




# Leadership-Driven Pathways to BIM Maturity: Integrating Transformational Dimensions in Latin American AEC Digital Transformation-A Scoping Review



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## Supplementary Material A. Qualitative synthesis corpus (N = 14): studies contributing to the conceptual framework.

#	Author(s)	Year	Context	Method	Sample	Leadership Construct	BIM Maturity Stage	Specific Contribution to Framework
S1	Li <i>et al.</i> [36]	2024	China	SEM	N = 124 construction organizations	Transformational leadership-organizational unlearning- BIM implementation level	Stage 1	<b>Core empirical validation:</b> Demonstrates that TL contributes to BIM implementation primarily through organizational unlearning ( $\beta = 0.31, p < 0.01$ ). Leaders who stimulate questioning of established routines (intellectual stimulation) enable the abandonment of legacy practices necessary for Stage 1 transition. Confirms that TL's effect is mediated, not direct, and that leadership operates through organizational mechanisms.
S2	Vu and Hsieh [37]	2025	Taiwan / Vietnam	CB-SEM	N = 224 BIM projects	Contingent reward leadership-BIM coordination -project performance; BIM maturity as moderator	Stage 2	<b>Stage 2 boundary condition:</b> Contingent reward (transactional) leadership enhances BIM project performance through coordination effectiveness. BIM maturity in information management moderates this relationship; higher maturity strengthens coordination effects. Indicates that transactional mechanisms may complement TL at Stage 2.

#	Author(s)	Year	Context	Method	Sample	Leadership Construct	BIM Maturity Stage	Specific Contribution to Framework
S3	Vu and Hsieh [37]	2025	Taiwan / Vietnam	CB-SEM	N = 224 BIM projects	Inspirational motivation-BIM coordination-project performance; appointing party BIM commitment as moderator	Stage 1-2	<b>Dimension-specific empirical validation:</b> The inspirational motivation dimension of TL enables BIM project coordination and performance. Appointing party BIM commitment moderates effectiveness when top-level vision is absent; inspirational motivation at the project manager level cannot fully compensate. Supports idealized influence prescription at Stage 1.
S4	Han et al. [45]	2025	China	SEM	N = 261 project team members	TL- team reflexivity-project team resilience-project success	Stages 1-3	<b>Mediating mechanisms:</b> TL positively influences project success through two pathways: team reflexivity (collective self-assessment) and team resilience (recovery from setbacks). Reflexivity supports Stage 2 protocol experimentation, while resilience sustains Stage 3 innovation under ecosystem complexity.
S5	Olugboyege, O. [43]	2022	Nigeria / Global	Mixed methods (Grounded Theory + AI modeling)	Qualitative interviews + survey data	BIM leadership capacity: orientation, procedures, responsibilities, environment, and maturity	Stages 1-3	<b>BIM-specific leadership theory:</b> Develops BIM Leadership Theory, identifying five leadership capacities: BIM-friendly orientation, BIM-focused procedures, BIM responsibilities, BIM-enabled environment, and maturity. AI modeling validates that coordination of functions, individuals, and transition alignment is the primary leadership requirement.
S6	Omer et al. [1]	2022	Multi-country (AEC)	Systematic review + empirical survey	12 BIM-based construction projects	Constructive leadership (vision, support, stimulation) vs. destructive leadership (authoritarian, passive) in BIM contexts	Stages 1-2	<b>Behavioral repertoire mapping:</b> Identifies constructive behaviors (vision articulation, support, intellectual challenge) enabling BIM adoption and destructive behaviors (authoritarian control, passive avoidance) inhibiting maturity progression. Provides behavioral vocabulary for operationalizing TL dimensions in BIM settings.
S7	Siebelink et al. [31]	2021	Netherlands	Mixed methods (survey + case studies)	Multi-level organizational data across maturity tiers	BIM barriers differentiated by organizational level and maturity	Stages 1-3	<b>Stage-contingent barrier differentiation:</b> Barriers differ across maturity levels: individual resistance dominates Stage 1, process coordination at Stage 2, and inter-organizational complexity at Stage 3. Supports the argument that leadership emphasis must shift across stages due to differing challenges.
S8	Shojaei, et al. [39]	2023	UK	Qualitative exploratory (interviews)	4 large UK contractors	BIM adoption enablers: committed leadership as #1 factor	Stages 1-2	<b>Leadership operationalization:</b> "Committed leadership and management" was identified as the most critical enabler. Operationalized as strategic vision, resource allocation, advocacy, and trust-building. Maps to idealized influence (Stage 1) and inspirational motivation (Stage 2).
S9	Alankarage et al. [40]	2022	Australia	Qualitative case studies (Schein's model)	3 BIM-enabled contractor organizations	Organizational BIM culture at artifact, espoused values, and basic assumptions levels	Stages 2-3	<b>Cultural depth analysis:</b> BIM culture operates at artifact, espoused values, and basic assumptions levels. Leadership influences all levels, but basic assumptions are most resistant and critical for Stage 2-3 transition. Informs individualized consideration addressing deep cultural beliefs.

#	Author(s)	Year	Context	Method	Sample	Leadership Construct	BIM Maturity Stage	Specific Contribution to Framework
S10	Gao <i>et al.</i> [41]	2024	China	fsQCA + Survey	N = 312 construction professionals	Configuration pathways to active BIM use: leadership support × training × incentives × culture	Stages 2-3	<b>Configurational perspective:</b> Leadership support alone is insufficient; active BIM use requires combinations of leadership, training, incentives, and culture. Identifies multiple equifinal pathways, indicating leadership is necessary but must be contextualized within organizational systems.
S11	Olugboyege <i>et al.</i> [32]	2021	South Africa	Mixed methods (SEM + interviews)	N = 187 questionnaires; 15 interviews	Top management leadership commitment as strongest BIM success predictor	Stages 1-2	<b>Developing country evidence:</b> Leadership commitment is the strongest predictor of BIM success. Operationalized as resource allocation, advocacy, and strategic communication. High power-distance culture amplifies leader visibility effects.
S12	Diaz Schery <i>et al.</i> [33]	2024	Brazil / Global	Bibliometric + systematic review	576 records-qualitative synthesis	Leadership as a transversal critical factor for BIM-based digital transformation	Stages 1-3	<b>Field-level gap identification:</b> Leadership is a cross-cutting critical factor in BIM digital transformation. Human and organizational factors consistently outweigh technical considerations across all maturity stages.
S13	Brito <i>et al.</i> [4]	2021	Brazil	Framework + survey	Brazilian public organizations	BIM adoption CSFs: leadership commitment among the top 3 factors in the Brazilian context	Stage 1	<b>Latin American empirical evidence:</b> Leadership commitment ranks among the top CSFs. High power-distance culture amplifies the symbolic weight of leader commitment and increases BIM engagement when leaders visibly endorse BIM.
S14	Ozcan-Deniz, <i>et al.</i> [42]	2025	Turkey / Developing countries	Systematic review + public client perspective	Multi-country developing context	BIM adoption factors from public clients: leadership and institutional enablers in developing contexts	Stage 1	<b>Institutional leadership in developing economies:</b> Top management leadership, government policy support, and institutional incentives are primary enablers. In weak market-driven BIM contexts, institutional leadership becomes the decisive adoption trigger.

**Supplementary Material B. Summary of the systematic selection process following PRISMA guidelines.**

Stage	Action	Exclusion Criteria	Records Excluded	Records Remaining
Identification	Database search in Scopus	-	-	576
-	Application of temporal, typological, and language filters	Not within the period 2013-2025	69	-
-	-	Not an Article or Book	45	-
-	-	Not in English or Portuguese	9	-
-	Subtotal excluded	-	123	453
Screening	Title and abstract verification	Not related to leadership	-	-
-	-	Insufficient detail	-	-
-	-	Speculative content	-	-
-	Subtotal excluded	-	381	72
Eligibility	Full-text assessment for bibliometric analysis	Documents outside the central themes	58	14
Included	Studies included in the final review	-	-	14

Source: PRISMA guidelines (Page *et al.*, 2021).