Organizational readiness for building information modeling

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Abstract

Purpose – The main factor that leads organizations to implement Building Information Modeling (BIM) is customer demand. While this is a frequent topic in the BIM literature, few studies address BIM organizational readiness. Due to this gap in BIM implementation literature, this paper aims to understand what affects organizational BIM readiness and how the BIM readiness process occurs.

Design/methodology/approach – The present paper adopts design science research as a methodological approach. A literature review examined 69 journal articles. The analysis focused on multiple theories, such as organizational readiness for change, adoption and diffusion of innovations and project management.

Findings – By investigating BIM organizational readiness, this study presents a construct and a conceptual model for driving BIM readiness.

Originality/value – This study can benefit researchers and organizations. The results presented may drive further research and discussions on the topic. But it is important to state that these results must be tested on real situations.

Keywords Building information modeling, BIM implementations, BIM readiness, Readiness for change, Innovations implementation, Organizational readiness

Paper type Research paper

1. Introduction

According to Ahuja *et al.* (2020), customer demand is the main driver of building information modeling (BIM) implementation. However, the organization must understand BIM as a systemic innovation enabled by information technology (IT). BIM digitally represents all information from construction projects, transforming processes involved in construction projects. Transformations brought about by BIM cause evolutionary and revolutionary changes in organizations (Gu and London, 2010; Murguia *et al.*, 2021).

When deciding to implement BIM, organizations need to initiate the shift toward The Point of Adoption BIM. Throughout this process, they lead preparation for adoption of BIM tools, workflows and protocols (Succar and Kassen, 2016). Proper planning of this change is essential for a successful BIM implementation. Poorly conducted change processes result in a low level of organizational readiness, which can lead to failure in the implementation process (Lokuge *et al.*, 2019), BIM abandonment (Lee and Yu, 2017) or project failures in terms of intended benefits (Abbasianjahromi *et al.*, 2019).

Despite the importance of BIM organizational readiness (BIM readiness), this topic is rarely discussed in the literature. Studies dedicated to BIM readiness present readiness models focused on specific types of organizations. Furthermore, few of them consider theories

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and models for implementing innovations and readiness for change. This paper aims to understand what affects BIM readiness and how it occurs. Thus, we seek to broaden discussion on BIM readiness by developing a conceptual model. The conceptual model is based on a literature review and adaptable to any organization regardless of type or size.

This article uses three theories to achieve the proposed objective: (1) organizational readiness for change, (2) process of implementing innovations and (3) project management. As well as Damschroder *et al.* (2009), we use the term theory as a collective reference for models, theories and structures. The BIM definition adopted justifies the choice of the first two theories. The tradition of implementing innovations employing project management techniques used in industry (Murphy, 2014) justifies the third theory.

The article is structured in four sections. The introduction addresses the topic, objectives, and relevance of the article, as well as providing a brief theoretical review and synthesis of studies dedicated to BIM readiness. Then, research methodology, presents, justifies and describes the adopted methodology (Design Science Research – DSR). The Findings section presents the construct and conceptual model developed for BIM readiness. Finally, are presented the study's limitations, theoretical and practical implications and suggestions for further research.

1.1 Organizational readiness for change

The organizational readiness for changes is essential to facilitate that changes implementation can occur successfully and meet intended objectives. Readiness involves all organization managerial levels, implying multiple and simultaneous transformations in the team, workflow, decision making and reward systems (Weiner, 2009).

Readiness encompasses factors that may be necessary, but not always enough, for change to occur or succeed about anticipated outcomes (Lehman *et al.*, 2002; Weiner, 2009). The demand for tasks (what is necessary for implementation?), the availability of resources (are there the necessary resources?) and situational factors (does the current state of the organization allow the change implementation?) are the main determinants for achieving change implementation capacity (Weiner, 2009).

1.2 Adoption and diffusion of innovations

Hammed *et al.* (2012) proposed a conceptual model for adopting innovation in IT. They consider that innovation is something new that causes changes and can be a product, a process or a practice. Its adoption is a process that results in the full use of innovation. Hammed *et al.* (2012) investigated several studies and theories, such as diffusion of innovation theory, technology acceptance model, technology organization and environment model and unified theory of acceptance and use of technology model. They divide studies on innovation implementation into three aspects: individual, group and organizations. According to authors, characteristics of innovation, organization, environment, manager and user influence IT innovation implementation. Furthermore implementation of IT innovation is a three-step process, namely, (Hammed *et al.*, 2012):

(1) Initiation: The organization recognizes the need to implement innovation, acquires knowledge or awareness about innovation, and takes action on whether or not to adopt innovation;

(2) Adoption-decision: The organization evaluates innovation from technical, financial and strategic perspectives, allocating the necessary resources for procurement of innovation;

(3) Implementation: The organization acquires innovation, prepares the organization for its use and confirms the innovation and user acceptance, ending the process in the actual and continuous use of innovation within the organization.

1.3 Project management

We adopt Project Management Institute (PMI) standards and guidelines as project management theory. According PMI, a project is a temporary effort undertaken to create a unique product, service or result. A project can generate change in organizations, involving or not a transition state. Projects have a life cycle divided into four phases: (1) project initiation, (2) organization and preparation, (3) execution and (4) project completion. Project management involves five groups of processes: (1) initiation, (2) planning, (3) execution, (4) monitoring and control and (5) closure. Project management also involves 10 areas of knowledge: (1) integration management, (2) scope management, (3) schedule management, (4) cost management, (5) quality management, (6) resource management, (7) communications management, (8) risk management, (9) procurement management and (10) stakeholder management (PMI, 2017).

1.4 BIM implementation

BIM implementation can be defined as the "set of activities carried out by an organizational unit to prepare, implement or improve its BIM deliverables (products) and their related workflows (processes)" (Succar and Kassem, 2015, p. 04). Succar and Kassem (2015) consider that BIM adoption is complex, occurring in three stages: (1) readiness (the pre-implementation status), (2) capability (object-based modeling, model-based collaboration and network-based integration) and (3) maturity (ad-hoc or low maturity, defined or medium-low maturity, managed or medium maturity, integrated or medium-high maturity and optimized or high maturity).

Other authors have also proposed BIM adoption models. For example, Ahmed and Kassem's (2018) model is based on the Diffusion of Innovation Theory, the Institutional Theory and the Point of Adoption model. They propose a model composed of five stages:

(1) Awareness stage, the organization is exposed to innovation, starting to gain knowledge about it.

(2) Intention to adopt stage, the organization develops a favorable attitude, or not, about innovation.

(3) The Point of Adoption stage signals the beginning of an intentional set of experimental activities (pilot project) to implement BIM.

(4) Implementation stage, the organization starts using BIM, or one of its specific stages, in real-life (nonexperimental) activities.

(5) Confirmation stage, the organization extends BIM disclosure or one of its specific capability stages.

In turn, Almuntaser *et al.* (2018) adopt project management standards and guidelines to propose a BIM implementation model divided into three phases: (1) the pre-BIM implementation phase, referring to preparation for implementation, (2) the BIM implementation phase, which begins with pilot project selection managed according to PMI structure and (3) post-BIM implementation phase evaluates the implementation and BIM maturity. In the last phase, improvements are proposed and implemented. In common, all models recognize the need for the preparation stage for BIM implementation and establish the pilot project as a starting point for BIM implementation itself. The present study interprets the Point of Adoption as the end of the BIM readiness stage.

1.5 BIM readiness

BIM readiness is "the situation before BIM implementation that represents the propensity of an organization or organizational unit to adopt BIM tools, workflows, and protocols" (Succar and Kassem, 2016, p. 03). Or as "the psychological will or state of readiness to carry out BIM

implementation activities" (Liao *et al.*, 2020, p. 701). Authors such as Gu and London (2010), Hanafi *et al.* (2016), Succar and Kassem (2016), Juan *et al.* (2016), Lee and Yu (2017), Abbasianjahromi *et al.* (2019), Abbasnejad *et al.* (2021) and Liao *et al.* (2020) and others studied BIM readiness. Table 1 – summary of BIM readiness studies presents a summary of these studies.

2. Research methodology

The research development followed the first stage of DSR (Figure 1 – DSR Steps) which is the construction of the artifact (Voordijk and Adriaanse, 2016). DSR was adopted because it is a design-oriented approach to artifacts that offers solutions to real problems (Lacerda *et al.*, 2013). Therefore, it is an approach that adheres to the research objective. For a better understanding of the DSR consult the references.

2.1 Problem identification

Conducting a preliminary literature review identified the research problem. This review found that few studies addressed readiness and maturity of organizations for BIM implementation. Assuming that BIM is an IT-based innovation that causes changes in organizations, two research questions arise: RQ1) what affects organizational readiness to implement innovations and changes? RQ2) How to achieve BIM readiness?

2.2 Systematic literature review

The next stage of the DSR led to two Literature Reviews (LR). The first LR (LR-1) followed the strategy presented in Table 2 – strategies for conducting LR-1.

Subsequently, LR-2 sought studies that investigated BIM implementation (Table 3 – strategies for conducting LR-2).

2.3 Artifacts identification and classes of problems configuration

The search problem can be configured as an implementation problem. The LR-1 results contributed to the identification of evaluated artifacts referring to this class of problems.

The CiteSpace bibliometric analysis software analyzed the results of the LR-1, allowing the full reading of the most cited articles to compose the theoretical framework. RL-1 identified and selected the Consolidated Framework for Implementation Research (CFIR) (Damschroder *et al.*, 2009) to assess factors that impact the implementation of changes. CFIR is the result of a comprehensive literature review and, according to Birken *et al.* (2018), is the construct most used by implementation researchers.

2.4 Selected artifact design

This study proposes two artifacts: a construct and a model. The construct was developed in three phases:

(1) Selection of the CFIR;

(2) CFIR expansion (CFIR-2). CFIR is a construct focused on health services. Therefore, new studies were incorporated such as: readiness for innovations in (1) health services (Lehman *et al.*, 2002; Damschroder *et al.*, 2009; Weiner, 2009), (2) industry (Kotter, 1995), (3) information technology (Hameed *et al.* 2012; Lokuge *et al.*, 2019), (4) big data (Ramezani and Nasrollahi, 2020) and (5) theoretical review study (Vakola, 2013). The objective was to find similarities and differences in terminology and construct that could contribute to a generalization and expansion of the CFIR. The

Table 1.
Summary of BIM readiness studies

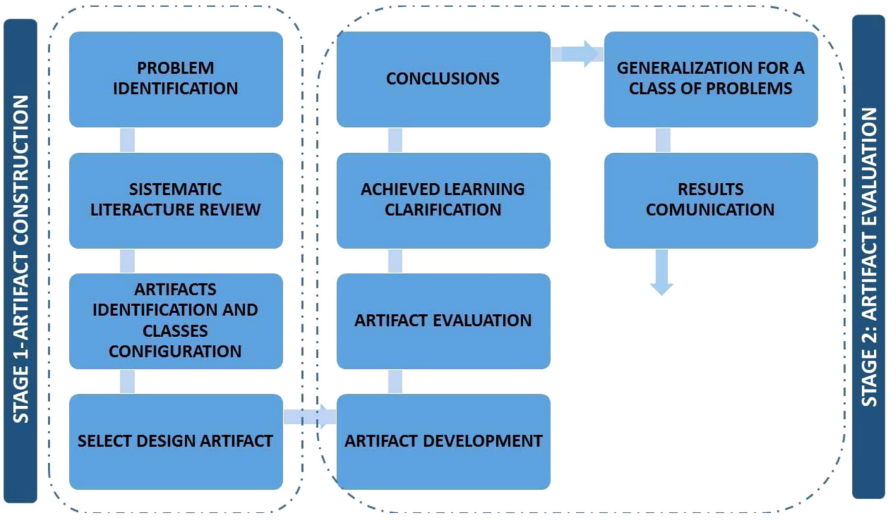
Author	Study object	Contributions	Gaps
Gu and London (2010)	BIM readiness at the Australian industrial level	The multidisciplinary framework that assists in decision-making for BIM implementation in construction projects. The framework considers technical and nontechnical aspects, suggesting that BIM industrial readiness analysis be done about product, processes and people	The Framework provides the information intended for those who are "ready" for BIM or actively implementing BIM, neglecting those who are starting the BIM readiness process. In addition, the article does not consider theories of readiness for change and diffusion of innovations. The paper does not answer questions on how to achieve BIM readiness
Hanafi *et al.* (2016)	BIM readiness at the organizational level in Malaysian architectural firms	Addressed BIM readiness, presenting BIM implementation requirements ranked by degree of importance. Thus, they help architecture firms plan BIM readiness	The article does not consider theories of readiness for change and diffusion of innovations. It neglects cultural issues. The article does not present the BIM readiness measurement system, nor the steps to achieve BIM readiness
Succar and Kassem (2016)	Literature review	Presented a unique conceptual model for BIM adoption at the organizational level with gradual and cyclical implementation levels that involve readiness, capacity, maturity and BIM diffusion within the organization. Defined BIM readiness and presented the Point of Adoption Model. Overlay theories of organizational readiness, capacity building and innovation diffusion to broaden BIM implementation in organizations understanding	Questions such as identifying factors that affect BIM readiness and how to achieve BIM readiness were not answered
Juan *et al.* (2016)	BIM implementation in Thai architectural firms	Relied on the Technology Acceptance Model (TAM), the Balanced Scorecard (BSC), the Knowledge Management Systems (KMS) and organizational readiness theory to develop a system that can be used to assess the readiness and acceptance of a firm to adopt BIM and BIM-based building permit review process and to establish a predictive model based on artificial neural networks (ANNs) that can be applied by architectural firms to evaluate the feasibility of adopting BIM in the future The authors considered that BIM implementation generates organizational changes, justifying the need to approach BIM readiness from readiness for change perspective	It presents tools to measure BIM readiness, but does not present the steps needed to achieve that readiness

(*continued*)

Table 1.

Author	Study object	Contributions	Gaps
Lee and Yu (2017)	BIM readiness of Korean construction companies	The research was supported by the Information System Success Model and TAM, to assess readiness of BIM acceptance in projects. For them, BIM acceptance readiness is "an organization's readiness regarding various prerequisites favorable to the use of BIM" (Lee and Yu, 2017, pp. 555–556). Through this concept, they determined the key BIM acceptance factors to propose a BIM acceptance readiness model, allowing owners to assess the BIM acceptance readiness by stakeholders and project performance improvement	Did not consider theories of readiness for change in this study
Abbasianjahromi *et al.* (2019)	BIM implementation in Iranian consulting firms	The article proposes a framework to assess the maturity and readiness of consulting firms for BIM implementation. Technical and economic barriers to BIM implementation are the basis of the framework	Neglect nontechnical issues and do not provide tools for assessing BIM readiness
Abbasnejad *et al.* (2021)	Literature review	The study conducted a systematic literature review identifying and discussing enablers that can contribute to BIM implementation at the organizational level	The article does not consider theories of readiness for change or theories of diffusion of innovations. The paper does not present BIM readiness measurement systems, nor the steps to achieve BIM readiness
Liao *et al.* (2020)	BIM implementation in projects	The article proposes a model that allows project leaders to assess readiness for BIM implementation. The identification of the critical activities of a construction project serves as the basis for the model	The paper did not consider theories of readiness for change in this study

Source(s): Authors (2022)



Source(s): Lacerda *et al.* (2013); Voordijk and Adriaanse (2016) – adapted

Figure 1.
DSR steps

CFIR-2 relied on a careful review of concepts and terminologies adopted by the different authors. As a result, some terminologies were standardized and concepts included:

(3) CFIR-2 comparison with BIM literature. The comparison identified contrasts and similarities and allowed the development of an initial BIM Readiness Model. The complete reading of 69 articles (RL-2) refined the model.

3. Findings

The studies about BIM implementation, with rare exceptions, address the triad of processes, technology and policies. These studies ignore less tangible issues, for example, organizational climate and individual characteristics. In studies dedicated to stages of the BIM implementation process, the BIM readiness stage is almost unanimous. However, there is a gap in factors that impact BIM readiness and the sub-processes inserted in that stage.

3.1 Organizational readiness to BIM – ORBIM

The Organizational readiness to BIM (ORBIM) is a construct of 11 core domains that interact with themselves to influence BIM readiness. Domains carry a set of factors that must be evaluated and considered during the BIM implementation preparation. These domains are: (1) institutional motivation, (2) BIM characteristic, (3) BIM valence, (4) cultural readiness, (5) individual/collective readiness, (6) resource readiness, (7) IT readiness, (8) strategic readiness, (8) cognitive readiness, (9) readiness for partnerships and (10) engagement and competence of BIM agents (Lehman *et al.*, 2002; Damschroder *et al.*, 2009; Vakola, 2013; Lokuge *et al.*, 2019). Next, this article presents the description of the domains.

3.1.1 Institutional motivation. According to Lehman *et al.* (2002), no innovation will be implemented without a motivation to do so. External and internal issues influence institutional motivation, such as the imposition of BIM by customers (Ahuja *et al.*, 2020) and

Stage	Purpose	Description
Purpose and objectives	Explain the purpose of the literature review	Expand knowledge about organizational readiness and innovation implementation issues. Identify possible satisfactory established solutions (identify artifacts). Identify which factors impact the implementation of changes
Primary font type definition	Sets which materials will be collected	Articles published in journals. Articles published in conferences and gray literature were disregarded, following the criteria of Yalcinkaya and Singh (2015)
Definition of primary sources	Define material collection source	Web of Science. It is one of the major databases and has a broad scope and scientific robustness (Olawumi *et al.*, 2017). It is a primary database of CiteSpace (Chen, 2006)
Defining the Search String	Combine search terms with logical operators and characters to restrict and identify objects of interest	"*organizational readiness*"
Boundary conditions	Define search boundary conditions	Presence of search terms in the title, abstract or keywords
Article selection criteria	Define selection criteria for articles returned from databases. Allow efficient and effective screening for evaluation	Articles not repeated – 490 articles returned
Extraction and analysis of bibliometric indicators	Minimize the subjective criteria of researchers in the selection of material. Identify indicators that help in the composition of the theoretical background, and justification of the study developed, among others. Adequate for defining material qualification criteria	Extracted indicators: cited references, cited authors and articles. The selection of articles followed the criteria of Magalhães and Mello (2021) based on frequency and centrality metrics. CiteSpace was the tool used, according to the criteria of Li *et al.* (2017) – 105 selected articles
Standardization of material selection	Reduce the complete reading of a large amount of material. Select the material that most adheres to the objectives of the review	Five selected articles
Snowball sampling or exploratory review	Identify relevant materials in the cited references or deepen the understanding of a topic brought up during the articles reading and assembly of the knowledge matrix	Inclusion of five more articles
Search date		November – 2020
Number of articles worked		10
Timespan		1981–2020

Table 2.
Strategies for conducting LR-1

Source(s): Authors (2022)

the search for innovations that can strengthen existing weaknesses in an organization's business (Abbasianjahromi *et al.*, 2019). Understanding what factors drive the organization to BIM is crucial for a successful implementation. Implementing BIM only to comply with government requirements may not add value to the business and may not bring the benefits promised by BIM, discrediting innovation. Therefore, the decision to implement BIM must be

Stage	Description
Purpose and objectives	Understand the BIM implementation process, especially the factors that can impact BIM readiness stage and the BIM readiness process conduction
Primary font type definition	Articles published in journals. Articles published in conferences and gray literature were disregarded, following the criteria of Yalcinkaya and Singh (2015)
Definition of primary sources	Web of Science and Scopus, according to the criteria of Olawumi *et al.* (2017)
Defining the Search String	"Building Information Model*" and ("maturity" or "readiness" or "implementation" or "adoption")
Boundary conditions	Presence of search terms in the title, abstract or keywords
Article selection criteria	Articles not repeated. Articles published in English. Theories, frameworks, or models for implementing BIM. Studies that investigated the BIM implementation including barriers, risks and critical success factors; factors leading to BIM adoption; BIM maturity; case studies; individual aspects; BIM readiness; organizational aspects; BIM skills; BIM climate, BIM culture and point of BIM adoption
Definition of material qualification criteria	Peer-reviewed articles. Evaluation of journals scope regarding the research objective. Journals whose classification is equal to or greater than B2, according to the norm of the Coordination for the Improvement of Higher Education Personnel – CAPES Foundation
Standardization of material selection	The standardization of material selection followed
Repository and knowledge matrix	Organize the selected material and the information collected such as: (1) title, (2) abstract, (3) keywords (4) authors, (5) document type, (6) methodology, (7) objective, (8) research questions, (9) limitations (10) contributions, for example
Search date	September – 2021
Initial number of returned papers	1.806 artigos Scopus + 1.832 artigos Web of Science = 3.638
Amount of articles after standardization of material selection	107 articles selected for the elaboration of the knowledge matrix
Amount of articles selected after preparation of the knowledge matrix	69 articles – total of articles worked in the elaboration of the construct and the theoretical model

Source(s): Authors (2022)

Table 3. Strategies for conducting LR-2

connected to recognition of the need for change, knowledge about BIM, the organization's long-term vision and strategy (Wang *et al.*, 2019) and the commitment of sponsors (Damschroder *et al.*, 2009).

3.1.2 BIM characteristic. BIM characteristic is related to the level of exposure and knowledge of characteristics such as (1) relative advantage; (2) observability, (3) adaptability, (4) testability, (5) complexity, (6) costs, (7) compatibility (Damschroder *et al.*, 2009), (8) perceived ease of use, (9) perceived usefulness (Ahmed and Kassem, 2018), (10) amount of BIM workpower available for contracting, (11) number of specialists available in the market to offer training and consultancy (Vidalakis *et al.*, 2020) and (12) technological factors such as interoperability (Chen *et al.*, 2019). This domain impacts the decision to incorporate or not BIM in business (Ahmed and Kassem, 2018). Inadequate exposure and understanding of BIM can lead to misperceptions, frustrated expectations and the belief that BIM is not business-friendly and contribute to resistance to implementation (Awwad *et al.*, 2022).

3.1.3 BIM valence. Valence is related to BIM value for the organization and people. For Weiner (2009), the more people want to change (BIM), the easier the change process is. The following factors can affect individual valence: (1) organization involvement, (2) access to

BIM knowledge and information (Damschroder *et al.*, 2009) and (3) individual motivations to learn and employ BIM in their professional activities (Weiner, 2009).

The perception of value also affects the organization, as can be verified from the implementation climate. Six factors can affect the implementation climate: (1) tension for change, (2) relative priority, (3) compatibility, (4) incentives and rewards, (5) goals and feedback and (6) learning climate (Damschroder *et al.*, 2009).

3.1.4 Cultural readiness. Lokuge *et al.* (2019) define cultural readiness as "the strength of core values of the organization that facilitates digital innovation" (BIM). Organizational culture is one of the crucial factors for the change's successful implementation. The implementation of innovations not relevant or consistent with the organizational culture can be counterproductive (Lehman *et al.*, 2002). van Eijnatten and van Galen (2002) relate the failure of implementation measures to the low ability to change intangible elements of organizational culture.

Denison *et al.* (2012) considers that the following attributes reflect the organizational culture: (1) organization strategic direction: vision, mission, objectives and goals; (2) values: agreements, coordination and integration; (3) collective involvement with the organization: autonomy of teams and individuals, leadership style and guidance, capacity development and (4) the organization's ability to adapt: incorporation of innovations and changes, customer focus and organizational learning. Lokuge *et al.* (2019) identified three factors that impact an organizational culture focused on innovation: (1) the sharing of ideas in a digitally connected environment, (2) the decentralized decision-making process and (3) risk aversion.

3.1.5 Individual and collective readiness. According to Vakola (2013), individual and collective readiness are associated and should be evaluated together. Individual/collective readiness is related to the propensity of a member/group to be involved in the implementation process. This propensity is based on psychological predispositions, and shaped by organizational and change context (Vakola, 2013). Individual/collective readiness can be affected by factors such as (1) confidence in one's BIM skills (self-efficacy) (2) relative priority (3) confidence in the organization's ability to promote BIM implementation, (4) incentives and rewards, (5) social influence, (6) clarity in the organization's communication regarding BIM objectives, (7) compatibility (8) learning climate, (9) organization involvement and commitment, (10) degree of exposure to BIM, (11) perceived usefulness and (12) perception and appreciation of BIM benefits (Ahmed and Kassem, 2018; Damschroder *et al.*, 2009; Hua and Liu, 2017).

3.1.6 Resource readiness. Resource readiness is not about resource availability but the flexibility the organization has to configure and reconfigure its resources to facilitate digital innovation (BIM) needs (Lokuge *et al.*, 2019). The following factors can impact resource readiness domain (1) adequacy of physical space (Gomes, 2015), (2) adequate amount of labor (Lehman *et al.*, 2002), (3) team's BIM skill (Abbasianjahromi *et al.*, 2019), (4) technical and knowledge support (Shehzad *et al.*, 2022) and (5) geographic distribution of facilities and resources (PMI, 2017).

3.1.7 Information technology readiness. IT readiness is the strength of IT's portfolio to facilitate digital innovation (BIM) (Lokuge *et al.*, 2019). In this aspect, Mahamadu *et al.* (2019) consider that organizations with high maturity in information systems and a vision with strategic monitoring goals in IT tend to have an advantage during BIM implementation. Therefore, this dimension assesses (1) the degree of dependence and criticality of the organization on IT to execute business strategies, (2) whether there is an IT strategy addressing the level and allocation of investments, (3) management and guarantee of information security and (4) whether the organization has the set of technological skills necessary for the implementation of BIM (Succar, 2010), among others.

3.1.8 Strategic readiness. Strategic vision helps identify areas where BIM can support organizational objectives, driving BIM vision, BIM strategic planning and BIM competencies

needed to achieve business objectives (Dakhil *et al.*, 2019). Therefore, strategic readiness can be understood as "a set of managerial activities in which an organization engages to facilitate digital innovation" (Lokuge *et al.*, 2019, p. 21). For Lokuge *et al.* (2019) the three factors that impact strategic readiness are (1) clarity of objectives, (2) relevance and (3) the communication strategy.

3.1.9 Cognitive readiness. Cognitive readiness is the strength of a knowledge base of the organization to facilitate digital innovation (BIM) (Lokuge *et al.*, 2019). This domain is affected by the following factors: (1) knowledge of business processes (Sacks *et al.*, 2018) (2) individual level of BIM competence, (3) technical and nontechnical skills and capabilities necessary for professionals to develop BIM activities (Succar *et al.*, 2013) and (4) the team's adaptability (Lokuge *et al.*, 2019).

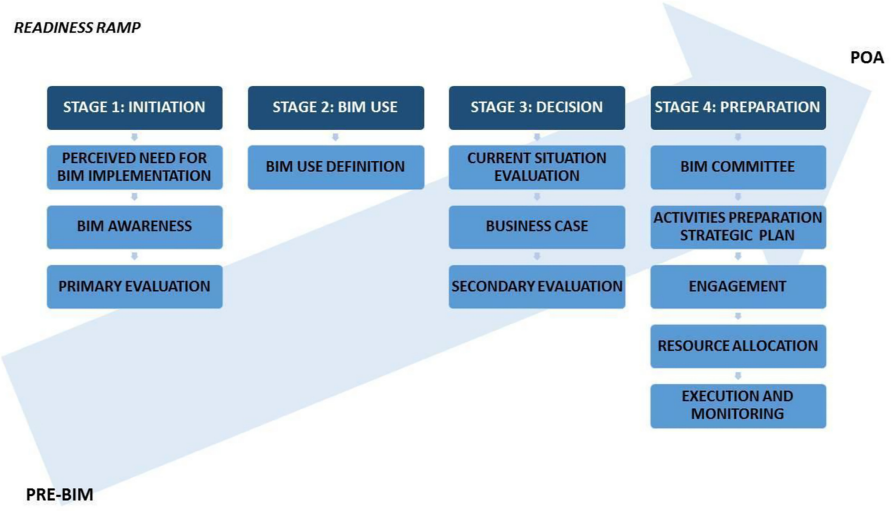
3.1.10 Readiness for partnerships. Partnership readiness is understood as the relationship between the organization and external stakeholders. Examples of external stakeholders are suppliers, external consultants and customers. With the formation of partnerships, the organization can count on the ecosystem of partner organizations in the development and implementation of collaborative innovations (Lokuge *et al.*, 2019) such as BIM.

3.1.11 Engagement and competence of BIM agents. The domain of engagement and competence of BIM agents involves (1) training BIM leaders, (2) accession of the indispensable actors to the BIM implementation process and (3) mobilization of allies (Lindblad, 2019). BIM agents (leaders, actors and allies) need to be endowed with the minimally necessary BIM skills (technical and nontechnical) to conduct the implementation process (Gomes, 2015).

3.2 BIM readiness model

BIM Readiness Model is a conceptual model for BIM readiness process. The model is proposed in four stages and 12 steps illustrated in Figure 2 – BIM Readiness Model.

3.2.1 Initiation. At this stage, the organization realizes the need for BIM implementation, is exposed to BIM, BIM awareness and assesses whether the organization will initiate the BIM readiness process (primary assessment) (Hameed *et al.*, 2012). The perception of BIM



Source(s): Authors (2022)

Figure 2.
BIM readiness model

implementation needs is directly related to the institutional motivation for BIM implementation, while BIM understanding and primary assessment are affected by BIM characteristics (Ahmed and Kassem, 2018).

The primary assessment considers (1) value that BIM will bring to the organization, (2) costs and risks involved (operational and nonoperational), (3) return on investment, (4) whether BIM will meet business needs, (5) whether BIM technological tools that the organization intends to employ work well and (6) if results are reliable (Park *et al.*, 2019; Ahuja *et al.*, 2020). Another important consideration is the possibility of testing related to pilot project execution (Almuntaser *et al.*, 2018), involving acquisition of software, training, financial investments, etc. Therefore, the organization must be aware of (1) necessary investments during the BIM readiness stage, (2) risks involved in the process and (3) what the BIM rejection, if any, could mean for the organization. In view of the results of the primary assessment, the organization authorizes, or not, the start of the BIM preparation process.

3.2.2 BIM Use. BIM, as a tool, has several uses and applications that vary according to the stage of the life cycle of construction projects and the objectives to be achieved. Thus, the organization must define the desired BIM Use and BIM capability stage. Each stage of capability and each BIM Use has particularities in terms of challenges and associated benefits (Hong *et al.*, 2019). Therefore, the definition of BIM Use is related to the mission, values, objectives and benefits that the organization expects to obtain with BIM (Wu *et al.*, 2017) and directly influences organizational changes, directing the investments necessary for the BIM implementation (Abdirad, 2017). The use of innovation is not reported by theorists that investigated organizational readiness. However, its presence is perceived in the BIM literature. In this way, the present paper interprets the definition of BIM Use as a peculiarity of the implementation of BIM.

3.2.3 Decision. At this stage the organization: (1) assesses whether the organization's current situation allows for BIM implementation, in terms of domains and factors that impact BIM readiness, (2) prepares the business case for secondary assessment in technical, financial and strategic terms and (3) decides whether or not to initiate BIM readiness (Hameed *et al.*, 2012; Love *et al.*, 2020; Weiner, 2009). This phase is useful for planning the BIM implementation process.

3.2.4 Preparation. At this moment, the organization starts activities that allow the POA realization: (1) formation of a BIM committee, (2) elaboration of a strategic plan, (3) resource allocation and (4) execution and monitoring of the plan (Gomes, 2015). PMI (2017) establishes a project management framework that can be used to prepare the management plan for BIM implementation activities. The implementation plan must also contain the areas of BIM implementation and the development of new work processes (Gomes, 2015).

4. Conclusion

4.1 Theoretical and practical implication

Proper organizational readiness is critical to successful BIM implementation. The study started from theories about organizational readiness for change, models for implementing innovations and project management standards and guidelines to understand the BIM readiness process. Literature reviews allowed the design of a construct formed by 11 domains (ORBIM). ORBIM identifies the key factors that affect BIM readiness, including the less tangible aspects that are often omitted by the BIM literature.

The incorporation of ORBIM can represent a great challenge for the organization. But its strategic management can maximize BIM readiness results. However, just embedding ORBIM is not enough for BIM readiness to occur. BIM readiness is a process with steps to be managed. In addition, this article proposes a model that guides organizations about actions to be taken during the BIM preparation process.

The BIM Readiness Model shows that the BIM implementation process behaves differently from other innovations. The three generic steps described by Hameed *et al.* (2012) occur during BIM preparation (BIM readiness). That is, throughout the BIM readiness, the organization: (1) recognizes the need to implement BIM, (2) acquires knowledge about BIM, (3) takes an attitude as to whether or not to implement BIM (primary assessment), (4) evaluates the innovation from a technical, financial, and strategic point of view (business case – secondary evaluation), (5) allocates the necessary resources for the acquisition of innovation (BIM) and (6) acquire the innovation and prepare the organization for its use in test events. With this, the BIM Readiness Model expands the BIM adoption models brought by the literature review, decomposing the phases of the BIM readiness ramp.

4.2 Limitation of the study and suggestions for future research

In general terms, in answering the research questions, this article suggests that the success of BIM readiness is mutually dependent on the stages of the BIM Readiness Model and the incorporation of ORBIM. However, both the ORBIM and the BIM Readiness Model need to be evaluated and tested. Therefore, it is suggested that future researchers continue the development of DSR, analyzing results presented in real situations. Furthermore, the combination of the BIM Readiness Model and ORBIM can contribute to a conceptual instrument for a practical and multidimensional assessment of BIM readiness. The paper was limited to investigate BIM readiness to the point of adoption. Therefore, issues such as the elaboration of a BIM Execution Plan (BEP) were not considered, as the study understands that it is an integral part of the Adoption Points processes.

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