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A Conceptual Framework for Organisational Readiness in Building Information Modelling (BIM) Adoption

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ABSTRACT

Building Information Modelling (BIM) has emerged as a transformative digital technology within the construction industry. It supports integrated approaches to design, construction and facilities management within a unified digital environment. BIM has been widely recognised for improving project efficiency, strengthening collaboration and enhancing sustainability outcomes. However, its adoption remains uneven across organisations, particularly in developing economies where variations in organisational readiness, technological capability and human competency continue to impede effective implementation. These challenges underscore the importance of understanding the multidimensional factors that shape organisational preparedness for BIM. This study proposes a conceptual framework for assessing organisational readiness for BIM adoption by integrating four key dimensions: technological readiness, organisational capability and leadership, human competency and digital culture, and the external and regulatory environment. Drawing on the Technology Organization Environment (TOE) framework, the Diffusion of Innovation (DOI) theory and established organisational readiness constructs; the framework offers a structured, theory driven foundation for examining how internal and external conditions interact to influence BIM implementation outcomes. The proposed framework positions BIM adoption as a dynamic and interconnected organisational process that extends beyond technology acquisition. It emphasises the critical roles of leadership commitment, strategic alignment, workforce capability and compliance with regulatory and industry expectations. By offering a holistic perspective on readiness, the framework is intended to serve as an analytical foundation for practitioners, policymakers and researchers, subject to future empirical validation. Ultimately, the framework contributes to ongoing efforts to advance digital transformation and collaborative innovation within the broader agenda of Construction 4.0.

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1. Introduction

The construction industry is undergoing a rapid digital transformation driven by increasing demands for enhanced productivity, cost reduction and improved collaboration among project stakeholders [1]. Traditional project delivery methods often suffer from fragmentation, information silos and coordination inefficiencies which contribute to delays, cost overruns and rework. In response to these longstanding challenges, Building Information Modelling (BIM) has emerged as a core enabling technology that supports the transition toward more integrated, data-driven and collaborative project environments. BIM facilitates the digital representation of physical and functional characteristics of buildings, enabling seamless integration of design, construction and facilities management processes within a unified digital ecosystem [2]. Through this capability, BIM adoption has been linked to improvements in project coordination, design accuracy, sustainability performance and communication efficiency, demonstrating measurable benefits across multiple stages of the project lifecycle [3].

Despite the well documented advantages of BIM, its adoption remains inconsistent across organisations, particularly within developing countries where digital advancement is uneven and organisational capabilities vary widely. Numerous challenges persist, including limited technical infrastructure, high initial investment costs, insufficient interoperability and the lack of trained or experienced personnel capable of managing BIM processes and workflows [4]. Furthermore, organisational readiness referring to the internal ability and willingness of a firm to implement technological innovations has increasingly been identified as a critical determinant of BIM success. Elements such as leadership commitment, strategic alignment of digital objectives, effective resource allocation and the cultivation of a supportive digital culture significantly influence the uptake and long-term utilisation of BIM within organisations [5]. In addition to these internal considerations, external factors such as government regulations, national BIM mandates, industry standards and competitive market pressures further shape the pace, direction and extent of BIM adoption [6]. These external drivers can accelerate digital transformation, but they may also create compliance burdens for organisations lacking adequate digital maturity.

Although prior research has extensively explored the barriers, benefits and drivers associated with BIM adoption, existing studies often analyse these elements in isolation. There remains a noticeable absence of a comprehensive, theory driven framework that integrates technological, organisational, human and external dimensions into a unified perspective of organisational readiness [7]. This gap is significant because organisations that initiate BIM adoption without appropriate structural, cultural and competency related adjustments frequently encounter implementation failures, reduced effectiveness or underutilisation of BIM functionalities. Such shortcomings may result in project inefficiencies, misalignment of expectations or even abandonment of BIM initiatives entirely [8]. Therefore, there is a pressing need for a holistic framework that not only synthesises insights from existing literature but also provides conceptual clarity regarding the interdependent factors influencing BIM readiness in construction organisations.

In response to this gap, the present study proposes a conceptual framework that integrates key insights from the Technology Organization Environment (TOE) framework, Diffusion of Innovation (DOI) theory and established organisational readiness constructs. Together, these theoretical lenses offer a multidimensional understanding of BIM adoption by capturing the technological capabilities, organisational structures, human competencies and contextual factors that influence readiness levels [9]. By developing this integrative framework, the study aims to provide a structured foundation for guiding organisations, policymakers and researchers in evaluating and strengthening readiness for BIM implementation, ultimately contributing to more effective digital transformation

within the construction industry. Unlike existing BIM readiness models that primarily categorise factors into static dimensions, this framework advances current knowledge by conceptualising BIM readiness as a dynamic and interdependent organisational system, explicitly highlighting reciprocal relationships between leadership, digital culture, technological capability and regulatory pressure. While prior models often assess readiness as a checklist of conditions, the proposed framework reconceptualises readiness as an iterative transformation process, particularly relevant for organisations in developing construction economies.

2. Methodology

This study adopts a conceptual research design to develop a theoretically grounded and multidimensional framework for organisational readiness in Building Information Modelling (BIM) adoption. Established scholarly knowledge was synthesised through three sequential components: literature collection and selection, thematic analysis and conceptual framework construction, applied systematically to ensure academic rigour and conceptual coherence.

The literature review involved the identification, screening and appraisal of relevant BIM studies, followed by a structured thematic analysis to identify recurring factors and readiness dimensions. These dimensions were subsequently integrated with established theoretical models to construct a comprehensive conceptual framework reflecting the multifaceted nature of BIM adoption.

The overall methodological flow of the study is illustrated in Figure 1, which outlines the progression from literature synthesis to framework development.

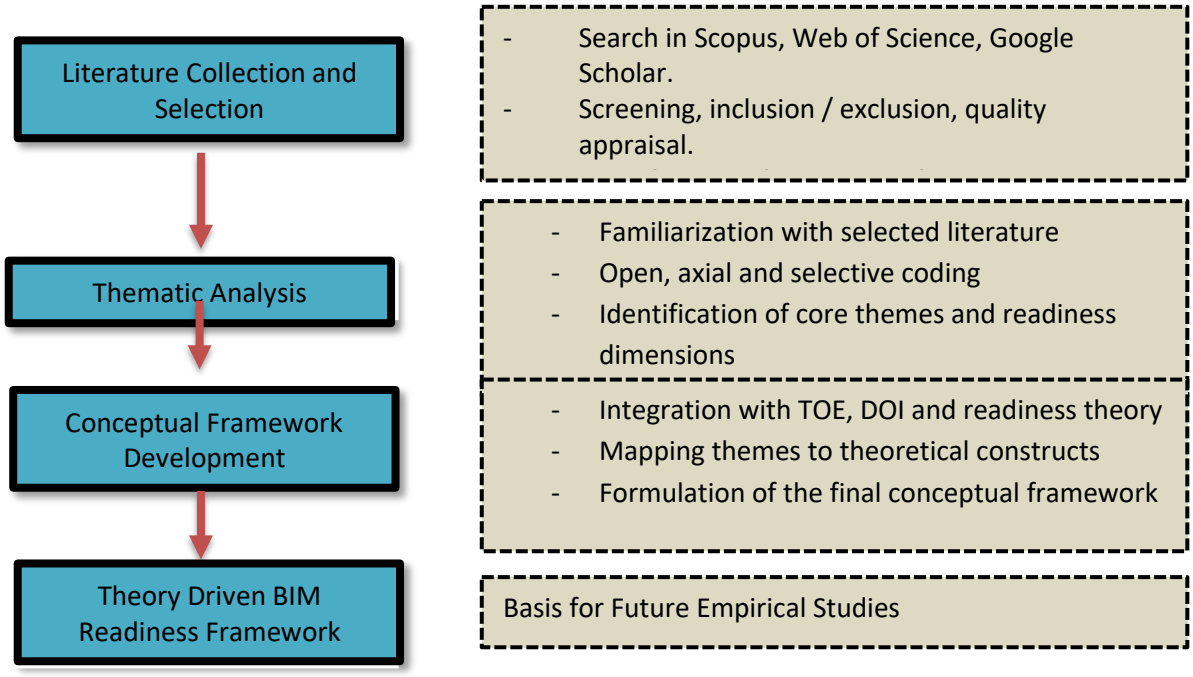

Fig. 1. Conceptual research design for development of organisational readiness framework for Building Information Modelling (BIM)

This framework was developed through a theory driven thematic synthesis, combining a structured literature review with systematic qualitative coding and theoretical mapping. Although

expert consultation was not conducted at this stage, the proposed framework is positioned as a conceptual diagnostic tool, rather than a validated assessment instrument at this stage.

2.1 Literature Collection and Selection

The process of collecting and selecting literature was undertaken using a systematic and narrative review approach to ensure that all materials analysed were contemporary, methodologically sound and directly relevant to the study's objectives. Three major academic databases were used, namely Scopus, Web of Science and Google Scholar, as these platforms offer extensive indexing of peer-reviewed studies in construction management, digital technologies and organisational transformation.

A structured search strategy was developed using refined combinations of keywords such as "BIM adoption", "BIM implementation barriers", "organisational readiness", "BIM Malaysia", "digital construction" and "Construction 4.0". These keywords were enhanced using iterative clustering together with backward and forward reference tracing to ensure wide coverage and the inclusion of high-quality studies that examined BIM adoption factors in both developed and developing construction markets.

The initial search identified a corpus of 48 articles. Titles and abstracts were screened using predefined inclusion criteria, namely publication years between 2023 and 2025, availability of full text, clarity of methodological design and relevance to technological, organisational, human or environmental factors influencing BIM adoption. Editorial commentaries, non-empirical papers and studies lacking methodological transparency were excluded.

A second round of appraisal assessed the methodological rigour and conceptual relevance of the remaining studies. This appraisal considered clarity of research objectives, quality of theoretical grounding, methodological coherence and relevance to BIM implementation within developing construction industries. Through this systematic assessment, 28 articles were shortlisted. From these, 12 key studies were selected for in depth thematic analysis due to their strong theoretical contributions and relevance to readiness constructs.

2.2 Thematic Analysis

A thematic analysis was conducted to synthesise findings from the selected literature. The analysis followed established qualitative coding procedures adapted for conceptual integration. The process began with repeated readings of the 12 selected studies to familiarise the researcher with the content and to extract initial insights on challenges, drivers, competencies, organisational preparedness, technological barriers and regulatory issues related to BIM adoption.

During the open coding stage, meaning units from the text were coded line by line. This resulted in more than sixty initial codes that captured factors such as technological infrastructure, software interoperability, leadership commitment, resource allocation, workforce capability, digital culture and regulatory pressures [14]. These codes represented diverse insights from consulting firms, SMEs, large contractors, facility management organisations and government-linked agencies.

The initial codes were then refined through axial coding, during which conceptually related codes were grouped into broader thematic categories. This process produced several major clusters, including technological infrastructure and support, organisational strategy and leadership, human capital and digital competence, and external drivers and regulatory requirements [15].

Selective coding was subsequently used to integrate these clusters into four overarching readiness dimensions, namely technological readiness, organisational capability and leadership,

human competency and digital culture, and the external and regulatory environment [16]. These dimensions were compared across different organisational contexts, including companies in Malaysia, ASEAN member states and global case studies, to ensure conceptual robustness and generalisability.

2.3 Conceptual Framework Development

The final stage involved constructing a conceptual framework that integrates the thematic findings with established theoretical models. Three theoretical foundations guided this integration, namely the Technology Organisation Environment (TOE) framework, Diffusion of Innovation (DOI) theory and organisational readiness theory. These theories were selected because they collectively explain technological adoption from structural, behavioural and capability-based perspectives.

The thematic dimensions were mapped onto relevant components of these theories to ensure conceptual alignment. For example, technological readiness corresponds to the technology context within the TOE framework, organisational capability and leadership align with the organisational context, human competency intersects with DOI's attributes of innovation adoption as well as organisational readiness constructs, and the external environment dimension reflects the environmental context emphasised in the TOE model [17].

The emerging conceptual model was structured to depict BIM readiness as a dynamic and interdependent system. Interrelationships among dimensions were identified through theory-literature triangulation. These interrelationships include the influence of leadership commitment on cultivating a digital culture, the impact of technological adequacy on fostering user confidence and the role of regulatory pressures in accelerating organisational transformation.

Conceptual validation was carried out by comparing the proposed model with existing BIM readiness frameworks, international standards and empirical findings from related studies. This validation confirmed the coherence, applicability and theoretical relevance of the model across diverse construction contexts, particularly in developing economies undergoing digital transformation [18].

3. Results

The thematic analysis undertaken in this study led to the development of a comprehensive conceptual framework for organisational readiness in BIM adoption. The analysis revealed four principal and interrelated dimensions that collectively shape an organisation's ability to initiate, manage and sustain BIM implementation. These dimensions reflect the technological infrastructure, organisational structures, human capabilities and external conditions that influence readiness across diverse construction environments.

The first dimension, technological readiness concerns the extent to which an organisation possesses the technical infrastructure required to support BIM utilisation. This includes the adequacy and reliability of hardware, software and network systems, together with the level of software interoperability and system integration necessary for effective information exchange. Seamless technological integration is vital for enabling efficient collaboration, minimising data fragmentation and ensuring the stability of model-based workflows throughout the project lifecycle [19].

The second dimension organisational capability and leadership, encompasses the strategic and structural capacity of an organisation to guide and support BIM implementation. Central to this dimension is strong top management commitment, which is instrumental in establishing priorities, allocating resources and aligning BIM initiatives with broader organisational objectives. Effective

leadership contributes to a supportive organisational culture, encourages the adoption of digital practices and ensures that change management processes are systematically executed. These efforts collectively reduce resistance, enhance coordination and reinforce overall organisational readiness for BIM [20].

The third dimension human competency and digital culture, relates to the skills, knowledge and attitudes of employees in engaging with BIM technologies and workflows. Successful adoption requires a digitally competent workforce that is equipped with relevant technical capabilities and adaptable to technological change. Structured training programmes, continuous professional development and active knowledge-sharing practices are essential for fostering a positive digital mindset. These initiatives promote innovation, strengthen problem-solving abilities and cultivate collaborative behaviours that maximise the value of BIM across project stages [21].

The fourth dimension, external drivers and regulatory expectations, captures the broader environmental influences that shape organisational decision-making in relation to BIM adoption. These include industry standards, government policies, regulatory requirements and competitive market pressures. Adherence to regulatory frameworks, alignment with industry benchmarks and responsiveness to market demands act as significant enablers that encourage organisations to enhance internal readiness and accelerate BIM uptake [22].

Collectively, these four dimensions form an integrated system that positions BIM readiness as a dynamic, interdependent and iterative organisational process. Progress in one dimension has reinforcing effects on others, resulting in cumulative improvements in adoption outcomes. The interrelationships among these dimensions are illustrated in Figure 2, which depicts how technological capability, organisational leadership, human readiness and external pressures converge to influence the overall success of BIM implementation. Figure 1 therefore provides a visual representation of the multidimensional and interconnected nature of the proposed framework.

By synthesising technological, organisational, human and environmental considerations, the proposed framework offers a holistic and practical lens through which practitioners can assess readiness levels, identify capability gaps and design targeted intervention strategies that strengthen BIM implementation. It enables construction firms to evaluate the maturity of their digital infrastructure, the adequacy of leadership support and resource allocation, the preparedness of their workforce and the influence of external policies or industry pressures on adoption decisions. Such comprehensive insights allow organisations to prioritise capacity-building efforts, develop phased digital transformation plans and align BIM initiatives with wider organisational objectives and regulatory expectations.

Furthermore, the framework provides researchers with a structured conceptual foundation for examining the multidimensional interplay among readiness factors and for evaluating BIM adoption outcomes across different organisational, industrial and national contexts. It supports comparative studies across sectors, facilitates theory building in digital construction research and enables scholars to test causal relationships, mediating effects and readiness performance linkages through empirical inquiry. In doing so, the framework contributes to a deeper understanding of how technology, organisational dynamics, human competencies and external environments collectively shape digital innovation pathways in the construction industry.

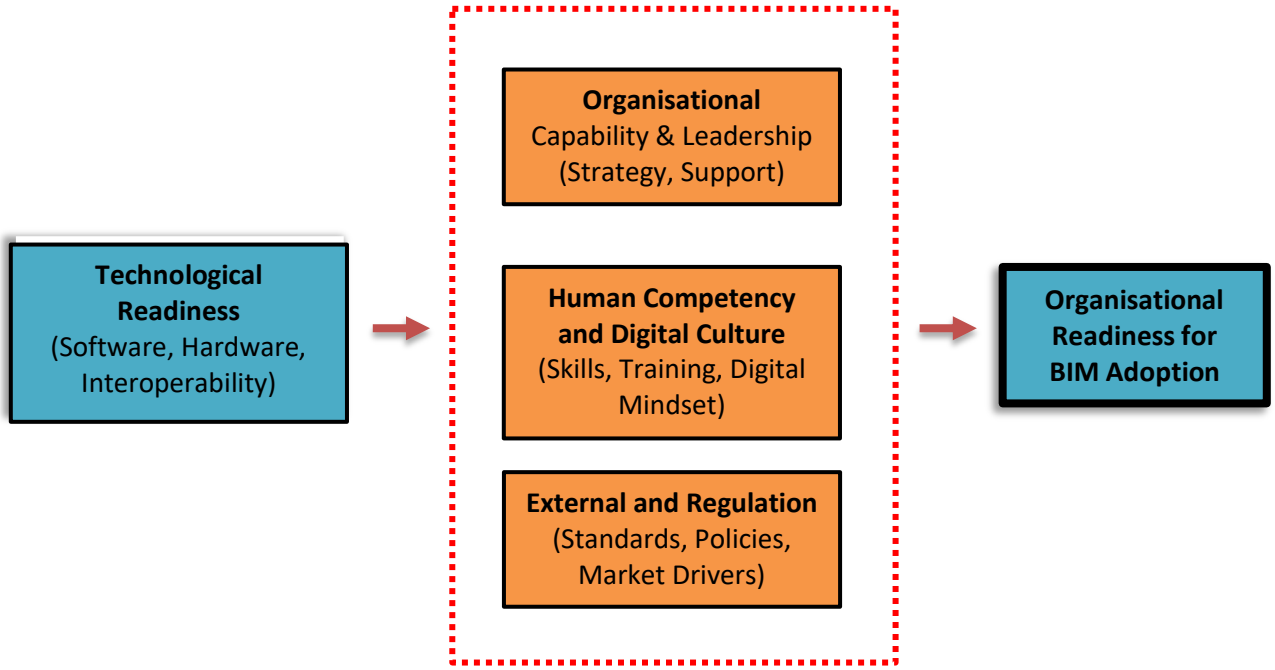

Fig. 2. Conceptual framework for organisational readiness in BIM adoption

4. Conclusion

This study proposes a conceptual framework for organisational readiness in BIM adoption by integrating technological, organisational, human and external dimensions into a coherent and theory-driven model. The findings emphasise that successful BIM implementation extends beyond the provision of technological infrastructure. It requires strong and committed leadership, a strategically aligned organisational structure, a digitally competent workforce and a culture that actively supports innovation. Additionally, alignment with external drivers, including regulatory mandates, industry standards and market expectations, plays a significant role in shaping an organisation's readiness trajectory.

The framework developed in this study serves as a robust analytical tool for assessing organisational preparedness, identifying capability gaps and formulating targeted interventions to strengthen BIM adoption efforts. Its multidimensional perspective offers practical value to construction practitioners seeking to enhance digital maturity, as well as policymakers aiming to design supportive regulatory environments. Nevertheless, the practical implementation of the framework may be constrained by organisational resistance to change, high upfront investment costs, fragmented data environments and limited interoperability between BIM platforms. These challenges should therefore be considered as moderating conditions when applying the framework in practice, particularly within organisations at an early stage of digital maturity in developing construction economies.

Future research may operationalise the framework by examining measurable indicators such as leadership digital orientation, BIM training intensity, software interoperability maturity and regulatory compliance pressure, using survey based structural equation modelling or multiple case study validation. Such validation would enable deeper insights into contextual variations and readiness patterns. Further studies may also explore inter-organisational collaboration, supply chain integration and the broader impact of BIM adoption on project performance, sustainability outcomes

and Construction 4.0 transformation. Overall, this conceptual framework contributes meaningfully to ongoing scholarly discussions on digital transformation in the construction industry. It offers actionable guidance for enhancing organisational readiness and supports the advancement of BIM as a strategic enabler of innovation, efficiency and collaborative practice

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