruns are widespread. Ensuring that decision-making mechanisms in critical areas such as Project Schedule Management, Resource Management, and Cost Management rely on data rather than estimations, this system also contributes to creating a common digital language among project stakeholders.

BIM-centric digital integration is not solely a technical solution; it also introduces a new management paradigm in terms of efficiency, accountability, and proactive governance. In this context, the proposed system aims to provide a tangible contribution to the digital transformation of the construction sector and sustainably restructure the planning, execution, monitoring, and control phases of project management.

1. INTRODUCTION: DIGITALIZATION

The construction industry has long faced structural challenges such as time and budget overruns due to complex processes involving high-budget projects, long schedules, and numerous stakeholders. A major portion of projects exceed their designated duration and cost targets, posing severe risks for investors, contractors, and public institutions. One of the most significant challenges is that project management cannot be conducted through an adequately data-driven and unified system. However, effective project management becomes possible not only through decision-making but also through digitally tracking, processing, and presenting data transparently to all stakeholders. Establishing project management on a digital foundation bridges the gaps between processes, offering substantial advantages in efficiency, traceability, and accountability.

In this regard, Building Information Modeling (BIM) presents significant opportunities for digitalizing project management. Yet, in many local projects, BIM is still treated merely as a three-dimensional modeling process; its integration with other essential project management components—such as schedules, progress payments, budgets, and cost control—remains unachieved. This fragmented structure decelerates decision-making, restricts access to information, and leads to inefficiencies. Unifying and processing project components with BIM processes through Data Engineering applications creates a major opportunity for digital project management.

Integrating project management components with BIM models empowers data-driven, up-to-date, and accurate decision-making while increasing process traceability and overall transparency across the project. This document aims to demonstrate, with a holistic perspective, how BIM-based digital integration can be architected in construction projects and how this approach resolves current industry-wide challenges.

2. THE PROBLEM: LIMITATIONS OF CONVENTIONAL MANAGEMENT PRACTICES

Traditional management approaches, applied in construction projects for decades, struggle to provide adequate solutions in an era where project components are progressively digitalized. A significant portion of deviations observed in core control areas—such as time, cost, and resources—stems from the intuitive, manual, and disconnected operation of these conventional structures. Below is a summary of how these limitations impact project performance:

DELAYS	The lack of critical path visibility and the restriction of schedule tracking solely to the planning team limit timely intervention. Delays in reflecting field developments onto the schedule result in a reactive management approach rather than a proactive one
COST OVERRUNS	Budget tracking and progress payment reviews typically proceed via manual spreadsheets and email traffic. This disconnected framework, detached from real-time data, leads to the late detection of cost deviations and renders overall project financial forecasting impossible.
WORKFLOW DISCONNECTION	Fragmented value streams among different project functions, conflicting data across units on identical subjects, manual reporting methods, and document clutter impede execution and control processes; this prevents the formation of a reliable, up-to-date data-sharing infrastructure among stakeholders.
LACK OF SYSTEMIC FOUNDATION	Software solutions used in projects generally operate in silos, lacking data integration. This scattered architecture prevents components within the planning, executing, monitoring, and controlling groups from converging on a common ground, making holistic management unfeasible.
UNDERUTILIZED TALENT	Inability to execute BIM-supported digital transformation effectively and failure to minimize manual workloads cause creative and analytical talents to be wasted on low-value tasks like routine data entry, resulting in wasted human capital and diminished institutional productivity.

3. CONCEPTUAL FRAMEWORK: DATA-DRIVEN DIGITAL PROJECT MANAGEMENT

Performance management in modern construction projects relies not only on scheduling tools, but on systems where data is contextualized, analyzed, and integrated into decision-making processes. Accordingly, the following concepts constitute the foundational components of the proposed solution:

3.1. Building Information Modeling (BIM)

BIM is not merely a 3D visualization tool; it serves as a digital platform for data generation, sharing, and management in construction projects. By modeling the spatial, temporal, and financial relationships of project components, it provides comprehensive data to decision-support processes from design to field execution. Synchronizing elements such as schedules, quantity takeoffs, and cost estimates directly with the BIM model allows for dynamic project monitoring.

3.2. Data Engineering

Data engineering encompasses the structuring, transformation, and preparation for analysis of data originating from disparate project sources (BIM models, schedules, field logs, progress payments, accounting systems, etc.). In this context, ETL (Extract-Transform-Load) pipelines are implemented, establishing a centralized data architecture through data warehouses or data lakes. This architecture ensures reliable and sustainable analytics and reporting.

3.3. Data Analytics

Data analytics enables extracting meaningful insights and predictive foresights from structured data. In project management, this covers metrics such as comparing actual vs. planned progress, resource utilization efficiency, production rates, and cost trends. Advanced analytics facilitate early warning systems, early detection of potential variances, and data-backed managerial decisions.

3.4. Business Intelligence (BI)

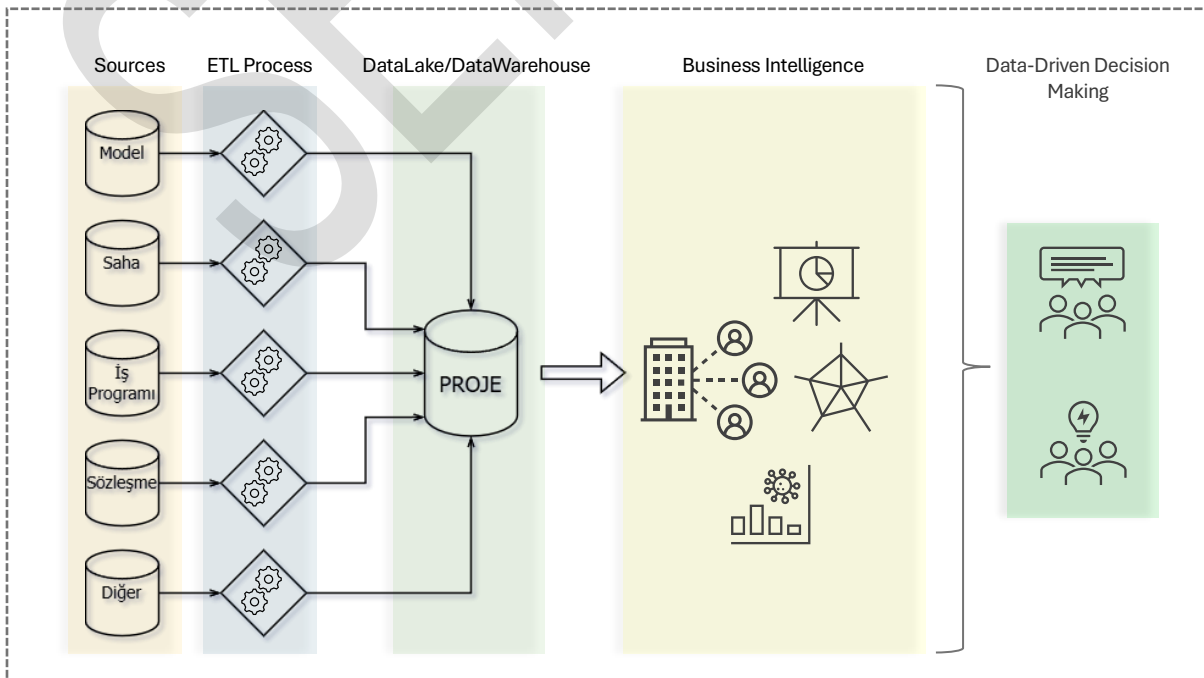
Business intelligence systems provide digital dashboards and reporting tools to visualize, track, and embed project data into decision mechanisms. These systems grant project managers, investors, and site teams' access to a single source of truth, establishing transparency and a unified digital language. Dashboards visually present schedule health, cost variances, and progress metrics to reinforce proactive governance.

3.5. Model-Based Management

The model-based management approach signifies a dynamic, data-driven philosophy where all the aforementioned elements function in synchronization. By integrating with time, cost, and resource metrics, the BIM model acts as a "digital twin" covering not only design, but also execution and control phases. This framework renders the planning-executing-monitoring loop transparent, traceable, and measurable within a digital ecosystem.

4. THE SOLUTION: SENATOPM APPROACH

The SenatoPM Approach is a digital systems framework developed to manage the planning, execution, monitoring, and control processes of construction projects in an integrated, measurable, and data-driven manner. At its core lies an integrated data infrastructure that enables the concurrent processing of BIM modeling, schedule management, resource planning, cost control, and site data.



SenatoPM consolidates all data generated across the project lifecycle into unified data pools, processing them through ETL pipelines and integrating them into decision-support systems. This enables continuous comparisons between planned and actual values within Schedule Management; early identification of bottlenecks and variances lends management processes a proactive character. In Resource Management, material and equipment utilization are monitored digitally to eliminate waste and forecast demands punctually. In Cost Management, budget and cost control workflows process data in real time, making instant tracking of financial variances possible. Replacing manual calculations with automated routines renders progress payment preparation accurate, dependable, and swift.

Key components of the approach include:

4.1. BIM-Based Planning and Monitoring

The BIM model functions as a live digital asset by pairing directly with the schedule and bill of quantities. Time, scope, and resource utilization can be visualized across the model, allowing direct comparisons between planned milestones and actual site status.

4.2. Data-Centric Integration

Disparate inputs from Primavera, Excel, ERP/accounting software, payment certificates, and field reports are consolidated into a centralized data structure within SenatoPM. This ensures multidisciplinary teams make decisions rooted in the exact same data.

4.3. Automated Variance and Performance Analysis

Automated algorithmic workflows process raw data to evaluate schedule, cost, and resource variances. The system highlights critical path deviations, delivering actionable early warnings to decisionmakers.

4.4. Real-Time Visualization and Reporting

Project status is visualized dynamically through business intelligence dashboards. Completion percentages, actual costs, burn rates, and schedule slippages are presented via visual indicators, transforming project management from static spreadsheets into intuitive, interactive interfaces.

4.5. Automated Progress Payment Processing

Field records linked to the BIM model integrate directly into payment applications, generating digital progress statements via automated computations. This eliminates manual calculation errors while providing a rapid, auditable, and transparent financial tracking mechanism between the client and contractor.

4.6. Scalable and Sustainable Architecture

The SenatoPM approach features an adaptable architecture suited for projects of any scale. The platform integrates easily with new projects and interfaces seamlessly with internal enterprise systems. Its scalable infrastructure captures historical project data to build institutional memory, empowering data-informed insights for upcoming tenders and executions.

SenatoPM aims to transcend legacy project management tools by fostering a digitalized, integrated, and data-driven management culture. This setup ensures that sound decisions are executed at the right time, with the right data, both in the field and at headquarters.

5. CONCLUSION AND ROADMAP

The BIM-based digital project management approach presented in this document addresses the core weaknesses of conventional methodologies, notably data scarcity and lack of integration. By converging project management disciplines onto a unified digital ground, the SenatoPM model makes schedule, cost, and resource governance data-driven, traceable, and sustainable.

Evolving Building Information Modeling (BIM) from an isolated drafting/design instrument into an enterprise data platform positioned at the center of the asset lifecycle forms the cornerstone of this transformation. When unified with operational field inputs, schedules, and financial records, this setup establishes an automated, real-time framework for decision-support mechanisms.

The roadmap outlines this operational shift across three strategic phases:

Establishing Digital Infrastructure:

Integrating BIM modeling protocols, data warehouse architecture, digital site-capture mechanisms, and project management applications.

Data-Centric Governance:

Digitalizing workflows to support data-driven execution, establishing robust ETL pipelines, and deploying automated operational dashboards.

Enterprise Rollout and Continuous Improvement:

Standardizing system adoption across cross-functional project teams and external stakeholders, tracking core KPIs, and steering the architecture toward a continuous learning system.

The SenatoPM approach represents not merely a software stack, but a framework driving institutional mindset transformation. Embracing this model establishes the foundation for a more predictable, sustainable, and auditable project delivery standard for owners, general contractors, and public authorities alike.