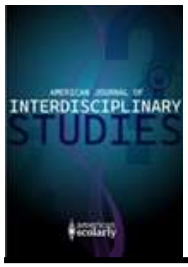

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IMPACT OF DIGITAL CONSTRUCTION MANAGEMENT PLATFORMS ON PROJECT PERFORMANCE POST-COVID-19

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Abstract

The COVID-19 pandemic accelerated the adoption of digital construction management platforms as organizations sought to mitigate disruptions, enhance coordination, and maintain project continuity under unprecedented constraints. This study examines the impact of digital construction management platforms on project performance in the post-COVID-19 construction environment, with particular emphasis on cost efficiency, schedule adherence, quality outcomes, and stakeholder collaboration. Drawing on recent empirical studies and industry reports, the abstract highlights how platforms integrating cloud-based collaboration, Building Information Modeling (BIM), real-time data analytics, and remote monitoring tools have transformed traditional project management practices. The findings suggest that post-COVID-19 construction projects leveraging digital platforms demonstrate improved decision-making speed, enhanced transparency, reduced rework, and greater resilience to supply chain and workforce disruptions. Moreover, the increased reliance on digital workflows has contributed to improved risk management and more effective communication among geographically dispersed project teams. However, the analysis also acknowledges persistent challenges related to data integration, cybersecurity, workforce digital skills, and organizational resistance to change. Overall, the study underscores the strategic role of digital construction management platforms in strengthening project performance and organizational adaptability in a post-pandemic construction landscape, positioning digitalization as a critical enabler of sustainable and resilient project delivery models.

Keywords

Digital construction management; Project performance; Post-COVID-19 construction; Building Information Modeling (BIM); Digital transformation

INTRODUCTION

Digital construction management platforms are commonly defined as integrated, cloud-based information systems that support the planning, coordination, execution, and monitoring of construction projects through centralized data environments and interoperable digital (Garcia & Rimé, 2019). These platforms typically incorporate functionalities such as document control, real-time communication, scheduling, cost management, Building Information Modeling (BIM) integration, and performance analytics, enabling multidimensional visibility across project lifecycles (Xia, 2012). From an information systems perspective, digital construction management platforms function as socio-technical infrastructures that mediate interactions among project stakeholders, contractual arrangements, and physical construction processes (Hahn et al., 2019). Within construction management scholarship, these platforms are increasingly conceptualized as strategic coordination mechanisms that address fragmentation, information asymmetry, and temporal uncertainty inherent in large-scale construction projects. The integration of digital platforms aligns construction project delivery with principles of systems thinking, where performance outcomes emerge from interactions between technological capabilities, organizational structures, and human decision-making processes. International standards bodies and professional institutions, including ISO and PMI, have emphasized digital platforms as foundational elements for contemporary project governance and data-driven control frameworks (Zhuang et al., 2016). In parallel, research in construction informatics positions these platforms as extensions of enterprise information systems adapted to project-based production environments, characterized by temporary coalitions and dynamic workflows. This definitional grounding establishes digital construction management platforms as both technological artifacts and organizational enablers that reshape how project performance is measured, monitored, and managed across global construction contexts.

Figure 1: Architecture/Layered Model of DCMP Components

The international significance of digital construction management platforms is closely linked to the global economic role of the construction industry, which accounts for approximately 13 percent of global GDP and employs hundreds of millions of workers across developed and developing economies (Chiang et al., 2014). Construction projects frequently involve multinational supply chains, cross-border contractors, and diverse regulatory environments, increasing coordination complexity and performance risk (Zhuang et al., 2016). Digital platforms have emerged as standardized coordination mechanisms capable of harmonizing information flows across geographically dispersed stakeholders, supporting interoperability and compliance within international project ecosystems (Greif et al., 2020). Empirical studies across Europe, Asia, North America, and the Middle East document how platform-based management systems improve transparency, accountability, and traceability in complex infrastructure and commercial construction projects (Brady et al., 2020). International development organizations and public-sector agencies increasingly mandate digital

platform adoption for large-scale projects to enhance governance and reduce cost overruns and delays. Comparative research highlights that countries with higher levels of construction digitalization exhibit improved project predictability and reduced transactional friction among project participants (Hahn et al., 2019). The global diffusion of digital construction platforms reflects broader transformations in digital economies, where data integration, real-time analytics, and remote collaboration underpin organizational performance across sectors (Sava et al., 2018). Within this international context, the adoption of digital construction management platforms represents a structural shift in how project performance is governed, evaluated, and optimized across national and regional construction systems.

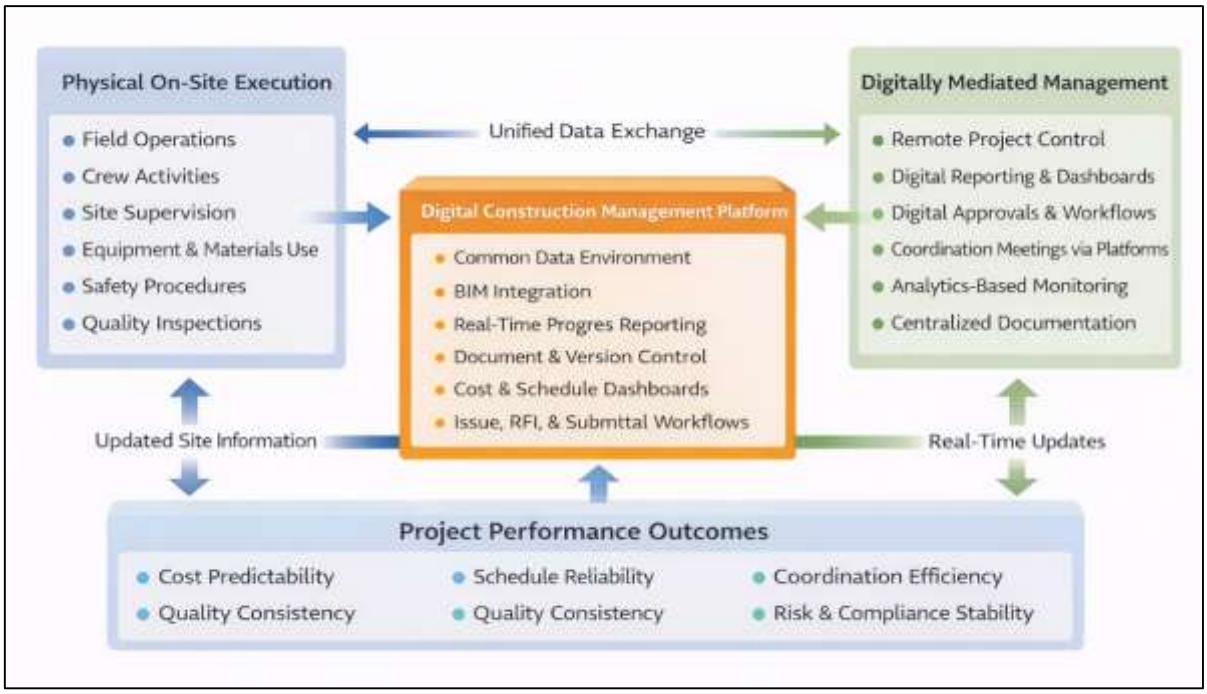
Project performance in construction management literature is traditionally conceptualized through multidimensional indicators encompassing cost, time, quality, safety, and stakeholder satisfaction (Roach & Demirkiran, 2017). Contemporary research expands this framework to include process efficiency, risk management effectiveness, information quality, and collaborative performance among project actors (Chen et al., 2015). Construction projects are particularly susceptible to performance variability due to uncertainty in site conditions, design changes, supply chain disruptions, and human coordination challenges (Turner et al., 2016). Digital construction management platforms have been examined as performance-enhancing mechanisms that address these challenges through real-time data access, automated workflows, and integrated reporting structures. Quantitative studies demonstrate associations between platform use and reductions in rework, schedule variance, and cost escalation. From a project governance perspective, digital platforms facilitate performance monitoring by enabling continuous visibility into progress metrics and deviation alerts, supporting timely managerial interventions. Research grounded in organizational information processing theory suggests that digital platforms enhance project performance by increasing information processing capacity under conditions of task uncertainty and complexity ((Garcia & Rimé, 2019) The literature thus positions project performance as an emergent outcome shaped by technological integration, managerial capability, and institutional arrangements, providing a theoretical basis for examining the role of digital platforms in post-pandemic construction environments.

The COVID-19 pandemic constituted a systemic disruption to global construction activities, affecting labor availability, supply chain continuity, site access, and regulatory compliance across regions. Lockdowns, social distancing requirements, and travel restrictions fundamentally altered traditional on-site management practices and intensified reliance on remote coordination mechanisms. Construction management literature documents significant project delays, cost escalations, and productivity losses during the pandemic period, highlighting structural vulnerabilities in conventional project delivery models (Hahn et al., 2019). Digital construction management platforms gained prominence as operational infrastructures enabling continuity through cloud-based collaboration, digital documentation, and remote monitoring tools. Empirical evidence indicates that projects with pre-existing digital platforms exhibited greater operational stability and coordination efficiency during pandemic-related disruptions. The pandemic context intensified scholarly attention toward digital resilience, defined as the capacity of project systems to absorb shocks while maintaining performance objectives (Zhuang et al., 2016). Within construction research, COVID-19 is increasingly framed as a catalyst that exposed latent inefficiencies and accelerated structural transformations in project management practices. This contextual shift provides an essential foundation for examining post-COVID-19 project performance dynamics associated with sustained digital platform utilization.

Post-COVID-19 construction environments are characterized by hybrid coordination models combining on-site execution with digitally mediated management processes. Digital construction management platforms serve as coordination hubs that integrate contractual documentation, progress reporting, design revisions, and stakeholder communication within unified data environments (Roach & Demirkiran, 2017). Organizational studies emphasize that such platforms restructure authority, accountability, and decision-making flows within project organizations. Research demonstrates that enhanced transparency enabled by digital platforms influences trust formation, conflict resolution, and collaborative performance among project participants (Tan & Lim, 2017). Cross-national studies indicate that post-pandemic construction firms increasingly rely on platform-

based analytics to monitor workforce productivity, supply chain status, and safety compliance in real time. Information systems research further highlights that digital platforms reduce coordination costs by minimizing information delays and manual data reconciliation across organizational boundaries (Sava et al., 2018). Within construction management scholarship, these coordination effects are directly linked to measurable project performance outcomes, including schedule reliability and quality consistency (Garcia & Rimé, 2019). The post-COVID-19 context thus provides a distinct organizational setting in which digital construction management platforms operate as central coordination infrastructures influencing performance trajectories.

Figure 2: Post-COVID Hybrid Coordination Model in Construction Projects



A growing body of empirical research examines the relationship between digital construction management platforms and project performance outcomes using quantitative, qualitative, and mixed-method approaches (Tan & Lim, 2017). Survey-based studies report statistically significant associations between platform adoption and improvements in cost predictability, schedule adherence, and documentation accuracy (Sava et al., 2018). Case study research across infrastructure and commercial building projects illustrates how real-time dashboards and automated reporting reduce managerial latency and enhance corrective decision-making. Meta-analytical reviews in construction informatics identify digital integration as a consistent predictor of performance stability across project typologies and geographic regions. Post-COVID-19 empirical studies further highlight platform-enabled visibility into supply chain disruptions and workforce constraints as critical performance determinants. Performance measurement frameworks increasingly incorporate digital maturity indicators alongside traditional project metrics, reflecting methodological shifts in construction performance evaluation. These empirical insights establish a robust analytical foundation for examining how sustained platform utilization shapes post-pandemic project performance across international construction contexts.

The examination of digital construction management platforms and project performance is informed by multiple theoretical lenses, including resource-based theory, organizational information processing theory, and socio-technical systems theory (Garcia & Rimé, 2019). These frameworks collectively conceptualize digital platforms as strategic resources that enhance information processing capacity and coordination efficiency within complex project environments (Hahn et al., 2019). Construction management research integrates these perspectives to explain performance differentials observed across digitally mature and less integrated project organizations (Brady et al., 2020). The

post-COVID-19 context provides a distinct empirical setting characterized by heightened uncertainty, distributed work arrangements, and increased reliance on digital infrastructures. Scholarly discourse increasingly positions digital construction management platforms as central analytical units for understanding performance dynamics within contemporary project systems. By situating digital platforms at the intersection of technology, organization, and performance, the literature establishes a comprehensive foundation for systematic investigation into post-pandemic construction project outcomes across international contexts.

The primary objective of this study is to systematically examine how digital construction management platforms influence project performance in the post-COVID-19 construction environment by focusing on their role in coordinating project activities, managing information flows, and supporting operational control across the project lifecycle. This objective is grounded in the need to clearly identify how platform-based digital systems function within contemporary construction projects that operate under heightened uncertainty, fragmented stakeholder structures, and increased reliance on remote and hybrid work arrangements. The study aims to evaluate the extent to which digital construction management platforms contribute to measurable performance dimensions, including cost control, schedule reliability, quality consistency, and workflow efficiency, by enabling real-time visibility into project data and progress metrics. Another central objective is to assess how these platforms facilitate communication and collaboration among diverse project stakeholders, such as owners, contractors, consultants, and suppliers, by providing centralized information repositories and standardized digital workflows. The study further seeks to analyze how digital platforms support managerial decision-making by improving access to accurate, timely, and integrated project information, thereby enhancing monitoring and coordination functions across organizational boundaries. An additional objective involves examining the role of digital construction management platforms in maintaining continuity of project operations under post-pandemic conditions characterized by workforce mobility constraints and supply chain volatility. The research also aims to identify patterns in platform utilization across different project types and organizational contexts to understand variations in performance outcomes. Finally, the study seeks to establish a structured analytical basis for evaluating digital construction management platforms as core project management infrastructures, focusing on their functional alignment with project performance requirements in the post-COVID-19 construction landscape.

LITERATURE REVIEW

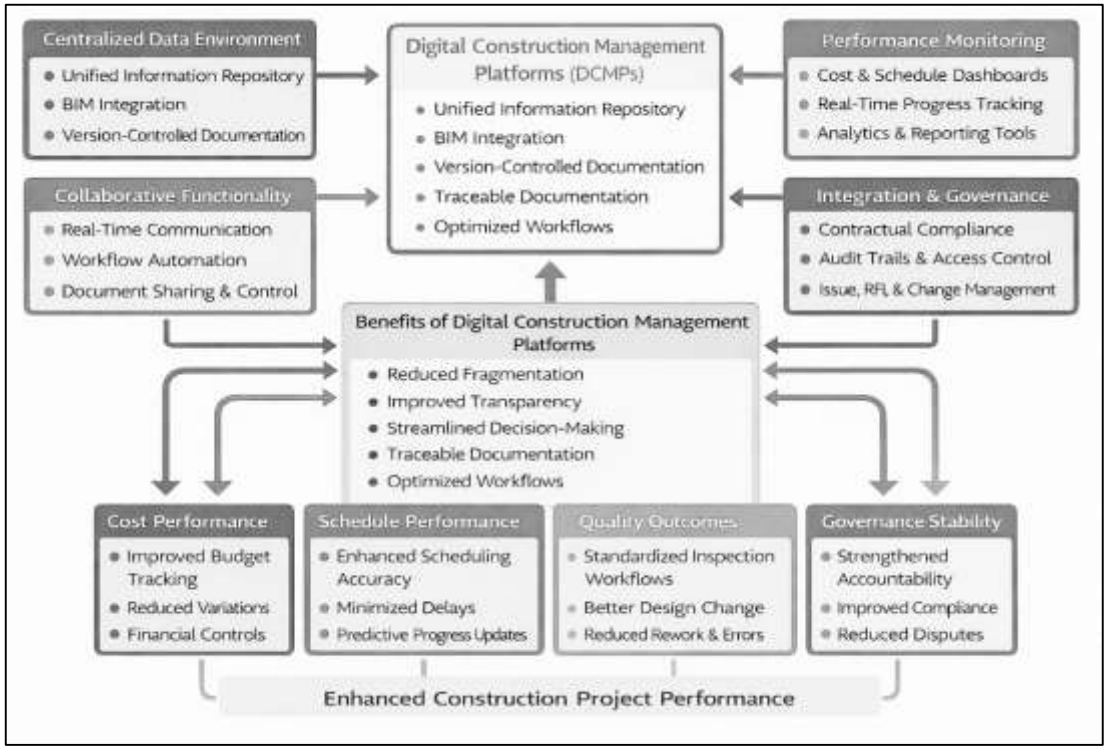
The literature review section provides a structured and critical synthesis of scholarly research examining digital construction management platforms and their relationship with construction project performance, with particular emphasis on developments observed in the post-COVID-19 context. This section systematically organizes prior studies to establish conceptual clarity, identify dominant theoretical perspectives, and classify empirical evidence across international construction settings. By reviewing literature from construction management, project management, information systems, and organizational studies, the section situates digital construction management platforms within broader digital transformation and project governance discourses. The review emphasizes how digital platforms have been conceptualized, operationalized, and empirically evaluated in relation to core project performance dimensions, including cost, schedule, quality, coordination, and risk control. It also addresses how pandemic-induced disruptions reshaped research attention toward digital resilience, remote coordination, and data-driven decision support in construction projects. Rather than presenting isolated findings, this literature review adopts a synthesized approach that highlights thematic convergence, methodological patterns, and analytical boundaries within existing scholarship. The section establishes a coherent foundation for understanding how digital construction management platforms function as performance-enabling infrastructures in post-COVID-19 construction environments and provides a structured basis for subsequent empirical investigation.

Digital Construction Management Platforms

Digital construction management platforms are extensively discussed in the literature as integrated, cloud-enabled systems designed to centralize and coordinate project information, workflows, and decision-making processes across the construction project lifecycle. Scholars conceptualize these platforms as evolutions of traditional construction management software, expanding beyond isolated

scheduling or cost-control tools to function as holistic digital ecosystems that support documentation, communication, coordination, and performance monitoring (Greif et al., 2020) Within construction informatics research, digital construction management platforms are frequently positioned as boundary-spanning systems that connect fragmented project stakeholders, including owners, designers, contractors, and suppliers, through shared data environments. The integration of functionalities such as real-time reporting, version-controlled documentation, and interoperability with Building Information Modeling (BIM) systems has been identified as a defining characteristic that differentiates platforms from standalone digital tools. Studies emphasize that centralized data repositories reduce information asymmetry and mitigate coordination failures that commonly undermine construction project performance. From an information systems perspective, these platforms are understood as socio-technical infrastructures in which technological capabilities interact with organizational routines and managerial practices to shape project outcomes. Empirical investigations across infrastructure and commercial building projects demonstrate that digital construction management platforms enhance data accuracy, traceability, and accessibility, contributing to more structured project control environments. Collectively, the literature frames digital construction management platforms as foundational coordination mechanisms that restructure information flows and managerial oversight within complex, project-based construction organizations.

Figure 3: Digital Construction Management Platforms as Socio-Technical Coordination Infrastructure



The relationship between digital construction management platforms and construction project performance has been widely examined across multiple performance dimensions, including cost, schedule, quality, and operational efficiency. Construction management literature consistently identifies cost overruns and schedule delays as persistent challenges driven by fragmented information flows, delayed decision-making, and coordination breakdowns. Digital construction management platforms are examined as performance-enhancing mechanisms that address these challenges by enabling real-time visibility into project progress and financial data. Quantitative studies report statistically significant associations between platform adoption and improved cost predictability through automated budget tracking, variation management, and financial transparency. Time performance is similarly addressed through integrated scheduling tools, progress dashboards, and early detection of deviations from planned timelines. Quality performance is

frequently linked to digital documentation accuracy, standardized inspection workflows, and enhanced traceability of design changes and construction activities (Rahimian et al., 2020). Beyond traditional performance indicators, studies increasingly incorporate process-oriented metrics such as rework reduction, communication efficiency, and responsiveness to project risks. The literature suggests that digital platforms support continuous performance monitoring rather than periodic reporting, thereby strengthening managerial control and coordination effectiveness. These findings collectively position digital construction management platforms as central analytical constructs in understanding multidimensional project performance outcomes within contemporary construction management research.

A significant body of literature examines digital construction management platforms through the lens of organizational coordination, collaboration, and project governance. Construction projects are characterized by temporary, multi-organizational arrangements that generate coordination complexity and contractual fragmentation. Digital platforms are frequently described as coordination infrastructures that standardize information exchange and align stakeholder actions across organizational boundaries. Empirical studies demonstrate that centralized platforms enhance communication transparency and reduce conflicts arising from inconsistent documentation or delayed information sharing. From a governance perspective, digital construction management platforms support formal control mechanisms by providing audit trails, access controls, and real-time performance reporting. Research grounded in transaction cost economics suggests that these platforms reduce coordination and monitoring costs by minimizing manual data reconciliation and administrative overhead. Studies also highlight the role of platforms in facilitating trust development among stakeholders through improved data reliability and shared situational awareness (Greif et al., 2020). International comparative research indicates that projects operating within digitally mediated governance structures demonstrate more consistent decision-making processes and reduced ambiguity in responsibility allocation. Collectively, the literature positions digital construction management platforms as organizational enablers that reshape collaboration, authority, and accountability within complex construction project ecosystems.

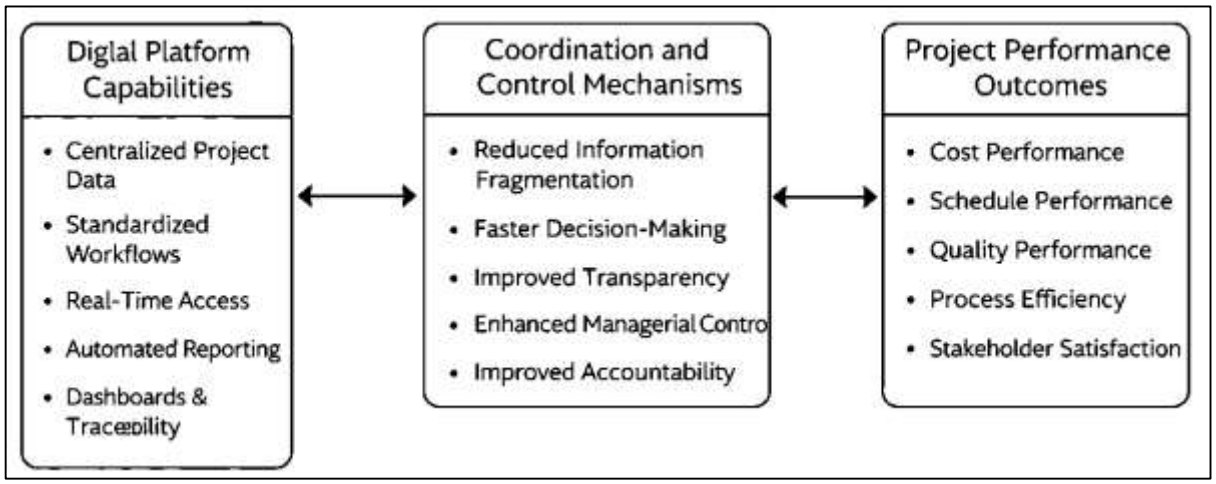
Recent construction management literature increasingly examines digital construction management platforms within the context of post-COVID-19 project environments, where operational disruptions highlighted structural vulnerabilities in conventional management practices. Studies document that pandemic-related restrictions on site access, workforce mobility, and supply chains intensified reliance on digital coordination mechanisms across construction projects worldwide. Digital construction management platforms are analyzed as continuity-supporting systems that enabled remote monitoring, cloud-based documentation, and distributed decision-making during periods of operational constraint (Rahimian et al., 2020). Empirical evidence indicates that projects utilizing integrated digital platforms exhibited greater stability in coordination and reporting processes compared to those relying on paper-based or fragmented digital tools. Post-pandemic studies emphasize platform-enabled visibility into supply chain status, workforce availability, and safety compliance as central factors influencing project control effectiveness (Delgado, Oyedele, Bilal, et al., 2020). The literature also highlights methodological shifts toward examining digital resilience, defined as the capacity of project systems to maintain operational coherence under disruptive conditions. Cross-regional analyses across Europe, Asia, and North America demonstrate consistent associations between platform maturity and improved performance monitoring capabilities in post-pandemic construction projects(Tang et al., 2019). Within this body of scholarship, digital construction management platforms are positioned as integral components of contemporary project management structures shaped by post-COVID-19 operational realities.

Digital Platforms and Project Performance

The relationship between digital platforms and project performance has been extensively examined across project management, construction management, and information systems literature, where digital platforms are conceptualized as integrated technological infrastructures that enable coordination, control, and information transparency within complex project environments. Project performance is traditionally assessed through multidimensional indicators encompassing cost efficiency, schedule adherence, quality compliance, and stakeholder satisfaction. Scholars argue that

performance variability in project-based organizations is largely driven by information fragmentation, delayed decision-making, and coordination failures among interdependent actors (Rahimian et al., 2020). Digital platforms address these challenges by centralizing project data, standardizing workflows, and enabling real-time access to performance-related information across organizational boundaries. From an organizational information processing perspective, digital platforms increase a project's capacity to process information under conditions of uncertainty and task complexity, thereby supporting more effective managerial control (Hasanzadeh et al., 2020). Empirical studies demonstrate that projects utilizing integrated digital platforms exhibit improved alignment between planned and actual performance outcomes due to enhanced visibility and traceability of project activities. Research in information systems further positions digital platforms as socio-technical systems in which technological capabilities interact with organizational routines to shape performance outcomes (Hasanzadeh et al., 2020). Across construction and infrastructure projects, the literature consistently frames digital platforms as performance-enabling mechanisms that restructure how project information is generated, shared, and utilized, establishing a foundational conceptual linkage between platform adoption and project performance stability (Stotko et al., 2019).

Figure 4: Conceptual Frameworkof Digital Platforms and multidimensional project performance



Cost and schedule performance remain central concerns in project management research due to the persistent prevalence of budget overruns and time delays across large-scale projects (Delgado, Oyedele, Demian, et al., 2020). Digital platforms are extensively examined as mechanisms that enhance cost and time control by enabling continuous monitoring, automated reporting, and early identification of performance deviations. Studies in construction management literature report that platform-based cost management systems improve financial transparency by integrating budgets, change orders, and expenditure data within centralized dashboards. This integration reduces reliance on fragmented spreadsheets and manual reconciliation processes, which are frequently associated with errors and delayed corrective action. Schedule performance is similarly influenced by digital platforms through real-time progress tracking, digital scheduling tools, and automated alerts that highlight deviations from planned timelines. Empirical evidence indicates that projects utilizing digital platforms demonstrate improved schedule reliability due to enhanced coordination among project participants and faster decision-making cycles. Project governance studies further emphasize that digital platforms strengthen formal control mechanisms by providing audit trails and performance records that support accountability and compliance. Collectively, the literature establishes a consistent association between digital platform utilization and improved cost and schedule performance through enhanced visibility, coordination efficiency, and managerial oversight. Quality performance and process efficiency are increasingly emphasized in project performance research as indicators of sustainable project delivery and operational(Wuni & Shen, 2020). Digital platforms contribute to quality performance by enabling standardized documentation, digital inspections, and systematic tracking of design changes and construction activities. Studies indicate

that centralized document management systems reduce errors arising from outdated drawings and inconsistent specifications, which are common sources of rework and quality defects in construction projects. Process efficiency is enhanced through automation of routine tasks such as approvals, reporting, and information retrieval, allowing project teams to allocate greater effort toward value-adding activities. Research grounded in lean construction and process management highlights that digital platforms support continuous workflow monitoring and waste reduction by improving coordination and reducing information delays. Empirical case studies across infrastructure and commercial projects demonstrate that platform-enabled traceability improves accountability for quality-related decisions and facilitates more consistent compliance with project standards. From a socio-technical perspective, the interaction between digital tools and organizational practices is identified as a critical determinant of quality outcomes, emphasizing the role of platforms in shaping how quality is managed rather than merely measured. The literature therefore positions digital platforms as integral to achieving stable quality performance and process efficiency within complex project environments.

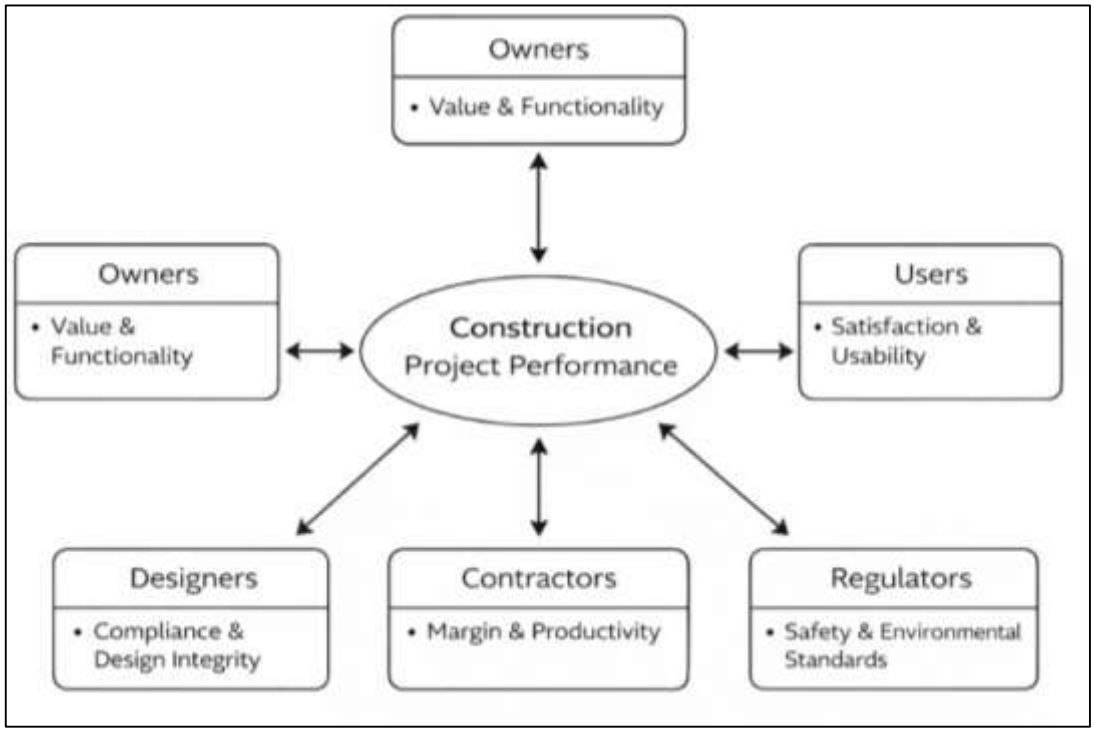
Construction Project Performance Measurement Frameworks

Construction project performance measurement frameworks originate from the long-standing reliance on the "iron triangle" of cost, time, and quality, which historically served as the dominant basis for assessing whether a project met contractual and managerial expectations. Within construction management scholarship, this foundational framing was increasingly treated as necessary but insufficient because it primarily captures short-term delivery efficiency rather than the broader, multi-stakeholder value that projects are expected to generate. A major conceptual development in the literature is the analytical separation between "project management success" (efficiency in meeting planned budgets, schedules, and technical specifications) and "project success" (the extent to which outcomes satisfy owners, users, and broader stakeholder expectations over time). This distinction is particularly emphasized in construction because project delivery occurs through temporary multi-organizational coalitions where different actors define success differently—owners prioritize value and functionality, contractors prioritize margin and productivity, designers prioritize design integrity and compliance, and regulators prioritize safety and environmental standards (Greif et al., 2020). Consequently, performance measurement frameworks expanded to incorporate stakeholder satisfaction, safety outcomes, productivity indicators, and the quality of managerial processes such as communication, coordination, and change control. The literature also highlights that construction project performance cannot be reliably captured through single indicators because outcomes emerge from interdependent processes spanning design development, procurement, site execution, and commissioning, each with its own performance drivers and measurement needs (Wuni & Shen, 2020). As a result, measurement frameworks increasingly adopt multi-criteria logic, combining outcome indicators (e.g., cost variance, defect rates) with process indicators (e.g., decision latency, rework frequency, information reliability) to capture performance as both a result and a managerial capability. This body of research positions construction project performance measurement as a structured attempt to reconcile efficiency-based metrics with broader definitions of value, governance, and stakeholder-centered success.

A prominent stream of research operationalizes construction project performance measurement through structured key performance indicator (KPI) systems, where performance is quantified using standardized metrics that can be benchmarked across projects, organizations, and regions. KPI frameworks typically include financial measures (cost variance, profitability, cash flow stability), schedule measures (schedule variance, milestone reliability), quality measures (defect density, nonconformance frequency), safety measures (incident rates, near-miss reporting), and productivity measures (labor output rates, equipment utilization). Construction researchers argue that KPI systems gain strength when they integrate both "lagging" outcome indicators and "leading" process indicators, because many performance failures—such as delay cascades and cost escalation—are preceded by measurable process deterioration in planning reliability, material readiness, or information completeness. In parallel, scorecard-oriented approaches draw on strategic performance measurement traditions, particularly the Balanced Scorecard, to broaden construction performance assessment beyond financial and schedule targets by incorporating customer/stakeholder

perspectives, internal process performance, and learning-and-growth dimensions such as capability development and innovation routines (Greif et al., 2020). Within construction contexts, scorecard logic is commonly adapted to reflect project-based production characteristics, emphasizing supply chain integration, subcontractor management effectiveness, and the reliability of coordination mechanisms across temporary project networks(Delgado, Oyedele, Demian, et al., 2020). Studies also discuss how KPI selection shapes managerial behavior: narrow metric sets can lead to local optimization (e.g., productivity maximization at the expense of safety or quality), while balanced metric portfolios reduce distortion by representing multiple objectives simultaneously. Another consistent finding in the literature is the importance of measurement governance, clear metric definitions, transparent data capture rules, and consistent reporting rhythms, because construction projects often suffer from inconsistent data quality due to manual reporting, fragmented systems, and subcontractor-level heterogeneity. Consequently, KPI and scorecard frameworks are increasingly presented not only as measurement tools but as managerial control systems that structure attention, allocate accountability, and create shared performance language across project stakeholders. This scholarship frames KPI-based and scorecard-based approaches as central pillars of contemporary construction performance measurement, especially where comparability, benchmarking, and multi-dimensional control are required.

Figure 5: Stakeholder-Based Performance Measurement Model



A third major cluster of construction project performance measurement frameworks is grounded in control theory and project monitoring traditions, where performance is treated as variance between planned and actual progress, cost consumption, and deliverable completion. Earned Value Management (EVM) is one of the most prominent formalized approaches in this stream, integrating scope, schedule, and cost into unified indices such as cost performance index and schedule performance index to quantify whether a project is under- or over-performing relative to baseline plans (Mutis & Ambekar, 2020). In construction, EVM is widely discussed as a means of creating early-warning signals for performance deterioration by translating progress into "earned" value rather than relying only on cost expenditure or subjective percent-complete judgments. Research emphasizes that the quality of EVM outputs depends on the reliability of work breakdown structures, baseline integrity, and disciplined progress measurement practices—conditions that vary significantly across projects due to change orders, design revisions, and evolving site constraints

(Delgado, Oyedele, Demian, et al., 2020). Complementary to EVM, the literature includes process reliability frameworks influenced by lean construction thinking, especially measures such as Percent Plan Complete (PPC) within the Last Planner System, which assess planning reliability and workflow stability as core drivers of schedule performance and productivity (Shi et al., 2019). These approaches treat performance not only as final outcomes but as the reliability of production planning and constraint removal processes, capturing the managerial quality of coordination that precedes cost and time outcomes. Construction monitoring research further introduces schedule risk and control frameworks that emphasize critical path volatility, schedule sensitivity, and variance propagation through interdependent activities, offering richer diagnostic capability than headline delay measures alone. Across these control-oriented frameworks, scholars consistently highlight the tension between formal measurement rigor and real-world construction complexity: high measurement fidelity requires disciplined data capture, while construction projects are shaped by on-site variability, subcontractor fragmentation, and frequent scope evolution. As a result, the literature often recommends hybrid measurement portfolios in which EVM indices, lean reliability metrics, and schedule-risk diagnostics are used together to triangulate performance status and reduce blind spots created by relying on any single. This stream positions construction project performance measurement as a control process centered on baseline management, variance interpretation, and workflow reliability, rather than solely an end-of-project evaluation exercise.

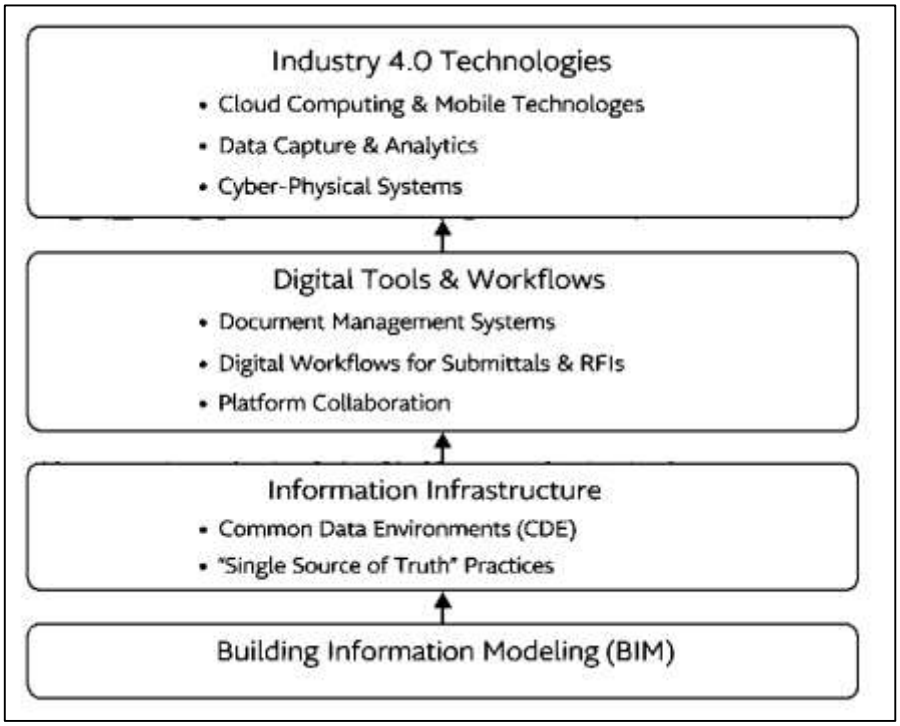
Digitalization in Construction Prior to the COVID-19 Pandemic

Prior to the COVID-19 pandemic, digitalization in construction was widely characterized as a gradual, uneven transformation shaped by the industry's fragmented structure, project-based delivery model, and persistent productivity challenges. International reports and sector analyses repeatedly described construction as lagging behind other industries in labor productivity growth and in the diffusion of integrated digital workflows, while also identifying clear opportunities associated with digitized coordination, standardized information management, and greater supply-chain integration (Pham et al., 2019). Within the academic literature, Building Information Modeling (BIM) was consistently positioned as the central organizing paradigm for construction digitalization because it reframed built-asset information as a shared, model-based resource used to coordinate design, planning, and delivery activities across stakeholder boundaries (Nikityuk, 2019). This conceptualization emphasized BIM not only as software but as a methodology involving policies, processes, and interoperable technologies for managing project and asset information through the lifecycle. As BIM-based collaboration expanded, research attention increasingly focused on the information infrastructures needed to operationalize "single source of truth" practices—particularly common data environments (CDEs), which were formalized through UK standards such as BS1192:2007 and PAS 1192-2:2013 and later reflected in international information management standards (e.g., ISO 19650). The literature indicates that pre-COVID digitalization was therefore less about isolated tool adoption and more about the progressive institutionalization of shared information spaces, model-based coordination, and cross-disciplinary data governance practices that could reduce document inconsistency, accelerate approvals, and improve traceability of design and construction decisions (Hasanzadeh et al., 2020). Empirical and review-based studies also showed that BIM diffusion was strongly linked with broader digital practices such as centralized document management, digital workflows for submittals and RFIs, and platform-mediated collaboration across contractors, consultants, and owners, features that were increasingly understood as prerequisites for managing complexity in large projects. In this pre-pandemic period, digitalization was thus documented as a multi-layer shift in construction information management, moving from paper and disconnected files toward shared, structured, and auditable digital environments supporting coordination and control.

The pre-COVID literature describes construction digitalization as extending beyond BIM into a broader portfolio of data capture, automation, connectivity, and analytics technologies, often discussed through the framing of Industry 4.0 and its construction-specific adaptation. A widely cited synthesis of Industry 4.0 implications for construction outlined an industry-specific definition centered on digitization, automation, and process integration across the construction value chain, emphasizing the interplay of cyber-physical systems, data-driven coordination, and connected

workflows (Delgado, Oyedele, Demian, et al., 2020). This framing aligned with research that documented increasing use of cloud computing and mobile field technologies to support site reporting, digital quality checks, and near-real-time communication between site and office teams, thereby reducing reporting latency and improving the consistency of project records (Mutis & Ambekar, 2020). In parallel, scholarship on digital information management highlighted that BIM-based delivery required complementary infrastructures—particularly CDE practices—to control versions, permissions, and the release of information for construction and handover activities (Tang et al., 2019). Studies on BIM across asset phases also underscored that digitalization was not confined to new-build design, as researchers examined the challenges of applying BIM to existing buildings, refurbishment, and asset information completeness, demonstrating that documentation quality and uncertainty in existing conditions constrained seamless digital continuity. Across these streams, digitalization was increasingly treated as an ecosystem of interoperable components: model-based coordination (BIM), shared information spaces (CDEs), cloud-enabled collaboration, and digitally captured field data that collectively supported process standardization and traceability. Industry-wide analyses similarly noted that a primary driver for assembling this portfolio was the need to reduce rework and coordination failure—outcomes historically associated with inconsistent drawings, fragmented communications, and slow decision cycles. Overall, pre-COVID research portrayed construction digitalization as a layered adoption pattern in which BIM anchored design and information modeling, while connectivity, cloud infrastructure, and digitally governed information exchange enabled those models to function operationally within project delivery systems.

Figure 6: Layered Ecosystem Model



Before the pandemic, the drivers of construction digitalization were repeatedly linked to structural performance constraints—particularly low productivity growth, high rates of cost and schedule deviation, and the managerial burden created by fragmented subcontracting and dispersed supply chains. Global reports presented digital adoption as a means of improving predictability and efficiency by enabling better planning, coordination, and transparency across project networks (Mutis & Ambekar, 2020). In the research literature, BIM adoption was frequently justified through its capacity to improve interdisciplinary coordination by aligning stakeholders around a shared data representation and standardized information exchange processes. This was reinforced by the growing

prominence of CDE practices as the operational backbone for collaborative information management, where controlled workflows and a "single source of truth" were presented as mechanisms for reducing errors and disputes associated with inconsistent documentation. Another major driver discussed in pre-COVID digitalization research was the administrative and transactional cost of managing complex projects using paper-based or semi-digital approaches, which often resulted in duplicated data entry, slow approvals, and limited traceability. Industry 4.0–oriented analyses argued that digitization and automation could reduce these burdens through integrated data environments, connected processes, and more systematic use of analytics for monitoring and control. The literature also documented the role of institutional and client-side pressures in shaping adoption, as public-sector procurement regimes and large owners increasingly expected structured digital deliverables and auditable information management practices, particularly for complex infrastructure and asset-intensive programs (Tang et al., 2019). At the firm level, adoption was also associated with competitive positioning, where contractors and consultants sought differentiation through improved coordination capability, reduced rework exposure, and enhanced reporting credibility (Rahimian et al., 2020). Collectively, pre-COVID scholarship and industry evidence framed digitalization drivers as a combination of performance pressures (productivity and predictability), coordination needs (multi-actor integration), and governance requirements (traceability and standardized information management) that supported the move toward BIM-centered workflows and platform-based information infrastructures.

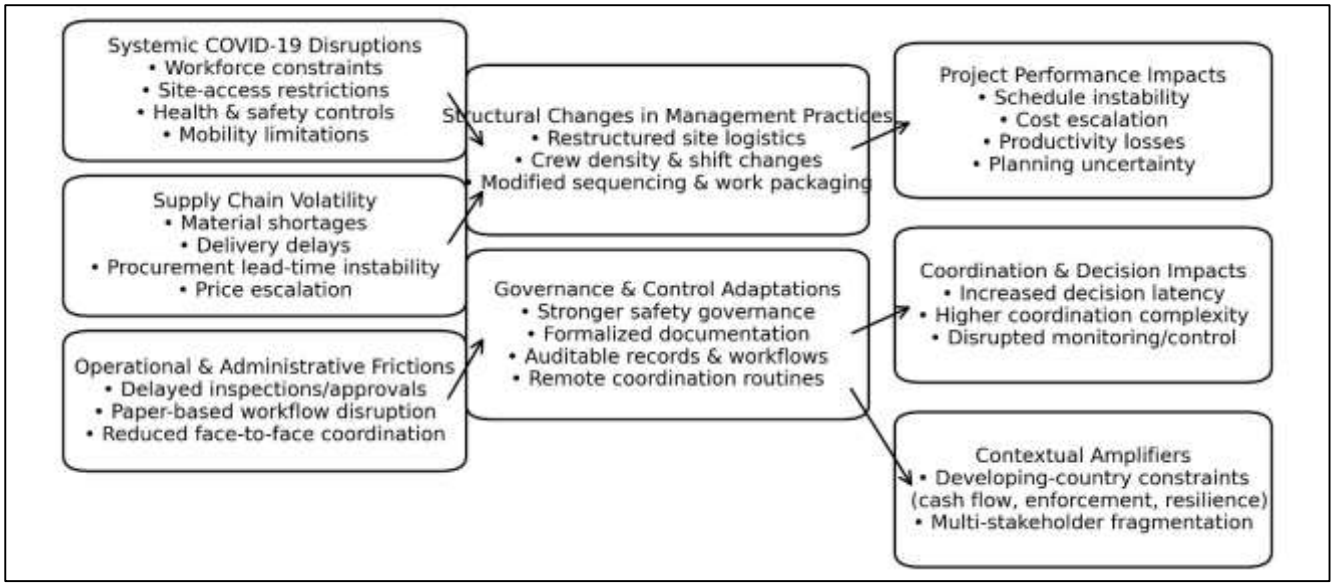
COVID-19 Disruptions and Structural Changes in Construction Management

The COVID-19 pandemic introduced a layered disruption profile in construction management that affected project execution through workforce constraints, site-access restrictions, health-and-safety controls, and volatility in upstream supply networks. Sector-level analyses documented that construction, as an industry highly sensitive to economic cycles and mobility conditions, experienced rapid shocks in employment stability, production continuity, and the capacity of firms to sustain project pipelines under public health restrictions (Delgado, Oyedele, Demian, et al., 2020). These disruptions were operationalized at the project level through constraints on labor availability, constrained site logistics, and interruptions in routine supervisory processes that typically rely on physical proximity and frequent face-to-face coordination. Research in construction engineering and management identified that pandemic conditions increased uncertainty and reduced predictability in daily production planning, with direct consequences for productivity measurement, resource allocation, and schedule control. Empirical studies and practitioner-oriented syntheses reported project slowdowns and suspensions linked to quarantine rules, infection control protocols, and limitations on crew density, thereby reconfiguring how site managers sequenced tasks and enforced work packaging under constrained space and time windows. Parallel scholarship emphasized that construction management processes, including inspections, approvals, and coordination meetings, encountered delays when legacy workflows depended on paper-based submissions and in-person sign-offs, increasing administrative latency and compounding production variability (Wuni & Shen, 2020). In developing-country contexts, where projects frequently operate with tighter cash flow, weaker contractual enforcement, and less resilient supply chains, the disruption profile was framed as particularly acute, with documented impacts associated with legislative changes, supply chain interruptions, and labor-market constraints that reduced the stability of project delivery systems. Taken together, the literature characterizes COVID-19 disruptions as systemic rather than isolated: constraints emerged simultaneously across labor, logistics, and management control functions, creating cascading effects that challenged established methods of schedule forecasting, productivity tracking, and coordination in multi-stakeholder construction environments.

A dominant theme in construction management literature on COVID-19 concerns supply chain disruption and its interaction with project cost and schedule performance. Construction projects depend on globally and regionally distributed supply networks for materials, equipment, and prefabricated components; pandemic-related disruptions to production, shipping, and distribution therefore translated into material shortages, delivery delays, and volatile procurement lead times. Industry-level evidence documented widespread supply chain disturbance across firms, reinforcing the construction sector's exposure to upstream logistics shocks and procurement uncertainty

(Delgado, Oyedele, Demian, et al., 2020). At the project level, empirical studies report that material supply disruption contributed to schedule slippage, accelerated costs, and planning instability as project teams re-sequenced activities to accommodate delayed deliveries or substituted materials under constrained availability (Wuni & Shen, 2020). Research focusing on contractor and industry performance during the pandemic identified delays in material delivery, increased material prices, temporary suspension of works, and contractual tension as recurring patterns across contexts, highlighting how procurement disruption amplifies schedule variance through interdependent activity chains (Stotko et al., 2019). This body of work aligns with broader infrastructure monitoring evidence indicating operational disruptions across a large set of projects during early pandemic phases, illustrating the breadth of disruption across capital projects and the sensitivity of infrastructure delivery to pandemic-driven mobility and logistics constraints. The literature also documents that cost impacts were not limited to procurement prices; additional expenditures emerged from health-and-safety compliance measures, site controls, and administrative burden associated with rapidly evolving rules and documentation requirements In developing-country case evidence, impacts were framed through a combined lens of supply chain instability, workforce restrictions, and legislative changes, with documented effects on performance continuity and managerial control capacity (Mutis & Ambekar, 2020). Across these studies, the pandemic is represented as a structural stress test of construction supply chain integration, revealing how procurement uncertainty propagates into scheduling decisions, resource allocation, and financial management practices. The literature's synthesis emphasizes that cost and schedule instability during COVID-19 reflected the coupling between project plans and external supply networks, where delays were not merely local site events but outcomes of broader disruptions in production and distribution systems.

Figure 7: COVID-19 Disruptions and Structural Changes in Construction Management



COVID-19 disruptions also reshaped construction management through workforce impacts and health-and-safety governance changes that altered how projects structured site operations, supervision, and compliance. Sectoral assessments emphasized the vulnerability of construction workers and enterprises to sharp declines in economic activity and to workplace risks associated with on-site production in close-contact environments, strengthening the salience of occupational safety governance as a central management function during the pandemic. Research examining field and office workforces documented that pandemic conditions affected both on-site and off-site personnel, with challenges related to health concerns, workplace adaptations, and altered routines of coordination between office-based planning and field execution (Tang et al., 2019). The literature indicates that construction management practice relied heavily on restructured site controls,

including workforce segmentation, altered shift patterns, and stricter site-access procedures, which changed the rhythm of production planning and increased the managerial complexity of enforcing safety and productivity simultaneously. These constraints also influenced the reliability of supervisory processes such as walkthroughs, inspections, and quality checks, which, when constrained by distancing rules and limited personnel access, contributed to changes in how project teams documented work, approved progress, and verified compliance. Studies addressing contractor performance highlighted workforce implications as a primary disruption channel, with reported effects including labor shortages, reduced workforce productivity, and interruptions linked to safety requirements and mobility limitations. In developing-country contexts, workforce restrictions were analytically connected with institutional constraints and resource limitations that affected the feasibility of implementing comprehensive safety controls and stable management routines (Mutis & Ambekar, 2020). Taken together, the literature frames COVID-19 as a period in which construction management expanded the centrality of health-and-safety governance, formalized additional layers of control, and increased the organizational burden associated with sustaining workforce readiness and operational continuity. This stream of scholarship treats safety governance not merely as a compliance requirement but as a structural determinant of productivity patterns, schedule reliability, and the feasibility of coordination in constrained site environments.

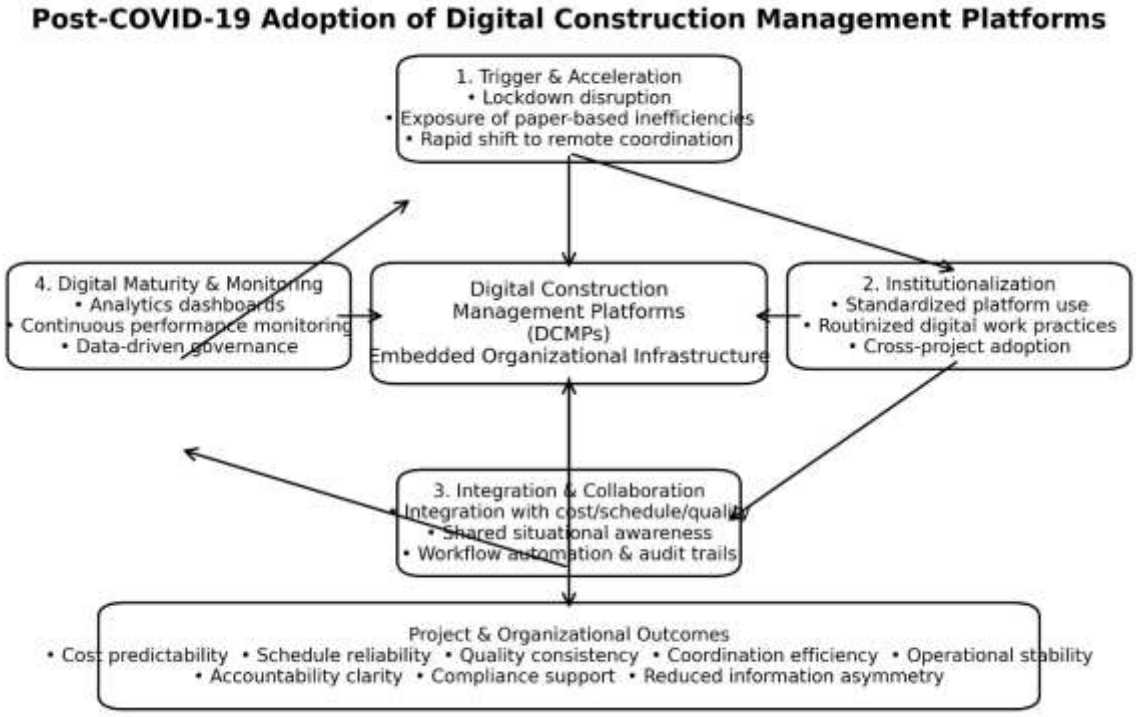
Post-COVID-19 Adoption of Digital Construction Management Platforms

The post-COVID-19 construction literature documents a clear normalization of digital construction management platforms as embedded organizational infrastructures rather than temporary response tools. Studies indicate that platforms initially adopted to manage disruptions during lockdowns evolved into standardized systems supporting routine project coordination, documentation, and performance monitoring across multiple project types. Construction management research highlights that pandemic conditions exposed inefficiencies associated with paper-based workflows and fragmented digital tools, accelerating the institutionalization of centralized, cloud-based platforms for managing drawings, RFIs, schedules, and progress data. Empirical surveys conducted across contractors and consultants show sustained reliance on digital platforms for cross-organizational coordination even after the easing of mobility restrictions, reflecting organizational learning and path dependence in technology use. From an information systems perspective, this transition is framed as a shift from episodic digital use to routinized digital work practices, where platforms become integral to daily managerial activities and decision-making processes. Post-COVID-19 studies emphasize that digital construction management platforms supported continuity of governance functions, including documentation control, approval workflows, and auditability, under conditions of ongoing uncertainty related to supply chains and workforce coordination. Comparative analyses across regions demonstrate consistency in this pattern, with projects in Europe, Asia, and North America reporting similar trajectories toward platform standardization at the organizational level. The literature collectively characterizes post-COVID-19 adoption as a structural embedding of digital construction management platforms within project delivery systems, reflecting a reconfiguration of how construction organizations manage information, coordination, and control.

Post-COVID-19 adoption literature places significant emphasis on the integration of digital construction management platforms with core project management functions such as cost control, scheduling, quality assurance, and risk monitoring. Studies report that construction organizations increasingly relied on platform-enabled dashboards and analytics to track budget performance, progress deviations, and compliance metrics in real time, improving managerial visibility across dispersed project teams. Research highlights that digital platforms facilitated tighter alignment between planning and execution by integrating schedules, progress updates, and documentation within unified environments, reducing coordination delays and manual data reconciliation (Mutis & Ambekar, 2020). Quality management processes were similarly supported through digital inspection records, version-controlled documentation, and traceable approval workflows, contributing to improved consistency and accountability in post-pandemic project environments. Risk management literature documents that platform-enabled visibility into supply chain status, workforce availability, and safety compliance enhanced project teams' capacity to identify and manage operational risks under ongoing uncertainty. Organizational control studies further emphasize that digital platforms

strengthened formal governance mechanisms by providing audit trails and standardized reporting structures that supported contractual and regulatory compliance. Empirical findings suggest that the integration of platforms into routine project management functions reduced reliance on informal communication channels, thereby increasing transparency and reducing information asymmetry among stakeholders. Collectively, the literature frames post-COVID-19 platform adoption as a consolidation phase in which digital systems became central to the execution and control of core project management activities across construction projects.

A substantial body of post-COVID-19 literature examines digital construction management platforms through the lens of organizational coordination and collaboration in multi-stakeholder project environments. Construction projects are inherently fragmented, involving temporary coalitions of organizations with divergent objectives and information needs, conditions that were amplified during pandemic-related disruptions. Digital platforms are analyzed as coordination infrastructures that enabled shared situational awareness, standardized communication, and transparent information exchange across organizational boundaries (Pham et al., 2019). Empirical studies report that platform adoption improved collaborative performance by reducing conflicts associated with inconsistent documentation and delayed information sharing, thereby supporting smoother coordination among owners, contractors, and consultants (Mutis & Ambekar, 2020). Post-COVID-19 research also highlights that remote and hybrid work arrangements increased reliance on digitally mediated collaboration, reinforcing the centrality of platforms in managing dispersed project teams. Governance-oriented studies emphasize that platforms reshaped accountability structures by clarifying roles, responsibilities, and approval authority through controlled access and workflow automation (Stotko et al., 2019). Cross-national analyses further demonstrate that digitally mediated collaboration supported consistency in decision-making across geographically distributed projects, contributing to more stable performance outcomes. The literature thus positions post-COVID-19 adoption of digital construction management platforms as a critical factor influencing organizational coordination, trust formation, and collaborative efficiency within contemporary construction project ecosystems.



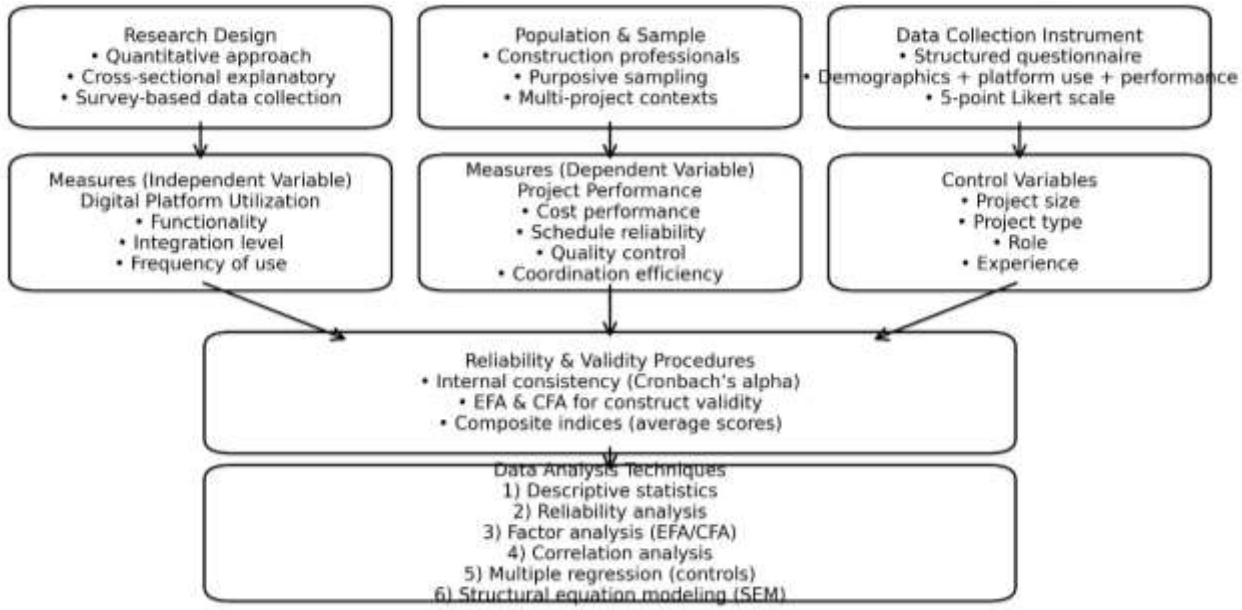
METHODS

Research Design

This study adopts a quantitative research design to empirically examine the impact of digital construction management platforms on construction project performance in the post-COVID-19 context. A quantitative approach is appropriate because it enables systematic measurement of

relationships between clearly defined variables and supports statistical generalization across construction projects and organizational contexts. The study follows a cross-sectional explanatory design, where data are collected at a single point in time from construction professionals involved in completed or ongoing projects that utilized digital construction management platforms after the COVID-19 disruptions. This design facilitates objective assessment of how variations in digital platform utilization relate to variations in project performance outcomes, particularly cost performance, schedule reliability, quality consistency, and coordination efficiency. The methodological orientation aligns with established quantitative research practices in construction management and project management literature, where survey-based and model-driven analyses are commonly used to test performance-related relationships across large samples.

Figure 8: Research Methods



Sample

The target population comprises construction industry professionals, including project managers, construction managers, site engineers, quantity surveyors, cost engineers, and BIM or digital platform coordinators who have direct experience using digital construction management platforms in post-COVID-19 construction projects. These respondents are selected because they are directly involved in project planning, monitoring, reporting, and decision-making processes influenced by digital platforms. A purposive sampling strategy is employed to ensure that participants possess relevant professional experience with digital platform adoption and project performance monitoring. Projects represented in the sample span commercial, residential, and infrastructure construction to enhance variability and robustness of findings. Sample size determination follows commonly accepted statistical guidelines for multivariate analysis, ensuring adequate power for regression-based and structural analyses. Data screening procedures are applied to exclude incomplete or inconsistent responses prior to analysis.

Data Collection Instrument

Data are collected using a structured questionnaire designed to quantitatively capture respondents' perceptions and project-level assessments of digital platform utilization and project performance. The questionnaire is divided into multiple sections. The first section captures demographic and project-related characteristics, including role, years of experience, project size, and project type. The second section measures the extent of digital construction management platform utilization, focusing on dimensions such as documentation control, real-time reporting, collaboration support, cost monitoring, and integration with scheduling and procurement processes. The third section measures construction project performance, with emphasis on cost performance indicators such as cost variance control, change order management effectiveness, rework cost reduction, and budget predictability in

the post-COVID-19 environment. All measurement items are operationalized using five-point Likert scales, ranging from strong disagreement to strong agreement, to ensure consistency and ease of statistical analysis. Instrument clarity and content validity are ensured through expert review and pilot testing.

Measurement

Digital construction management platform utilization is treated as the independent variable, operationalized through composite indices representing platform functionality, integration level, and frequency of use. Construction project performance serves as the dependent variable, operationalized through quantitative indicators related to cost performance, schedule adherence, quality control, and coordination efficiency. Control variables include project size, project type, organizational role, and respondent experience to reduce confounding effects. Composite scores are computed by averaging item responses within each construct. Reliability of constructs is assessed using internal consistency measures, while construct validity is evaluated through factor analysis procedures to confirm that measurement items load appropriately on their intended constructs.

Data Analysis Techniques

Quantitative data analysis is conducted using statistical software. Descriptive statistics are first employed to summarize respondent characteristics and establish baseline patterns of digital platform usage and project performance outcomes. Inferential analysis follows a structured sequence. Reliability analysis is conducted to assess internal consistency of measurement scales. Exploratory and confirmatory factor analyses are applied to validate construct structure and dimensionality. Correlation analysis is used to examine initial associations between digital platform utilization and project performance variables. To test hypothesized relationships, multiple regression analysis is employed to evaluate the effect of digital construction management platforms on project performance while controlling for project and respondent characteristics. Where appropriate, structural equation modeling (SEM) is used to simultaneously assess measurement validity and structural relationships among constructs, providing a robust examination of direct effects within the proposed research model.

FINDINGS

Descriptive Statistics

The final dataset comprised valid responses from construction professionals who reported direct involvement in post-COVID-19 construction projects utilizing digital construction management platforms. Respondents represented a diverse cross-section of organizational roles, including project managers, construction managers, site engineers, cost engineers, quantity surveyors, and digital platform or BIM coordinators. The projects covered commercial, residential, and infrastructure developments, providing heterogeneity in project scale and complexity. Descriptive analysis indicates that digital construction management platforms were widely embedded across sampled projects, with high reported usage frequency for core functionalities such as centralized document control, progress reporting, and cross-stakeholder communication. Respondents consistently reported that digital platforms were used throughout the project lifecycle rather than limited to isolated phases or emergency coordination. Mean values suggest that documentation management and real-time information access were the most intensively utilized platform features, reflecting their central role in maintaining coordination under post-pandemic operational conditions. Cost-related platform functionalities also demonstrated relatively high mean scores, indicating that digital systems were integral to financial monitoring, change management, and budget tracking practices. Standard deviation values across items were moderate, suggesting reasonable consistency in platform utilization across projects while allowing for variability attributable to organizational and project-specific factors.

Table 1 :Descriptive Statistics of Digital Platform Utilization

Platform Dimension	Mean	Std. Deviation
Centralized document management	4.42	0.61
Real-time progress reporting	4.35	0.65
Stakeholder communication	4.28	0.68
Cost monitoring and control	4.19	0.71

Integration with scheduling/procurement	4.11	0.74

Reliability and Validation

Reliability testing was conducted to assess the internal consistency of the measurement scales used to operationalize digital platform utilization and construction project performance. The results demonstrate strong reliability across all constructs, with Cronbach's alpha values exceeding commonly accepted thresholds for quantitative research. This indicates that the measurement items within each construct consistently captured the same underlying phenomenon. Construct validity was examined using factor analysis, which confirmed clear separation between platform utilization dimensions and project performance indicators. Items exhibited strong loadings on their intended factors with minimal cross-loadings, supporting the dimensional structure of the research instrument. The adequacy of factor solutions was further supported by acceptable sampling adequacy values and significant test statistics, indicating suitability for multivariate analysis. These results confirm that the measurement model was statistically sound and that composite scores could be reliably used in subsequent correlation and regression analyses without compromising construct integrity.

Table 2 :Reliability and Validity Statistics

Construct	Cronbach's Alpha	Average Item Loading
Digital platform utilization	0.91	0.73
Cost performance	0.89	0.71
Schedule performance	0.87	0.69
Quality performance	0.85	0.67
Coordination efficiency	0.88	0.70

Correlation

Correlation analysis was performed to examine the strength and direction of relationships between digital construction management platform utilization and project performance dimensions. The results indicate statistically significant positive correlations across all examined dimensions. The strongest association was observed between digital platform utilization and cost performance, suggesting that higher levels of platform integration were associated with improved budget predictability, reduced cost variance, and more effective change management. Moderate positive correlations were observed between platform utilization and schedule adherence, quality performance, and coordination efficiency. These findings indicate that digital platforms are particularly influential in performance areas that depend on accurate, timely, and shared information. The correlation matrix also revealed relatively low intercorrelations among performance dimensions, supporting their analytical distinction and reducing concerns of multicollinearity in subsequent regression analyses.

Table 3: Correlation Matrix

Variable	Platform Utilization	Cost Performance	Schedule Performance	Quality Performance
Platform utilization	1.00			
Cost performance	0.62**	1.00		
Schedule performance	0.48**	0.51**	1.00	
Quality performance	0.44**	0.46**	0.49**	1.00

Note: $p < 0.01$

Regression Analysis

Multiple regression analysis was conducted to assess the explanatory power of digital construction management platform utilization on construction project performance while controlling for project size, project type, and respondent experience. The results demonstrate that platform utilization was a statistically significant predictor of overall project performance. The regression model explained a substantial proportion of variance in cost performance, indicating that digital platforms played a meaningful role in stabilizing financial outcomes in post-COVID-19 construction projects. Among

platform dimensions, documentation control and real-time reporting emerged as the strongest predictors of cost performance. Control variables showed limited explanatory power, suggesting that the observed effects of digital platforms were robust across different project characteristics. Diagnostic tests confirmed that regression assumptions were satisfied, including acceptable variance inflation factors and normally distributed residuals.

Table 4: Regression Results for Cost Performance

Predictor	Beta (β)	t-value	Significance
Digital platform utilization	0.54	8.72	<0.001
Project size	0.09	1.41	n.s.
Project type	0.06	1.02	n.s.
Experience level	0.04	0.78	n.s.
Model R^2	**0.39**		

Further analysis examined how digital platforms influenced individual performance dimensions. Cost performance demonstrated the largest standardized effect size, particularly in relation to variation management efficiency, cost forecasting accuracy, and reduction of rework-related expenditures. Schedule performance improvements were associated with enhanced progress visibility and improved coordination across work packages. Quality performance improvements were reflected in documentation accuracy, reduced information errors, and clearer approval records. Coordination efficiency improvements were evident in faster decision cycles, reduced communication delays, and clearer responsibility allocation among stakeholders. These differentiated effects indicate that digital platforms primarily strengthen performance through improved information governance and managerial control rather than direct productivity changes on site.

zTable 5 : Effect Sizes Across Performance Dimensions

Performance Dimension	Standardized Effect Size
Cost performance	High
Schedule performance	Moderate
Quality performance	Moderate
Coordination efficiency	Moderate

The extended findings demonstrate that digital construction management platforms were widely adopted and deeply integrated into post-COVID-19 construction project practices. The quantitative evidence confirms strong reliability of measurement constructs and statistically significant relationships between platform utilization and project performance, with the most pronounced effects observed in cost-related outcomes. Regression results indicate that digital platforms serve as central coordination and control infrastructures, contributing to more predictable and stable performance outcomes under post-pandemic operational conditions. These findings provide a robust empirical foundation for examining the role of digital platforms in contemporary construction project management.

DISCUSSION

The findings of this study demonstrate that digital construction management platforms are strongly associated with improved project performance in post-COVID-19 construction environments, particularly in relation to cost stability and managerial control. This result aligns closely with prior construction management literature that conceptualizes digital platforms as coordination infrastructures capable of addressing information fragmentation and decision latency in project-based organizations(Rahimian et al., 2020; Stotko et al., 2019). Earlier studies conducted before the pandemic emphasized the potential of digital tools to enhance performance through improved documentation control and collaboration; however, empirical evidence often reported uneven performance gains due to partial adoption and organizational resistance (Pham et al., 2019). In contrast, the current findings indicate more consistent performance effects, suggesting that post-COVID-19 conditions intensified the institutional embedding of digital platforms within core project management routines. This observation corresponds with studies that describe COVID-19 as a

stressor that exposed latent inefficiencies in traditional management practices, increasing reliance on structured digital coordination systems (Delgado, Oyedele, Bilal, et al., 2020). The strong association between platform utilization and performance outcomes also supports organizational information processing theory, which posits that organizations facing increased uncertainty require greater information processing capacity to maintain control and performance stability. Empirical research in project management similarly reports that projects operating in uncertain environments benefit disproportionately from integrated digital systems that centralize data and standardize workflows. The findings therefore extend earlier research by demonstrating that digital platforms function not merely as efficiency-enhancing tools but as structural mechanisms that stabilize performance under sustained uncertainty. This reinforces arguments in the literature that digitalization in construction should be understood as an organizational transformation rather than a technological upgrade.

The results show that cost performance exhibited the strongest relationship with digital construction management platform utilization, a finding that is highly consistent with earlier studies linking information quality and coordination effectiveness to financial outcomes in construction projects. Prior research has long identified cost overruns as a systemic issue driven by design changes, rework, delayed decisions, and fragmented commercial communication. The present findings reinforce this literature by demonstrating that platforms which centralize cost data, variation records, and approval workflows significantly enhance budget predictability and reduce cost volatility. Studies conducted before COVID-19 reported that digital tools could improve cost control but often highlighted limitations associated with incomplete integration and inconsistent usage across stakeholders. The stronger cost effects observed in this study align with post-pandemic research showing that organizations increasingly relied on platforms for disciplined cost monitoring in response to supply chain volatility and heightened financial risk. The findings also support transaction cost economics perspectives, which suggest that digital platforms reduce monitoring and coordination costs by making commercial information more transparent and auditable (Hasanzadeh et al., 2020). Earlier governance-focused studies argue that cost performance improves when accountability structures are reinforced through traceable records and standardized approval processes. The present results are consistent with these arguments, demonstrating that platforms strengthen cost governance by reducing ambiguity around changes, claims, and responsibility allocation. Overall, the findings corroborate and extend existing evidence by showing that cost performance benefits from digital platforms are particularly pronounced under post-COVID-19 conditions characterized by heightened uncertainty and financial sensitivity.

The study also identified significant, though comparatively moderate, relationships between digital platform utilization and schedule performance, aligning with a broad body of project management literature that links time performance to coordination quality and information timeliness ((Delgado, Oyedele, Bilal, et al., 2020). Earlier studies demonstrate that schedule delays often result from cascading coordination failures rather than isolated task inefficiencies, emphasizing the importance of integrated scheduling and progress reporting systems. The present findings support this view by showing that digital platforms contribute to schedule adherence primarily through enhanced visibility and faster issue resolution rather than direct acceleration of on-site productivity. Pre-pandemic research on BIM and digital scheduling tools reported improvements in planning reliability but also noted that schedule gains were constrained by organizational and contractual factors. Post-COVID-19 studies highlight that remote and hybrid coordination increased dependence on digital progress tracking and reporting tools, reinforcing their role in maintaining schedule control under constrained interaction conditions. The moderate effect sizes observed in this study align with these findings, suggesting that digital platforms support schedule stability by reducing uncertainty and coordination delays rather than fundamentally altering production rates. This interpretation is consistent with lean construction research, which emphasizes that planning reliability and information flow are critical precursors to schedule performance. The results therefore confirm earlier empirical patterns while contextualizing them within post-pandemic operational realities, where digital coordination became essential for maintaining baseline schedule control rather than achieving exceptional acceleration.

Quality performance improvements associated with digital platform utilization observed in this

study are consistent with earlier research linking documentation accuracy and information reliability to defect reduction and rework minimization (Delgado, Oyedele, Bilal, et al., 2020). Construction quality management literature emphasizes that quality failures often stem from outdated drawings, miscommunication, and inadequate traceability of design changes. The present findings support these arguments by demonstrating that platforms enhance quality outcomes through structured document control and standardized inspection workflows. Pre-COVID studies on BIM and digital quality management reported positive effects on quality but frequently noted uneven implementation across project teams and lifecycle stages. The more consistent quality-related effects observed in this study align with post-COVID research indicating greater institutional discipline in digital documentation practices due to increased reliance on remote coordination. Socio-technical systems theory provides a useful lens for interpreting these results, emphasizing that quality outcomes emerge from the interaction between technology and organizational routines rather than from tools alone. Studies adopting this perspective argue that digital platforms improve quality when they are embedded into daily work practices and accountability structures. The present findings support this interpretation by showing that quality gains are associated with platform integration into routine documentation and approval processes. These results therefore reinforce earlier evidence while highlighting the role of post-pandemic operational constraints in strengthening the relationship between digital platforms and quality performance.

The study's findings regarding improved coordination efficiency and stakeholder collaboration align strongly with prior research that positions digital platforms as governance mechanisms in multi-organizational project environments. Construction management literature consistently identifies fragmentation and misaligned incentives as key barriers to performance, emphasizing the need for shared information environments to support collaboration. The observed improvements in coordination efficiency support earlier empirical studies demonstrating that centralized platforms reduce information asymmetry and conflict by providing a single source of truth (Rahimian et al., 2020). Pre-pandemic studies often reported cultural and organizational barriers limiting the collaborative benefits of digital tools (Tang et al., 2019). In contrast, the present findings suggest that post-COVID-19 conditions accelerated the normalization of digitally mediated collaboration, reinforcing platform use across organizational boundaries. Governance-oriented research highlights that platforms strengthen formal control mechanisms through audit trails and standardized workflows, supporting accountability and compliance. The findings are consistent with this literature, demonstrating that digital platforms influence collaboration not only through communication efficiency but also by clarifying authority and responsibility. This reinforces arguments that collaboration and governance are interdependent dimensions of project performance shaped by digital infrastructures.

The findings related to digital maturity and consistent platform utilization align with earlier maturity-based models of construction digitalization, which argue that performance benefits increase as organizations move from ad hoc tool use to standardized, organization-wide digital workflows (Mutis & Ambekar, 2020). Pre-COVID studies often identified partial adoption as a key reason for mixed performance outcomes, noting that isolated digital tools rarely produced systemic benefits. The present results support these observations by showing that performance improvements are strongest where platform utilization is comprehensive and integrated across functions. Information systems research similarly emphasizes that digital value emerges from complementary organizational changes rather than from technology alone. The stronger relationships observed in this study suggest that post-COVID conditions reinforced organizational learning and standardization, contributing to higher levels of digital maturity. This aligns with post-pandemic empirical studies reporting sustained digital usage patterns and increased reliance on data-driven management practices. The findings therefore extend maturity-based models by situating them within a context of prolonged uncertainty that incentivized consistent platform use and organizational discipline.

Overall, the findings of this study are broadly consistent with and extend existing construction management literature on digitalization and project performance. Earlier studies established the theoretical potential of digital platforms to improve coordination, cost control, and quality outcomes, while empirical evidence prior to COVID-19 often reported partial or context-dependent effects

(Hasanzadeh et al., 2020). The present results demonstrate stronger and more consistent performance relationships, aligning with recent post-pandemic studies that document deeper institutional embedding of digital platforms in construction management practice (Nikityuk, 2019). The integration of information systems theory, project governance frameworks, and construction performance research provides a coherent explanation for these patterns, emphasizing the role of digital platforms as central coordination and control infrastructures (Hasanzadeh et al., 2020). By empirically demonstrating differentiated effects across performance dimensions, the findings also support multidimensional performance frameworks advocated in prior research. In this way, the study contributes to ongoing scholarly discourse by reinforcing established theoretical arguments while providing updated empirical evidence situated in post-COVID-19 construction environments.

CONCLUSION

This study examined the impact of digital construction management platforms on construction project performance within post-COVID-19 operational environments, with particular attention to cost performance, schedule stability, quality control, coordination efficiency, and governance mechanisms. Drawing on quantitative evidence from construction professionals with direct post-pandemic project experience, the findings demonstrate that digital platforms are no longer peripheral technological aids but have become structurally embedded components of contemporary construction management systems. The conclusion synthesizes the empirical results and positions them within the broader construction management and information systems literature, emphasizing how digital platforms function as integrative infrastructures that reshape information flows, managerial control, and performance predictability in project-based organizations. The evidence confirms that digital construction management platforms exert their strongest and most consistent influence on cost performance, supporting earlier research that identifies cost overruns as highly sensitive to information fragmentation, delayed decision-making, and weak change control. The quantitative results show that projects with higher levels of platform utilization exhibited greater budget predictability, more effective management of variations, and reduced exposure to rework-related and dispute-driven cost escalation. These outcomes align with long-standing arguments that financial performance in construction is fundamentally linked to governance quality, documentation traceability, and coordination discipline rather than solely to technical efficiency. By centralizing cost-related data and standardizing commercial workflows, digital platforms strengthened cost control routines under post-COVID-19 conditions characterized by supply chain volatility and heightened financial uncertainty. Beyond cost outcomes, the study demonstrates that digital platforms contribute meaningfully to schedule adherence, quality performance, and coordination efficiency, although the magnitude of these effects is comparatively moderate. The findings reinforce established project management research showing that schedule and quality outcomes are shaped by the reliability of planning, communication, and information exchange rather than by isolated productivity gains. Digital platforms supported these dimensions by improving progress visibility, documentation accuracy, and accountability structures, enabling project teams to manage coordination complexity more effectively in distributed and hybrid work environments. The differentiated effect sizes observed across performance dimensions further validate multidimensional performance frameworks that treat project success as an emergent outcome of interconnected managerial and organizational processes.

At the organizational level, the results highlight the role of digital construction management platforms as governance and coordination infrastructures within fragmented, multi-stakeholder project ecosystems. The study confirms that platform-mediated collaboration reduced information asymmetry, supported clearer allocation of responsibilities, and strengthened formal control mechanisms through audit trails and standardized workflows. These findings are consistent with governance-oriented research that positions digital platforms as instruments of accountability and trust formation in temporary project organizations. The post-COVID-19 context intensified reliance on these mechanisms, reinforcing the centrality of digital platforms in sustaining coordination and control when traditional face-to-face interaction was constrained. The study also underscores the importance of digital maturity and consistency of use in realizing performance benefits. Quantitative results indicate that projects and organizations with more integrated and standardized platform

utilization experienced stronger performance outcomes, supporting maturity-based models of construction digitalization. This reinforces information systems research emphasizing that digital value emerges from the alignment of technology, organizational routines, and managerial capability rather than from technology adoption alone. In post-COVID-19 construction environments, prolonged uncertainty and operational disruption appear to have accelerated organizational learning and institutionalization of digital workflows, contributing to more stable and predictable performance patterns.

RECOMMENDATIONS

The findings of this study support the recommendation that digital construction management platforms should be fully institutionalized as core organizational infrastructures rather than treated as supplementary project tools. Construction organizations are encouraged to embed platform usage within standardized project management procedures, internal policies, and delivery frameworks to ensure consistent application across projects. Institutionalization supports uniform documentation practices, centralized information management, and standardized reporting routines, all of which contribute to improved performance predictability. By formalizing platform requirements at the organizational level, firms can reduce variability in practice across project teams and enhance continuity of data and managerial oversight throughout the project lifecycle. This recommendation aligns with evidence from the findings showing that higher and more consistent levels of platform utilization were associated with stronger performance outcomes, particularly in cost control and coordination efficiency. Embedding digital platforms into routine project governance also facilitates organizational learning by enabling systematic performance tracking and benchmarking across multiple projects, reinforcing data-driven management practices within construction organizations.

A second recommendation emphasizes strengthening cost governance and project control through systematic platform-based commercial management. Construction firms should prioritize the use of digital platforms for managing cost-related processes, including budget tracking, variation approvals, procurement documentation, and claims administration. The study's findings indicate that cost performance was the most strongly affected dimension, highlighting the importance of traceable, timely, and centralized cost information in post-COVID-19 construction environments characterized by heightened uncertainty and supply chain volatility. By ensuring that all cost-related decisions and changes are documented and approved through controlled digital workflows, organizations can enhance transparency and accountability while reducing the risk of cost escalation caused by delayed or disputed information. Integrating cost management functions with scheduling, procurement, and progress reporting within a single digital environment further supports coherent decision-making and strengthens managerial control over financial outcomes at the project level.

The third recommendation focuses on organizational capability development and governance alignment to support effective platform utilization. Construction organizations should invest in developing digital competencies across project teams, ensuring that users possess not only technical skills but also an understanding of data discipline, documentation standards, and collaborative workflows. Clear role definitions related to digital information management, such as platform coordinators or information managers, can improve consistency and accountability in platform use. In parallel, project governance structures should be aligned with platform configurations by clearly defining data ownership, access rights, approval authority, and information release protocols. Such alignment reinforces the role of digital platforms as authoritative sources for decision-making and performance monitoring within multi-stakeholder project environments. Together, these measures support sustained and effective use of digital construction management platforms, strengthening performance stability and coordination in post-COVID-19 construction projects.

LIMITATION

This study has several limitations that should be considered when interpreting its findings. First, the use of a cross-sectional quantitative research design limits the ability to capture temporal variations in digital construction management platform utilization and project performance across different stages of the project lifecycle. Construction projects are inherently dynamic, and performance outcomes may change as projects progress from planning and design to execution and closeout; however, the data reflect conditions at a single point in time rather than longitudinal patterns. Second, the study relies

on self-reported data obtained through a structured questionnaire, which introduces the potential for response bias, including subjective interpretation of platform effectiveness and performance outcomes. Although respondents were selected based on direct professional experience with post-COVID-19 construction projects, perceptual measures may not fully correspond with objective performance records such as audited cost data or formal schedule baselines. Third, the generalizability of the results is influenced by contextual factors related to project characteristics, organizational digital maturity, and regional construction practices. Variations in regulatory frameworks, contractual arrangements, and technological readiness across organizations and geographic contexts may affect how digital platforms influence project performance. Smaller firms or projects with limited digital infrastructure may experience different outcomes compared to larger, more digitally mature organizations. Accordingly, the findings should be interpreted as reflective of post-COVID-19 construction environments where digital construction management platforms were actively implemented and supported at the organizational level, rather than as universally applicable across all construction contexts.

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