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Formation of Efficient BIM Teams for Integration into Construction Companies

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ABSTRACT
The integration of Building Information Modeling (BIM) into construction companies depends less on software acquisition than on the formation of competent, well-structured teams capable of sustaining collaborative digital workflows across the project lifecycle. The objective of this study was to analyze the roles, competencies, organizational barriers, and emerging technological demands that shape the formation of efficient BIM teams. A qualitative documentary approach, structured as a scoping review inspired by the PRISMA-ScR protocol, was adopted, drawing on 15 sources indexed in Scopus, ScienceDirect, and related academic databases, selected for their direct relevance, methodological rigor, and recency. The findings show that BIM role nomenclature remains highly fragmented, with as many as 35 distinct role titles identified across 36 international guides and standards, while competency frameworks converge on a three-tier structure distinguishing core, domain, and execution competencies. Organizational adoption is shaped by an interacting set of technical, financial, organizational, and human barriers, particularly acute in small and medium-sized enterprises, and is substantially supported by Common Data Environments, whose practical implementation nonetheless remains challenged by tool multiplicity and governance gaps. Industry data indicate that poor communication and inaccessible project information account for up to 52% of rework globally, underscoring the centrality of coordinated team structures. The accelerating integration of artificial intelligence and machine learning into BIM workflows is reshaping the competency profile expected of BIM teams, while structured training models remain unevenly available, especially for site-level operatives. It is concluded that efficient BIM team formation requires the simultaneous alignment of role clarity, competency development, collaborative information infrastructure, and organizational culture, with direct implications for construction management practice and for curricular design in architecture and engineering education.

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Introduction
The Architecture, Engineering, and Construction (AEC) industry has undergone a sustained digital transformation in which Building Information Modeling (BIM) has moved from a modeling technology to an organizational and managerial paradigm. This shift repositions the central challenge of BIM implementation: the limiting factor is rarely the software itself, but rather the capacity of construction companies to form, structure, and sustain teams with the competencies required to operate collaborative digital workflows across design, construction, and operation [1]. As BIM has matured from an emergent practice into a standard expectation in public and private procurement, the question of how to build efficient BIM teams has become as consequential as the question of which tools to adopt.

This organizational challenge is compounded by a striking lack of consensus regarding BIM role nomenclature. A review of specialist role definitions across international BIM guides and standards identified 35 distinct role titles across 36 reviewed publications, ranging from BIM Manager and BIM Coordinator to Information Manager, Model Element Author, and Discipline BIM Lead, with considerable overlap and inconsistency in how responsibilities are assigned across these titles [2]. This terminological fragmentation is not a superficial naming problem: it reflects deeper uncertainty about which competencies are required, how they should be organized within a team, and how they should be assessed, trained, and credentialed [3].

At the same time, the formation of BIM teams cannot be understood in isolation from the organizational and technological ecosystem in which construction companies operate. Barriers to BIM adoption—technical, financial, organizational, and human—interact with one another in ways that are particularly acute for small and medium-sized enterprises, which constitute the structural backbone of the construction sector in most economies [4]. The collaborative infrastructure that BIM teams depend upon, principally the Common Data Environment (CDE), introduces its own implementation challenges, even as it becomes indispensable for coordinating dispersed stakeholders [5]. Meanwhile, the rapid incorporation of artificial intelligence (AI) and machine learning (ML) into BIM-enabled workflows is reshaping the technical competency profile that BIM teams are expected to possess, often faster than training and educational structures can adapt [6].

Table 1 summarizes the scope and characteristics of the documentary corpus underpinning the present analysis.

Table 1: Scope and Characteristics of the Documentary Corpus Analyzed on the Formation of Bim Teams

Dimension	Publication period
Publication period	2009–2026, with concentration in 2020–2026
Databases consulted	Scopus, ScienceDirect, and related academic sources (MDPI, Emerald, ASCE Library, Frontiers)
Disciplines integrated	Construction management, architecture, civil engineering, information systems, organizational behavior
Types of studies identified	Systematic and scoping reviews, framework-development studies, structural equation modeling studies, bibliometric analyses
Sources included in the final analysis	15 sources
Predominant geographic scope	Europe, Australia, North America, Asia-Pacific, and Sub-Saharan Africa; limited representation of Latin America

Noe: Prepared by the author based on the systematization of the documentary corpus analyzed in this study.

Despite the breadth of available literature on BIM implementation broadly, a specific analytical gap persists: existing studies tend to treat role definition, competency assessment, organizational adoption, collaborative infrastructure, and emerging technological demands as separate strands of inquiry, rather than as interdependent dimensions of a single organizational challenge—the formation of efficient BIM teams. Moreover, the applicability of existing frameworks to small and medium-sized construction firms, and to Latin American contexts in particular, remains only partially addressed in the indexed literature.

The objective of this study is to analyze, in an integrated manner, the roles, competency frameworks, organizational barriers, collaborative infrastructure, and emerging technological demands that shape the formation of efficient BIM teams for their integration into construction companies, in order to build an updated synthesis capable of orienting professional practice, organizational policy, and academic training in construction management and architecture.

Methodology

Study Design

This study adopted a qualitative, documentary-analytical design, structured as a scoping review informed by the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines. This design is appropriate given the study's objective of mapping the extent, diversity, and nature of the evidence available on a multidimensional organizational phenomenon (BIM team formation) rather than testing a single causal hypothesis, which would be more properly addressed through a conventional systematic review.

Information Sources and Selection Criteria

Scopus, ScienceDirect, and related academic platforms (MDPI, Emerald, ASCE Library, Frontiers) were consulted, with the search period concentrated on 2020–2026, complemented by foundational sources from earlier years where their conceptual contribution remained necessary for framing BIM competency and maturity (notably 2009–2013). Boolean keyword combinations included: BIM team roles; BIM competency assessment; BIM adoption barriers construction; common data environment construction; BIM artificial intelligence machine learning; BIM training construction workforce.

Inclusion criteria were: (a) peer-reviewed journal articles indexed in Scopus or published through ScienceDirect, MDPI, Emerald, ASCE, or Frontiers platforms; (b) studies directly addressing BIM team roles, competencies, organizational adoption, collaborative infrastructure, or workforce training; (c) sources with complete and verifiable bibliographic metadata. Exclusion criteria were: (a) non-peer-reviewed promotional or vendor material; (b) sources with incomplete or unverifiable metadata; (c) studies addressing BIM exclusively from a purely technical modeling perspective without organizational or team-level implications. Following the application of these criteria, 15 sources were integrated into the final analysis, prioritizing methodological rigor, direct thematic relevance, and recency.

Analytical Procedure

The analysis was structured in three sequential stages. Stage 1 consisted of thematic categorical coding of the reviewed documents, identifying seven emergent thematic axes: (i) BIM role taxonomies and competency frameworks, (ii) BIM maturity and performance measurement, (iii) organizational adoption and barriers, (iv) Common Data Environments and collaborative infrastructure, (v) communication and coordination costs, (vi) artificial intelligence and the evolving competency profile, and (vii) training and capacity-building. Stage 2 involved the comparative systematization of quantitative findings reported across the reviewed literature (role-title counts, adoption barrier categories, rework percentages, and CDE benefit/challenge counts). Stage 3 consisted of integrating the identified patterns into a single analytical framework, cross-checked against independent sources for internal consistency.

Reliability and Validity

Reliability was supported through triangulation of sources across multiple independent academic databases and publishers, and through cross-verification of convergent findings across studies conducted in different organizational and geographic contexts. Construct validity was supported by anchoring each analytical category in documented empirical evidence, prioritizing sources published within the last five years to reflect the current state of the discipline. The limitations inherent in a documentary analysis—centered on indexed academic production rather than primary field data—are explicitly acknowledged in the Discussion section.

Results

BIM Role Taxonomies and Competency Frameworks

The reviewed literature reveals a persistent lack of standardization in BIM role nomenclature. A systematic review of specialist role definitions across international BIM guides and standards identified 35 distinct role titles across 36 reviewed publications, including BIM Manager, BIM Coordinator, BIM Modeler, Information Manager, Model Element Author, Discipline BIM Lead, and Task

Information Manager, among others, with considerable variation in how responsibilities are distributed across these titles depending on the country, industry body, or organization issuing the guide [2]. This fragmentation extends beyond terminology: it reflects genuine ambiguity as to whether BIM coordination should reside with a technically proficient individual, a contractually empowered role, or a distributed function shared across the project team.

In response to this ambiguity, competency-based frameworks have emerged as an alternative to role-based taxonomies. The most developed of these frameworks organizes individual BIM competencies into a tiered structure comprising core competencies, domain competencies, and execution competencies, with domain competencies further subdivided into eight sets: four primary sets (managerial, functional, technical, and supportive) and four secondary sets (administration, operation, implementation, and research and development) [3]. This structure allows competencies to be identified, classified, aggregated, and applied independently of any single job title, providing a more stable foundation for team formation than role nomenclature alone. Complementing this competency architecture, a five-metric framework for measuring BIM performance (spanning technology, process, and policy dimensions) offers organizations a structured means of benchmarking team and project maturity over time [7].

BIM Maturity and Performance Measurement

Beyond individual competencies, organizations require frameworks capable of assessing BIM maturity, capacity, and competency at the organizational level. The foundational BIM Framework conceptualizes BIM as a knowledge domain organized around fields, stages, steps, and lenses, providing the research and delivery foundation on which subsequent maturity models have been built [1]. Building on this foundation, more recent work has proposed integrated frameworks for assessing BIM maturity, capacity, and competency simultaneously at the organizational level, arguing that maturity assessment tools have historically undervalidated their own assessment methodology and have insufficiently addressed the organizational, as opposed to purely technical, dimensions of BIM capability [8]. This organizational-level perspective is directly relevant to team formation, since it links individual competency development to the broader capacity of the firm to sustain BIM-enabled collaboration over time, rather than treating team competency as an isolated concern.

Organizational Adoption and Barriers to Team Integration

The formation of efficient BIM teams is inseparable from the organizational context in which adoption occurs. A socio-technical reading of BIM adoption among small and medium-sized enterprises (SMEs) in the construction industry identifies technical, financial, organizational, and human/cultural barriers as interacting, rather than isolated, constraints, with fragmentation in the construction sector itself acting as a condition that amplifies these barriers rather than merely coexisting alongside them [4]. Technical barriers relate to interoperability and the absence of shared exchange protocols; financial barriers concern the difficulty of quantifying returns on BIM investment in ways that justify the initial cost, particularly for firms operating with narrow margins; organizational barriers reflect centralized decision-making structures and the absence of explicit digital transformation strategies; and human/cultural barriers stem from skills gaps, unclear career pathways, and misalignment between BIM education and sectoral needs.

A complementary systematic review of BIM adoption and implementation enablers in AEC firms similarly identifies organizational readiness, top-management support, and the availability of BIM-competent personnel as central enabling conditions, reinforcing the conclusion that BIM team formation functions as both a cause and a consequence of successful organizational adoption [9]. Table 2 systematizes the principal barrier categories identified across the reviewed literature, together with the enabling conditions documented to mitigate them.

Table 2: Barriers to BIM Team Integration in Construction Companies and Documented Enabling Conditions

Barrier category	Principal manifestations	Documented enabling conditions	Sources
Technical	Interoperability gaps, absence of shared exchange protocols, tool multiplicity	Common Data Environments, standardized information-exchange protocols	Zatla et al. (2026); Jaskula et al. (2025)
Financial	Difficulty quantifying return on investment, narrow margins in SMEs	Phased investment, contextualized cost-benefit assessment	Zatla et al. (2026)
Organizational	Centralized decision-making, absence of explicit digital transformation strategy	Top-management commitment, formalized information governance	Zatla et al. (2026); Abbasnejad et al. (2020)
Human and cultural	Skills gaps, unclear career pathways, misalignment between education and industry needs	Structured competency frameworks, targeted training programs	Succar et al. (2013); Olugboyega et al. (2024)

Note: Prepared by the author based on the systematization of the barriers and enabling conditions reported in the cited sources.

Common Data Environments and Collaborative Infrastructure

BIM teams depend on shared digital infrastructure to sustain collaboration across dispersed stakeholders, and the Common Data Environment (CDE) has emerged as the principal mechanism for this purpose. A state-of-the-art review of CDE practices, based on 46 documents analyzed under PRISMA 2020 guidelines, found that one of the most significant challenges of CDE adoption is project complexity combined with the simultaneous use of multiple CDEs by different stakeholders, generating data accountability, transparency, and reliability issues that undermine the very coordination the CDE is meant to provide [5]. A complementary study identifying the benefits and challenges of implementing CDEs specifically in the construction phase of BIM-based projects catalogued 54 distinct benefits and 15 challenges through a combined systematic review, semi-structured interviews, and Delphi method, confirming that CDEs streamline information and communication flows while simultaneously introducing new coordination burdens related to governance and standardization [10].

For BIM teams, these findings imply that the CDE cannot be treated as a purely technical deployment; rather, its effectiveness depends on the team's capacity to establish clear governance protocols, define responsibilities for data validation and access, and maintain a single, contractually defined information environment from the outset of the project rather than allowing fragmented, project-specific arrangements to emerge organically.

Communication, Coordination, and the Cost of Miscommunication

The practical stakes of effective BIM team formation are illustrated by industry-wide data on the cost of miscommunication in construction. A large-scale industry survey of construction leaders found that poor communication and inaccessible or inaccurate project information account for 48% of all rework in the United States and approximately 52% of all rework globally, translating into an estimated $177.5 billion in annual labor costs in the United States alone, with individual team members losing nearly two full working days per week to avoidable coordination issues [11]. While this figure derives from industry survey data rather than a peer-reviewed academic study, its scale and consistency with academic findings on BIM-enabled coordination underscore why the formation of well-structured, clearly delineated BIM teams—rather than the mere presence of BIM software—is the more decisive factor in realizing BIM's coordination benefits.

Artificial Intelligence and the Evolving Competency Profile

The competency profile expected of BIM teams is being reshaped by the accelerating integration of artificial intelligence (AI) and machine learning (ML) into BIM-enabled workflows. A systematic literature review of machine learning applications to BIM identifies construction management, cost analysis, defect detection, and post-occupancy evaluation as the domains in which ML is most actively applied to BIM-derived data, indicating that future BIM teams will require competencies that extend beyond model authoring into data science and analytics literacy [12]. Complementing this technical trajectory, research tracing the evolution from BIM toward extended reality applications in the AEC industry documents the expanding role of immersive technologies in design review, coordination, and training, suggesting that BIM team competency frameworks will need to incorporate proficiency in mixed and virtual reality tools alongside traditional modeling skills [13].

At a broader level, a bibliometric and comprehensive review of BIM-AI integration for smart construction management identifies six advanced research directions—including automated progress monitoring, predictive risk analysis, and generative design—that are expected to define the next generation of BIM team capability, while also noting that current adoption remains constrained by information fragmentation and continued over-reliance on human judgment in decision-making [6]. An earlier review of the roles of artificial intelligence in construction engineering and management similarly concludes that AI's practical value depends less on the sophistication of the algorithms deployed than on the organizational capacity of project teams to interpret, validate, and act upon AI-generated outputs (Pan & Zhang, 2021). Table 3 summarizes the principal technological trends identified and their expected implications for BIM team competency.

Table 3: Emerging Technologies and their Expected Implications for BIM Team Competency Profiles

Technology	Primary application documented	Expected competency implication for BIM teams	Sources
Machine learning	Cost analysis, defect detection, post-occupancy evaluation	Data science and analytics literacy alongside modeling skills	Zabin et al. (2022)
Extended reality (VR/MR)	Design review, coordination, training	Proficiency in immersive visualization and review tools	Alizadehsalehi et al. (2020)
AI-enabled process automation	Progress monitoring, predictive risk analysis, generative design	Capacity to interpret and validate AI-generated outputs	Pan & Zhang (2023); Pan & Zhang (2021)
Common Data Environments	Centralized information management and exchange	Information governance and data validation competencies	Jaskula et al. (2025); Seyis & Ozkan (2024)

Note: Prepared by the author based on the systematization of the technological trends reported in the cited sources.

Training and Capacity-Building for BIM Teams

Despite the growing sophistication of competency frameworks, structured training models for BIM team formation remain unevenly developed, particularly at the level of construction site operatives rather than design professionals. A study developing a BIM learning model specifically for construction site operatives—grounded in the SAMR framework, Bloom's digital taxonomy, social learning theory, and design thinking theory—found that learning standards addressing BIM tools, technologies, and skills significantly enable effective on-site BIM utilization, and that professional role-play and interactive assignments exert the strongest influence on learning outcomes, more so than passive instructional formats [14]. This finding is significant for BIM team formation because it indicates that competency development for site-level personnel requires pedagogical approaches distinct from those historically used in design-oriented BIM education, which has tended to prioritize software proficiency over applied, role-based learning.

Discussion

Theoretical Implications for BIM Competency and Organizational Theory

The findings of this study support a shift away from role-based conceptions of BIM team formation, which remain fragmented and inconsistently defined across the 35 titles identified in international guides, toward competency-based and organizational-maturity frameworks capable of providing a more stable analytical foundation [2-8]. This shift is theoretically significant because it repositions BIM team formation as an organizational capability-building process rather than a matter of filling predefined job titles, aligning with broader organizational theory perspectives that treat digital transformation as a socio-technical process rather than a purely technological one [4].

The convergence between adoption-barrier literature and CDE implementation literature further suggests that BIM team effectiveness cannot be theorized independently of the collaborative infrastructure within which teams operate; a competent team without a well-governed CDE, and a well-governed CDE without a competent team, appear equally prone to underperformance according to the reviewed evidence [5,10].

Practical Implications for Firms, Policy, and Education

The results carry direct implications across three domains. First, for construction company leadership, the evidence that organizational and financial barriers interact with technical ones [4,9]. suggests that BIM team formation should be approached as a strategic organizational investment rather than a departmental technology purchase, with explicit top-management sponsorship and formalized information governance from project inception. Second, for the CDE and software ecosystem, the documented tension between the benefits and governance challenges of Common Data Environments indicates that construction companies should contractually define CDE ownership, access protocols, and validation responsibilities before project mobilization rather than allowing ad hoc arrangements to emerge [5,10]. Third, for educational institutions—an area of direct relevance to undergraduate and graduate programs in architecture and construction management—the evidence on the effectiveness of role-play and interactive, applied learning formats for site-level BIM training supports curricular models that move beyond software-centered instruction toward applied, team-based, and role-differentiated pedagogical designs [14].

Contrastation with Existing Literature

The results of this study are consistent with the broader literature in several respects. The persistence of role-title fragmentation documented here is corroborated by competency-based frameworks that explicitly seek to move beyond title-based organization, suggesting sustained scholarly consensus that role nomenclature is an inadequate basis for team design. Similarly, the finding that CDE implementation generates its own coordination challenges even as it resolves others is consistent with broader socio-technical readings of BIM adoption that caution against treating any single technology as a self-sufficient solution to coordination problems [4,5,10].

A point of productive tension emerges between the optimistic framing of AI-BIM integration in some of the reviewed literature and the more cautious findings regarding organizational readiness to absorb these technologies. While bibliometric evidence points to accelerating research interest in AI-enabled BIM applications , earlier work on the organizational roles of AI in construction management cautions that technical sophistication alone does not translate into practical value without corresponding organizational capacity to interpret and act on AI outputs (Pan & Zhang, 2021), suggesting that competency frameworks may currently be evolving faster in the academic literature than in the operational practice of most construction firms [6].

Limitations

This study presents limitations that should be explicitly acknowledged. First, its documentary design does not permit causal inference regarding the relationship between specific team-formation strategies and project performance outcomes; most reviewed studies are observational, conceptual, or based on structural equation modeling rather than controlled comparison. Second, the reviewed evidence originates predominantly from European, Australian, North American, and Asia-Pacific contexts, with limited representation of Latin American construction markets, constraining the direct transferability of findings to contexts such as Peru. Third, one influential data point regarding the cost of miscommunication derives from industry survey research rather than peer-reviewed academic literature; while its scale and consistency with academic findings support its inclusion, it should be interpreted as corroborating rather than establishing the study's core theoretical claims [11].

Conclusions

This study has systematized the available evidence on the roles, competencies, organizational barriers, collaborative infrastructure, and emerging technological demands that shape the formation of efficient BIM teams, demonstrating that this is a multidimensional organizational phenomenon whose effectiveness depends on the simultaneous alignment of role clarity, competency development, information infrastructure, and organizational culture.

The first conclusion is that BIM role nomenclature remains a poor foundation for team design, given the coexistence of 35 distinct role titles across reviewed international guides, and that competency-based frameworks distinguishing core, domain, and execution competencies offer a more stable and transferable basis for structuring BIM teams across organizational contexts.

The second conclusion is that organizational adoption barriers—technical, financial, organizational, and human—interact rather than operate in isolation, with small and medium-sized construction enterprises facing a particularly acute version of this interaction, such that BIM team formation strategies must be tailored to firm size and organizational maturity rather than applied uniformly.

The third conclusion is that Common Data Environments, while indispensable to BIM team coordination, introduce governance challenges of their own, such that their effective use depends on the team's capacity to establish clear protocols for data validation, access, and responsibility from the outset of each project.

The fourth conclusion is that the accelerating integration of artificial intelligence and machine learning into BIM workflows is expanding the competency profile expected of BIM teams beyond traditional modeling skills into data literacy and AI-output interpretation, at a pace that appears to be outstripping the availability of structured training programs, particularly for construction site operatives.

Recommendations

For BIM Managers and Construction Company Leadership

- Structure BIM teams around documented competency tiers rather than inherited or informally defined role titles, using assessment frameworks that distinguish core, domain, and execution competencies.
- Secure explicit top-management sponsorship and formal information governance protocols before project mobilization, rather than allowing BIM team responsibilities to be defined ad hoc during execution.

For Software Providers and CDE Administrators

- Design Common Data Environment solutions with built-in governance features that reduce the risk of tool multiplicity and data accountability gaps documented in the reviewed literature.

For Policy Makers and Industry Associations

- Support small and medium-sized construction enterprises through targeted, non-isolated interventions that address financial, technical, and organizational barriers simultaneously, rather than through single-dimension incentive programs.

For Educational Institutions

- Incorporate applied, role-differentiated, and interactive pedagogical formats—including role-play and scenario-based learning—into BIM curricula for both design professionals and construction site operatives, following the evidence on the effectiveness of these formats over passive instructional models.

Future Research Lines

Longitudinal assessment of BIM team performance: develop field studies that track whether competency-based team structures produce measurable improvements in project coordination outcomes over multiple project cycles, rather than relying on cross-sectional or perception-based data.

Latin American contextual adaptation: replicate the present analysis with specific attention to the regulatory, educational, and market conditions of Latin American construction industries, given their marginal representation in the current indexed literature.

Comparative evaluation of CDE governance models: conduct comparative studies examining which specific CDE governance arrangements most effectively reduce the coordination challenges documented in the reviewed literature.

Organizational readiness for AI-BIM integration: investigate the specific organizational and training conditions that enable construction companies to translate AI-BIM research advances into practical team-level capability, rather than assuming technological availability alone drives adoption.

Team-level training effectiveness studies: extend the applied, role-based training models validated for construction site operatives to other BIM team roles, evaluating their comparative effectiveness against traditional software-centered instruction.

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