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Capability And Maturity Assessment of Bim in Indian Aeco Industry

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Abstract:
Building Information Modeling (BIM) has emerged as a transformative digital methodology capable of reshaping the Architecture, Engineering, Construction, and Operations (AECO) industry through integrated data management, enhanced collaboration, and lifecycle-based decision-making. While several developed countries have institutionalized BIM through regulatory mandates and standardized maturity frameworks, the Indian AECO industry continues to exhibit uneven adoption characterized by fragmented capabilities and varying maturity levels. This study presents a comprehensive capability and maturity assessment of BIM implementation in the Indian AECO sector by synthesizing recent scholarly literature, industry reports, and professional practices published up to 2024. The paper critically evaluates technological readiness, organizational competencies, process integration, policy frameworks, and human capital dimensions influencing BIM adoption. A conceptual BIM capability–maturity assessment model is developed and contextualized for India, highlighting gaps between current practices and global benchmarks. The findings indicate that although BIM adoption in India is progressing from visualization-centric use toward collaborative and data-driven practices, significant challenges persist in interoperability, standardization, contractual frameworks, and skill development. The study contributes to the existing body of knowledge by offering a structured assessment approach and policy-oriented recommendations aimed at accelerating BIM maturity across public and private AECO projects in India.

Keywords: Building Information Modeling, BIM Maturity, BIM Capability, Indian AECO Industry, Digital Construction, Industry 4.0, Construction Informatics

1. Introduction

The global AECO industry is undergoing a paradigm shift driven by digital transformation, automation, and data-centric project delivery systems. Among these, Building Information

Modeling (BIM) has gained recognition as a core enabler of productivity enhancement, risk mitigation, sustainability integration, and lifecycle asset management. BIM transcends conventional computer-aided design by enabling multidimensional modeling (3D, 4D, 5D, and beyond), collaborative workflows, and real-time data exchange among stakeholders. In countries such as the United Kingdom, Singapore, Finland, and Australia, BIM adoption has been reinforced through national mandates, standardized maturity models, and institutional capacity-building programs, as reported by recent studies (Zhang et al., 2024; Liu & Issa, 2024).

In contrast, the Indian AECO industry—despite its rapid growth, large infrastructure investments, and ambitious initiatives such as Smart Cities Mission and Gati Shakti—continues to face challenges in achieving consistent and mature BIM implementation. Existing research highlights that BIM use in India remains largely project-specific, visualization-oriented, and dependent on individual organizational initiatives rather than systemic integration (Patil & Laishram, 2024; Arunkumar et al., 2024). This disparity underscores the need for a structured assessment of BIM capability and maturity tailored to the Indian context.

This paper aims to address this gap by systematically examining BIM capability and maturity levels within the Indian AECO industry. By integrating contemporary literature (2020–2024) and aligning global BIM maturity frameworks with local industry realities, the study seeks to offer an evidence-based assessment that can inform policymakers, practitioners, and researchers.

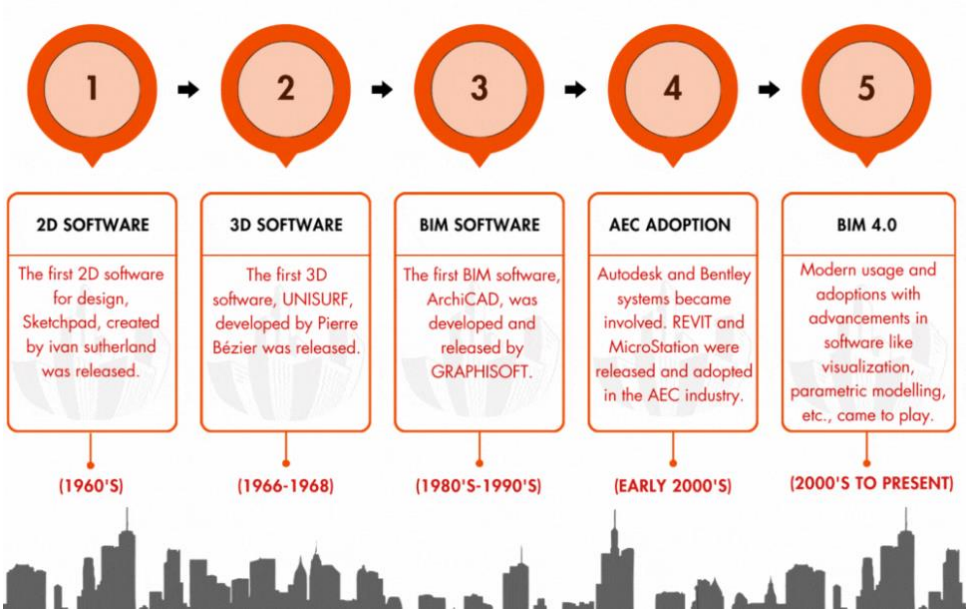

Figure 1. Evolution of Building Information Modeling (BIM) Adoption in the Indian AECO Industry

2. Conceptual Framework of BIM Capability and Maturity

BIM capability and maturity, though often used interchangeably, represent distinct yet interrelated constructs. BIM capability refers to an organization's or industry's capacity to deploy BIM tools, processes, and skills effectively, encompassing technological infrastructure, human resources, and organizational readiness. BIM maturity, on the other hand, reflects the

extent to which BIM practices are standardized, integrated, optimized, and institutionalized over time (Succar, 2009; updated interpretations by Hosseini et al., 2024).

Recent literature emphasizes that BIM maturity evolves through progressive stages, typically beginning with basic 3D modeling and advancing toward collaborative, integrated, and data-driven ecosystems aligned with digital twins and smart asset management (Sacks et al., 2024). In the Indian context, studies indicate a predominance of early-stage maturity characterized by isolated model use and limited cross-disciplinary integration (Bansal et al., 2024).

A contextualized framework for India must therefore integrate global maturity dimensions—technology, process, policy, and people—while accounting for local constraints such as fragmented supply chains, informal contracting practices, and skill shortages. Table 1 summarizes the conceptual dimensions used in this study to assess BIM capability and maturity within the Indian AECO sector.

Table 1. Conceptual Dimensions for BIM Capability and Maturity Assessment

Dimension	Description
Technological Capability	Availability and effective use of BIM software, hardware, interoperability tools, and data environments
Organizational Capability	Management support, BIM leadership roles, investment capacity, and change readiness
Process Maturity	Level of BIM integration across project stages, disciplines, and workflows
Human Capital	Skill levels, training mechanisms, academic–industry alignment
Policy and Standards	Presence of guidelines, mandates, contractual frameworks, and data standards

3. Current State of BIM Adoption in the Indian AECO Industry

The Indian AECO industry has witnessed a gradual increase in BIM awareness and adoption over the past decade, driven primarily by multinational firms, large infrastructure projects, and private real estate developers. Recent surveys conducted between 2022 and 2024 indicate that BIM usage in India is concentrated in architectural visualization, clash detection, and quantity take-offs, with limited penetration into 4D scheduling, 5D cost integration, and facilities management (Kumar & Jha, 2024; Nair et al., 2024).

Public sector adoption remains sporadic, despite policy-level acknowledgment of digital construction benefits. Studies note that while agencies such as metro rail corporations and highway authorities have initiated BIM pilots, the absence of enforceable national BIM mandates hampers consistent implementation (Sharma & Kansal, 2024). Furthermore, small and medium enterprises (SMEs), which constitute a significant portion of India's construction ecosystem, face barriers related to cost, skill availability, and uncertain return on investment (Chaudhuri et al., 2024).

From a capability perspective, technological access has improved due to cloud-based BIM platforms and subscription-based software models. However, interoperability challenges persist due to inconsistent data standards and limited use of open BIM protocols, as highlighted

by Singh et al. (2024). Organizationally, BIM adoption often depends on individual champions rather than institutionalized strategies, resulting in uneven maturity across projects and firms.

4. BIM Capability–Maturity Assessment of the Indian AECO Industry

An assessment of BIM capability and maturity in India reveals a transitional landscape marked by partial integration and emerging best practices. Based on synthesized evidence from recent empirical and review studies (2020–2024), the Indian AECO industry largely occupies an intermediate maturity zone, oscillating between model-based collaboration and fragmented workflows.

Technological capability has advanced significantly, with widespread access to 3D modeling tools and basic collaboration platforms. However, advanced capabilities such as common data environments (CDEs), digital twins, and AI-enabled analytics remain limited to large organizations and select infrastructure projects (Rao et al., 2024). Process maturity is constrained by traditional procurement methods that discourage early stakeholder collaboration, thereby limiting BIM's integrative potential.

Human capital emerges as a critical bottleneck. While BIM-related academic programs and professional certifications have expanded, multiple studies report a mismatch between industry expectations and graduate skill sets (Mehta & Patel, 2024). Continuous professional development remains inconsistent, particularly among contractors and site engineers.

Table 2 presents a synthesized assessment of BIM maturity levels across key dimensions in the Indian AECO industry, derived from recent literature and industry surveys.

Table 2. Indicative BIM Maturity Levels in the Indian AECO Industry

Dimension	Predominant Maturity Level	Key Observations
Technology	Medium	Strong 3D use; limited advanced analytics
Process	Low–Medium	Fragmented workflows; weak lifecycle integration
Organization	Medium	Leadership-driven rather than system-driven
Human Capital	Low–Medium	Skill gaps; uneven training coverage
Policy & Standards	Low	Absence of national BIM mandate

5. Challenges and Drivers Influencing BIM Maturity in India

The progression of BIM maturity in India is shaped by a complex interplay of drivers and barriers. On the positive side, rapid urbanization, infrastructure investment, and global client expectations act as strong drivers for BIM adoption (World Bank-aligned studies cited by Gupta et al., 2024). Additionally, Industry 4.0 convergence, including IoT, cloud computing, and data analytics, is creating new opportunities for BIM-enabled project delivery.

Conversely, challenges remain substantial. Contractual and legal uncertainties regarding model ownership, liability, and data security discourage collaborative BIM practices (Iyer &

Choudhury, 2024). Resistance to change, particularly among experienced professionals accustomed to traditional methods, further slows maturity progression. Financial constraints, especially for SMEs, limit investment in software, training, and process reengineering.

Policy fragmentation represents another major impediment. Unlike countries with centralized BIM roadmaps, India lacks a unified national BIM strategy, resulting in inconsistent guidelines and limited institutional support (Joshi et al., 2024). The literature consistently emphasizes that without coordinated policy intervention, BIM maturity gains are likely to remain incremental rather than transformative.

6. Conclusions and Recommendations

This study has presented a comprehensive assessment of BIM capability and maturity within the Indian AECO industry by synthesizing contemporary research and aligning global maturity frameworks with local realities. The findings indicate that while BIM adoption in India has moved beyond experimental stages, the industry remains constrained by partial integration, skill gaps, and policy limitations. Technological capability has progressed faster than organizational and process maturity, resulting in underutilization of BIM's full lifecycle potential.

To accelerate BIM maturity, the study recommends the formulation of a national BIM roadmap tailored to India's diverse construction ecosystem. Such a roadmap should integrate standardized guidelines, capacity-building programs, and phased mandates for public projects. Industry–academia collaboration must be strengthened to align skill development with evolving BIM competencies. Furthermore, procurement reforms promoting collaborative project delivery methods can enhance process maturity and value realization.

In conclusion, BIM represents a strategic lever for improving productivity, sustainability, and transparency in the Indian AECO industry. A coordinated approach addressing capability development and maturity progression is essential for harnessing BIM's transformative potential and positioning India within the global digital construction landscape.

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