THE IMPACT OF IMPLEMENTING AUTOMATED CONSTRUCTION PROJECT MANAGEMENT SYSTEMS ON THE OPERATIONAL EFFICIENCY OF CONSTRUCTION COMPANIES

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ABSTRACT

The article examines the impact of implementing automated construction project management systems on the operational efficiency of construction companies under conditions of managerial digitalization. It analyzes the comprehensive effect of digital platforms on schedule compliance, cost control, and organizational manageability. The study emphasizes that the digital transformation of project management contributes to the reduction of time and financial losses, enhances the predictability of outcomes, and increases the resilience of project portfolios. Based on the synthesis of peer-reviewed empirical studies and industry case reports, this study demonstrates that the implementation of automated construction project management systems is consistently associated with improvements in schedule adherence, cost control, and organizational efficiency. The article presents a structured approach to evaluating digitalization effects using normalized performance indicators, highlighting that management automation is not merely a technological upgrade but a tool for systemic economic optimization of construction company operations.

KEYWORDS: management automation, construction projects, digital transformation, operational efficiency, cost control, construction company management

1. INTRODUCTION

The contemporary construction industry is characterized by a high level of project complexity, multi-layered stakeholder coordination, and significant capital intensity, which collectively impose increased requirements on the quality of project management. Under conditions of growing market volatility, stricter regulatory and investor demands, and reduced allowable project delivery timeframes, the operational efficiency of construction companies becomes a critical determinant of their resilience and competitive position. In this context, automated construction project management systems are increasingly adopted to integrate planning, schedule control, budgeting, and resource coordination within a unified digital environment.

The aim of this study is to analyze the mechanisms through which automated construction project management systems influence key parameters of operational efficiency in construction companies under conditions of managerial digitalization.

The scientific novelty of this study lies in the development of a comprehensive analytical framework for assessing the economic implications of implementing automated construction project management systems, based on the alignment of managerial processes with resulting economic performance indicators. Unlike existing studies, the research emphasizes the identification of systemic digitalization effects that extend beyond the local automation of individual management functions. The practical significance of the study is determined by the applicability of its conclusions to substantiating managerial decisions related to the digital transformation of project management, as well as to enhancing the investment stability and predictability of construction companies.

2. METHODS

The methodological framework of the study is based on a comparative and structural-analytical approach to assessing the impact of automated construction project management systems on the operational efficiency of construction companies. Data synthesis was conducted using systematized sources of industry analytics, peer-reviewed scientific publications, and empirical case studies reflecting practical experience in the implementation of digital project management systems.

Efficiency assessment was performed using normalized operational indicators, including compliance with project schedules, deviations of actual costs from budgeted values, levels of resource utilization, and indicators of project process controllability. The analysis accounted for differences in company scale and levels of digital maturity, while the interpretation of the observed effects was supported by comparisons with industry benchmarks and the findings of independent studies on the digitalization of construction management.

The analysis covers studies and industry reports published between 2023 and 2025, reflecting the most recent stage of digital transformation in construction project management. Source selection included peer-reviewed academic publications as well as industry reports and documented case studies from leading construction technology providers and professional associations. Relevance criteria focused on research addressing construction project management systems, BIM-enabled project control, earned value management (EVM/EAC), and the integration of project platforms with financial and procurement processes. To ensure comparability, performance indicators were analyzed using normalized relative metrics and benchmark-based comparisons reported in the original sources.

3. RESULTS

The implementation of automated construction project management systems exerts a multifaceted impact on the operational efficiency of construction companies, affecting both planning and control processes as well as the mechanisms of project activity coordination. The digitalization of managerial functions creates conditions for more structured decision-making, enhanced transparency of project processes, and reduced uncertainty associated with the execution of construction projects.

4. Impact of automated project management systems on project delivery timeframes and schedule compliance

Automated construction project management systems represent digital managerial platforms that provide centralized planning, coordination, and control of project execution throughout the entire construction lifecycle [1]. Such systems integrate schedule network planning, resource management, tracking of actual progress, change control, and reporting mechanisms, thereby forming a unified information environment for the project team and related stakeholders. Through the formalization of procedures and the standardization of data, these systems reduce discrepancies between planned and actual project parameters and enhance the controllability of processes that are critical to meeting project schedules.

For a structured presentation of the impact of automated construction project management systems on schedule compliance, it is appropriate to distinguish the key areas of operational influence and the corresponding digital functions (table 1).

Table 1: Influence pathways of construction project management automation on schedule performance [2, 3]

Influence pathway on schedule performance	Core system function	Operational effect	Evaluation indicator
Planning and work breakdown	Network scheduling, WBS.	Higher plan accuracy; fewer unjustified schedule shifts.	Baseline re-planning frequency; average phase delay.
Critical path control	Critical path calculation; float monitoring.	Lower risk of cascading delays.	Share of critical-path tasks; change in critical-path duration.
Plan–actual monitoring	Actuals capture; dashboards; alerts.	Earlier deviation detection; faster corrective response.	Time to detect deviation; time to corrective decision.

Change control	Change register; impact assessment.	More stable timelines under scope changes.	Share of changes with impact assessment; number of unapproved changes.
Resource – schedule alignment	Resource planning; load leveling.	Fewer delays caused by resource shortages/conflicts.	Resource overload rate; share of delays due to resources.
Stakeholder coordination	Single source of truth; role-based access.	Shorter approval cycles; fewer version conflicts.	Approval cycle time; number of data/version conflicts.
Stage manageability	Milestones; status workflows; reporting rules.	Better execution discipline; fewer missed milestones.	On-time milestone rate; average milestone slippage.
Completion forecasting	Trend-based forecasting from actuals.	Lower completion-date forecast error.	Completion forecast error; forecast revision frequency.

The results of recent industry surveys confirm that the primary sources of schedule disruptions in construction projects remain time losses associated with searching for up-to-date information and correcting defects caused by data fragmentation and insufficient coordination. In particular, the international Procore report The Future State of Construction, based on a survey of more than 1,200 construction decision-makers, indicates that approximately 18% of project time is spent on data searching activities (fig. 1).
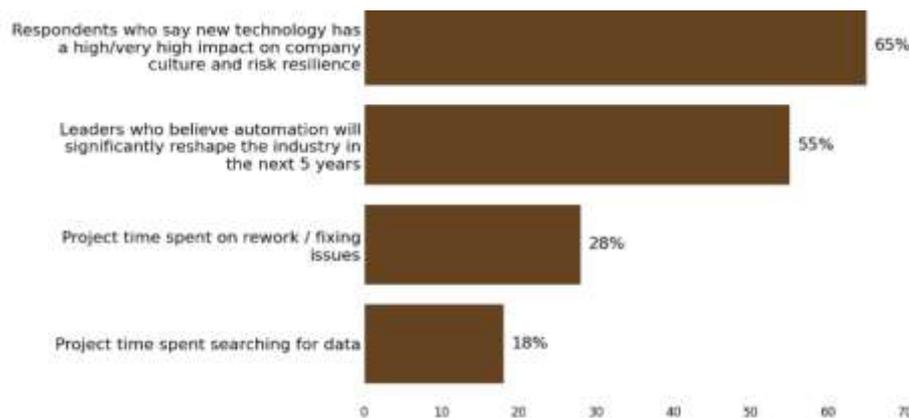

Figure 1: Impact of digital project management practices on schedule performance and organizational efficiency in construction projects [4]

Additionally, according to the Pulse of the Profession report, organizations with a high level of project

management maturity complete approximately 73–75 % of projects within planned schedules, whereas in organizations with a low level of maturity this share is about 50–55 % [5]. Moreover, companies that systematically apply formalized monitoring and performance control practices demonstrate a 2.5-times higher likelihood of achieving project objectives and a threefold lower proportion of projects with significant schedule deviations compared to organizations in which such practices are applied irregularly.

An example of an empirical study confirming the quantitative impact of digital project management systems on schedule adherence is the work by Das K., Khursheed S., and Paul V. K. (2025), published in Discover Materials [6]. The authors conducted a comparative analysis of several construction projects implemented with and without the use of digital management tools based on a BIM platform. The results indicate that the integration of automated planning and control mechanisms reduced average project durations by approximately 1,143–1,300 hours, whereas comparable projects without digital management exhibited schedule extensions of up to 30 %. These findings confirm that the implementation of automated systems contributes to improved predictability of schedule performance and a reduced risk of cumulative time deviations.

Thus, the adoption of automated construction project management systems generates a sustained managerial effect with respect to schedule compliance and the stability of project timelines. Digital formalization of planning, monitoring, and execution control reduces the dependence of project schedules on subjective factors and fragmented managerial information, thereby ensuring more predictable dynamics of project phase execution. Taken together, the identified effects allow automated project management systems to be regarded not only as tools of operational support but also as instruments for mitigating time-related risks, which have direct economic relevance for construction companies and their investment attractiveness.

5. Impact of automated systems on cost control and operational profitability

Automated construction project management systems provide a unified logic for structuring cost estimates and budgets through a standardized cost breakdown structure and for linking costs to specific activities and project phases, which enables direct comparison between planned and actual expenditures across consistent analytical dimensions [7]. In practice, this reduces the frequency of situations in which cost overruns are identified only after they have occurred and establishes an earlier financial control framework by means of regular updates on completed work volumes, committed obligations, and expected payments.

The report Quantifying the Value of Project Management Software for Construction (based on a survey of project owners/clients and contractors) demonstrates that at an "optimized" level of software

utilization, the ability to collect and effectively use detailed budgetary and cost data increases, while tangible financial effects are simultaneously observed (fig. 2).
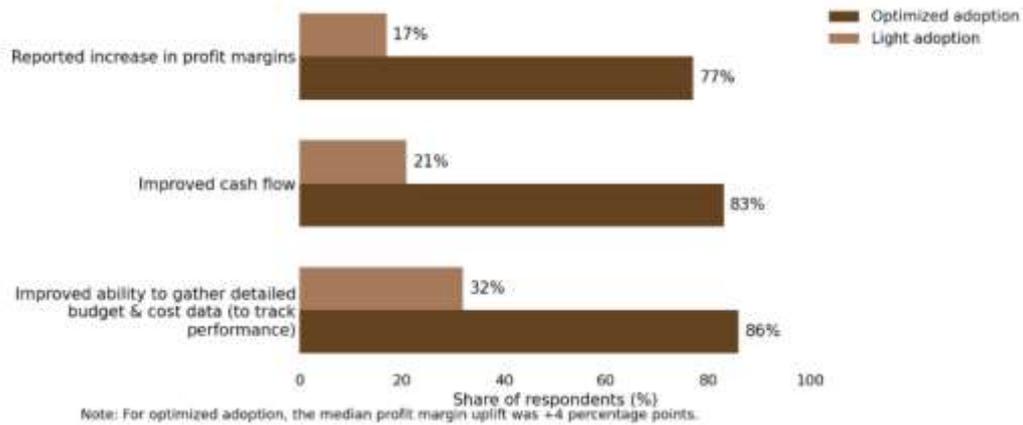

Figure 2: Reported financial impacts of construction project management software adoption: optimized versus light use [8]

A key mechanism underlying the economic effect is the transition from recording "payment facts" to managing contractual commitments and the forecasted cost at completion, whereby the system captures not only incurred expenditures but also contractual obligations, procurement requests, approved change orders, and expected amounts required to close completed work packages. This model enhances the controllability of budget deviations and reduces the likelihood of uncontrolled cost escalation when work scopes change, as all modifications are formalized, assessed in terms of their budgetary impact, and reflected in the estimate at completion (EAC) [9].

This theoretical assumption is supported by the study conducted by Yalçın G., Bayram S., and Çıtakoğlu H. (2024), in which the authors examine the forecasting of the estimate at completion in construction projects based on Earned Value Management data and demonstrate that regular updating of performance indicators significantly improves the accuracy of final cost estimation compared with approaches relying solely on actual costs. The authors analyze a real residential construction project comprising 13 types of work that was monitored daily over a period of 122 days; on this basis, a dataset of 2,318 observations (19 EAC methods × 122 days) was generated, and six machine learning models were compared using MAPE, RRMSE, and R^2 metrics, with one configuration achieving an R^2 value of up to 0.9878 [10].

In another study, Qasem A. M. J. et al. (2025) propose a quantitative model for assessing the impact of change orders on contractor cash flow – the Change Order Impact Index – based on the Analytic

Hierarchy Process (AHP) and Multi-Attribute Utility Theory (MAUT) [11]. The results indicate that project financing schemes contribute the largest share to cash flow risk (44 %), followed by contract type (30 %) and change order characteristics (26 %). Among the subfactors, the availability of funds within the financing structure has the highest weight (56 %). These findings confirm that the implementation of automated construction project management systems, which ensure the formalized registration of changes and their financial implications, serves as a practical tool for enhancing cost controllability and the resilience of a construction company's operational cash flows.

In addition, the digital management framework integrates financial control with procurement and contract management, thereby enhancing procurement discipline, reducing the risk of duplicate orders, and lowering transaction costs associated with the manual approval of invoices and acceptance documents [12]. An applied example can be found in the experience of the U.S.-based general contractor GCS-SIGAL, which implemented an integrated digital framework for project and financial management by linking a construction project management system with its corporate ERP platform. According to a published industry case study, the automation of invoice approval workflows and their direct transfer to the financial system reduced average invoice processing time by approximately five working days, while the cumulative economic effect from reduced labor intensity and transaction costs was estimated by the company at around $85,000 per year [13]. This case illustrates that integrating financial control with procurement and contract management within automated project management systems contributes to improved procurement discipline and generates a measurable positive effect on the operational efficiency of construction companies.

Taken together, these effects influence the operational profitability of construction companies through the reduction of non-productive expenses, improved accuracy in project margin planning, and decreased variability of results across projects within a single portfolio. More stable cost control and a lower share of expenses associated with rework and organizational inefficiencies enhance the predictability of operating profit and cash flow resilience, while managerial decisions regarding resource reallocation and contract adjustments are made on the basis of timely and comparable data.

6. Changes in the organizational and managerial efficiency of construction companies

The implementation of automated construction project management systems leads to a reconfiguration of organizational management frameworks, primarily through the centralization of project information and the standardization of stakeholder interactions. Digital platforms create a unified information environment for recording planned parameters, tracking work execution status, managing change-related decisions, and storing key project documentation, thereby reducing the dependence of managerial decisions on localized data sources and fragmented departmental practices. As a result, coordination within project teams is strengthened, approval delays are reduced, and the reproducibility

of managerial procedures is enhanced, which establishes a basis for assessing specific organizational effects and their associated performance indicators (table 2).

Table 2: Organizational and managerial efficiency effects of construction project management automation [14-16]

Organizational effect	Digital mechanism	Operational outcome	Indicative metric
Coordination improvement	Single source of truth; shared workflows.	Fewer coordination delays; higher alignment.	Approval cycle time; number of coordination-related delays.
Accountability clarity	Role-based access; responsibility matrices.	Lower ambiguity in ownership; faster decision routing.	Decision lead time; share of tasks with assigned owner.
Reporting standardization	Unified reporting templates; automated status updates.	Higher comparability across projects; less manual reporting.	Reporting effort (hours); frequency of reporting errors.
Reduced transaction costs	Automated approvals; digital document routing.	Less non-productive time in internal processes.	Number of manual handoffs; time spent on approvals.
Portfolio manageability	Cross-project dashboards; unified KPI logic.	Better resource allocation and early issue detection.	Frequency of reallocation decisions; share of projects with early risk flags.
Knowledge retention	Documented decisions; change and risk registers.	Higher process continuity under staff turnover.	Onboarding time; completeness of project documentation.

Structuring the observed effects through managerial mechanisms and performance indicators demonstrates that the organizational changes are not declarative in nature but quantitatively measurable: managerial communication becomes more formalized, while key operational processes become comparable across projects and organizational units. The automation of approval workflows, clarification of roles, and formalization of reporting reduce transaction costs and the likelihood of version conflicts, thereby enhancing execution discipline and the quality of managerial decision-making through access to up-to-date information. In addition, the digital management framework increases organizational resilience under conditions of personnel turnover, as project knowledge is

captured in standardized artifacts – such as change and risk registers, decision libraries, and management action histories – which reduces losses of controllability during staff rotation and supports continuity in portfolio-level project management.

An illustrative example of the digital transformation of organizational management frameworks – encompassing the creation of a unified information environment, standardization of procedures, clarification of responsibilities, and reproducibility of managerial actions – is provided by the experience of the U.S.-based company Rogers-O'Brien Construction. Through the implementation of digital quality control workflows, specifically the digitization of its quality program using Procore Action Plans, the company reported time savings of approximately 200 hours per project [17]. These gains were achieved through the reduction of manual operations, increased transparency of execution, and a decrease in rework, which directly correlates with improved managerial discipline and lower internal transaction costs.

An example of enhanced controllability and accelerated cross-functional coordination in a large-scale project is provided by the experience of McCarthy Building Companies (USA). Through the use of a unified digital construction management platform on the Allegiant Stadium project, the company reported a reduction in time losses caused by "information gaps," specifically a decrease in project interruptions by approximately five hours per month due to faster access to data [18]. The project also achieved its scheduling objective, being completed within 40 months while meeting both schedule and budget targets, which methodologically confirms the linkage between data centralization, accelerated managerial decision-making, and improved execution discipline.

Taken together, the presented results support the conclusion that the implementation of automated construction project management systems leads to the institutionalization of managerial processes and an increase in the organizational maturity of construction companies. Coordination, allocation of responsibilities, change control, and managerial reporting are transferred into a regulated digital framework with comparable performance indicators [19]. This transition reduces transactional losses of time and resources, enhances the reproducibility of managerial decisions, and strengthens portfolio-level controllability through earlier identification of deviations and more responsive resource reallocation. Practical case studies demonstrate that these effects are expressed in measurable outcomes, including reduced labor input and coordination-related time losses, as well as more consistent achievement of project target parameters, which directly supports the overall conclusion of the article regarding the impact of project management digitalization on the operational efficiency of construction businesses.

7. DISCUSSION

The implementation of automated construction project management systems enhances the operational efficiency of construction companies by simultaneously improving schedule adherence, cost control, and organizational manageability. These effects are achieved through reduced time losses, earlier deviation detection, and a shift toward proactive cost forecasting. Digitalization also strengthens project governance by centralizing data, standardizing workflows, and clarifying responsibilities, thereby supporting consistent and reproducible decision-making across portfolios. However, the scale of these benefits depends on the level of digital maturity, system integration, and data discipline. When fully implemented, automation serves not merely as a technical upgrade but as a strategic mechanism for minimizing operational risks and increasing the predictability of financial performance, directly influencing the resilience and investment appeal of construction firms.

8. CONCLUSION

The implementation of automated construction project management systems enhances the operational efficiency of construction companies through three interrelated effects: the reduction of schedule deviations enabled by more accurate planning and regular plan–actual comparisons; strengthened cost control achieved through the shift from recording costs "upon payment" to managing commitments and forecasting the cost at completion; and the reduction of internal transaction costs through the standardization of approval processes, reporting, and responsibility allocation within a unified digital framework. To achieve a sustainable economic outcome, such implementation should be approached as a managerial process redesign rather than a purely technological upgrade. This includes establishing unified rules for work breakdown structures and change registers, linking project phases to cost breakdown structures and procurement commitments with regular updates of cost-at-completion and cash-flow forecasts, and, where possible, integrating the project management platform with financial and procurement systems to reduce manual operations and duplication.

From an efficiency assessment perspective, the most informative indicators include adherence to control milestones, approval cycle times, budget deviations, accuracy of cost-at-completion forecasts, and the share of rework. Monitoring these indicators across a project portfolio makes it possible to directly associate the digitalization of project management with improvements in margin stability and the predictability of financial results.

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