Cultural orientations and strategic capability for the adoption of building information modeling in construction firms

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Abstract
Digitalization is redefining products and business models worldwide. This places a demand for transformation in a firm’s organizational culture and strategy. This study thus assesses the cultural orientations and strategic capability required for the adoption of building information modeling (BIM) in construction firms as a platform for the enhancement of digital transformation. It examines the prevalence of the orientations and capability, evaluates the relationship among cultural orientations, strategic capability, and BIM adoption as well as predicts a model of BIM adoption from culture and strategy. Data were collected through questionnaires administered to top management staff in construction firms in Lagos State. Factor Analysis, Correlation, and Regression were the adopted statistical tools. The results revealed production, task accomplishment, innovative construction process, workforce, knowledge management, environmental, founder’s belief as well as conflict resolution as the prevalent cultural orientations. The availability of resources to communicate, interact, and collaborate digitally as well as leadership capability to organize and coordinate digitally are the top two strategic capabilities. Despite the respondents’ level of agreement on the constructs; culture and strategic capability contribute 18% of the BIM model. The study concludes that the more the firms’ leadership interacts with digitally oriented clients, embeds digitalization in a mission statement, and adopts innovative construction processes, the better the BIM adoption. It is recommended that the firms’ leadership develop or re-configure an innovative culture and re-strategize construction activities digitally by adopting BIM which can be turned into a dynamic capability for firm improvement and competitiveness.

KEYWORDS
building information modeling (BIM), construction, culture, digitalization, strategy
1 | INTRODUCTION

Digital transformation has affected nations, industries, firms, and individuals in diverse ways; the construction industry is no exception. Due to its unique characteristics, it is widely acclaimed that the construction industry is slow in the adoption of digitalization in comparison with other industries. This slow trend appears to transcend various industrial revolutions.1,2 The industry characteristics and culture have led to critical challenges contributing to inefficiency and waste. As culture has direct implications towards digitalization, there is an urgent need, for firms’ leadership in the sector to adopt modern business models.3,4 This is imperative as business models of the 21st century enhance a range of unprecedented possibilities that are capable of generating value for both an organization and its clientele at minimal cost based on its resources, capabilities, and strategy.3,5 Towards this, various digital technologies abound in the literature.

From the beginning of civilization around 1800 when the steam engine became the major driving force for industries, to the second industrial age when electricity was discovered, the construction sector has played a key role. During this period, electrification was employed to accelerate and automate production processes.1,2,6 With the advent of the third industrial revolution in the 1970s; further advancement was made on information technology. As a result, extensive use of computers and internet facilities became widespread with human labor gradually replaced with machines.7

The current dispensation, tagged ‘industry 4.0’ is an era of information technologies and the advent of machines powered by artificial intelligence (AI). According to References 7,8 the introduction of AI is a great difference between the fourth industrial revolution and the third. With industry 4.0, organizations are transforming exponentially through the conversion of analog information into digital ones. Artificial intelligence describes a technology whereby work processes meant for human beings are taken over by machines, commonly referred to as ‘intelligent agents’. With the intelligent agents’ ability to perceive the surroundings; actions that maximize the chances of success are undertaken, in better ways, amidst constraints.5-8 Thus, with AI tasks are semi-/fully automated, or numerically controlled on/off-site.7,8 To further enhance digitization, building information modeling (BIM) emerged as a platform/software. BIM is a digital-modeling software, with an industry-wide consensus on its ability to enhance organizational flexibility and innovativeness.9-11 Nevertheless, despite its awareness, BIM implementation is slow among developing countries. Considering the plethora of challenges faced by construction firms in developing countries, there is a need for greater adoption of BIM.

Consequently, while the importance of innovative technologies cannot be over-emphasized; the route to adoption creates a change that has to be managed within the organization. A larger percentage of previous studies on BIM dealt with the drivers/determinants, barriers/challenges, and benefits/significance.10-12 However, one of the reasons for the slow digitization among construction firms is the interdependence of cultural orientations and strategic capability.13-16 To bridge this research gap, there is a need for more studies on organizational changes that are necessary for digitalization. Adopting Johnson’s cultural importance and Teece’s dynamic capability theories16,17; this study highlights some of the internal changes that come with the digital transformation process. Digital transformation is a hybrid of technology with an internal process of culture and strategy as managed by firm leadership. Firms’ leadership, therefore, needs to devise cultural orientations and strategic capabilities that will go with the technology for the needed transformation.16-18

As BIM remains the overarching software that supports the interaction and practicality of most of the technological transformation in the industry, this study examines the needed alterations in culture and strategy towards BIM adoption. The research questions are what are the needed culture and strategic capability for BIM adoption in construction firms? This study, therefore, assesses the cultural orientations and strategic capability required for the adoption of BIM in construction firms as a platform for digital transformation. The knowledge of the cultural orientations and strategic capability will assist construction organizations to understand the most important orientations and dynamic capability and thus facilitate the behavior at the different stages of BIM adoption. Furthermore, it will assist the organizations to form policies that will suit the way projects are managed or operated. Finally, the development of the required cultural orientations and strategic capability, towards BIM adoption, over time, will become a dynamic capability.

2 | ORGANIZATIONAL CULTURE AND BIM

BIM adoption is a form of organizational change.14,18 In referring to the UNESCO (1982), widely recognized definitions for culture,19 summarized it as the entirety of complex but distinctive cognitive, immaterial, intellectual and emotional feature that distinguishes a group. The authors further depict culture as that concrete whole that allows critical judgment, moral commitment, discerning values, and decision-making. Organizational culture is the culture of a social group that
springs from the underlying assumptions and beliefs of members about what they share in common, how the group operates and relates. It comprises attitudes and resultant behavior that originate from a combination of intentional and non-intentional processes, enacted or shaped by leadership styles.\textsuperscript{13,14}

Emphasizing the significance of culture,\textsuperscript{13} opined that the only thing of real importance that leaders do is to create and manage culture. Culture is a set of basic assumptions that a group has devised, discovered, or developed on learning how to deal with external adaptation problems, which have worked well to be considered valid and taught to new members as the right way to perceive. Reference 13 illustrated organizational culture with three layers. The core is the innermost layer. This layer is referred to as basic assumptions. This is the engine room that regulates how the firm works, based on experiences and perceptions. The assumptions are never challenged. The author highlighted some assumptions relating to truthfulness in physical and social matters, and the significance of time or space management. The next layer comprises values. Values are at higher levels of consciousness: they depict members' opinions on 'how things should be'. Values are instrumental to organizational members in clarifying issues, debating on what is desirable or undesirable. Values seldom lead directly to basic assumptions. Artifacts and symbols occupy the outermost layer. It represents the visible part of the culture. Physical artifacts include office settings, dress code, and furniture. This layer is the most visible, easily noticeable, and vulnerable to change.\textsuperscript{13,14,20}

The culture in an organization develops incrementally, through a series of processes in which a firm learns and re-learns.\textsuperscript{14,20} In construction, resources are recombined using BIM as an interface and through codification of the routines, culture is created. The more the leadership gains knowledge, the more robust the culture becomes.\textsuperscript{14,21} An existing culture is based on the ideologies, values, assumptions, beliefs, and attitudes of members. These are aggregated in form of behavior and meanings that impact the firm. Thus, the managerial perceptions based on internal integration and external adaptation, influence organizational practices. Leaders and managers have thus been challenged to revolutionize organizational culture to address challenges within the firm.\textsuperscript{20-22}

3 | BIM ADOPTION LEVELS AND CULTURAL ORIENTATIONS

The transition from the traditional usage of the 2D environment to Computer-Aided Design (CAD) and drafting to BIM requires extensive efforts to migrate. One of the requirements is the adoption of a new culture of use. These cover a range of activities which are not limited to building new templates of BIM models specific to a firm’s need; paying attention to legal risks; training needs; developing standards, a common language, and modalities for creating/sharing BIM models.\textsuperscript{23,24} These factors are culture-enablers. Culture thus becomes a valuable strategic asset to exploit digital technologies.

BIM adoption practices alter the processes and protocols in an organization, hence organizational change management of which culture is a key component.\textsuperscript{25} This is evident in previous studies whereby organizational change management elements like culture, structure, strategy have been identified as major barriers to technological adoption.\textsuperscript{26-28} Based on the impact of leadership on a firm's performance, the culture exhibited is considered as cultural orientation. Cultural orientations are practices that are prevalent among construction firms’ leadership as part of the capability needed for internal and external integration. From the literature, fifty (50) sentences describing the different orientations of construction firms’ manager, founder or owner (leadership) are set out under eight major headings thus: client service orientation (CSO), conflict/dispute resolution (CDR), environmental orientation (ENV), information and communication technology (ICT), innovation, learning, and knowledge management (ILKM), production orientation (PRO), task and goal accomplishment (TAGA) and workforce orientation.\textsuperscript{16,25-29}

Briefly, ENV relates to the scanning of the business environment, gathering information, and making provisions for the needed changes by matching the information received with organizational capabilities and converting such to feedback that can be turned into dynamic capabilities.\textsuperscript{18,29} Reference 18 assert that an organization relates to the environment to accomplish the required fundamental business transformation by defining the values, initiatives, and strategic intents required. ILKM entail the recognition of both technological and non-technological innovation, transformation through research and development (R&D), and upkeep with recent and best practices that are critical in the industry. A major constraint to project execution is a lack of awareness and knowledge. Therefore, knowledge repository development and maintenance are of importance as the need for innovation will only be successful when different stages of knowledge are fully communicated and understood through continuous learning. There are supports for innovation and leadership commitment as cultural factors affecting technology adoption.\textsuperscript{24,26}

Client orientation examines leadership dispensation towards achieving overall improvement. This capability includes consideration for clients’ objectives, interests, and satisfaction.\textsuperscript{24} TAGA entails a firm’s contributions towards best practice
and global competitiveness which requires an investment in autonomous systems rather than adherence to traditional methods. Consequently, goal accomplishment is task-related: it centers on management decisions on the level of commitment as well as the decisions on what is right. Planning, job structuring, monitoring, working environment, and project benchmarking are subsets of accomplishment as BIM adoption is encouraged by clearly defined goals. For PRO the management leadership style in organizing and controlling the production process will be enhanced through automation. Issues relating to project plans and schedules, materials management, safety, harmonious relationships, subcontracting, and performance standards will be enhanced thus resulting in less wastage in terms of time and resources.

A workforce that is adequately trained is better equipped, so it will do more in less time. Factors such as commitment, training, and development, rewards and recognition, teamwork/team building, employees’ participation are the variables in this orientation as the workforce needed to be equipped to take up the challenges. Digitalization enhances data assemblage; therefore, communication channels should be unambiguous and reflect what is valued. ICT covers the availability or lack of relevant information on materials, labor and technology adoption, and sophisticated tools. Conflicts are inevitable in construction and are destructive when not properly managed; however, many AI variants are available for dispute handling and resolution. The variables for CDR include harmonious relationship/interaction, clearly defined and allocated functions, the building of relationships, and means of conflict resolution.

4 | BIM ADOPTION AND ITS IMPLICATION FOR THE DIGITAL RACE

To overcome the challenges associated with the traditional method of construction and its ultimate increase in production time and cost, BIM came to the fore. Unlike the traditional model, BIM offers a digital model that incorporates information management and integrates the efforts of the stakeholders in the supply chain. As a digital diary-BIM presents a repository of knowledge that can be adopted, upgraded, re-cast, and shared to enhance decisions and policy throughout a project life cycle. BIM allows information on materials, components’ specifications/locations/details, construction techniques, and maintenance to be fed into a model right from the conceptualization stage, thereby providing a platform on which subsequent information can be presented for project objective/improvement.

BIM started as three-dimensional (3D) digital models showing the physical and functional characteristics of a facility. As a result, a project owner experiences how the facility looks and how it operates in the 3D format before detailed design, thereby assisting stakeholders in the decision-making process. Thus, the construction process can be examined, simulated, and scenario-tested to eliminate or reduce the risk of hazards and incidences. This information, when enabled with the internet of things (IoT) deployment: a knowledge-reservoir can be gradually built for the firm’s improved performance. With 4D (time scheduling), the series/stages of operations that are to be adhered to or follow-through, are displayed, thereby promoting cost-effectiveness, innovative designs, build-ability, and decommissioning. Rather than having a series of meetings with the design team for a compromise to be reached, with a 5D BIM application, the client and team members meet remotely to identify issues and resolve such timely and appropriately. With this series of information and documents relating to the way the structure is built, the operation and maintenance of the facility are enhanced with BIM 6D (facility management). Thus, logged-in information provides real-time, preventive maintenance schedules to reduce maintenance challenges. Other merits abound on the BIM -continuum till the nth model. These benefits are made possible as a result of the data-bound to a virtual building model that can be defined, analyzed, and parameterized with the ultimate goal of providing holistic information on the project.

Naturally, with 2D, such valuable information is lost; therefore the needed organizational changes that will enhance the adoption of BIM are imperative because organizational transformation is required to fully leverage the benefits of digital transformation. Since most of the numerous complex questions arising from the design and construction of buildings and infrastructure will be resolved through BIM, construction firms need to be poised for the needed requirements for proper implementation of BIM as a digitalization interface.

5 | BIM ADOPTION LEVELS AND STRATEGIC CAPABILITIES

Digitalization efforts are geared towards excellent business operations; hence the need for the newer business model. BIM adoption is a cultural change—it needs to be redirected with a strategy for competitive advantage. A central building block to improved business models and transformation in the field of strategic management is dynamic capabilities (DC). Unlike the previous competitive advantage paradigms, the DC possesses two strong terms: capability and
Dynamic capabilities, as the name implies, depicts a firm’s capacity to make anew its competencies to achieve congruence with the changing business environment. In the construction industry, this becomes paramount with emerging occurrences in the sector, where the routines are being disrupted, and the disruption coalesced, made seamless through the adoption of BIM. Capabilities relate to management strategic roles in appropriately adapting, integrating, and reconfiguring internal and external organizational resources such as culture. This becomes expedient because the process of maintaining a competitive advantage is limitless and dynamic.

Dynamic capabilities framework explains firms’ responsiveness to rapid technological and market changes. Through DC, firm leadership develops the ability to sense change, the ability, and the resources to seize opportunities and turn around the duo for organizational transformation as the micro-foundation of firm adaptation. This is so as dynamic capabilities help identify new products/services plus the configurations of competencies required. Through this, the required specific capabilities for competitiveness will be developed and continuously renewed thereby preparing a link between the present and the future.

A firm’s leadership or management thus needs to be conversant with the techniques for sensing the change, seizing opportunities, and converting such to competitive advantage. According to References 17,38, firms develop capabilities from many starting points and along different paths. Organizational culture presents a path. Reference 17 infers that the dynamic capability (DC) path is shaped by well-known learning mechanisms like repeated practice.

Digital transformation journey encompasses technology, radical cultural and strategic change, the variables for the constructs need to be identified and understood. In line with this, Reference 32 submits that BIM adoption remains low due to the challenges of implementation guidelines and strategies. This is also supported by References 36,37 that unique, intangible capability aside from technology should be harnessed. Based on the importance of sensing, seizing, and transformation through the adoption of BIM, the dynamic capability within the context of this paper is the strategy that is set for digitalization, as digital transformation is an essential component of strategic thinking. Such ability is employed to acquire new resources, combine old and new in a value-creating model. Besides, it describes a firm’s competence in knowing what the market expectations are, implications of alterations, boundaries enlargement, and putting in place the required resources that will correspond to the latest development. It is a measure of the presence of available opportunity with the degree of preparedness in the firm as well as the understanding of what the digital phenomenon requires as far as information and knowledge exchange is concerned.

The variables adopted are eight namely: willingness and the resources to scan, retrieve, organize, share and store information digitally; the ability and resources to communicate, interact, and collaborate using digital tools; the ability and resources to produce tasks/jobs requirements with digital tools; the ability and resources to communicate, collaborate, cooperate and network in a digital environment; the ability and resources to enhance and promote autonomous learning and embed such in the vision statement; willingness and readiness of leadership to organize, coordinate, manage the team with multicultural diversity in a digitally coordinated platform; the ability to seek and engage clients that are digitally oriented or canvass clientsto adopt digitally oriented designs and construction techniques.

According to Reference 24 in referencing the Efficiency and Reform Group (2011), BIM levels in the UK are as follows, each level is impacted by culture and strategic capability:

- Level 0-2D models using (electronic) paper as the exchange mechanism.
- Level 1-collaboration tool that provides a common data environment.
- Level 2 -BIM tools with attached data, commercially managed (4D and 5D elements inclusive).
- Level 3-data integration enabled by web services known as managed integrated BIM (iBIM).

6 MATERIALS AND METHODS

A quantitative research approach was adopted to enhance the determination of the relationship between the facts derived in the study and the findings/theories from previous studies, therefore paving ways for further inquiries. Culture and strategy are as important as technology in the transformation process. This study, therefore, assesses construction firms’ cultural and strategic capability for the adoption of BIM for the enhancement of digital transformation, through the leadership of the firms. Construction firms thus become the population with construction managers/owners/CEOs as the sampling elements. A population of 166 construction firms was drawn from the list of construction firms registered with the Lagos State Tender board and a list of registered construction firms from their Institute. Using the formula in Equation
TABLE 1  KMO and Bartlett's test of cultural orientations for sample adequacy

|                          | Value  |
|--------------------------|--------|
| Kaiser–Meyer–Olkin       | 0.711  |
| Approximate chi-square   | 425.386|
| Bartlett's test of sphericity | 28    |
| Sig.                     | 0.000  |

TABLE 2  KMO and Bartlett's test of strategic capability for sample adequacy

|                          | Value  |
|--------------------------|--------|
| Kaiser–Meyer–Olkin       | 0.484  |
| Approximate chi-square   | 2691.854|
| Bartlett's test of sphericity | 1225  |
| Sig.                     | 0.000  |

(1), a sample size of 116 was calculated from a population frame of 166 firms. This implies that the total sample size for the study will not be less than 116. Based on the review of the literature, a research instrument was developed. The cultural capabilities are assessed as cultural orientation. A total of 50 statements were arrived at for the orientations. For the strategic capability, eight sentences describing a firm’s awareness and preparedness for transformation were developed. The transformation was measured as the level of adoption of BIM. For this, three Likert scales of 1–3 for no-adoption, low adoption, and moderate adoption were used. For the cultural and strategic capabilities, the respondents’ level of agreement or disagreement was expressed on a 5-point-Likert scale of 1–5 indicating strongly disagree to strongly agree. Cronbach’s alpha values for cultural orientation and strategic capability are 0.946 and 0.637 respectively. The lower value obtained for strategic capability might be due to the lower number of items measuring the construct. The value of 0.637 although questionable is neither poor nor unacceptable. Also, Bartlett’s test was conducted on the variables and was found satisfactory based on the significance.

\[ n = \frac{z^2 \times N \times \delta_p^2}{e^2(N-1) + Z^2 \times \delta_p^2} \]  

where \( n \) = sample size; \( N \) = population size; \( e \) = level of precision (5%); \( Z \) = value of standard normal variant at a given confidence level (1.96); \( \delta_p^2 \) = standard deviation of the population (0.5).

7 | RESULTS AND DISCUSSIONS

Tables 1 and 2 illustrate the result of the KMO and Bartlett’s Test for cultural orientations and strategic capability respectively.

The results indicated that the research instrument was reliable with high internal consistency among the items.

7.1 | Factor analysis on cultural orientations

Factor analysis was conducted on the 50 cultural orientations to test the factorability, as well as to review the number of orientations to be considered in further analysis. Principal components analysis was used to identify and compute composite scores for the factors underlying the orientations as presented in Table 3.

Table 3 shows the factor loadings of each statement of cultural orientations (CO), with all items having a factor loading value greater than 0.5 (which is the minimum acceptable value for each item as implied by). The rotated component matrix loadings are as discussed below. Component 1 has six factors thus: good working relationship with subcontractors (0.747), emphasizing client’s interest (0.731), coordination and assistance is encouraged (0.685), accountability for the quality of work done (0.672), satisfying the need of the client (0.669), and amicable resolutions of challenges (0.606). These factors have a common theme (Client interest), so it is termed Client service orientation. The second component loadings are 4 and include the availability of sophisticated ICT tools, (0.812), automation of site production activities
| Cultural orientation | Components | 1   | 2    | 3    | 4    | 5    | 6    | 7    | 8    |
|----------------------|------------|-----|------|------|------|------|------|------|------|
| Good working relationship with subcontractors | 0.747      |     |      |      |      |      |      |      |      |
| Emphasizing clients interest | 0.731      |     |      |      |      |      |      |      |      |
| Cooperation and assistance is strongly encouraged | 0.685      |     |      |      |      |      |      |      |      |
| Being accountable for the quality of work done | 0.672      |     |      |      |      |      |      |      |      |
| Satisfying the need of the client | 0.669      |     |      |      |      |      |      |      |      |
| Amicable resolution of challenges, and so forth, is encouraged | 0.606      |     |      |      |      |      |      |      |      |
| Availability of sophisticated ICT tools | 0.812      |     |      |      |      |      |      |      |      |
| Automation of site production activities | 0.761      |     |      |      |      |      |      |      |      |
| Computerization of construction activities | 0.757      |     |      |      |      |      |      |      |      |
| Practicing seamless communication throughout | 0.731      |     |      |      |      |      |      |      |      |
| Compensation for a job well done | 0.772      |     |      |      |      |      |      |      |      |
| Improving employees skills for better performance | 0.750      |     |      |      |      |      |      |      |      |
| Capability for developing employees potentials | 0.736      |     |      |      |      |      |      |      |      |
| Communication between and among members | 0.700      |     |      |      |      |      |      |      |      |
| Emphasizing team building/committed team | 0.681      |     |      |      |      |      |      |      |      |
| Recognition of leaders priorities and beliefs towards | 0.743      |     |      |      |      |      |      |      |      |
| Sourcing for information/alternative ways | 0.703      |     |      |      |      |      |      |      |      |
| Imbibing cultural values to aid goals attainment | 0.637      |     |      |      |      |      |      |      |      |
| Building trust by listening, and accepting failure | 0.618      |     |      |      |      |      |      |      |      |
| Responsiveness to changes in the business environment | 0.741      |     |      |      |      |      |      |      |      |
| Emphasizing economic as well as social impact | 0.660      |     |      |      |      |      |      |      |      |
| Venturing into some opportunities in the market | 0.636      |     |      |      |      |      |      |      |      |
| Providing training in knowledge | 0.739      |     |      |      |      |      |      |      |      |
| Provisions of workshops on knowledge management | 0.702      |     |      |      |      |      |      |      |      |
| Punishment for immoral and/or unethical conduct | 0.660      |     |      |      |      |      |      |      |      |
| The reward for a new achievement or knowledge | 0.603      |     |      |      |      |      |      |      |      |
| Conformance to the legal provision in a contract document | 0.778      |     |      |      |      |      |      |      |      |
| Adherence to project plans and schedules | 0.775      |     |      |      |      |      |      |      |      |
| Implementing periodic site meetings | 0.758      |     |      |      |      |      |      |      |      |
| Encourage outsourcing/subcontracting | 0.631      |     |      |      |      |      |      |      |      |
| Eigen values. | 15.5 | 3.35 | 2.82 | 2.52 | 2.07 | 1.88 | 1.54 | 1.48 |
| Percentage of variance | 29.9 | 6.99 | 5.62 | 5.33 | 4.16 | 3.81 | 3.19 | 3.13 |
| Number of factors | 6  | 4  | 5  | 4  | 3  | 4  | 2  | 2  |

**Note:** Extraction method: Principal component analysis; Rotation method: Varimax with Kaiser normalization; rotation converged in eight iterations.
TABLE 4 Prevalence of strategic capability in construction firms

| Strategic capability variables | SD (1) | D (2) | MOD (3) | AGR (4) | SAG (5) | Mean | Std | Sum | Rank |
|-------------------------------|--------|-------|---------|---------|---------|------|-----|-----|------|
| Communicate, interact, and collaborate digitally | 4      | 3     | 5       | 53      | 51      | 4.26 | 0.866 | 494 | 1    |
| Leadership capability to organize, coordinate, manage team digitally | 4      | 3     | 10      | 55      | 44      | 4.14 | 0.932 | 480 | 2    |
| Produce job requirements with digital tools and understanding | 4      | 3     | 5       | 65      | 39      | 4.14 | 0.884 | 480 | 2    |
| Commitment to human capital for digital transformation | 2      | 5     | 13      | 56      | 40      | 4.09 | 0.884 | 475 | 4    |
| Search for and organize or share information digitally | 4      | 3     | 4       | 81      | 24      | 4.02 | 0.813 | 466 | 5    |
| Enhance, manage and promote autonomous learning and embed it in vision statement | 4      | 9     | 1       | 71      | 31      | 4.00 | 0.951 | 464 | 6    |
| Seek and engage clients that are digitally oriented or canvass clients to adopt digitally oriented techniques/products | 4      | 3     | 13      | 68      | 28      | 3.97 | 0.879 | 461 | 7    |
| Production and network on a digital platform | 9      | 2     | 12      | 62      | 31      | 3.90 | 1.066 | 452 | 8    |

Note: N = number of respondents (116). Interpretative scale: 1.00 ≤ MS < 1.49 means strongly disagree (SD), 1.50 ≤ MS < 2.49 disagree (D), 2.50 ≤ MS < 3.49 moderately disagree (MOD), 3.50 ≤ MS < 4.49 means agree (AGR) and 4.50 ≤ MS ≤ 5.0 strongly agree (SAG). Std = standard deviation.

(0.761), computerization of construction activities (0.757), and practicing seamless communication. (0.731)—these factors are tagged with innovative construction processes. The third component comprises five factors (compensation for a job well done, improving employees’ skills for better performance, capability for developing employee’s potentials, communication among members, and emphasizing team building). As the central notion is on team management, it is referred to as Workforce management. Recognition of leader’s priority and belief towards recruitment (0.743), sourcing for information/alternative way of doing things (0.703), building trust by listening (0.637), and enhancing user acceptance (0.618) are in component four, so it is coined as the Founders/leader’s belief. Component five is termed External/Environmental orientation due to the three loaded factors. Component six covers 4 loadings described thus: providing training in knowledge (0.739), provisions of workshops on knowledge management (0.702), punishment for immoral and/or unethical conduct (0.660), and reward for a new achievement /sharing knowledge (0.603). This component is referred to as Knowledge management. The seventh component is termed Production orientation while the eighth is Task and goal accomplishment.

The prevalence of the eight cultural orientations (CSO, ICP, WFM, FLB, EO, KM, PRO, and TGA) with high factor loadings is an indication of culture as a frame of reference and a major determinant on the digitalization route. The significance of the promoter (client) on innovative construction practices coupled with firm owners’ (or managers) ability to act strategically, scanning the environment (EO), and taking decisions based on the business environment is germane in the adoption of current industry practices such as BIM. Also, BIM adoption entails the cultivation of new ways to deal with issues that range from ethics, skills, coordination, change management, stakeholders input, training, and quality standards as embedded within the eight orientations. The implication is that the cultural values as described are imperative to BIM adoption.24,30

7.2 Prevalence of strategic capability

The construction firms’ leadership expressed their level of agreement on the selected variables of strategic capability on a 5 point-Likert scale as presented in Table 4.

Table 4 shows the prevalent dimensions of strategic capability in construction firms. The results show a general agreement among the firms’ leadership on the variables as measures of the strategic capability for BIM. The first three most prevalent variables are the ability and resources to communicate, interact and collaborate digitally; willingness and leadership capability to organize, coordinate, manage team digitally as well as the ability and resources to make job requirements with digital tools to enhance understanding. These first three variables are inter-woven; a firm that possesses the readiness and willingness to scan the environment for the needed information will only do so if there is a leadership capability that
supports such initiatives. Such information when gathered will then be implemented to reflect positively in the business. Looking at the strategic variables critically, it is revealed that the mean scores are greater than the average, indicating the relative importance of all the variables. This is so because the capabilities work as a system and are all needed to attain digital transformation.13,38,40

7.3 Level of adoption of BIM in construction firms

The level of BIM adoption is as depicted in Figure 1.

Figure 1 shows that the ratio of no adoption to low and moderate adoption is 2:2:1. That is for every five firms, two are on no adoption while three are on adoption. This result is a bit promising as it is a shift from the results of laggards as recorded by previous studies,23,24,30 though the level of implementation is still low due to some factors such as top management support, BIM knowledge, and capability.41,42

7.4 Test for significant relationship among cultural orientation, strategic capability, and BIM adoption in construction firms

This objective is dual. The first part examines the relationship between cultural orientations and strategic capability among construction firms while the second objective is on the significant relationship between cultural orientation, strategic capability, and BIM adoption. For this reason, two hypotheses are formulated. The first hypothesis (H1) states that there is no significant relationship between cultural orientations and strategic capability in construction firms while the second hypothesis (H2) states that there is no correlation between cultural orientations, strategic capability, and BIM adoption in construction firms. Both analyses were done using Pearson’s Product Moment Correlations as presented. The decision rule for the rejection of the hypothesis was that, it is statistically significant when \( p\text{-value} \leq 0.05 \) and insignificant when \( p\text{-value} > 0.05 \). The results are presented in Table 5.

Table 5 reveals the test of correlation among cultural orientations, strategic capability, and BIM adoption. There is no significant correlation either between BIM adoption and the eight cultural orientations (\( r = -0.251 \)) or BIM adoption and the strategic capability (\( r = -0.213 \)), with the variables combined. Nevertheless, there is a significant negative correlation between BIM adoption and the variables of either cultural orientations (CO) or strategic capability (SC). For CO, the innovative construction process has a negative correlation with BIM adoption (\( r = -0.312^* \)). Likewise, a significant but negative correlation exists between BIM adoption and seeking/engaging digitally oriented clients (\( r = -0.286^{**} \)) as well as enhancing/promoting autonomous learning and embedding it in the vision statement (\( r = -0.239^* \)). This result implies that for the culture, the more the culture of innovative construction practices, the lesser the BIM adoption. Likewise, the two variables of the strategic capability are in opposite directions with the adoption. Thus, the hypothesis that states that there is no correlation among cultural orientations, strategic capability, and BIM adoption in the construction firms, is rejected. For the other hypothesis that sought for the relationship between the culture and the strategic capability, the result is positive (\( r = 0.270^* \)) with TAGA correlating positively (though weakly) with seeking clients that are digitally inclined. Therefore, the other hypothesis that states that there is no relationship between cultural orientations and strategic capability in construction firms is also rejected.
TABLE 5 Correlation analysis on cultural orientation, strategic capability, and BIM adoption

| Variables | r-Values |
|-----------|----------|
| **Level of BIM Adoption** | 1 |
| **Cultural Orientations** | -0.251 |
| Innovative construction process | -0.312<sup>a</sup> |
| **Strategic Capability** | -0.213 |
| Seek and engage clients that are digitally oriented or canvass clients to adopt digitally oriented techniques/products | -0.286<sup>b</sup> |
| Enhance, manage and promote autonomous learning and embed it in the vision statement | -0.239<sup>a</sup> |
| **Cultural Orientations** | 1 |
| Task and goal accomplishment | |
| **Strategic Capability** | |
| Seek and engage clients that are digitally oriented or canvass clients to adopt digitally oriented techniques/products. | 0.270<sup>a</sup> |

<sup>a</sup>Correlation is significant at the 0.05 level (2-tailed).  
<sup>b</sup>Correlation is significant at the 0.01 level (2-tailed).

TABLE 6 Regression model for BIM adoption

| Variables | Unstandardized coef. | Std. error | Stand. coef. | T | Sig. | F | R | R² | Adj.R² |
|-----------|----------------------|------------|--------------|---|------|---|---|----|-------|
| (Constant) | 3.272 | 0.503 | | 6.499 | 0.001 | 4.826 | 1.42 | 0.177 | 0.140 |
| DC | -0.182 | 0.087 | -0.288 | -2.085 | 0.043 |
| ICP | -0.281 | 0.126 | -0.312 | -2.224 | 0.031 |

Note: *p < 0.05, 95% confidence level. DC = seeking/engaging clients that are digitally oriented/canvassing clients to adopt digitally oriented techniques, ICP = innovative construction process. Durbin–Watson = 0.922. Standard error of the estimate = 0.66925.

7.5 Regression model for BIM adoption

Emanating from the correlation results, a model for BIM adoption through cultural orientations and strategic capability is as presented. The result of the regression model for BIM adoption is as shown in Table 6. The ANOVA result is significant at p = 0.013 depicting seeking/engaging clients that are digitally oriented or canvassing clients to adopt digitally oriented techniques and innovative construction process as the predictors of BIM adoption for transformation. The Durbin-Watson value is close to a unit (DW = 0.922), which is an indicator of autocorrelation while the standard error of the estimate is 67%. The regression model (3.272 –0.182DC –0.281 ICP) explains only 17.70% of BIM adoption. This result implies that despite the general agreement among the respondents on the various orientations and strategic capability, the effect on BIM adoption is still at the infancy stage. It, therefore, becomes imperative for the organizations (or the leadership) to consider the strategy and the cultural orientations critically towards BIM adoption to improve the predictability of the model.

8 DISCUSSION OF FINDINGS

The results revealed a general agreement by the firms’ leadership on the variables of the constructs as measures of cultural orientations and strategic capability. All the eight cultural orientations (namely: client, innovative construction process, workforce management, founder/leader belief, external orientation, knowledge management, production and task accomplishment (i.e., CSO, ICP, WFM, FLB, EO, KM, PRO, and TGA) are prevalent, hence their contributions to BIM adoption as the orientations cover different aspects of project management impacting firm’s transformation. The
eight cultural orientations reflect the importance of organizational culture as a mediator of the transformation process. As expressed by previous studies, a digital culture should be client-centric CSO, innovative (ICP), collaborative (WFM), adaptive (FLB), environmentally responsive (EO), technological-driven (KM), flexible (PRO), open (PRO), and information/data-driven (TGA) by References 32,41,42.

The first three most prevalent variables of strategic capability (which are the willingness and resources for digital communication, interaction, and collaboration; leadership capability to organize, coordinate/manage team digitally as well as making job requirements digitally to enhance understanding) relate to communication (in which modern methods are incorporated). The importance of clear, apt, and concise communication with feedback is stressed in industry transformation. The prevalence of the strategic capability explains dynamic capability as part of the internal changes required to move from the traditional business model to the modern model.35,38

Besides, the results on the level of BIM adoption revealed three out of every five firms progressing on the adoption scale. This result seems impressive as it reveals greater interest in BIM; however, the level and extent of progress made need to be ascertained.23,24,32 On the relationship between CO and SA, a weak positive correlation implied that the efforts on getting digitally inclined and responsive clients that would drive the needed capability for BIM adoption, be enhanced. For the relationship between the culture and BIM, the more the firms’ leadership aspires to do better culturally through innovative construction processes, the lesser the reflection on BIM adoption because as the innovative processes go up, the BIM adoption decreases. Likewise, on strategic capability and BIM; the negative correlation between BIM adoption and the digitally oriented client as well as embedding digital ideas in the vision and mission statement implied that the more the firms try to canvas client to adopt digitalization or embed transformation in the mission statement; the lesser the adoption of BIM by the firms. The results revealed that the culture and the strategy in the firms are not adequately tuned-in for transformation. As digital transformation requires a strategy that fosters innovative culture and vice versa, the firms’ leadership needs to build dynamic capability that will re-construct the culture required for BIM adoption.

For the model, it was revealed that both seeking/engaging clients that are digitally oriented/canvasing clients to adopt digitally oriented techniques and innovative construction process appeared as the predictors of BIM adoption. Thus; the role of the client, his education, and innovative construction process (that covers variables such as seamless communication, digitization, and automation of processes) are major determinants of BIM adoption in construction firms. The lower percentage obtained from the model is an indication of the variables of cultural orientations and strategic capability to reflect in practical terms within the firms as expected based on previous studies.23,24,32 The implication is that the two variables that predicted the models for BIM adoption needed to be carefully monitored or managed by the firms as part of the change management practices required for BIM adoption.

Summarily, the results revealed a general agreement by the firms’ leadership on the variables of the constructs as measures of cultural orientations and strategic capability. Despite the level of agreement on the variables by the firms and the results on the level of adoption, the relationship between the present orientations (that is the culture) and the dynamic capability is weakly correlated, revealing how a digitally inclined client determines how tasks are conducted on-site or at the head office. This needs further improvement because the r-value is just about a quarter of what is expected. A value that is close to a unit will give an equivalent BIM adoption. In other words, there is a need for the more digitally inclined client for BIM adoption and the resources for digitization on the part of the firms.

9 | CONCLUSION AND FURTHER STUDIES

This study examined the cultural orientations and strategic capability as part of the organizational change management required in BIM adoption for firm level digitization. The study revealed the need for innovative construction processes as the required culture. For the strategic capability, the importance of digitally oriented clients and having digitalization as part of the vision and mission statements were emphasized. This is evident as the orientation and the capability variables have a significant correlation with BIM adoption, although the result implied that the firms need to do more on the prevailing culture and strategy generally and the significant variables, specifically. Consequently, the model of digital transformation developed was predicted by just a fraction of the culture and strategy. The model was predicted by an innovative construction process, digitally inclined clients as well as embedding digitalization in the mission statement. That is, an innovative culture and strategic capability that first considers digitization as part of its mission statement, then moves ahead to engage digitally inclined clients.

The study concludes that the firms’ leadership needs to embed digitalization as part of the mission statement, interact with digitally oriented clients and employ innovative construction processes that will improve the way tasks are conducted.
for BIM adoption. That is, the firms’ leadership needs to be visionary, innovative, and manage the client as part of the requirements at the various levels of BIM adoption, at the different stages of the construction cycle and inculcate such into their routines. In other words, the firms need to increase efforts on innovative construction processes and increase the strategic intent to canvass clients into adopting digital technology or leverage/re-design tasks that can be achieved by embedding digitalization in the strategic statement. This is imperative because organizational transformation relies on the identification/responses to a series of dynamic processes within the business environment.

To increase the predictive capability of the model, the firms need to harmonize the culture of innovative construction processes. This can be achieved by adopting sophisticated tools, automation of site tasks, computerization of construction activities, and seamless communication. On the strategic capability, the embodiment of digitalization in the mission statement in conjunction with digitally oriented clients will improve the model prediction, as both the culture and the strategy will become dynamic capability. For instance, within the orientation, there is a need to enhance innovative construction processes which can be achieved through taking projects in sections. For the strategy too, communication, interaction, and collaboration should be enhanced more digitally through training, re-training, recruitment, and induction or setting up a digital team.

Based on the foregoing, BIM requires a series of organizational changes that come with a premium, a situation whereby the clients become digitally inclined will encourage BIM adoption. This can further be enhanced by the government making policy recommendations for BIM usage, which may be in some aspects of construction works. Besides, the government and other relevant bodies should make some provisions to cushion the effect of the cost-inherent in the transition journey.

BIM as an advancement on 2D requires newer skills and a cultural change; a situation in which the environment or the client clings to the old model will not be healthy for transformation. There is a need, therefore, for joint awareness on the significance of BIM adoption through the provision of workshops and seminars for all and sundry. Also, to improve the image of the construction industry, the government could encourage the indigenous firms through collaboration with other firms that have adopted BIM and/or delivered projects through the BIM platform.

The adoption of BIM is enhanced by several drivers and determinants, as an innovative practice is a key variable; the firm leadership needs to look at real-time innovative processes that will aid BIM adoption, such as the segment of work assigned for BIM implementation. With the needed cultural orientations and strategic capability, BIM adoption, in conjunction with the intelligent agents, will become a dynamic capability that can serve as improved business models for the construction firms. Further studies can be conducted on various orientations and capabilities and how they affect the different stages of BIM adoption.

10  LIMITATION OF THE STUDY

This study briefly reviews the literature on transformation tools in the industry and argues that as BIM presents an overarching platform; its adoption will enhance the image of the indigenous construction firms and place them on the pedestal of industry best practice. The study is thus limited to the views of selected professionals on fewer variables of culture and strategy as parameters of BIM adoption. Future researches are to be conducted, probably with larger sample sizes or through case studies.

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