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Journal of Asian Architecture and Building Engineering

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tabe20

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To cite this article: Tianjiao Li, Zhiwei Helian & Xiujuan Jin (09 Jul 2024): The organizational mechanism of new technology implementation: an empirical study in the Chinese construction industry, Journal of Asian Architecture and Building Engineering, DOI: 10.1080/13467581.2024.2378006

To link to this article: https://doi.org/10.1080/13467581.2024.2378006

Published online: 09 Jul 2024.

JOURNAL OF ASIAN ARCHITECTURE AND BUILDING ENGINEERING
https://doi.org/10.1080/13467581.2024.2378006

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CONSTRUCTION MANAGEMENT

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The organizational mechanism of new technology implementation: an empirical study in the Chinese construction industry

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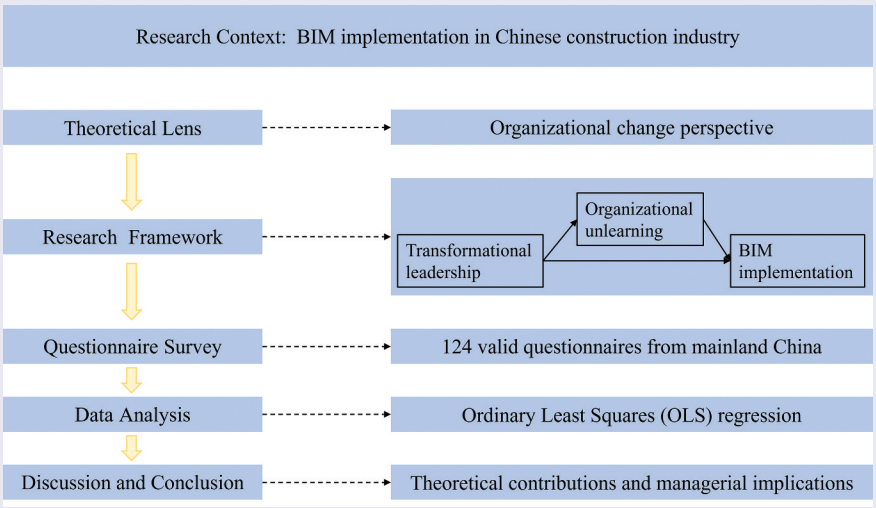
ABSTRACT

In the past decade or so, an increasing number of construction organizations have shifted from traditional CAD to BIM, which requires organizations to make corresponding changes and can be seen as a progressive organizational change. However, existing research knows little about the organizational management mechanisms for BIM implementation. From the perspective of organizational change, considering the role of transformational leadership and organizational unlearning, this study constructs a framework to explore the organizational mechanism of BIM implementation. Based on empirical analysis of 124 samples from mainland China, it was found that transformational leadership contributes to the improvement of an organization's BIM implementation level and the pathway is mainly achieved through organizational unlearning. This study contributes to the construction industry's organizational change and new technology implementation by inferring and validating the positive roles of transformational leadership and organizational unlearning in promoting BIM implementation. Research findings can also provide helpful guidance for industry participants to implement BIM within organizations successfully.



ARTICLE HISTORY
Received 9 February 2024
Accepted 5 July 2024

KEYWORDS
Building information modeling (BIM); transformational leadership; organizational unlearning; organizational change; new technology implementation

1. Introduction

In today's swiftly advancing market landscape, the timely and effective adoption of emerging technologies has become a core competency for construction firms in maintaining their competitive edge. BIM is continuously evolving as a novel technology or technological process that has been extensively validated for its advantages in construction projects. At the same time, BIM implementation is increasingly being interpreted as an organizational change as which often involves the implementation of systems, infrastructure, services, and technology that have not previously existed in an organization, bringing with them alterations to organizational practices and structures (Becker 2010; Liao and Teo 2018, 2019; Maali et al. 2020). Successful BIM implementation in projects requires organizations that are deeply rooted in traditional drafting practices to update and adapt to new working methods for innovative project delivery, changing the current practices and processes and significantly transforming both intra- and inter-organizational settings (Papadonikolaki 2018; Zakaria et al. 2013). A wealth of research indicates that successfully adopting new

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technological practices within construction firms proves highly challenging, demanding substantial organizational endeavors in change management (Aldossari et al. 2021). While numerous studies have delved into identifying and examining organizational factors related to BIM application, there needs to be more investigation into the specific organizational mechanisms of change management. Researchers stress the importance of organizational management in technological updates yet fail to provide further explanations regarding the specific mechanisms of organizational change management during the process.

Leadership plays a pivotal role in facilitating organizational change smoothly, crucially contributing to establishing legitimacy and commitment throughout the change process (Jacobs, Witteloostuijn, and Christe-Zeyse 2013). Researchers usually identify leadership as a crucial enabler of construction innovation (Ozorhon, Abbott, and Aouad 2014). Aga et al. (2016) delineate that among various leadership styles, transformational leadership is highly associated with project-oriented organizations, exerting a positive influence on project success. Furthermore, Eisenbach et al. (1999) also indicate that, compared to other types of leadership, transformational leadership is more suitable for implementing change. Although the topic of leadership has been under academic study for several decades, in terms of BIM implementation, there has still been very limited evidence about the role of transformational leadership. As early as 2014, Chan, Liu, and Fellows (2014), based on the results of a structural equation model from data from 300 respondents from Hong Kong contractors, had already demonstrated that transformational leadership has a positive predictive effect on the innovation climate. However, for a long time, scholars have not incorporated transformational leadership into the framework for BIM implementation. Larsson et al. (2015) have also criticized the fact that the majority of literature in the field of construction management has largely overlooked the impact of leadership style on project success. Based on the research findings of Tichy and Devanna (1990), transformational leadership often involves leading and participating in a process that entails recognizing the need for change, creating a new vision, and then institutionalizing the change. This aligns perfectly with the process of implementing BIM. According to the existing research, successful BIM implementation depends on top management support (Ahuja et al. 2016; Attarzadeh, Nath, and Tiong 2015; Faisal Shehzad et al. 2022; Okakpu et al. 2018; Son et al. 2014; Song et al. 2017; Son, Lee, and Kim 2015). Organizational design to support the BIM system within the company is highly instrumental to the successful implementation of BIM. In the case of the Malaysian construction industry, Zakaria et al. (2013) pointed out that, to reduce the resistance from people, most of the companies came out with their strategies, for instance, developing training and education programs, changing management style and developing new roles and responsibilities. Rajabi et al. (2022) also stated that the manager should have a broad vision of the staff's skills and organizational resources, which allows the organization to increase its BIM capability. Gledson and Greenwood (2017) also contended that adopting BIM was a decision made by the upper management of an organization with authority and awareness of innovation. Transformational leaders will create a culture that embraces change (Eisenbach, Watson, and Pillai 1999). Under the structure of transformational leadership, leaders could discern desired changes and guide and encourage members to achieve the vision (Avolio, Bass, and Jung 1999). Thus, the first research question posed in this paper is: Does transformational leadership influence the implementation of BIM, and if so, how?

In the case of the Hong Kong construction industry, Chan, Olawumi, and Ho (2019) found that the inherent resistance to change by construction stakeholders is one of the major barriers to BIM adoption. This implies that the existence of prior knowledge and established mental models may hinder transformative efforts during the process of implementing new technologies (Becker 2010). Therefore, in addition to effective leadership, the key to successful BIM implementation lies in initiating and sustaining effective organizational learning throughout the process. In earlier times, Huber (1996) highlighted the significance of organizational learning during technological change. However, general organizational learning places greater emphasis on knowledge accumulation and dissemination, neglecting the significance of change and adaptation (Akgun et al. 2007). Akgun et al. (2007) observed that during the evolution of organizations, they usually develop a set of defensive routines, which may lead to inertia, hamper change, and impede internal innovation. Within such organizations, integrating new knowledge and practices is challenging until old ones are discarded (Morais-Storz and Nguyen 2017). As a representative of technological advancement in the construction field, BIM has been continuously evolving and iterating over time, which requires employees within construction organizations to continuously update their knowledge and relinquish outdated, inefficient methods prior to, or at least at the same time. Existing research on overcoming organizational inertia emphasizes the importance of organizational unlearning (Akgun et al. 2007; Leal-Rodríguez et al. 2015; Wang et al. 2023). Tsang and Zahra (2008) suggest that organizational unlearning enables organizations to discard old practices, modify unsupportive organizational structures, and establish a more effective pathway for searching, acquiring, and integrating knowledge. Some scholars also argue that companies must first undo their learning of old ideas before attempting new ideas (Fernandez and Sune 2009). It

is challenging for companies to establish new routines without unlearning because entrenched routines may create competency traps and cognitive structures that impede external knowledge acquisition (Morais-Storz and Nguyen 2017). Consequently, unlearning can be considered a significant facilitator in the BIM implementation process. Therefore, the second research question of this paper is how unlearning contributes to the BIM implementation process. Additionally, prior studies have shown the association between leadership and organizational learning (García-Morales, Jiménez-Barrionuevo, and Gutiérrez-Gutiérrez 2012; Noruzy et al. 2013; Vashdi, Levitats, and Grimland 2019). Transformational leaders establish teams, provide direction and energy, and support processes of change and organizational learning (Bass 1999; McDonough 2000). By fostering intellectual stimulation, transformational leaders empower organizational members with motivational and confident support to drive organizational learning (Coad and Berry 1998). We argue that, in construction organizations, a leader who embraces fresh perspectives, fosters creativity, encourages experimentation, and embraces risk-taking can facilitate unlearning and then promote the implementation of BIM. Thus, this paper further investigates the mediating role of organizational unlearning.

Based on the above discussion, the purpose of this paper is to enrich the understanding of BIM implementation from an organizational change perspective, with a particular focus on the impact of transformational leadership on BIM implementation, as well as the mediating role of organizational unlearning. To be specific, this paper assumed that the top manager's transformational leadership will promote organizational unlearning, thus improving the BIM implementation level of construction organizations. By doing so, this study contributes to the existing literature in the following aspects. First, this paper enriches the literature on the antecedents of BIM implementation and explaining the organizational mechanisms of BIM implementation by providing an organizational change framework that links transformational leadership and organizational unlearning. Second, the inclusion of transformational leadership and organizational unlearning in the research framework of BIM implementation expands the boundaries of the theoretical applicability of transformational leadership and provides a plausible explanation of the mechanism of transformational leadership's effect on organizational change, as well as enriches the research on the antecedents of organizational unlearning. All in all, despite the wealth of literature from construction management investigators on organizational change and management strategies during BIM implementation, much of it draws heavily from insider insights and experiences within organizations. More robust empirical research in this field would be instrumental in validating or challenging many of the assumptions, recommendations, and theories surrounding BIM implementation.

The remainder of this paper is structured as follows: the next section introduces the theoretical perspective of this research and then develops the hypotheses tested in this study. Next, the methodology section presents a sampling frame, data collection process, and variable measurements. Subsequently, the empirical results of the proposed hypothesized model are presented. The paper concludes with a summary of the essential findings, theoretical contributions, managerial implications, limitations, and directions for future research to develop this burgeoning area of BIM implementation.

2. Theoretical background and hypothesis development

2.1. BIM implementation: organizational change perspective

Organizational change arises from "an empirical observation of difference in form, quality or long-term state of an organizational entity, coming out of the deliberate introduction of new styles of thinking, acting or operating, looking for the adaptation to the environment or a performance improvement" (Pardo-Del-Val, Martinez-Fuentes, and Roig-Dobon 2012). In recent years, an increasing number of researchers have regarded the BIM implementation in construction projects as an organizational change (Azhar, Kang, and Ahmad 2014; Liao and Teo 2018, 2019; Maali et al. 2020), as participants may be entrenched in traditional drafting practices or fragmented BIM implementations and need to adapt to new project delivery processes using BIM (Liao and Teo 2018). Literature focused on BIM adoption also demonstrates that effective implementation of BIM requires significant changes in the way construction organizations work at almost every level of the building process, which requires not only learning new software applications but also how to reinvent workflows, how to train employees and assign responsibilities, and change the way building modeling is done (Arayici et al. 2011). In view of this, Liao and Teo (2018) examined people management during BIM implementation from an organizational change perspective and accordingly proposed a series of people management strategies. Liao and Teo (2019) further identified critical drivers for change towards full BIM implementation. Maali et al. (2020) validated relationships between specific change management practices and organizational adoption of new technology solutions based on 167 cases of organization-wide change. Aldossari et al. (2021) studied how organizational change management practices in firms were used to successfully implement alternative project delivery methods (APDMs) with nine semi-

structured interviews. These studies suggest that organizational change is a valuable lens for understanding BIM implementation. However, there is a lack of insight into how BIM implementation occurs at the organizational level.

Current studies highlight the critical role of top management support in an organization's BIM adoption decisions. However, there needs to be a more in-depth exploration of specific mechanisms of top management. According to the theoretical framework of organizational change, leadership is critical to the change management process and is a key determinant for organizations to execute change successfully (Carreiro and Oliveira 2019), as change requires the creation of a new system that institutionalizes new methods and processes (Eisenbach, Watson, and Pillai 1999). Among different types of leadership, change-oriented models of leadership, i.e., transformational leadership, have attracted the interest of managers and scholars. Tichy and Devanna (1990) noted that transformational leadership is often better able to recognize the need for change, create a new vision for the team, and institutionalize change. Eisenbach, Watson, and Pillai (1999) also mentioned that, as facilitators of organizational change, transformational leaders usually promote creating a culture that encourages team decision-making and behavioral control to neutralize resistance to change. Given this, incorporating transformational leadership into the theoretical model of BIM implementation can fill the research gap faced by BIM implementation research at the organizational level and enrich the understanding of BIM implementation from the perspective of organizational change.

Meanwhile, Becker (2010) noted that a critical change management issue associated with the implementation of new technologies is the existence of prior knowledge and established mental models, which may lead to resistance to change efforts. Further, he mentioned that changes in organizational information technology affect a wide range of practices and procedures and that the implementation of change requires organizations to learn new practices and procedures before or while abandoning old methods to adapt to new workflows; a process like this known as "unlearning" (Becker 2010). Many researchers highlighted the importance of unlearning in the organizational change period (Cegarra-Navarro and Moya 2005; Prahalad and Bettis 1986; Sinkula 2002; Starbuck 1996), and which has been identified as a critical driver of radical innovation (Lyu et al. 2020). It has been shown that new knowledge and routines can only enter an organization once the old ones are discarded (Morais-Storz and Nguyen 2017). In order to acquire the new knowledge needed for radical innovations that disrupt existing technologies and market trajectories (Zhou, Yim, and Tse 2005), firms must unlearn their outdated knowledge or beliefs to make room for new ones. Regarding the BIM implementation practices in construction firms, implementing BIM in construction projects also requires firms to abandon traditional design and production approaches to make room for digital information processing and digital knowledge. Regrettably, few works have been found to examine how organizations manage change in BIM implementation through unlearning and how unlearning occurs. Given this, this study aims to fill this research gap.

2.2. The effect of transformational leadership on BIM implementation

Leadership was regarded as "the ability of an individual to influence, motivate, and enable others to contribute toward the effectiveness and success of the organizations of which they are members" (House et al. 2002). Literature on organizational change highlights the importance of leadership in change management, as change requires creating a new system and institutionalizing new approaches (Kotter 1995). Among different types of leadership, transformational leadership is closely associated with organizational change (Eisenbach, Watson, and Pillai 1999). Waziri, Ali, and Aliagha (2015) stated that transformational leaders are more likely to develop followers, raise their need levels and uplift them, thus facilitating positive changes in individuals, groups and organizations.

Transformational leaders usually create an organizational culture that embraces change and calls on members to participate in the change process (Eisenbach, Watson, and Pillai 1999). Concerning the conceptualization of transformational leadership, Bass (1985) proposed that transformational leadership includes charisma or idealized influence, intellectual stimulation, and individualized consideration. Where idealized influence can help leaders build trust and increase followers' emotional identification with them, intellectual stimulation encourages followers to question how they do things, and individualized considerations provide followers with learning opportunities. Many works have been published based on this conception to test the important role of transformational leadership in the organizational change process. For example, the study conducted by Chen et al. (2012) found that transformational leadership is positively associated with organizational technological innovation. Yurov and Potter (2006) concluded that when IT leaders displayed transformational leadership qualities that resulted in a greater intent this would allow followers to contribute to system support and enhancement. As for the construction industry, Waziri, Ali, and Aliagha (2015) conducted a structural equation modeling analysis, and the results showed a positive and direct relationship between transformational leadership and IT adoption in construction organizations with a path coefficient of 0.79. Based

on the above discussion, it can be concluded that transformational leaders are more likely to recognize the importance of adopting BIM in projects, and create a digital vision for organizational members, call on them to put effort into the process of BIM implementation, and provide resources to support the adoption behavior of BIM with organizational members. Thus, the following hypothesis is proposed.

H1: A positive association exists between transformational leadership and BIM implementation.

2.3. The mediating role of organizational unlearning

As discussed, one of the critical issues for change management, especially for implementing new technologies, is the existence of prior knowledge and established mental models which may hinder change efforts (Becker 2010). Unlearning was defined as "the process by which individuals and organizations acknowledge and release prior learning (including assumptions and mental frameworks) in order to accommodate new information and behaviors" (Becker 2005), which has made claims as the heart of the organizational change process (Walsh and Ungson 1991), since March's organizational adaptation theory (Cyert and March 1963) and Lewin's (1951) organizational change theory. Hence, we assume that transformational leadership promotes BIM implementation in construction companies through organizational unlearning.

We argue that transformational leadership can stimulate unlearning behavior among organizational employees, which can be explained through the dimension of intellectual stimulation. To be specific, transformational leaders often encourage staff members to question their current ways of doing things (Dionne et al. 2004) and proactively provide them with direction, energy, and support for processes of change and organizational learning (Bass 1999; McDonough 2000). Furthermore, transformational leaders usually encourage shared mental models in technological organizations that favor continuous learning and facilitate technological learning and the use of new technologies (Senge et al. 1994). Correspondingly, organizational unlearning typically requires organizational members to overcome their reliance on prior ways of working and existing knowledge in order to make space for new practices and knowledge (Lyu et al. 2020). Sharma and Lenka (2024) noted that "transformational leaders help employees perceive the necessity of unlearning to change; employees pursue unlearning as a part of intrinsic motivation and self-development rather than fearing shame, anxiety, self-imposed pressure, or avoiding punishment." In this regard, transformational leadership could be regarded as a primary intervention to promote unlearning in organizations (Fiol and O'Connor 2017).

A case study on BIM experts in a mid-size organization by Lattuch and Hickey (2020) demonstrates that effectively translating implementation intentions into learning actions is an effective management practice for successful BIM implementation. On a global scale, BIM implementation is primarily characterized by a top-down approach, which necessitates effective leadership from the manager level and active engagement from staff members. Without the active participation of employees, BIM implementation and sustainability within an organization will be challenging. In this process, unlearning is an essential manifestation of employees' innovative change efforts, and leadership plays a crucial role in determining the extent of these efforts (Amabile et al. 2004; Chan, Liu, and Fellows 2014; Peterson 2009). Up to now, multiple studies have supported the mediating role of organizational learning between transformational leadership and organizational innovation and project success (García-Morales, Jiménez-Barrionuevo, and Gutiérrez-Gutiérrez 2012; Noruzy et al. 2013; Pham et al. 2023). Based on this, the following hypothesis is proposed.

H2: Organizational unlearning mediates the relationship between transformational leadership and BIM implementation.

3. Research design

3.1. Sampling

So far, due to various reasons, BIM has yet to be widely adopted in China, making it unfeasible to employ a completely random sampling approach for sample selection (Cao et al. 2017). Hence, this study conducted a literature review to understand the application of BIM in China. As a result, several leading cities were chosen as they are proven representatives of the BIM-leading metropolitan cities and BIM-developing counterparts (Cao et al. 2017, 2018; Ji et al. 2020; Jin et al. 2017; Xu et al. 2018; Zhang et al. 2021), including Beijing, Shanghai, Hangzhou, Shenzhen, and Guangzhou. Then, the authors reached staff members from the municipal construction bureaus of the target cities as they had deeper insights into the BIM implementation status within local construction firms. Consequently, the authors obtained a list of potential companies to be surveyed.

3.2. Data collection

Data was obtained by conducting a field questionnaire survey in construction firms. Following the approach of Cao et al. (2017), we selected target experienced professionals who directly engaged in BIM implementation activities for projects in mainland China, such as BIM

managers. In order to enhance the quality of the questionnaire and data, the initial questionnaire was reviewed by three professors and 10 industry practitioners to seek feedback for further revision and improvement. After multiple revisions, the questionnaire's final version was created and distributed to the respondents. Before the formal survey, the author contacted the senior and professional managers knowledgeable about BIM implementation and project management to explain the research purpose and possible managerial contributions in detail. Then, the author invited them to participate in the survey and fill in the questionnaires. Existing research demonstrates that these respondents can meet the research requirements well (Cao, Li, and Wang 2014). Then, the questionnaire was emailed to 220 respondents (representing 220 firms). After deleting invalid questionnaires filled in randomly with missing values and apparent regularity of answers and obtained 124 valid questionnaires with an effective rate of 56.36%. In addition, following the practice of Cao, Li, and Wang (2014), this study also conducted an analysis of variance (ANOVA) on the samples from different cities, and no statistically significant differences were found in the results.

The final sample was composed of 67.74% male and 32.26% female. Most of the respondents received a bachelor's degree in engineering management or computer science and possessed extensive working experience in the construction industry. Regarding the firm, 62.86% were state-owned, 37.14% were privately owned; 38.56% were designers, 41.82% were contractors, and 19.62% were clients; 68.24% employed more than 200 people, and 31.76% employed less; 29.62% established more than 40 years, 31.23% established between 20–40 years, 21.23% established between 10–20 years, and 17.92% established for 10 years or less.

3.3. Variable measurements

To ensure the reliability and validity of the results, the measurement tools were all derived from authoritative literature, and this study invited professional bilingual linguists to translate and proofread the content of the questionnaire. The items of transformational leadership and organizational unlearning were measured by 5-point Likert-type scales ranging from 1 = "strongly disagree" to 5 = "strongly agree".

(1) *Transformational leadership*. Transformational leadership was measured with seven items adopted from Carless, Wearing, and Mann (2000) to capture and assess each of the seven leader behaviors, such as treating staff as individuals, supporting and encouraging their development, and encouraging thinking about problems in new ways.
(2) *Organizational unlearning*. Four items were adapted from Casillas, Acedo, and Barbero (2010) and Akgun et al. (2007) to measure organizational unlearning.
(3) *BIM implementation*. The approach employed to measure the BIM implementation level was from Cao, Li, and Wang (2014). They summarized 13 BIM application areas based on a systematic literature work to measure the extent of BIM implementation in projects on a three-point scale 0 (not used), 1 (some use), and 2 (extensive use), which was applied in the subsequent study (Xing, Cao, and Cao 2023). The data obtained will be calculated as an average value of the implementation level in 13 areas for further analysis.
(4) *Control variable*. Besides, this study considered organization roles, organization size, and organization age as control variables.

4. Data analyses and results

This study employed software SPSS 20.0 and LISREL 8.7 to process data, including reliability and validity tests, correlation tests, and hypotheses tests.

4.1. Reliability and validity tests

To begin with, this study conducted reliability and validity tests; the results were summarized in Table 1.

Table 1. Results of reliability and validity tests.

Constructs	Items	λ	α	CR	AVE
TL	TL1	0.96	0.913	0.9329	0.6832
	TL2	0.98			
	TL3	0.92			
	TL4	0.57			
	TL5	0.64			
	TL6	0.75			
	TL7	0.87			
OU	OU1	0.75	0.890	0.8909	0.6702
	OU2	0.87			
	OU3	0.82			
	OU4	0.83			

Note: CR = Composite reliability; AVE = Average variance extracted; TL = Transformational leadership, OU = Organizational unlearning.

As shown in Table 1, the values of Cronbach's alpha of the examined constructs are all above 0.7, indicating that scales used in this study have higher reliability. As for validity tests, the values of factor loading (λ) all exceed 0.5, the values of average variance extracted (AVE) are greater than 0.5, and the values of the composite reliability (CR) are well above 0.8, which indicates that the constructs have good convergent validity. At the same time, the square root of AVE presented on the diagonal provides clear evidence that the constructs reach an ideal level in terms of discriminant validity as the values are greater than the inter-construct correlations.

4.2. Correlations and descriptive statistics

The results of correlations and descriptive statistics for all constructs are shown in Table 2. It can be seen that transformational leadership was significantly positively correlated with organizational unlearning ($r = 0.349$, $p < 0.001$), and BIM implementation ($r = 0.365$, $p < 0.001$). Meanwhile, organizational unlearning was significantly positively correlated with BIM implementation ($r = 0.286$, $p < 0.001$). These results are consistent with the hypotheses proposed in this study.

4.3. Hypotheses testing

In order to test Hypothesis 1, this study constructed and examined Model 2. As Table 3 shows, transformational leadership is positively associated with BIM implementation (Model 2, $\beta = 0.352$, $p < 0.001$). Hence, Hypothesis 1 was supported.

Table 2. Construct correlations and descriptive statistics.

Construct	1	2	3
TL	**0.8266**		
OU	0.349***	**0.8187**	
BI	0.365***	0.286***	–
Max	6.92	7.00	1.88
Min	1.50	2.60	0.63
Mean	5.1794	5.8919	1.1263
SD	1.1073	0.8046	0.8871

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; Bold values on the diagonal represent the square root of AVE; TL = Transformational leadership; OU = Organizational unlearning; BI = BIM implementation extent.

As for Hypothesis 2. This study first run the Model 1 and Model 3. It can be seen from Table 3 that transformational leadership has a positive impact on organizational unlearning (Model 1, $\beta = 0.345$, $p < 0.001$) and organizational unlearning has a positive impact on BIM implementation (Model 3, $\beta = 0.277$, $p < 0.01$). Based on this, this study runs the Model 4. However, although transformational leadership still positively affected BIM implementation, the normalization coefficient β changed from 0.352 to 0.289, indicating that organizational unlearning plays a mediating role between transformational leadership and organizational unlearning. Thus, Hypothesis 2 was supported.

5. Discussion

This paper reveals the organizational mechanisms of BIM implementation from an organizational change perspective, which theoretically complements and extends the existing literature on BIM implementation. Explicitly speaking, current research efforts on BIM implementation are either based on institutional theories examining the impact of external organizational pressures on BIM adoption (Cao et al. 2017; Saka, Chan, and Ajayi 2024) or on technology acceptance models examining how individual attitudes affect BIM adoption intentions and adoption decisions (Ahmed and Kassem 2018; Lee, Yu, and Jeong 2013; Yuan, Yang, and Xue 2019). These studies overlooked the organizational change management mechanisms required for BIM implementation. This study found that BIM implementation in construction organizations is the result of organizational unlearning under the guidance of transformational leader, highlighting the importance of leadership and organizational learning, and revealing the mechanisms. Although some researchers regard BIM implementation as an incremental organizational change (Azhar, Kang, and Ahmad 2014; Liao and Teo 2018, 2019), and there are studies focusing on the influencing factors of BIM implementation at the organizational level. However, these studies pay more attention to identifying factors (Liao and Teo 2018, 2019) rather than specific mechanisms of action, lacking theoretical examination and empirical verification of the relationships between these factors.

Table 3. Results for hypotheses.

	Model 1	Model 2	Model 3	Model 4
	OU	BL		
Control Variable				
Organization role	0.05	0.036	0.083	0.045
Organization size	0.095	0.017	0.06	0.034
Organization age	0.008	0.051	0.097	0.5
Independent variable				
TL	0.345***	0.352***		0.289**
Mediator				
OU			0.277**	0.181*
R^2	0.128***	0.137***	0.095**	0.165*
F	4.368**	4.704***	3.110*	4.665***

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; TL = Transformational leadership; OU = Organizational unlearning; BL= BIM implementation level.

This study incorporates both transformational leadership and organizational unlearning into the research framework. Further, it verifies the mediating effect of organizational unlearning, providing a comprehensive explanatory framework for understanding the BIM implementation process from an organizational change perspective.

This paper finds a positive effect of transformational leadership on BIM implementation, which provides a more nuanced and rational explanation for top management support from the perspective of leadership. This finding addresses the gap identified by Turner and Müller (2005) where they point out the lack of focus on project manager leadership styles in project management literature. Graham, Nikolova, and Sankaran (2020) also criticized the research in the field of architecture for its lack of reference to emerging leadership theories. In reviewing past research, scholars have emphasized the significant role of top management support (Abbasnejad et al. 2021; Doumbouya, Gao, and Guan 2016; Okakpu et al. 2018; Saka and Chan 2023) when discussing the factors influencing the implementation of BIM within construction firms. However, most of the studies conducted on the subject of top management support do not appear to have been grounded in established management theories to elucidate the manner in which leaders can impact the implementation of technology within organizational contexts. Insufficient attention has been given to the aspect of leadership. Admittedly, the concept of leadership has been dramatically underestimated in the literature on BIM implementation. For instance, Liao and Teo (2019), when examining the key change drivers for the comprehensive implementation of BIM, pointed out that the "BIM vision and leadership from management" were the factors most frequently mentioned by respondents, which are indeed integral components of transformational leadership. Although Olugboyega (2022) introduced the concept of BIM leadership to address the leadership needs associated with BIM transformation in construction organizations. However, there is a lack of discussion on the mechanisms through which leadership impacts BIM implementation. Moreover, they are skeptical about whether a transformational leadership style is suitable for leading BIM initiatives. The findings of this paper provide a solid response to this skepticism, demonstrating that transformational leadership is indeed an appropriate leadership style for BIM implementation, and align with the prior research conducted by various scholars (Chan, Liu, and Fellows 2014; Chen et al. 2012; Liu and Chan 2017; Pham, Pham, and Dang 2022; Pham et al. 2023; Waziri, Ali, and Aliagha 2015; Wong and Lam 2012), which demonstrated that transformational leadership practices have a significant impact on fostering technological innovation and organizational change.

The introduction of organizational unlearning provides a new perspective for understanding the difficulties and coping strategies of BIM implementation at the organizational level. It has been noted that the lack of BIM expertise is still quite common in the Chinese construction industry, and most organizations still lack the knowledge of how to adapt traditional design and construction processes to meet the requirements of BIM implementation based on their organizational and project features (Cao et al. 2017). Wong and Lam (2012) called for an examination of why some construction organizations struggle with effective learning and suggested further exploration into the processes that facilitate organizational unlearning. And they indicated that for construction organizations, external turbulence could serve as a trigger for organizational unlearning. However, this study found that leadership within the organization can also effectively promote organizational unlearning. This provides a beneficial supplement to their research findings and also enriches the field of organizational learning research within the construction management domain. In construction organizations, unlearning could be regarded as a prerequisite for new technology implementation, and through unlearning, organizations can discard outdated knowledge and beliefs to make room for the introduction and absorption of new technology. Recently, a literature review by Graham, Nikolova, and Sankaran (2020) revealed that organizational learning is a prominent issue facing the construction industry, calling on scholars in the field of construction to examine how different leadership approaches can support organizational learning within construction projects. Later, Sharma and Lenka (2024) pointed out that current research has many limitations in studying the role of top leadership in unlearning. There is a lack of empirical evidence to support the relationship between transformational leadership and organizational unlearning. This paper, based on the research context of BIM implementation, effectively addresses their concerns and confirms the positive relationship between transformational leadership and unlearning.

6. Conclusion

From an organizational change perspective, this study examines the organizational mechanisms of BIM implementation in construction companies by integrating transformational leadership and organizational unlearning, attempting to expand the research boundaries of BIM implementation at the organizational level. Empirical results based on 124 construction companies show that both transformational leadership and organizational unlearning have a positive impact on BIM implementation and that the impact of transformational leadership on BIM implementation is mainly achieved through

organizational unlearning. Under the guidance of transformational leadership, the organization discards outdated knowledge and beliefs by engaging in unlearning activities, which provides ample space for the learning and implementation of BIM knowledge, and consequently, the BIM implementation level was improved.

The findings of this paper can provide the following insights for organizations in the construction industry. First, managers of construction companies should recognize the crucial role of transformational leadership in implementing new technologies, take the initiative to understand the traits of transformational leadership and cultivate their transformational leadership style. For example, top managers are suggested to be open to emerging technologies, proactively learn market dynamics, and make efforts to overcome dependencies on prior knowledge and technological pathways. Second, construction companies should create a learning organization and establish mechanisms to identify and discard outdated processes and practices that are no longer applicable, making room for the adoption and application of BIM technology. This can be achieved through regular internal reviews and feedback sessions to understand the shortcomings of current technologies, encouraging employees to propose new technological solutions and leveraging organizational resources to help them overcome potential challenges and resistance when necessary. Lastly, creating a culture that encourages innovation and tolerates failure is well encouraged. When trying out new technologies, managers could create a safe-to-fail zone where employees can experiment with new ideas without the fear of negative consequences affecting their careers.

This study features several limitations, which may provide valuable insights for future studies. First, the data used for empirical analysis in this study are cross-sectional, which may have certain disadvantages in terms of causal arguments. A longitudinal research design is suggested to further validate the causal relationship between transformational leadership, organizational unlearning, and BIM implementation through data collection at multiple time points. Moreover, although we have conducted a pilot study to ensure the accuracy of the wording as much as possible during the questionnaire design process, given that this study was conducted in mainland China, which might be flawed with response bias in sample. Given that BIM implementation varies from country to country around the world, this paper encourages future research to validate and extend the research model of this study in other contexts to generate a more comprehensive understanding of the relationship between leadership and BIM implementation. Comparative studies based on different macro contexts would be very interesting. Meanwhile, collecting survey data in batches and at different times is also a practice worth considering to avoid the response bias.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

Data during the study is available from the corresponding author by request.

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