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BIM leadership theory for organisational BIM transformation

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Construction firms are struggling to stay in business as a result of BIM's new and compelling business model and potential. As a result, businesses must adapt their current operations to the BIM paradigm by developing new organisational leadership capabilities. While such BIM leadership capacity is critical in designing, advancing, and driving a competitive and successful BIM transformation, BIM researchers have largely ignored it. Thus, this research explores the leadership capacities to drive BIM transformation in construction organisations in order to determine whether it will provide a leadership model as a solution to the leadership demands of organisations undergoing BIM transformation. The study design was a confirmatory sequential mixed methods research strategy that included a theoretical framework established through literature synthesis, qualitative grounded theory, and artificial intelligence (AI)-based modelling. Following the GT analysis, leadership capacity to drive organisational BIM transformation equates to the capability to develop a BIM-friendly leadership orientation, build a BIM-focused leadership procedure, perform BIM-related leadership responsibilities, generate a BIM-enabled leadership environment, and reach maturity within the realms of these strengths. The overall results of the AI-based modelling demonstrated that the acceptable capacity needed by the leadership that is pivoting organisational BIM transformation is the capability to coordinate functions, individuals, and transition alignment; produce BIM-related policies and a positive atmosphere for BIM implementation; and impartiality in recruiting individuals for BIM leadership roles. The study's findings have implications for targeting key initiatives that might aid leaders in constructing adaptation strategies for organisational BIM transformation.

KEYWORDS

bim, BIM implementation, BIM leadership, BIM transformation, machine learning, BIM implementation in organisations

1 Introduction

The application of BIM in an organisation is referred to as organisational BIM transformation. According to Heaton and Parlikad. (2020), organisational BIM transformation is the process of integrating digital processes into organisations. As per Papadonikolaki and Aibinu. (2017), organisational BIM transformation is the

replacement of digital technology for labour to enhance efficiency; utilising BIM to gather, store, process, and transfer information; and using BIM to innovate, transform enterprises and the supply chain to obtain a competitive edge. Organizational BIM transformation, according to these definitions, is the process of conceptualising BIM as a method for changing the working and business processes of construction organisations. It further underlines that without BIM transformation, any country's BIM adoption process is incomplete, because BIM transformation is crucial to making meaning of BIM implementation in industry and projects (Troiani et al., 2020).

Scholars have attempted to tie BIM transformation to organisational settings due to its importance in completing the BIM implementation process. These scholarly efforts have resulted in studies of how major public clients commence BIM implementation in their organisations (Lindblad and Vass, 2015); the role of macro-BIM maturity factors in promoting micro-level implementation effectiveness in design firms (Troiani et al., 2020; Udomdech et al., 2021); organisational BIM implementation training needs (Semenov et al., 2021); and BIM factors for construction organisations (Mohammad et al., 2018). According to the findings of these research, BIM deployment in organisations will necessitate steadily larger modifications to the organisations' business processes and work practises, BIM mentoring and tutoring, and the creation of new role descriptions that include BIM leadership.

The necessity for BIM leadership becomes critical since organisations are generally unsure about how BIM deployment should and will affect their enterprises (Lindblad and Vass, 2015). According to Papadonikolaki and Aibinu. (2017), leadership is critical for BIM transformation in organisations because BIM disruption and its associated business models will affect the construction production process, which may not instantly result into additional business. While transformational leadership appears to be the best BIM leadership style (Islam et al., 2020), there are reasons to be sceptical. First, there are hurdles for organisational leadership during the transition process due to existing legacy business, normal operations, and specialised demands that correspond to leadership needs. Second, a basic premise of transformational leadership theory is that all leadership processes and outcomes are essentially the same. This has been heavily contested in the leadership literature (Odumeru and Ifeanyi, 2013; Asbari, 2020). Third, most transformational leadership studies rarely discuss in detail the influence mechanisms and interaction variables between transformational leadership and outcomes, which ultimately determine effectiveness. This means that transformational leadership cannot fully address the potential and challenges of BIM transformation, and that other leadership abilities are required for BIM transformational leadership.

Studies have recommended that for organizations to overcome transformation resistance and survive in the digital and change era associated with BIM transformation, they should extend and refine their current competencies or innovate (Lindblad and Gustavsson, 2021), combine transformational and change leadership (Alqatawenah, 2018), digital leadership skills, and the active participation of diverse stakeholders affected by transformation (Artuz and Bayraktar, 2021; Eryesil, 2021), strategic thinking and better organizational structures (de Araujo et al., 2021), and extensive knowledge of BIM and business process modelling (Ghaffarianhoseini et al., 2016). These criteria suggest that organisational BIM transformation has greatly altered existing leadership abilities and style because it covers all forms of transformations such as digital, process, and skill transformation. Achieving organisational BIM transformation necessitates a new type of leadership that is agile and varied enough to follow the digital route for business operations, as well as adopting new attitudes and capabilities to respond to organizational change. This type of leadership should have a leadership style that can transform the organization while also directing it in the appropriate path and with a clear and relevant vision. A capacity to address BIM concerns and duties for employees; digital technology competencies; a shared knowledge of BIM; and the availability of BIM-competent individuals.

While such BIM leadership capability is critical in establishing and guiding a competitive and successful BIM transformation, BIM scholars have largely ignored it. Thus, the goal of this study is to look into the leadership competencies required to drive BIM transformation in construction organizations and to suggest a leadership model as a solution to the leadership demands of organizations undergoing BIM transformation. The specific research objectives are to identify the indicators of organizational BIM transformation, analyze the various leadership demands related to organizational BIM transformation, investigate the right BIM leadership capacity for an effective organizational BIM transformation, and propose a BIM leadership theory based on the appropriate BIM leadership behaviour and competences.

2 Literature review

Papadonikolaki and Aibinu. (2017) remarked in a discussion of BIM business model innovation in construction businesses that leadership commitment was critical for achieving BIM adoption goals and that flexible organisational structures were adaptable to BIM modifications. It was also stated that the rate of BIM adoption and company success are dependent on leadership. Papadonikolaki and Aibinu. (2017) confirm Lindblad and Vass (2015)'s earlier conclusion that for BIM transformation to occur in organisations, changes in the organisation, work methods, and employee abilities are required. Other BIM transformation criteria, such as BIM maturity, BIM experience, and staff competency, have been

cited in the literature as necessitating the need for leadership (Ahnkoob et al., 2018; Hong et al., 2018; Sackey et al., 2019; Awwad et al., 2020; Heaton and Parlikad, 2020; Lindblad and Gustavsson, 2021). Ahankoob et al. (2018), for example, evaluate the impact of BIM maturity and years of experience on contractors' absorptive capacity to accept new knowledge for organisational learning. While BIM experience is a major predictor of contractor absorptive capacity, there is no significant association between BIM maturity and absorptive capacity, according to the study.

Hong et al. (2018) examined the benefits, costs, and constraints of BIM implementation for small and medium-sized construction contractor organisations. According to the study, the existing staff's capacity to use BIM tools will have a beneficial impact on the construction of an organisational knowledge-support system, which will determine the decision to adopt BIM. Sackey et al. (2019) investigate how construction organisations may deploy knowledge and adapt to the necessary abilities in order to respond appropriately to the ever-changing technological and organisational transformations to handle the contemporary construction difficulties. Following the study's findings, construction companies should focus on regularly addressing known tensions and inconsistencies between existing knowledge and the demands of a changing work environment. As per Poirier et al. (2015), radical innovation and numerous layers of embedded contextual elements will affect the BIM transition in specialist contracting for small and medium-sized firms. In an investigation of the recent BIM adoption condition, Ghaffarianhosein et al. (2016) discovered that approximately seventy-five percent of United Kingdom construction sector SMEs are non-BIM compliant. It was determined that SMEs still require staff and skill upgrades, quality assurance methods, and IT software/hardware solutions.

The BIM leadership consensus has not yet produced the proper BIM leadership style. In accordance with a literature analysis, the leadership requirements for BIM transformation in organisations include the leadership systems that will guide the transformational process, the change process, the digitalization process, and the developmental process. This means that transformational leadership is an appropriate leadership style for efficiently managing organisational change. This is because the primary goal of transformational leadership is to effect significant change in an organisation by appealing to followers' higher ideas and valuesand providing them with an uplifting sense of being linked to the change (Alqatawenah, 2018). Numerous studies have found transformational leadership to be effective in organisational change. Islam et al. (2020) investigated the impact of transformational leadership on employee championing behaviour during organisational transition. According to the findings of this study, transformational leadership has a considerable impact on employee trust in leadership and championing behaviour throughout organisational transition. Peng et al. (2020) discovered a favourable relationship between transformational leadership and employees' reactions to organisational change in a study examining the relationship between transformational leadership and commitment to change, openness to change, and preparedness for change.

Purwanto et al. (2021) discovered that transformational leadership had a positive and significant effect on organisational citizenship behaviour in supply chain management when they investigated the effects of transformational leadership, organisational commitment, and job satisfaction. Farahnak et al. (2020) investigated a multilevel model of transformational leadership and leaders' attitudes toward the innovation under consideration as predictors of employee attitudes and implementation success. The findings supported the existence of favourable correlations between transformative leadership and workforce attitudes. The findings also revealed that the leader's behaviours are more important than the leader's attitudes in terms of innovation implementation. Alrowwad et al. (2020) investigated the role of intellectual capital and creativity in moderating the relationship between transformational and transactional leadership and organisational success. As shown in the findings, transformational and transactional leadership have a favourable impact on organisational performance.

In order to confirm transformational leadership as effective in BIM transformation, BIM leadership must select personnel who are devoted, committed, and have a favourable attitude toward BIM transformation. It also implies that BIM leadership should centralise BIM knowledge by actively cooperating and conducting internal marketing to persuade colleagues of the benefits of BIM. However, the transformation and application of digital technologies that would result from BIM transformation are distinct concepts that would necessitate leadership (Papadonikolaki and Aibinu. (2017); Henricks et al., 2020; Faupel and Süß, 2019). Because of this fact, the concepts of change and digital leadership have emerged. As said by Usman (2020), when an organisation experiences significant organisational change or multiple organisational alterations, change leadership is required, regardless of whether transformational leadership is used. Change leaders, according to Dumas and Beinecke (2018), are critical in enabling their organisations to learn, develop, experiment, and prepare for change by continually seeking new viewpoints and fostering engagement within the business.

Ghavifekr and Adewale (2019) discovered that change leadership generates confidence in employees, stimulates them, and helps to ensure trust. Jung et al. (2020) explored the association between empowered leadership and organisational commitment to change. The findings demonstrated that empowered leadership was favourably associated to organisational change commitment. Dung and Hai (2020) discovered that transformational leadership has a positive and significant influence on job satisfaction and organisational

commitment to change in an investigation of the relationship between transformational leadership, job satisfaction, and employee commitment to organisational change. Change necessitates leadership because it is necessary to express the need for change, motivate the entire organisation to change, articulate the organization's vision for change, and make resources available for achieving change. Change leadership is also crucial since it necessitates being aware of corporate trends and evolutions, being resilient and flexible in producing and anticipating change, and responding positively to change (Dumas and Beinecke, 2018).

There is a limited understanding of how to facilitate BIM leadership capacity in relation to organisational BIM transformation and its contextual complexities. Existing leadership capacity knowledge has only covered frameworks for tourism leadership (Hirudayaraj and Sparkman, 2019; Fang et al., 2022), school leadership (Sentocnik et al., 2018; Owen et al., 2020; Sindhvad, 2021; Yue and Feng, 2021), healthcare leadership (Hartviksen et al., 2018), and clinical academic leadership (Westwood et al., 2018). According to Hirudayaraj and Sparkman (2019), leadership capacity prepares leaders for unexpected events as well as the complexities that arise before, during, and after these events. They also proposed that a framework for developing leadership capacity should include an understanding of the crisis processes and factors that can be known ahead of time, as well as the development of a mindset that allows the leader to address those factors that cannot be known ahead of time. As said by Owen et al. (2020), a leadership capacity programme should include both directive and collaborative elements, as well as transformative theoretical aspects. While according Hartviksen et al. (2018), a leadership capacity framework should include a mix of understanding the complex context, knowledge, trust, and confidence. In line with the findings of Yue and Feng (2021), leadership capacity development should include vision, collaborative culture, and atmosphere. Because BIM leadership is a digital technology, it demands the capacity to lead or guide other individuals, teams, or entire organisations with a fundamental technical understanding of the influence of digital technologies on the business (Amelda et al., 2021).

As noted by Artuz and Bayraktar (2021), digital leadership is the new leadership model because it allows a leader to be willing to carry her/his knowledge and skills forward and take continuous learning as a principle, which will put the leader and organisation one step ahead of competitors and follow digital trends. de Araujo et al. (2021) observed that digital leadership is critical for organisations to thrive in this new digital era as digitalization and technical innovations are reshaping organisational structures, processes, business models, and strategies. In the opinion of Thomson et al. (2016), an organisation may not be able to direct the strategic level of organisational and human resources under organisational strategic objectives to align the organisation with the external environment without digital leadership. In support, Brunner et al. (2021) argued that organisations may be unable to digitally adapt and accept new technology without digital leadership. This study leveraged literature findings to argue that the ideal leadership capability for BIM transformation is a combination of the behaviours and skills from transformational, digital, and change leadership.

3 Methodology

3.1 Research design

The research approach is based on a sequential mixed methods research design with three distinct phases that set it apart from exploratory sequential mixed methods research. Exploratory sequential mixed methods research is a mixed-method research configuration in which qualitative data is collected and used as a comparative data set in decoding and improving quantitative data findings (Asenahabi, 2019; Chiarini and Kumar, 2022). In a three-step research process, quantitative data is emphasised and applied to substantiate qualitative data rather than explain it in a confirmatory sequential mixed methods research design. The first step is to create a theoretical framework based on the existing literature. The second phase entails gathering qualitative data based on the theoretical framework and developing theory based on the qualitative data analysis using grounded theory analysis. In the third step, quantifiable data is collected and analysed using hypothesis testing methods in order to confirm the theory that was propounded in the second step (Olugboyega, 2022).

3.2 Study population and sampling

Three BIM champions and two BIM experts were interviewed for the qualitative portion of the study, all of whom are actively involved in the planning, decision-making, and execution of digital transformation in their organisations. The sample method and criterion utilised in selecting applicants for the in-depth interview were theoretical sampling with expert selection procedures. After theoretical saturation, the selection of experts was halted. The units of analysis in this study are Nigerian construction enterprises, with the senior management of these firms serving as the observed unit. A four-stage sampling and selection approach was used to choose the research population for quantitative data collection. The target demographic in the first step is

construction enterprises listed on the Federation of Construction Industry (FOCI) list. This results in a target population of 87 construction companies.

The second phase was a systematic selection of firms at a sample interval of three. Systematic sampling is a type of probability sampling in which researchers select members of a population at predetermined intervals. It mimics many of the randomization outcomes of simple random sampling and assigns each item a completely equal chance of being chosen (Mukherjee and Singh, 2021). In this study, the sampling interval was established by dividing the total projected population size by the preliminary sample size. Using the desired error margin, level of confidence, and total projected population size, the preliminary sample size was determined using an online sample size calculator (https://www.qualtrics.com/uk/experience-management/research/determine-sample-size/). This results in a research population of organizations. The sample frame and final sample size for the study were decided in the third and final step by taking an equal number of construction experts (3 per firm) from all of the selected firms. This results in a sample size of 87 research subjects. The study included 72 professionals, representing an 82.8% response rate.

The profiles of the respondents were analysed for factors such as BIM experience, managerial level, project experience, and leadership experience. Participants in the top management level accounted for 86.1% of all respondents, while those in the middle management level accounted for 13.8%. All respondents (100%) had received BIM training, 25% had worked on BIM projects, and 13.9% had assisted with BIM execution planning. In terms of project experience, 91.6% had more than 15 years of experience, while 8.33% had less than 15 years. In terms of leadership experience, 70.8% had been involved in decision-making, 61.1% had been involved in vision-casting, and 87.5% had been involved in business development meetings. The research participants' profiles revealed that they have the necessary project, management, BIM, and leadership experience to comprehend the research questions and give relevant information.

3.3 Data collection and measured variables

The qualitative data were collected through 90—120-min semi-structured interviews, which were then verbatim transcribed. The interview is a three-round process that includes pre-screening, technical, and probing rounds. The screening round was relatively brief and conducted over the phone. It was intended to use profiles to narrow down an extensive collection of experts. Second-round interviews were more in-depth, informative, technical, and open-ended. They took place in person and provided an opportunity to gain insights and understanding of the topic from the interviewees. The probing round was used to clarify insights, stances, hypotheses, missing information, and ambiguous concepts. The interview questions were created by distilling the theoretical framework's postulation into a set of questions for the interviewees. What are the primary signs of BIM transformation in a construction firm, regardless of size or area of specialisation? What are the varied leadership requirements for organisational BIM transformation? What role would transformational leadership behaviour, as well as change and digital leadership competencies, play in achieving a successful organisational BIM transformation? The quantitative data was collected using a face-to-face questionnaire survey with exhaustive interpretations of questions to ensure that participants understood the questions and completed the survey. The hypothesised framework resulting from the constructed grounded theory was used to generate the questionnaire questions. Table 1 shows the factors that were examined in the questionnaire.

3.4 Data analysis

Following the collection of qualitative data from interviews, Grounded Theory (GT) was used to analyse the qualitative data. GT is a theory testing and building process. It was used in this study to determine whether the postulation in the theoretical framework incorporated the BIM specialists' practical experience, knowledge, and terminologies. GT analysis was carried out by limiting respondent responses to concepts. The ideas were combined to build a theory that explains BIM leadership capacity and organisational BIM transformation. Based on the data comprehension, the developed theory was formulated into a hypothesised framework. The theoretical construction recognised the data's dependability and validity. This was judged by how well the qualitative data matched the research objectives. The appropriateness was determined by four criteria: whether the constructed GT fits the phenomenon of the study; whether the constructed GT is meaningful, understandable, and represents reality; whether the GT is built from integrated concepts; and whether the constructed GT provides hypotheses to guide further analysis or research (Sato, 2019). The generated GT was turned into a set of statements for the gathering of quantitative data. The hypothesised model in Figure 1 was constructed from Figure 2 and tested using a machine learning method through a series of different linear regressions.

Machine learning is a predictive modelling approach that focuses on minimising model error or creating the most accurate forecasts feasible at the sacrifice of explainability (Kassambara,

TABLE 1 results of the mean score analysis.

Construct and sub-constructs	Items	Mean score	Parallelity level
Indicators of organisational BIM transformation	Consensus for BIM implementation	4.44	Highly Agree
	Sustained BIM commitment	4.54	Highly Agree
	In-house BIM proficiency programme	4.11	Agree
	Site BIM transition programme	4.39	Highly Agree
Leadership needs of organisational BIM Transformation: *Digital transformation*	Ensuring digital capability	4.70	Highly Agree
	Ensuring digital innovation	4.75	Highly Agree
	Ensuring digital culture	4.79	Highly Agree
	Ensuring digital adaptability	4.89	Highly Agree
Leadership needs of organisational BIM Transformation: *People transformation*	Encourage employees to embrace capacity development	3.89	Agree
	Encourage employees to embrace organisational BIM vision	4.78	Highly Agree
	Encourage employees' BIM engagement	3.77	Agree
	Encourage employees' commitment to BIM	3.97	Agree
Leadership needs of organisational BIM Transformation: *Process transformation*	Create a conducive environment for BIM-based collaboration	4.56	Highly Agree
	Ensure shared understanding of BIM process	4.55	Highly Agree
	Create opportunity and support for acquiring BIM capacity	4.12	Agree
	Create competitive environment for BIM-based business opportunities	4.01	Agree
Leadership needs of organisational BIM Transformation: *Individual skills transformation*	Identify and promote highly BIM capable individuals	4.22	Highly Agree
	Allow highly BIM-competent individuals to manage BIM transformation	4.71	Highly Agree
	Identify employees that demonstrate extreme personal humility towards improving their BIM skills	4.63	Highly Agree
	Identify employees that demonstrate intense professional will towards improving their BIM skills	4.21	Highly Agree
Appropriate BIM leadership capacity (BIM-friendly leadership orientation): *Task-oriented leadership*	planning and organizing group and team activities towards BIM	3.44	Agree
	BIM decision-making	3.54	Agree
	BIM task coordination	4.20	Agree
	setting BIM goals	4.21	Highly Agree
	BIM performance management	4.28	Highly Agree
Appropriate BIM leadership capacity (BIM-friendly leadership orientation): *Relationship-oriented leadership*	Solving BIM-related problems	4.31	Highly Agree
	Recognizing BIM adoption pattern among the employees	4.38	Highly Agree
	Supporting employees to acquire BIM capacity	4.76	Highly Agree
	Trust the employees' BIM ability	4.56	Highly Agree
Appropriate BIM leadership capacity (BIM-friendly leadership orientation): *Change-oriented leadership*	Explore new BIM concepts	3.78	Agree
	Work towards improved BIM implementation in the future	3.86	Agree
	Learn from BIM pilot projects and experimentation	4.26	Highly Agree
	Uncover hidden BIM potentials in the employees	4.33	Highly Agree
Appropriate BIM leadership capacity (BIM-friendly leadership selection): *Selection considerations*	Traits	3.42	Agree
	Intelligence	3.43	Agree
	Style	3.78	Agree
	Personality	3.89	Agree
	Identity	3.44	Agree
	Values	3.57	Agree
Appropriate BIM leadership capacity (BIM-friendly leadership selection): *selection strategies*	Tenure-based strategy	4.20	Agree
	Position-based strategy	4.22	Highly Agree
	Competency-based strategy	4.38	Highly Agree
	Change-based strategy	4.59	Highly Agree
Appropriate BIM leadership capacity: *BIM-related leadership roles*	Coordinate work process	4.33	Highly Agree

(Continued on following page)

TABLE 1 (*Continued*) results of the mean score analysis.

Construct and sub-constructs	Items	Mean score	Parallelity level
	Monitor work process	4.83	Highly Agree
	Facilitate changes in resources	4.77	Highly Agree
	Provide mentorship	4.12	Agree
	Provide vision	3.42	Agree
	Provide motivation	4.28	Highly Agree
Appropriate BIM leadership capacity: *BIM-enabled leadership climates*	Encourage others to acquire BIM competence	4.10	Agree
	Encourage himself/herself to acquire BIM competence	4.17	Agree
	Agree to BIM implementation as a major part of leadership responsibilities	4.82	Highly Agree
	Agree to BIM implementation as essential to the organization	4.22	Highly Agree
Appropriate BIM leadership capacity: *BIM-enabled leadership maturity*	Exhibiting balanced leadership with a blend of personal humility and professional will	3.44	Agree
	Acquiring transactional and motivational qualities	3.48	Agree
	Acquiring people organization skills	3.52	Agree
	Exhibiting group cooperation skills	3.46	Agree
	Exhibiting BIM talents, skills, and knowledge	3.44	Agree

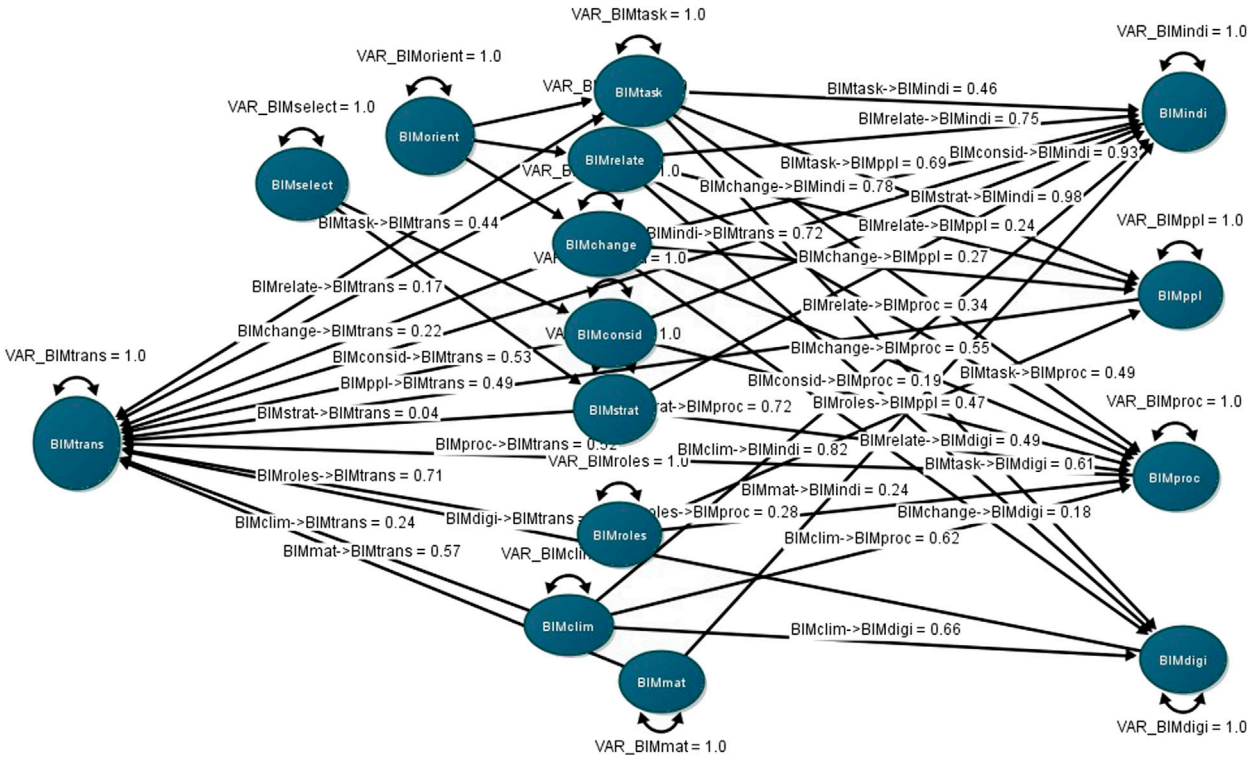

FIGURE 1
Validated model of BIM leadership for organisational BIM transformation.

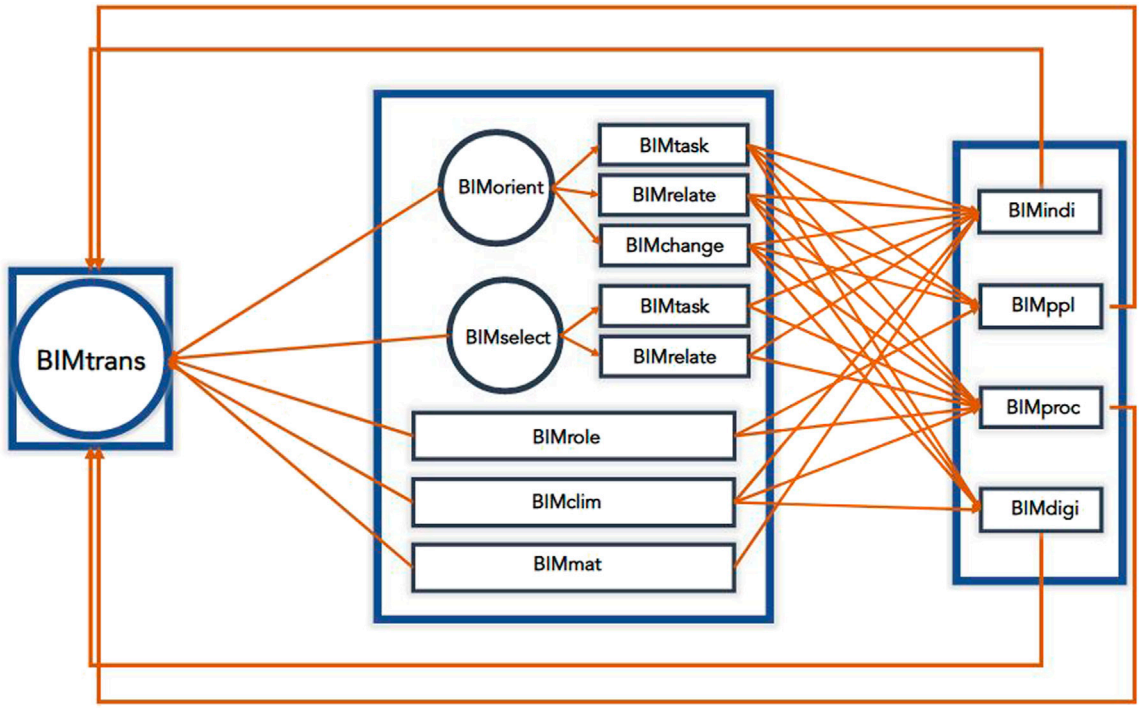

FIGURE 2
Hypothesised model of BIM leadership for organisational BIM transformation.

2018). By determining the effect (direct and mediational effects) and the link between variables in the theory, machine learning was utilised to validate the validity of the hypothesised relationships in the BIM leadership theory. The regression coefficients were used as path coefficients in the model to determine the direct and mediational effects. The conditional indirect influence of the mediating variable on the link between the predictor (BIM transformational leadership needs) and the outcome variable (Organisational BIM transformation) is tested using mediational analysis. WEKA version 3.8.6 machine learning software was employed for the analysis. For the machine learning analysis, a full training set of classifier mode and 10-fold cross validation were chosen. The Sobel test was used to measure the significance of the mediational effect. Mean Item Score Analysis (MISA) was used to determine the importance of the variables. The following is how the mean scores were interpreted: 1.01–1.80 = severely disagree, 1.81–2.60 = disagree, 2.61–3.40 = agree to some extent, 3.41–4.20 = agree, and 4.21–5.00 = highly agree. For the statements under each variable, Likert scale responses were used. To transform the variables to numerical variables for the Machine Learning study, the Likert values of all the statements under each variable were added.

4 Results

4.1 Theoretical framework of BIM leadership

Based on the aforementioned literature synthesis in section 2, four theoretical findings can be identified:

A BIM transformation in an organisation will produce disruption, culminating in a digital revolution and change that will require particular leadership skills.

While transformational leadership may be the most appropriate leadership style during times of BIM transformation, it is primarily focused on the people at the expense of the BIM process, BIM maturity, and BIM technology, all of which are critical parts of BIM transformation.

In addition to transformational leadership, digital leadership is essential to shape and express the organisational BIM vision through digital culture, digital insights, and digital competency.

Change leadership is also important in BIM transformation because it emphasises prudence and a thorough understanding of the organization's external environment and organisational change dynamics such as changes in the global environment, changes in labour, technological changes, and an increasingly

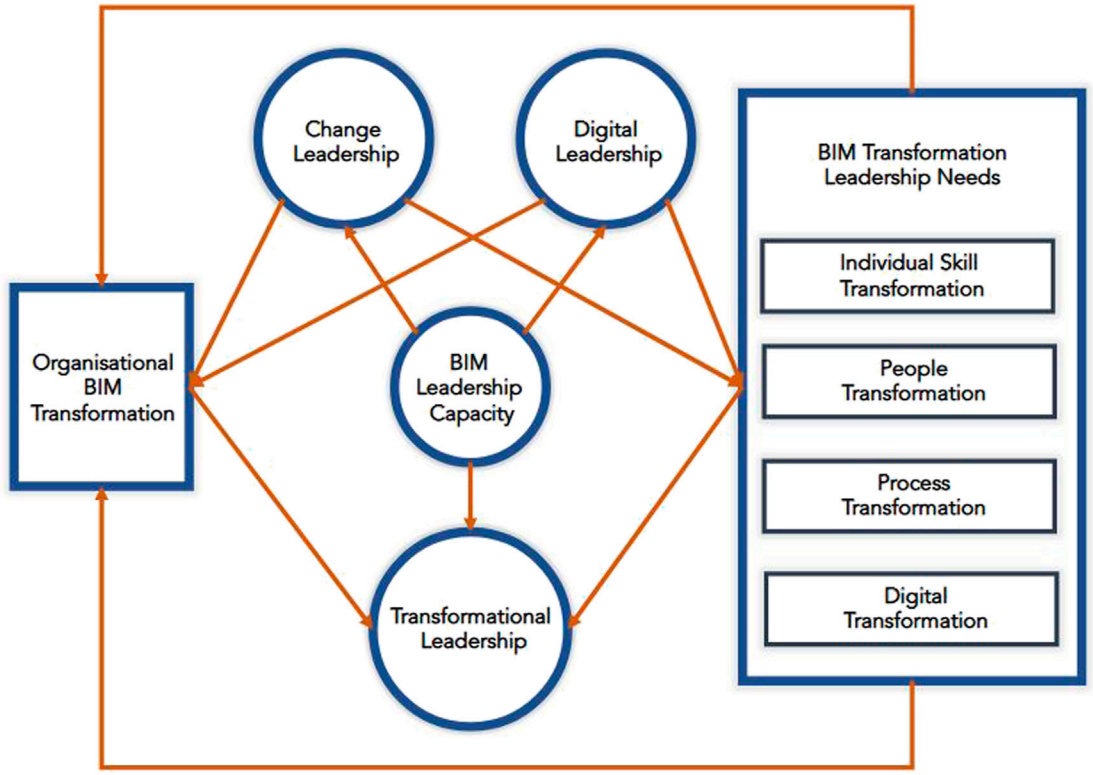

FIGURE 3
Theoretical framework of BIM leadership for organisational BIM transformation.

competitive environment, as well as a constantly changing economic environment.

Figure 3 depicts a theoretical framework that incorporates these theoretical concepts. According to the framework's claim, transformational leadership behaviour, as well as digital and change leadership competency, are required for an effective organisational BIM transformation. Individual skills, people, processes, and digital transformation will result from the availability of these leadership behaviours and competences, leading to BIM transformation in organisations.

4.2 Grounded theory of BIM leadership

The GT analysis results were given in accordance with the research goals. The first goal was to find markers of organisational BIM change. A construction organisation has achieved a BIM transformation, according to the interviewees, when there is consensus for BIM deployment, ongoing BIM commitment, and programmes that accommodate for in-house BIM competency and site BIM transfer. The following statements established this:

Employees' shared grasp of what BIM is and their dedication to BIM implementation are indications of BIM transformation in a construction organisation [R2].

An organisation that consistently encourages its personnel to use BIM on projects and 11 motivates them to build new and innovative BIM skills is considered to have successfully achieved BIM transformation [R4].

First, there must be proof of stakeholder involvement in BIM implementation. Second, in order to claim BIM transformation, a company must have aligned BIM with organisational enterprise. Third, the company must have a plan in place for BIM education and training. Finally, a BIM-transformed organisation must have made the usage of BIM on project sites an institutionalised practise [R2].

Regarding the numerous leadership needs associated with organisational BIM transformation, the interviewees' replies indicated that BIM transformation leadership in construction organisations necessitates the transformation of personnel, work processes, digital tools, and individual talents. The following statements demonstrate this:

Employees have their own personal and professional concerns and expectations. If a leader or an organization's leadership is attempting to achieve BIM transformation in a

company, the concerns and projections of the workforce must be addressed. This is critical because it is the employees who complete the work and integrate BIM into the work process. As a result, addressing employees' BIM-related demands is a critical leadership necessity of organisational BIM transformation [R1].

Organizational BIM transformation necessitates organisational leadership to cast the BIM vision, convey the vision, deliberate on its implementation, and sell the vision to managers and employees [R3].

Organizational leaders who want to use BIM must guarantee that capabilities in BIM technological tools are spread throughout the organisation. BIM skills and capabilities must be emphasised and encouraged from the bottom to top echelons. It is necessary to define BIM roles and responsibilities. Leadership must provide incentives and motivation for the development of BIM capabilities and innovation [R4].

The analysis of responses on the role of transformational, digital, and change management in achieving an effective organisational BIM transformation revealed that the leadership capacity required for organisational BIM transformation would be formed by the integration of leadership behaviour and competencies that would theoretically emerge from digital, transformational, and change leadership but would practically emerge from the determination of the leader. A BIM-friendly leadership orientation, BIM-focused leadership selection, BIM-related leadership responsibilities, and a BIM-enabled leadership climate and maturity would be required for such a determination. The following statements demonstrate this:

In practise, distinguishing between leadership behaviour and competence is tough. Reality, challenging situations, new and unexpected changes, and the leadership's innovativeness would blur the difference lines between ideas such as transformational, change, and digital leadership. As a result, for the practical implementation of BIM in an organisation, we are left with the leader's perspective. If the leadership was committed to achieving BIM transformation, they would have been persuaded of the importance of BIM implementation. They would also pick people with a similar attitude (those who are equally convinced of the importance of BIM) to drive the BIM transformation and interpret their roles and duties as needed. Resources would also need to be put in place for these individuals to grow in their responsibilities and capacities [R2].

Real-life events do not always occur in the same order. Although laws and theories can be proposed to describe a phenomenon, there will always be an exception. I firmly believe that transformational leadership, together with change and digital leadership, will better equip leaders of organisations seeking BIM transformation. However, because these leaders are preoccupied with their daily tasks, they are unaware of these hypotheses and criteria. Perhaps if they attend seminars and workshops, or read books or magazines that explain these concepts, they will understand what to do. However, based on my personal experience, I believe competent leaders are aware of transformational leadership and its application to BIM transformation. Because BIM introduces change and makes use of digital technology, change and digital leadership will play an important role in BIM transformation. In practise, a leader may not be aware of these theories, but through sincerity of purpose and function as a leader, a BIM-friendly attitude, BIM experience and knowledge, a desire for competitiveness and growth, and responsiveness, a leader would have indirectly applied transformational, change, and digital leadership, and much more, to organisational BIM transformation [R4].

A synthesis of the concepts derived from the GT analysis resulted in a postulation stating that the leadership capacity required to bring about individual skills, people, process, and digital transformation towards an effective organisational BIM transformation equates to the ability to acquire a BIM-friendly leadership orientation, establish a BIM-focused leadership selection system, play BIM-related leadership roles, create a BIM-enabled leadership climate, and mature within these abilities' domains. Figure 2 depicts the GT that was constructed.

(BIM_{trans} = organisational BIM transformation, BIM_{orient} = BIM-friendly leadership orientation, BIM_{task} = task-oriented leadership, BIM_{relate} = relationship-oriented leadership, BIM_{change} = change-oriented leadership, BIM_{select} = BIM-focused leadership selection, BIM_{consid} = leadership selection considerations, BIM_{strat} = leadership selection strategies, BIM_{roles} = BIM-related leadership roles, BIM_{clim} = BIM-enabled leadership climate, BIM_{mat} = BIM-enabled leadership maturity, BIM_{ind} = individual skills transformation, BIM_{ppl} = people transformation, BIM_{proc} = process transformation, BIM_{digi} = digital transformation).

4.3 Quantitative data analysis for BIM leadership variables

4.3.1 Indicators of BIM transformation in a construction firm

Table 1 shows the mean score (MS) analysis of BIM transformation indicators in a construction firm. According to the findings, respondents strongly agreed that BIM consensus (MS = 4.44), sustained BIM commitment (MS = 4.54), and a site BIM transition programme (MS = 4.39) are important markers of BIM transformation in a construction firm. The respondents agreed that an in-house BIM competency programme is a strong signal of BIM transformation in a construction firm, with an MS of 4.11.

4.3.2 Leadership needs of organisational BIM transformation

According to the findings in Table 1, organisational BIM transformation requires leadership for process, digital, people,

and individual skill change. Individual skill transformation requires organisations to identify and promote highly BIM capable individuals (MS = 4.22), allow highly BIM capable individuals to manage BIM transformation (MS = 4.71), identify employees who demonstrate extreme personal humility toward improving their BIM skills (MS = 4.63), and identify employees who demonstrate intense professional will toward improving their BIM skills (MS = 4.21). For digital transformation, the respondents strongly agreed that ensuring digital competence (MS = 4.70), digital innovation (MS = 4.74), digital culture (MS = 4.79), and digital adaptability (MS = 4.89) are needed in organisational BIM transformation.

Encouraging employees to embrace capacity development (MS = 3.98) and organisational BIM vision (MS = 4.78) were strongly agreed to as part of people transformation that requires leadership. Respondents also agreed that encouraging employees' BIM engagement (MS = 33 3.77) and employees' commitment to BIM (MS = 3.97) are the leadership needs of organisational BIM transformation that pertain to people transformation. For process transformation, the respondents strongly agreed that creating a conducive environment for BIM-based collaboration (MS = 4.56), ensuring shared understanding of the BIM process (MS 38 = 4.55), creating opportunity and support for acquiring BIM capacity (MS = 4.12), and creating a competitive environment for BIM-based business opportunities (MS = 4.01) are needed in organisational BIM transformation.

4.3.3 Appropriate BIM leadership capacity

As shown in Table 1, all the respondents strongly agreed to BIM-friendly leadership orientation, BIM-focused leadership selection, BIM-related leadership roles, BIM-enabled leadership climates, and BIM-enabled leadership maturity as the leadership capacities that would ensure organisational BIM transformation. For BIM-friendly leadership orientation, task, relationship, and change-oriented leadership were agreed to be the required leadership capacities. All the variables for these leadership competencies were agreed upon or strongly agreed upon by the respondents. Supporting employees to acquire BIM capacity (MS = 4.78), uncovering hidden BIM potential in the employees (MS = 4.33) were the highest scoring variables for task, relationship, and change-oriented leadership, respectively. For BIM-focused leadership selection, personality (MS = 3.89) and change-based strategy (MS = 4.59) were the highly significant variables agreed upon by the respondents for leadership selection considerations and strategies, respectively. Other variables were agreed to by the respondents as presented in Table 1.

Respondents strongly agreed on four variables: coordinate work process (MS = 4.33), monitor work process (MS = 4.83), facilitate changes in resources (MS = 4.77), provide motivation (MS = 4.28) and two variables: provide mentorship (MS = 4.12) and provide vision (MS = 3.42). The respondents strongly agreed that BIM-enabled leadership climates that are appropriate as BIM leadership capacity are encouraging others to acquire BIM competence (MS = 4.10), encouraging oneself to acquire BIM competence (MS = 4.17), agreeing to BIM implementation as a major part of leadership responsibilities (MS = 4.82), and agreeing to BIM implementation as essential to the organisation (MS = 4.22). Table 1 also revealed that the BIM-enabled leadership maturity that are appropriate as BIM leadership capacity for organisational BIM transformation include balancing leadership with a blend of personal humility and professional will (MS = 3.44); developing transactional and motivational qualities (MS = 3.48); developing people organisation skills (MS = 3.52); demonstrating group cooperation skills (MS = 3.46); and demonstrating BIM talents, skills, and knowledge (MS = 3.44).

4.3.4 Machine learning model of BIM leadership

The primary goal of this study was to develop a BIM leadership theory based on BIM leadership capacity that is applicable to organisational BIM transformation. To accomplish this goal, five hypotheses were derived from the GT in Figure 2 to explain the mediating role of BIM leadership capacity in the causative link between organisational BIM transformation and BIM transformational leadership needs: Hypothesis 1: A BIM-friendly leadership orientation mediates organisational BIM transformation through individual skills, people, process, and digital transformations. Hypothesis 2: BIM-focused leadership selection mediates organisational BIM transformation by transforming individual skills and processes. Hypothesis 3: BIM-related leadership roles mediate organisational BIM transformation by transforming processes and people. According to Hypothesis 4, BIM-enabled leadership climates mediate organisational BIM transformation through individual skills, process, and digital transformations. Hypothesis 5: Individual skill transformation facilitates organisational BIM transformation through BIM-enabled leadership maturity.

To test these predictions, a machine learning-based linear regression technique was used to estimate the path-specific impacts of BIM leadership ability variables on the variables of organisational BIM transformation and BIM transformational leadership demands. The variables of BIM's transformational leadership demands functioned as predictors in the path analysis, as shown in Figure 1, whereas the variables of BIM leadership capacity served as mediators. Organizational BIM transformation was the outcome variable. The analysis findings are shown in Table 2. The results showed that BIM leadership capacity mediated the influence of BIM transformational leadership needs on organisational BIM transformation. BIMind had a direct effect of 0.2813 on organisational BIM transformation. BIMtask lowered this to 0.1295, BIMrelate to 0.2106, BIMchange to 0.2191, BIMconsid to 0.2616, BIMstrat to 0.2766, BIMclim to 0.2309, and BIMmat to 0.0665. BIMmat had the strongest mediational effect, while BIMstrat had the smallest. BIMpple's direct influence on organisational BIM transformation was lowered from

TABLE 2 Mediational effect of BIM leadership capacity on the causal relationship between BIM transformational leadership on organisational BIM transformation.

Hypothesis	Hypothesised relationships	Direct effect	Mean Absolute error	Root Mean squared error	Mediation effect	Sig.	Interpretation
H1	BIM_{task} → BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.1295	0.00	Supported
	BIM_{task} → BIM_{trans} and BIM_{pple}	0.4878	0.9333	1.0887	0.3361	0.00	Supported
	BIM_{task} → BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.2513	0.00	Supported
	BIM_{task} → BIM_{trans} and BIM_{digi}	0.1048	1.0008	1.2115	0.0642	0.00	Supported
	BIM_{relate} →BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.2106	0.00	Supported
	BIM_{relate} →BIM_{trans} and BIM_{pple}	0.4878	0.9333	1.0887	0.1191	0.00	Supported
	BIM_{relate} →BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.1756	0.00	Supported
	BIM_{relate} → BIM_{trans} and BIM_{digi}	0.1048	1.0008	1.2115	0.0512	0.00	Supported
	BIM_{change} →BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.2191	0.00	Supported
	BIM_{change} →BIM_{trans} and BIM_{pple}	0.4878	0.9333	1.0887	0.1293	0.00	Supported
	BIM_{change} →BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.2837	0.00	Supported
	BIM_{change} →BIM_{trans} and BIM_{digi}	0.1048	1.0008	1.2115	0.0192	0.00	Supported
H2	BIM_{consid} →BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.2616	0.00	Supported
	BIM_{consid} →BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.0993	0.00	Supported
	BIMstrat →BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.2766	0.00	Supported
	BIMstrat →BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.3749	0.00	Supported
H3	BIMroles →BIM_{trans} and BIM_{ppl}	0.4878	0.9333	1.0887	0.2309	0.00	Supported
	BIMroles →BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.1439	0.00	Supported
H4	BIMclim →BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.2309	0.00	Supported
	BIMclim →BIM_{trans} and BIMproc	0.5181	1.2000	1.3333	0.3198	0.00	Supported
	BIMclim →BIM_{trans} and BIM_{digi}	0.1048	1.0008	1.2115	0.0693	0.00	Supported
H5	BIM_{mat} →BIM_{trans} and BIM_{indi}	0.2813	0.7556	0.9686	0.0665	0.00	Supported

0.4878 to 0.3361 by BIMtask, 0.1191 by BIMrelate, 0.2191 by BIMchange, and 0.2309 by BIMroles. BIMtask has the most mediation impact, whereas BIMrelate has the least. BIMtask reduced the direct effect of BIMproc on organisational BIM transformation from 0.5181 to 0.253, BIMrelate to 0.1756, BIMchange to 0.2837, BIMconsid to 0.0993, BIMstrat to 0.3749 BIMroles to 0.1439, and BIMclim to 0.3198. BIMstrat had the strongest mediational impact, while BIMclim had the weakest. BIMdigi had a direct effect of 0.1048 on organisational BIM transformation. BIMtask lowered the effect to 0.0642,

BIMrelate to 0.0512, BIMchange to 0.0192, and BIMclim to 0.0693. BIMchange has the most mediational effect, whilst BIMclim has the least. The importance and reduced influence of BIM transformational leadership needs variables on organisational BIM transformation *via* BIM leadership capacity show that mediation exists. The presence of mediation validates all hypotheses and lends support to the proposed BIM leadership theory.

5 Discussion

5.1 Indicators of BIM transformation in a construction firm

Consensus for BIM, continuous BIM commitment, site BIM transition, and an in-house BIM competency programme were discovered to be indications of BIM transformation in a construction firm. This finding is consistent with the definitions of BIM transformation provided by Papadonikolaki and Aibinu. (2017), Heaton and Parlikad. (2020), and Troiani et al. (2020), and suggests that establishing a consensus for BIM implementation in an organisation would foster trust, ensure ownership of BIM implementation, ensure commitment to the transformation process, and result in higher-quality outcomes that empower the organisation to move forward in the BIM transformation. It depicts a collaborative process in which all employees develop and agree to support the decision to use BIM in the organization's best interests. According to the findings, organisational BIM transformation should be a consensual decision-making process and a commitment to implementing BIM that satisfies every employee and involves all parties, as well as a willingness to invest time in developing a BIM execution strategy and proposal. When every employee's idea and concern are properly reviewed and handled in good faith, organisational BIM transformation officially begins. This is required for high-quality BIM implementation decisions with strong follow-through. Furthermore, the findings indicate that there must be buy-in from all employees on BIM aims; formal recognition of BIM implementation; cooperative formulation of BIM ideas; as well as a shared grasp of BIM concepts.

Based on the findings, organisational BIM transformation is on track when there is a consensus meeting when employees share their support and concerns. The conclusion of such a meeting will ensure that employees support the BIM transformation decisions taken. Their assistance would reduce BIM implementation-related conflict, build goodwill for BIM implementation, provide a common direction, increase participation and passion for BIM implementation, and improve cooperation for the BIM transformation process. The findings on sustained BIM commitment as a major indication of BIM transformation indicate that there may be challenges along the way, but a prolonged commitment will provide employees with the drive and energy needed to overcome the challenges. Employees will learn what they need to know to be more effective if they maintain their commitment. BIM transformation takes time, there will be obstacles and mistakes, but with consistent effort, a workable method will be discovered. Employees will learn from mistakes and setbacks, hold each other to high principles, rise to BIM implementation hurdles, grow their BIM abilities, and meet high standards with persistent commitment.

The application of BIM on construction sites, according to Whitlock et al. (2018), is the ultimate and practical implementation of BIM. This lends credence to the findings that the site BIM transition programme is a key predictor of organisational BIM transformation. The result is that until a construction business transfers its BIM expertise to the project site, all of its BIM implementation efforts will be ineffective. The findings imply that externally organised or vendor-supplied BIM training and workshops cannot adequately signal organisational BIM transformation or cover every specific workflow circumstance in every organisation. As a result, regardless of how much an organisation spends on BIM training or workshop attendance, an in-house BIM competence programme is still required.

Additional training should be organised to support local practises, allow employees to gain job related skills, allow the organisation to train its own specialists, and allow the organisation to hire individuals who are not BIM adept. An in-house BIM competency training will also give staff with the skills they need to perform BIM-related tasks and efficiently use the BIM system. The in-house BIM proficiency programme will save BIM transformation expenses by allowing internal employees with BIM competences to be pulled in for the proficiency course, in addition to long-term employee commitment. Similarly, an in-house BIM proficiency programme will most likely encourage innovation, allow employees to develop their BIM skills during working hours, strengthen employees' willingness for BIM innovation, ensure longterm organisational success and the ability to keep up with upcoming BIM innovations, and encourage employees to commit to lifelong BIM learning and value learning opportunities. This is critical since BIM research and development is progressing at a rapid pace.

5.2 Leadership needs of organisational BIM transformation

People transformation, according to the findings, is a crucial leadership need for organisational BIM transformation since it has a favourable impact on the overall success of organisational BIM transformation. People are the most essential resource and source of competitive advantage for organisations, and they are the key to BIM change. As a result, they are the most critical asset to harness for organisational BIM transformation.

Organizational BIM transformation can be accomplished through a people-centered transformation because the success of the transformation is dependent on the people involved (Islam et al., 2020). Furthermore, an organisation cannot be considered BIM competent unless its personnel are BIM-competent, inventive, and possess advanced BIM abilities. Organizational leaders must exercise caution when imposing BIM implementation on staff without considering their concerns or the construction of new supporting structures and governance mechanisms.

The findings also show that work and business processes must comply with BIM requirements without identifying the procedures that need to be changed or improved. Process transformation entails improving operational efficiency in existing business processes as well as completely changing corporate operations and workflows to meet business demands. A transition of this magnitude implies a considerable change in the work design, flow, events, and activities. Processes are fundamental to the operations and culture of every organisation. As a result, existing workflows must be modelled to identify gaps, repetition, and redundancy in order to achieve organisational BIM transformation. Following that, new concepts should be implemented, procedures should be modernised, essential business functions should be streamlined, and the business should be structured in accordance with the economic, social, and regulatory aspects of BIM.

As a result, at every step of organisational BIM change, leadership must take process transformation seriously. According to the findings, another leadership requirement of organisational BIM change is digital transformation. Responding to BIM disruption requires digital transformation. This is due to the fact that BIM incorporates digital innovation and disruption, which are the two pillars of digital transformation. As a result, digital tools and technology are required for BIM transformation. To achieve BIM transformation, leaders must weave digital technologies throughout all aspects of the organization (Brunner et al., 2021). This is crucial because digital transformation enables BIM innovation and demand to be met. It also makes the essence and value of BIM more accessible, such as time savings, remote communication, productivity, competitive advantage, innovation, collaboration, and decision-making. Digital transformation will also result in a shift from manual procedures to digital technology or automation, as well as several potentials for BIM innovation and workflow acceleration (Amelda et al., 2021). This will be accomplished through incorporating digital capabilities, tools, and technology into work processes. Organizations may compete better in the ever-changing technological environment by undergoing digital transformation.

Nonetheless, the studies revealed that digital, people, and process transformation are not an organization's only BIM transformation leadership requirements. This is because BIM capability derived from digital, process, and people transformation does not instill confidence and competence in employees to depart from their old, established method of working. Employees who have just received BIM training cannot perform at a proficient level right away. This is due to the possibility that the training programme was poorly conceived, established unrealistic expectations, or was organised by unqualified professionals. Individual BIM skill change requires re-skilling and ongoing growth. Individual steps should be taken by all personnel who are experiencing BIM transformation to create a personal BIM transformation strategy. This is critical because there are BIM skills that require individual development. The availability and promotion of these top-tier BIM-skilled employees is critical to a smoother road for organisational BIM transformation. Because they see BIM transformation as an opportunity rather than a danger, such individuals would greatly contribute to BIM transformation efforts. Similarly, the challenges associated with the reality of BIM transformation may cause digital, people, and process transformation to be stalled or ineffective, but with individual BIM skills transformation, employees will be convinced and motivated to continue with their personal transformation while also adhering to the organisational BIM transformation.

5.3 Appropriate BIM leadership capacity

This is critical because there are BIM skills that require individual development. The availability and promotion of these top-tier BIM-skilled employees is critical to a smoother road for organisational BIM transformation. Because they see BIM transformation as an opportunity rather than a danger, such individuals would greatly contribute to BIM transformation efforts. Similarly, the challenges associated with the reality of BIM transformation may cause digital, people, and process transformation to be stalled or ineffective, but with individual BIM skills transformation, employees will be convinced and motivated to continue with their personal transformation while also adhering to the organisational BIM transformation (Troiani et al., 2020). It will also be useful in guiding and coordinating the entire organisational BIM transformation process; locating the appropriate methods and resources to complete the work; evaluating the transformation's performance; establishing deadlines and responsibilities; and conveying tasks to staff.

According to the findings, selecting the proper leaders for organisational BIM transformation would not only decrease the costs and risks of BIM transformation, but will also assist the organisation in having an effective and competitive BIM transformation (Udomdech et al., 2021). Leaders who will manage organisational BIM transformation should be chosen in an open and fair process, ensuring that only qualified individuals for key leadership positions are chosen. Following the findings of this study, selection factors include intelligence,

attributes, style, personality, identity, and values. Tenure-based, position-based, competence-based, and change-based selection procedures are used. This indicates that context is important when it comes to selecting leaders for organisational BIM change. The candidates chosen should be compatible with BIM implementation in terms of value and style. Those evaluated for selection should not be anti-BIM, but rather have values and personalities that are compatible with BIM implementation. Otherwise, if the chosen leaders have beliefs and personalities that are not compatible with BIM implementation, the efficacy and dedication to organisational BIM transformation would suffer.

Employees would face an unexpected high level of stress as a result of BIM deployment. In this situation, leadership must equip staff with tools, resources, and support. In line with the findings of this study, the critical leadership roles that would be advantageous in this situation include organising and monitoring the work process, facilitating resource changes, and offering mentorship and motivation. These positions are required to establish clarity of purpose, serve as BIM role models, and bring everyone together to work toward BIM implementation. The findings also indicate that the ability to foster a BIM-friendly leadership climate is an important BIM leadership capability. This is critical because a BIM-friendly leadership atmosphere will foster an organisational climate conducive to increased efficiency and inspired personnel. It represents leadership characteristics and emphasises teamwork and achievement. It will develop BIM-related policies, practises, and measures, as well as aid in the development of a positive relationship with employees.

An improved and accommodating working environment that encourages BIM implementation, as regarded by employees, would also provide them with the opportunity to be trusted, valued, and developed. In light of the findings, it is critical to retain and promote talented BIM personnel while also assisting them in developing their BIM skill sets in order for them to become BIM leaders and be recognised for their devotion, achievement, and commitment to BIM transformation. BIM-enabled leadership maturity emphasises that leaders must evolve themselves in order to remain relevant, as well as help their workers develop through growth and development training programmes. This will ensure that everyone is on the correct track, creating value, making constructive contributions, and engaging in positive and rewarding interactions.

5.4 BIM leadership theory

The validation of the five hypotheses proposed to test BIM leadership theory suggests that achieving a successful BIM transformation in an organisation requires addressing employees' BIM concerns, ensuring shared understanding of work process change, ensuring the acquisition of digital competence, and motivating highly BIM competent individuals. Playing BIM-related leadership roles, providing BIM-enabled leadership climates and capacity, having a BIM friendly leadership orientation, and selecting BIM-focused employees for key leadership positions based on appropriate considerations and strategies all demonstrate the required leadership capacity. Organizational leadership must be able to be more effective during BIM transformation since BIM transformation will bring uncertainty and ambiguity. The efficacy of organisational leadership is dependent on the development of BIM-specific behaviours and competences, as proposed by BIM leadership theory. If organisational leadership does not have BIM leadership capabilities, it will be unable to promote higher participation or achieve a more sustainable BIM transformation. In addition, failing to develop BIM leadership capacity or appoint those with BIM leadership capacity to key and official BIM leadership positions will result in an unauthenticated leadership position and an ineffective BIM transformation (Mohammad et al., 2018).

As a notion, leadership capacity denotes the ability to modify leadership techniques in order to generate more or new effective methods of achieving goals (Asbari, 2020). Based on this, the traditional leadership method in organisational BIM transformation will fail. This is due to the fact that organisational BIM change provides a new leadership context, which influences existing leadership behaviours and competencies. This necessitates the development of a leadership mentality that will collect BIM-related leadership behaviours and abilities in order to evolve the leadership capacity required to ensure optimal performance during organisational BIM transformation.

6 Implications

The study's discoveries have consequences for leadership practise. The BIM leadership theory can help leaders who are advancing or planning an organisational BIM transformation identify their limitations and learn how to adapt. It is possible that a company has a hazy BIM transformation strategy. The BIM leadership theory would help leaders analyse and adapt to the BIM transformation situation. The study's findings have significance for identifying specific interventions that could assist leaders in developing capacity building plans for organisational BIM transformation. It will also assist leaders in identifying BIM's transformative leadership needs and adapting to those expectations.

BIM transformation is difficult, and commitment alone is insufficient. The study's propositions would assist leaders in creating accountability for BIM transformation, measuring leadership capability, reflecting on better methods to approach BIM transformation, determining the competences they lack, and developing training programmes for BIM managers, consultants, and leaders. The outcomes of this study also show that leaders should generally exhibit a promising vision and serve as charismatic role models to enhance employees' positive reactions to BIM

transformation and to inhibit negative reactions. Furthermore, this study has significance for producing leaders capable of future change by including BIM leadership capacity characteristics into corporate training programmes.

7 Limitations and future studies

A larger number of participants would improve the generalizability of the study's findings. This study also overlooked the impact of firm size on the required BIM leadership capacity. This study advises a larger sample size for future research, as well as an evaluation of the impact of business size on the effectiveness of BIM leadership capacity. It is also suggested that construction businesses' agility and flexibility in facilitating BIM transformation be explored. Future research topics include the relationship between BIM transformation and client satisfaction, the impact of business success on organisational BIM transformation, and theory for personal BIM transformation plans.

8 Conclusion

This study concludes that in construction organisations, organisational BIM transformation will be evident when there is a satisfactory and cooperative resolution to implement BIM; joint formulation of BIM implementation concepts; determination to resist BIM implementation difficulties and setbacks; transfer of BIM competence to project sites; and BIM training that supports local practises. All of this would not be possible unless there is leadership that utilizes the most critical resources of the organisation for a people-centered BIM transformation. Leadership is also required for the adoption of creative concepts and workflows, the incorporation of digital tools and technology into the culture and spirit of the business, and employee adoption of personal BIM transformation goals.

The ability to combine tasks, people, and change-orientation is the appropriate capacity that the leadership that is anchoring organisational BIM transformation demands. Their fairness in selecting candidates for BIM leadership positions and role-playing as a BIM mentor would also help to improve their leadership ability for organisational BIM transformation. To develop BIM leadership skills, the leadership must also be able to develop BIM-related policies and foster an atmosphere suitable to BIM implementation. The leadership owes it a duty to positively contribute to the growth of BIM-talented persons while building their BIM leadership capabilities. The BIM leadership capability encapsulates the leadership behaviours and competencies required to lead effectively during organisational BIM transformation, and its acquisition validates the BIM leadership position.

By developing an innovative theory to investigate the impact of leadership capacity on BIM transformation in the setting of BIM implementation, this study adds to the current literature of leadership, change management, and BIM implementation in organisations. The theory employs Grounded Theory and machine learning to draw connections between organisational BIM transformation and BIM transformational leadership requirements throughout BIM deployment. The theory describes how BIM leadership capacity and its components act as a moderator.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethic committee of the Obafemi Awolowo University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

OO conceptualised, analysed, and prepared the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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