

Global Journal of Business Strategy and Finance

ISSN 0000-0000

DAC Insight Publishers

<https://journals.dacinsightpublishers.com/GJBSF>



DIGITAL TRANSFORMATION READINESS OF CONSTRUCTION SMES: DETERMINANTS AND IMPLICATIONS FOR ORGANIZATIONAL PERFORMANCE

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ABSTRACT

Construction is among the least digital sectors of the economy, and the small and medium-sized enterprises that make up over ninety percent of the industry face resource, skill and cultural barriers that larger contractors do not. Digital transformation readiness, the organizational capacity to initiate, implement and sustain digital change, has attracted far less attention than technology adoption, and its link to performance has rarely been quantified. This study identifies the determinants of readiness among construction SMEs and its performance consequences. A cross-sectional questionnaire survey, built on the Technology–Organization–Environment framework and supplemented with dynamic capability items, was administered to owners, directors and senior managers of Nigerian construction SMEs. Of 172 replies received, 150 were usable, and every construct returned a Cronbach's alpha above 0.70. Multiple linear regression showed that technological, organizational and environmental context and dynamic capabilities together explained 52.4 percent of the variance in readiness, with organizational context carrying the largest coefficient ($B = 0.341$), followed by dynamic capabilities ($B = 0.298$), technological context ($B = 0.287$) and environmental context ($B = 0.156$). Readiness was moderate, at a mean of 3.54 on a five-point scale, lowest for dynamic capabilities (3.49) and highest for environmental context (3.82). Readiness in turn explained 37.5 percent of the variance in organizational performance ($B = 0.634$). Internal resources and adaptive capacities matter more to readiness than external pressure.

Keywords: digital transformation readiness, construction SMEs, organizational performance, Technology–Organization–Environment framework, dynamic capabilities, resource-based view

Received 1 January 2026; Received in revised form 20 January 2026; Accepted 22 January 2026, Available online 30 January 2026

1. INTRODUCTION

Construction is a key sector in the global economy, making a significant contribution to gross domestic product, employment and the development of physical infrastructure (Saka 2022). The industry has historically been marked by relatively modest productivity growth, high levels of waste, complex supply chains and ongoing difficulty in delivering projects, despite its economic importance (Alaloul *et al.* 2021). Construction is often said to be one of the least digital sectors of the economy, unlike the manufacturing and service industries, which have seen dramatic technological transformation (Wang *et al.* 2024).

Digital transformation is a strategic answer to these ongoing difficulties. It is the purposeful use of digital technologies, such as Building Information Modeling (BIM), Internet of Things (IoT), artificial intelligence (AI), digital twins, cloud computing, drones, robotics and advanced data analytics, within an organization's operations, decision-making and value creation processes (Sepasgozar *et al.* 2023). With proper use, these technologies may boost cooperation among project stakeholders, improve information management, decrease rework, enable improved cost and schedule control, and improve overall competitiveness (Mousavi *et al.* 2024).

Recently there has been more push from outside to digitalize. Clients increasingly demand digital deliverables, BIM requirements or national digital construction policies are being implemented by governments in various countries, and competitive forces are pushing enterprises to find efficiency benefits (Matos *et al.* 2024). Most larger contractors have reacted by investing in enterprise systems, digital platforms and specialized innovation divisions (Li and Liu 2024). The advantages of digital transformation are not, however, equally dispersed throughout the sector. Smaller enterprises are frequently unable to keep pace, leading to worries about a widening digital gap that might leave a huge portion of the construction industry marginalized (Shehadeh *et al.* 2023).

The construction sector in most nations is structured around small and medium-sized companies (SMEs). They usually represent over 90 percent of enterprises and a considerable proportion of employment and project delivery capability. The majority of construction SMEs face unique and often significant barriers to digital transformation (Donyavi *et al.* 2022).

One of the biggest issues is lack of resources. Many SMEs have little financial reserve and find it hard to justify the significant investment in software, hardware, training and consultation, particularly in an industry with narrow margins and volatile cash flow (Nkwinika and Akinola 2023). The situation is aggravated by human capital constraints. Small organizations often have shortages of digital skills and seldom have specialized IT or digital transformation staff. Owner-managers who do not have specialist expertise are therefore generally the ones who make the technological choices (Rupeika-Apoga and Petrovska 2022).

The transient and project-based nature of construction work further hinders the adoption of digital devices (Tran and Nguyen 2024). Processes, teams and supply-chain interactions differ from one project to the next, so it is hard to standardize digital processes or accrue organizational learning (Bhattacharya and Chatterjee 2022). Many SMEs are also in junior positions in the supply chain and rely on bigger contractors or customers for technical guidance. Without associated assistance, digital needs might cause SMEs to embrace technologies superficially or refuse them completely (Bhuiyan *et al.* 2024).

Organizational culture and the attitudes of managers are also crucial. Construction SMEs tend to have risk-averse, conservative cultures, formed by conventional traditions and short-term survival demands (Lijauco *et al.* 2020). Resistance to change, cynicism about the return on digital investment and a preference for the known may stall or hinder substantial transformation. These obstacles together mean many construction SMEs remain at low levels of digital maturity, which limits opportunities to enhance performance and compete successfully in an increasingly digitized market (Perera *et al.* 2023).

The digital revolution in building has attracted considerable academic attention yet major gaps still exist. Much of the extant research focuses on major contractors, specialized technologies (especially BIM), or generic trends of industry-wide adoption. Compared to other sectors, very little emphasis has been given to the notion of digital transformation readiness, the organizational capacity to facilitate the initiation, implementation and continuation of digital change, within the framework of construction SMEs.

Although studies have highlighted a range of hurdles to technology adoption, there is a dearth of rigorous investigation of the multi-dimensional drivers of preparedness and their relative relevance. The association between digital transformation readiness and organizational performance outcomes in construction SMEs is little explored in the literature. Much of the available evidence is still conceptual, anecdotal or based on case studies of larger organizations. There is a specific lack of quantitative research in the SME sector evaluating links between readiness factors, readiness itself and performance metrics.

This is an important gap. Policymakers, industry groups and SME management need to know better what drives readiness and how readiness impacts performance in order to provide a strong evidence framework for support programs and strategic choices. Such a vacuum has to be filled by theoretically sound and empirically robust research within the framework of construction SMEs.

This paper asks what determines digital transformation readiness among construction SMEs, and what that readiness is worth to the firms that achieve it. Three questions follow from it: which technological, organizational and environmental factors govern readiness, how those factors relate to the level of readiness a firm reaches, and whether readiness translates into organizational performance. We answer them by quantifying the determinants, measuring the readiness of the firms surveyed, testing the association between the two, and examining the link between readiness and performance, so that the recommendations the paper ends with rest on estimates rather than on impressions.

The study used a quantitative research design built around a structured questionnaire survey (Chan *et al.* 2019). The research questions concern determinants, the relationships between those determinants and readiness, and the consequences of readiness for performance, all of which are open to numerical measurement and statistical analysis. A cross-sectional survey of the kind used elsewhere to relate firm-level characteristics to operational and environmental outcomes in small and medium enterprises (Adeniji *et al.* 2024) collected standardized data from construction SMEs across Nigeria and supported the testing of the relationships the study proposed within the target population.

The questionnaire operationalized the multi-dimensional constructs the study required: the technological, organizational and environmental determinants, overall digital transformation

readiness, and several metrics of organizational performance (Trischler and Li-Ying 2022). Established measurement scales were carried into the construction SME context, as is usual in questionnaire studies that model relationships among latent constructs (Xiao *et al.* 2024). The design traded the contextual depth of interview work for breadth and comparability across firms, which is what quantifying the determinants and the readiness–performance link called for (McDermott 2023).

Several major contributions are made by this study. It contributes theoretically to understanding digital transformation readiness by combining ideas from the Technology–Organization–Environment framework, the Resource-Based View and Dynamic Capabilities theory in the under-researched setting of construction SMEs. It also adds to the literature by empirically investigating the readiness–performance link, so going beyond descriptive assessments of obstacles and adoption levels.

Methodologically the research applies quantitative tools to a complex organizational issue in the construction industry. In practical terms the results give SME owners and managers a basis on which to evaluate and improve their digital readiness. For governments and industry groups, the findings bear on targeted assistance programs, training efforts and regulatory measures to accelerate digital transformation among smaller construction enterprises. The work sits between academic knowledge of digital transformation and the practical problems construction SMEs face in an increasingly digital world.

The rest of this paper is arranged as follows. Section 2 covers relevant literature on digital transformation in construction, the idea of readiness, organizational performance in SMEs and the theoretical constructs behind the research. Section 3 deals with the study design, research methods, sampling strategy, construction of the questionnaire, measurement of constructs and data analysis techniques. Section 4 presents the empirical results, including descriptive statistics and the regression models. The findings are compared to the existing literature and the theoretical predictions in Section 5. Section 6 discusses the theoretical, practical and policy ramifications of the results, sets out the limits of the study and recommends directions for further research.

2. LITERATURE REVIEW

2.1 Digital Transformation in Construction

Digital transformation has surfaced in recent years as a significant occurrence that redefines business processes, operational practices and organizational competencies. This metamorphosis relies on digital technologies that can revolutionize the design and fabrication of structures, identify key stakeholders, redefine collaboration among Architecture, Engineering and Construction (AEC) professionals, and set new benchmarks for design performance (Ernstsen *et al.* 2021). In essence, digital transformation may enhance the construction industry across several facets, eventually steering it towards sustainability via modernization, as indicated in SDG9 (Costa 2024).

As per Ernstsen *et al.* (2021), enterprises have engaged in digital transformation guided by three nascent paradigms: optimized construction, user-data-centric physical environments, and value-oriented computational design. All three perspectives correspond with the primary sustainability facets included in the Triple Bottom Line of People, Planet and Profit (Nogueira *et al.* 2023). Effective construction may lead to financial savings, timely project completion, enhanced productivity and minimized waste, which can foster greater profitability, environmental

sustainability and revenue creation (Goh *et al.* 2023). User-centric data-informed built environments and value-oriented computational design may in turn promote the development of robust infrastructures. Comparable reorganizations of collaborative work around digital tools have been described in other sectors, among them media production and community-driven platforms (Santoso and Wijayanti 2024).

In relation to other economic sectors, Adekunle *et al.* (2024) reported that digital transformation within construction is still behind, exhibiting only limited advancement, which underscores its nascent phase and highlights the presence of obstacles. These obstacles include elements like professional identity, organizational traits, an unappealing business climate for innovation, and the sociotechnical aspects of digital transformation (Aliu and Oke 2023; Dolla *et al.* 2023). The construction industry's characteristics exacerbate these obstacles, characterized by a project-oriented, cost-conscious milieu often defined by disjointed project frameworks, inadequate coordination efficiency and sluggish productivity advancement (Zhang *et al.* 2023).

Consequently, as noted in Papadonikolaki *et al.* (2022), digital innovation, which includes the digital technologies contained inside digital transformation, challenges the conventional beliefs around innovation management. This nature necessitates significant changes that go beyond the technology aspect, including organizational, institutional, political, economic and social realms (Truffer *et al.* 2022). This presents a difficulty in comprehending digital transformation within the construction industry, since the sector is mostly occupied by established companies that originated prior to the digital age.

2.2 Concept of Digital Transformation Readiness

Karuppiah *et al.* (2024) observed that substantial progress in information and communication technology has provided several capabilities that enable companies to transform their business frameworks for a whole new digital age. As a result, a notion has lately surfaced in scholarly circles and among professionals, referred to as digital transformation (Wessel *et al.* 2021). Lorenz and Buchwald (2023) argued that digital transformation is a societal concept, indicating a cultural shift, since it embodies a process of social engagement and communal education through which individuals adopt and propagate digital technology. The concept has grown prevalent and is often seen as a shift in how an organization utilizes digital technology to create innovative business models that enhance value generation (Lanzolla *et al.* 2020). The digital revolution has fundamentally altered the characteristics of several organizations by drastically modifying procedures and business models across almost all sectors (Demirkan *et al.* 2016). Enterprises have consequently endeavored to address the competitive and global difficulties posed by the rapid and significant transformations induced by digital technologies, facing the peril of market survival if they fail to adapt (Reis *et al.* 2018). Nasution *et al.* (2018) stated that digital transformation has become essential for organizations to maintain competitiveness in today's digital landscape.

According to Teichert (2019), however, there exists no singular and widely recognized definition for the concept of digital transformation, which is sometimes seen in a simplified manner as a continuous process of integrating new technology for substantial change. Despite the emergence of digital transformation as a significant issue within the Information Systems domain in recent years, there remains a scarcity of publications that collectively examine the structures essential for delineating organizational digital transformation preparedness (Vial 2019). Comprehending the necessary procedures and context for effectively executing digital transformation in organizations is nonetheless vital in a world increasingly reliant on information and communication technology.

Gfrerer *et al.* (2021) accordingly stated that for digital transformation efforts to thrive inside organizations, those organizations must be sufficiently prepared for them.

The concept of readiness denotes the condition of being prepared or set for an event, illustrating a proactive stance for an impending occurrence or one that is almost at hand (Voß and Pawlowski 2019). E-readiness refers more particularly to the societal adaptation to address intricate challenges associated with the digital realm (Zarei and Kardgar 2024). Since its establishment, the notion of e-readiness has included several definitions and diverse assessment techniques, spanning distinct methodologies and outcomes (Sheoran and Vij 2022). Effective organizational digital transformation projects need organizations to be prepared to establish or enhance various competencies, contingent upon the business environment in which they function (Heubeck 2023; Mihu *et al.* 2023).

2.3 Organizational Performance in SMEs

According to Amoah *et al.* (2022), small and medium businesses are vital to the economic development of emerging nations, especially within the construction industry. They have a crucial role in generating income, creating employment opportunities and alleviating poverty (Mabasa *et al.* 2023). In Nigeria, small and medium-sized enterprises represent over 96 percent of all firms and provide about 75 percent of national employment (Onuwa *et al.* 2023). Small and medium-sized construction enterprises nevertheless have difficulties in obtaining contracts for intricate and lucrative projects, since consumers generally prefer bigger companies, especially those controlled by foreign investors (Donyavi *et al.* 2022). This inclination constrains the investigation of SMEs' capacity to enhance worldwide competitiveness (Ali and Hassan 2024).

Notwithstanding their possible impact on economic advancement and GDP expansion, empirical research on the efficacy of small and medium-sized construction enterprises in Nigeria is limited. Existing research such as Olaniyi and Adekanmbi (2022) is deficient in a comprehensive examination of the relationship between company size and project performance, which obstructs the evaluation of the construction sector's overall efficacy. The research by Alkilani and Loosemore (2022) in construction management has insufficiently examined the influence of company size on essential project performance metrics.

To maximize the potential of small and medium-sized construction enterprises, it is crucial to comprehend their profiles and attributes (Kissi *et al.* 2023). This comprehension may elucidate the categories of initiatives they can undertake and their efficiency regarding time and expenditure. By concentrating on these elements, stakeholders may more effectively recognize the contributions that SMEs make to the construction industry and the larger economy, resulting in superior project results and increased competitiveness for small enterprises (Vrečko *et al.* 2023).

2.4 RELEVANT THEORETICAL FRAMEWORKS

2.4.1 Technology–Organization–Environment (TOE) Framework

The Technology–Organization–Environment framework is often used in technology adoption research. This paradigm was initially introduced by Tornatzky and Fleischer (Justino *et al.* 2022). It implies that three interconnected contexts influence technological innovation: the technological context, including the technology's attributes and the organization's current technological foundation; the organizational context, including the firm's size, resources, structure and management support; and the environmental context, including industry traits, competitive pressure and the regulatory environment (Smit *et al.* 2024).

TOE is particularly relevant to the study of digital transformation readiness because it recognizes the effects of internal and external factors on adoption decisions and outcomes (Shonubi 2024). When applied to small and medium-sized firms in the construction sector, the framework offers a systematic method for organizing the aspects that affect readiness, which include internal capabilities, external expectations from clients, regulators and competitors, and technological infrastructure (Hong *et al.* 2019). It therefore gives a framework for carefully categorizing the various elements which help or hinder readiness.

2.4.2 Resource-Based View (RBV)

Another perspective is offered by the firm's Resource-Based View. According to RBV, the foundation of sustainable competitive advantage is the existence of valued, original, inimitable and non-substitutable resources and competences (Zvarimwa and Zimuto 2022). A firm's digital technology may become a competitive advantage when coupled with other resources, such as qualified staff, a strong corporate culture and efficient operations (Serafimova and Vasilev 2024).

From an RBV viewpoint, digital transformation readiness may be seen as a higher-order organizational skill that enables firms to effectively deploy digital resources (Hortovanyi *et al.* 2023). Construction SMEs that can successfully develop this preparation may therefore achieve performance advantages that their less prepared counterparts may struggle to replicate. The emphasis shifts from merely possessing technology to how effectively a firm can use technology to its advantage in the marketplace (Agustian *et al.* 2023).

2.4.3 Dynamic Capabilities Theory

Dynamic capabilities theory is based on the resource-based concept and focuses on the capacities of an organization to sense dangers and opportunities, mobilize resources, and reconfigure processes and assets in response to changing environments (Kero and Bogale 2023). Digital transformation is never static, since technology and customer expectations are continually evolving (Carreno 2024).

The question of how SMEs may achieve initial preparation and maintain or renew it over time therefore rests on dynamic capabilities (Quansah *et al.* 2022). The temporary nature of projects and the difference in technology requirements from one contract to another make the capacity to adapt digital practices essential in the construction business. This idea is a useful way of understanding long-term and flexible readiness, rather than a fixed state (Cao *et al.* 2023).

2.4.4 Institutional Theory

Institutional theory suggests that the evolution of organizational behavior is impacted by normative, mimetic and coercive effects among others (Dua 2022). In the construction sector, the use of digital technology might be motivated by customer demand, government legislation, standards of the industry and professional norms, even without internal preparation (Wang *et al.* 2024).

Coercive pressures come from laws and contracts, mimetic pressures from businesses trying to copy the strategies of their successful competitors, and normative pressures from discussions about what is considered best practice in a particular field and the expectations of professionals working in it (Saeed *et al.* 2018). Mimetic pressures are activated when firms attempt to copy the practices of their successful rivals (Su *et al.* 2024). From this viewpoint, certain small and medium-sized companies in the construction business implement digital initiatives more for external demands than for any real strategic conviction inside the organization (Bradač Hojnik and Huek 2023).

2.4.5 Diffusion of Innovations Theory

Diffusion of Innovations theory places emphasis on the features of innovations and the social mechanisms through which they are diffused. Some of the important features, including relative benefit, compatibility, complexity, trialability and observability, impact adoption (Mbatha 2024).

When considering construction SMEs, these traits assist in understanding why certain digital technologies are adopted and others resisted (Wang *et al.* 2020). Technologies that appear to offer obvious benefits, fit with current work practices and allow low-risk experimentation are more likely to be adopted. The theory also highlights the relevance of communication channels and social networks in the diffusion process, which is especially essential in an industry marked by project-based teamwork and informal knowledge sharing (Gondal 2023).

2.4.6 Integration of Theoretical Perspectives

Collectively, these frameworks offer a multi-level theoretical underpinning for the present investigation. The TOE framework provides a systematic approach to classifying the drivers of readiness in the technical, organizational and environmental contexts. The Resource-Based View and Dynamic Capabilities theory provide insights into how preparedness could transfer into organizational performance results. Institutional theory and Diffusion of Innovations theory are useful in understanding the external and social variables that are especially relevant in the construction sector. Building on these alternative perspectives, this study provides a comprehensive, theoretically based and contextually relevant understanding of digital transformation preparedness in construction SMEs.

3. RESEARCH METHODOLOGY

3.1 Research Design and Philosophical Stance

The application of quantitative research procedures is supported by a philosophical framework, positivism, within the context of this investigation. One of the core tenets of positivism is that causal links between variables can be examined via the collection of organized data and the statistical analysis of that data, and that social processes can be assessed in an objective way. The aim of this study was to determine the elements that determine the readiness of small and medium-sized construction companies for digital transformation, and the methods by which these factors affect the organization's performance. A quantitative survey-based approach suited that aim. It gathered uniform data from a relatively large sample and supported the testing of the relationships the study proposed across the target population.

The inquiry used a cross-sectional survey, drawing on information collected at one particular point in time. That arrangement let the study examine the variables that affect digital transformation readiness, how readiness currently stands, and the consequences of readiness for performance. Data were collected through a structured questionnaire, which gave a systematic assessment of the constructs under consideration.

3.2 Population and Sampling

The target population was small and medium companies operating in the Nigerian construction sector. Consistent with commonly used definitions, SMEs were classified as enterprises employing fewer than 250 workers, and the frame covered construction SMEs engaged in building, civil engineering, specialist construction activities or associated services.

A non-probability purposive sampling approach was used, supplemented by snowball referral from early respondents. Purposive sampling was warranted because the study needed respondents with sufficient understanding of their firm's digital practices, strategic direction and performance results, usually owners, directors or senior managers. Potential respondents were identified via Nigerian construction industry directories, professional organization membership lists and building industry networks. The sample size target was set from recommendations for multivariate analysis, especially structural equation modeling, where a minimum of 200 usable responses is generally recommended to ensure sufficient statistical power and model stability. An initial goal of 350 to 400 distributed questionnaires was established to account for non-response and partial returns.

3.3 Questionnaire Development and Data Collection

The questionnaire was designed in a structured multi-stage procedure. First, the available literature on digital transformation, technological readiness and organizational performance was evaluated to find proven measuring scales. Where appropriate scales existed, they were customized to the construction SME environment. Where gaps were uncovered, additional items were written from the theoretical frameworks and from earlier qualitative observations in the literature.

The final questionnaire carried four sections:

- Section A recorded firm demographic and organizational information: firm size, age, kind of construction activity, yearly turnover and respondent position.
- Section B covered the determinants of readiness, drawn from the Technology–Organization–Environment paradigm and supplemented with items on dynamic capacities and on resource-related aspects.
- Section C measured the level of digital transformation readiness.
- Section D measured organizational performance in financial and non-financial terms.

Every multi-item construct was measured on a five-point Likert scale running from 1 (strongly disagree) to 5 (strongly agree).

The questionnaire was reviewed by three academics who are experts in construction management and digital transformation and by two industry practitioners before full-scale administration. Feedback was used to modify the phrasing of items, reduce ambiguities and increase contextual relevance. A pilot study was then undertaken with 30 construction SME managers to evaluate clarity, completion time and preliminary dependability. Minor adjustments were made on the basis of the pilot findings.

The final questionnaire was administered to owners, directors and senior managers of construction SMEs across Nigeria. It was distributed electronically through a secure online survey platform, with paper-based distribution added where digital access was limited. Invitation emails and follow-up reminders were issued over an eight- to ten-week administration window to optimize response rates. Participation was optional, and respondents were guaranteed secrecy and anonymity.

3.4 Measurement of Constructs

Digital transformation readiness was treated as a multi-dimensional construct spanning technical, organizational and human preparation. The determinants were operationalized within the TOE framework as the technological context (relative advantage, compatibility, complexity and existing

technology infrastructure), the organizational context (top management support, financial resources, organizational culture and digital skills), and the environmental context (client pressure, competitive pressure and regulatory or government support). Further items capturing sensing, seizing and reconfiguring capabilities measured dynamic capabilities.

Organizational performance was measured by a mix of operational performance (project time, cost and quality performance), financial performance (profitability and turnover growth) and strategic performance (competitiveness and client satisfaction). Scales already validated in the construction management and information systems literature were adapted to the construction SME context to support content validity.

3.5 Data Analysis Techniques

Analysis proceeded in phases. Returned questionnaires were first screened for missing values, outliers and departures from normality, and cases carrying too many missing values on the Likert-scale items were set aside before analysis. The retained sample was then profiled and the major variables summarized descriptively.

Internal consistency was assessed for every multi-item construct using Cronbach's alpha, and content validity rested on the literature review and on the expert and practitioner review of the instrument described above. Composite scores were formed by averaging the items of each construct on the five-point scale.

The proposed linkages between the determinants, digital transformation readiness and organizational performance were then estimated by multiple linear regression: one model for the determinants of readiness, and a second for the effect of readiness on organizational performance. Explanatory power is reported as R^2 and adjusted R^2 , overall model significance by analysis of variance, and the contribution of each determinant by its unstandardized coefficient with the associated significance level. Because every determinant was measured on the same five-point scale, those coefficients are directly comparable with one another. Multicollinearity among the determinants was examined using tolerance and variance inflation factors.

The design also provided for a full measurement-model assessment by confirmatory factor analysis or partial least squares structural equation modeling, with composite reliability, average variance extracted, the Fornell–Larcker criterion and the heterotrait–monotrait ratio, followed by a structural model carrying path coefficients, bootstrapped significance levels, effect sizes and mediation tests. Those procedures were not estimated on this dataset. The achieved sample of 150 usable responses falls below the minimum of 200 generally recommended for stable estimation of a model of this size, as noted in the sampling discussion above, and the consequence is taken up again among the limitations of the study.

3.6 Validity, Reliability, and Ethical Considerations

Several steps were taken to protect the validity and reliability of the research. Content validity was established on the basis of the literature and the expert examination of the instrument. Construct reliability was evaluated using the internal consistency statistics reported in Section 4. Procedural remedies against common method bias were built into the instrument itself: respondent privacy was maintained, and the predictor and criterion items were separated within the questionnaire so that they were not answered as a single block. Common method bias nonetheless remains a caution on self-reported data and is returned to in Section 6.

Ethical permission was sought from the applicable institutional research ethics committee before data collection. Participants were supplied with an information leaflet that explained the goal of the research, the voluntary nature of participation and their right to withdraw. All data are held securely and reported solely in aggregate form to protect the confidentiality of organizations and individuals. Informed consent was obtained.

4. RESULTS

4.1 Usable Responses and Instrument Reliability

This section covers the findings of the survey undertaken to assess the factors of readiness for digital transformation among construction SMEs and the consequences of such readiness for organizational performance. The research was built on four major sets of factors: Technological Context, Organizational Context, Environmental Context and Dynamic Capabilities. The study also focused on the link between Digital Transformation Readiness and Organizational Performance. Data were gathered via a standardized questionnaire administered to owners, directors and senior managers of construction SMEs in Nigeria, and examined through descriptive and inferential statistics.

A total of 172 replies were received. After data cleaning, which excluded incomplete replies and cases with too many missing values on Likert-scale items, the final analytic sample consisted of 150 valid responses, 87.2 percent of the replies received. All Likert-scale questions were numerically coded on a five-point scale prior to analysis, with strongly disagree coded 1, disagree 2, neutral 3, agree 4 and strongly agree 5.

Before moving to the substantive analysis, the internal consistency of each multi-item construct was tested using Cronbach's alpha. Table 1 shows that all the constructs yielded alpha values above the standard 0.70 level, suggesting good dependability.

Table 1: Reliability statistics (Cronbach's alpha) for the study constructs.

Construct	No. of items	Cronbach's alpha
Technological Context	5	0.841
Organizational Context	6	0.887
Environmental Context	5	0.826
Dynamic Capabilities	4	0.863
Digital Transformation Readiness	6	0.912
Organizational Performance	8	0.894

Note. $n = 150$ valid responses. All six constructs yielded alpha values above the standard 0.70 level, suggesting good dependability.

4.2 Demographic Characteristics of Respondents

This section presents the demographic and firm profile of the respondents.

4.2.1 Position of Respondent

Table 2 and Figure 1 give the positions held by respondents. Owners and directors accounted for 45.3 percent of the sample and senior managers for a further 34.0 percent.

Table 2: Position of respondent.

Position	Frequency	Percentage (%)
Owner / Director	68	45.3
Senior Manager	51	34.0
Project Manager	24	16.0
Other	7	4.7
Total	150	100.0

Note. $n = 150$ valid responses. The table gives the position held by each respondent within the surveyed firm.

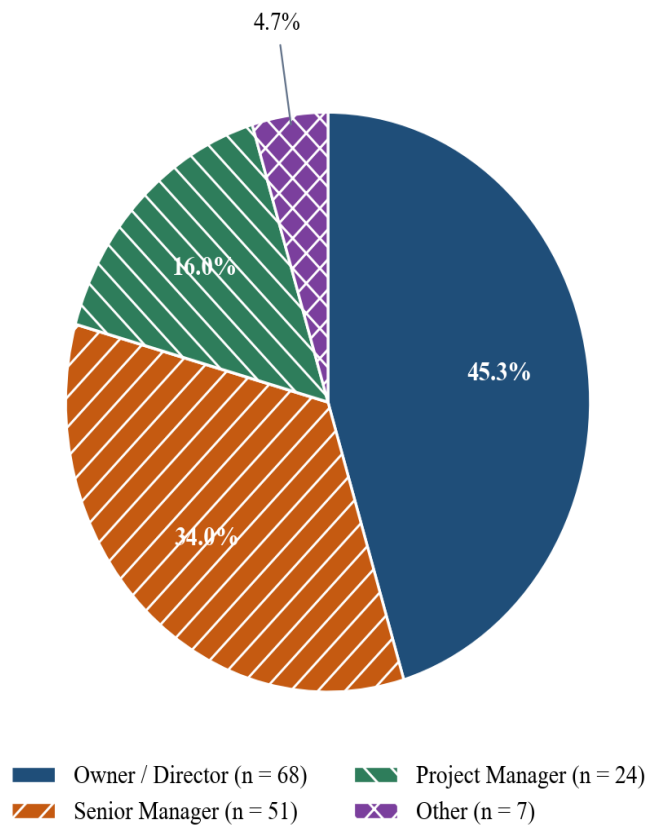


Figure 1: Position of respondent within the surveyed firm, as a share of the 150 valid responses. Owners and directors (blue, solid) hold 45.3 percent of the sample and senior managers (orange, hatched) a further 34.0 percent, so almost eight in ten responses come from the level at which digital investment decisions are taken in a construction SME.

4.2.2 Years of Experience in Construction

Table 3 and Figure 2 report industry experience. Only 12.7 percent of respondents had fewer than five years in construction, and 56.0 percent had more than ten.

Table 3: Years of experience in construction.

Years of experience	Frequency	Percentage (%)
Less than 5 years	19	12.7
5–10 years	47	31.3
11–15 years	42	28.0
More than 15 years	42	28.0
Total	150	100.0

Note. $n = 150$ valid responses. The table gives each respondent's length of experience in the construction industry.

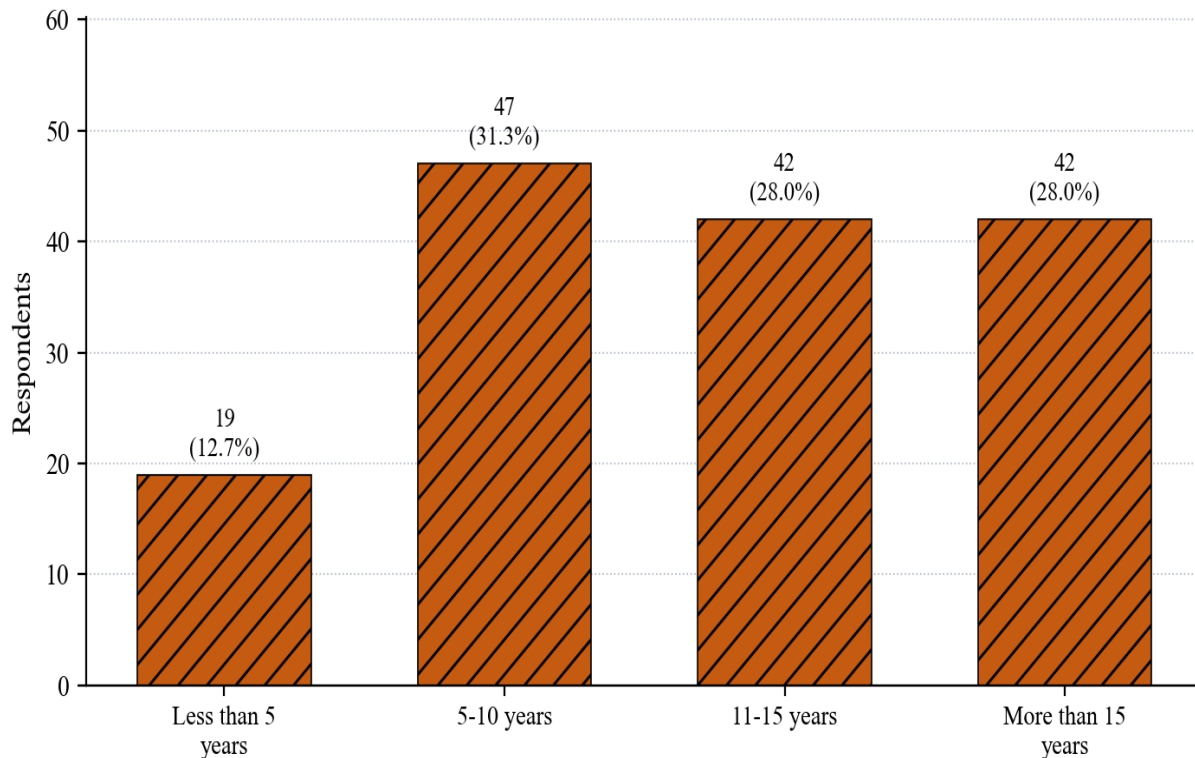


Figure 2: Years of experience in construction across the 150 respondents. The distribution is weighted towards experienced practitioners: 131 of 150 respondents, 87.3 percent, carry five years or more, and the two longest bands are equal at 42 respondents each.

4.2.3 Age of the Firm

Table 4 and Figure 3 give the age distribution of the surveyed firms, which is concentrated in the five to twenty year range.

Table 4: Age of the firm.

Firm age	Frequency	Percentage (%)
Less than 5 years	28	18.7
5–10 years	49	32.7
11–20 years	46	30.7
More than 20 years	27	18.0
Total	150	100.0

Note. $n = 150$ valid responses. The table gives the trading age of each surveyed firm at the time of the survey.

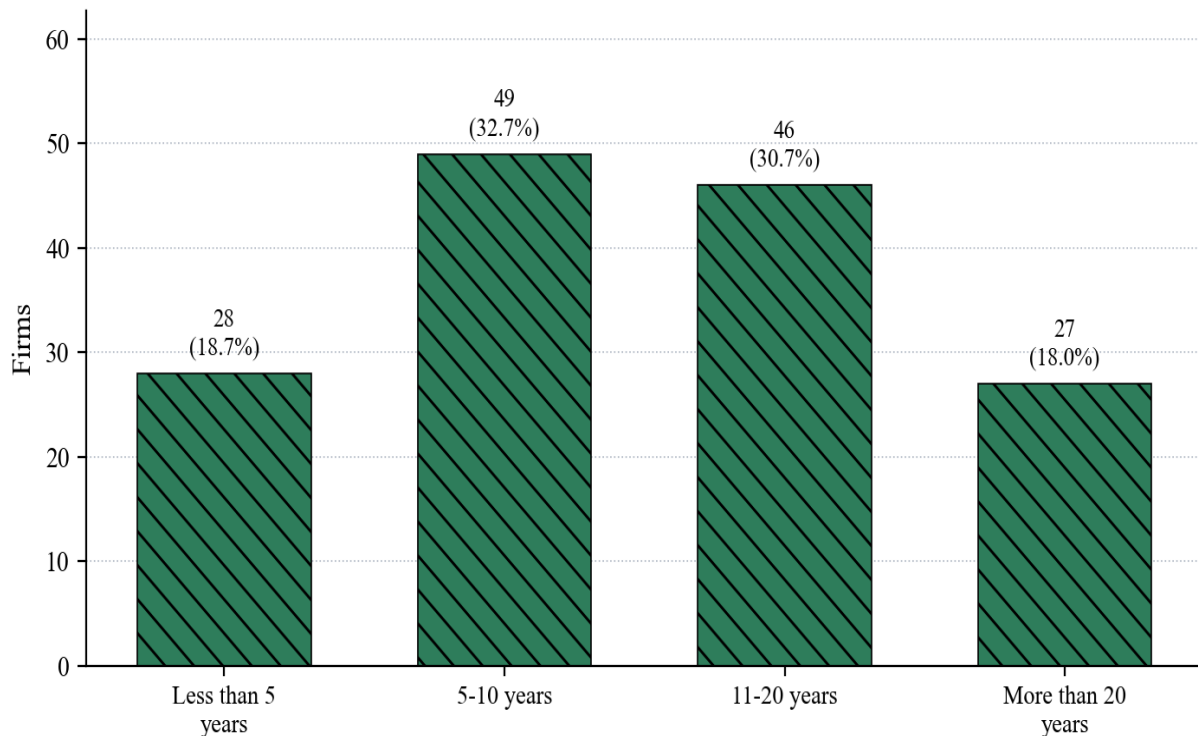


Figure 3: Age of the surveyed firms. The two middle bands, five to ten years and eleven to twenty years, together hold 95 of 150 firms, 63.3 percent, while the youngest and oldest bands are close to equal at 28 and 27 firms.

4.2.4 Firm Size (Number of Employees)

Table 5 and Figure 4 report employment size. Small firms of ten to forty-nine employees are the modal group at 52.0 percent.

Table 5: Firm size by number of employees.

Firm size	Frequency	Percentage (%)
1–9 (Micro)	41	27.3
10–49 (Small)	78	52.0
50–249 (Medium)	31	20.7
Total	150	100.0

Note. $n = 150$ valid responses. Size bands follow the employment thresholds used to define micro, small and medium enterprises in Section 3.

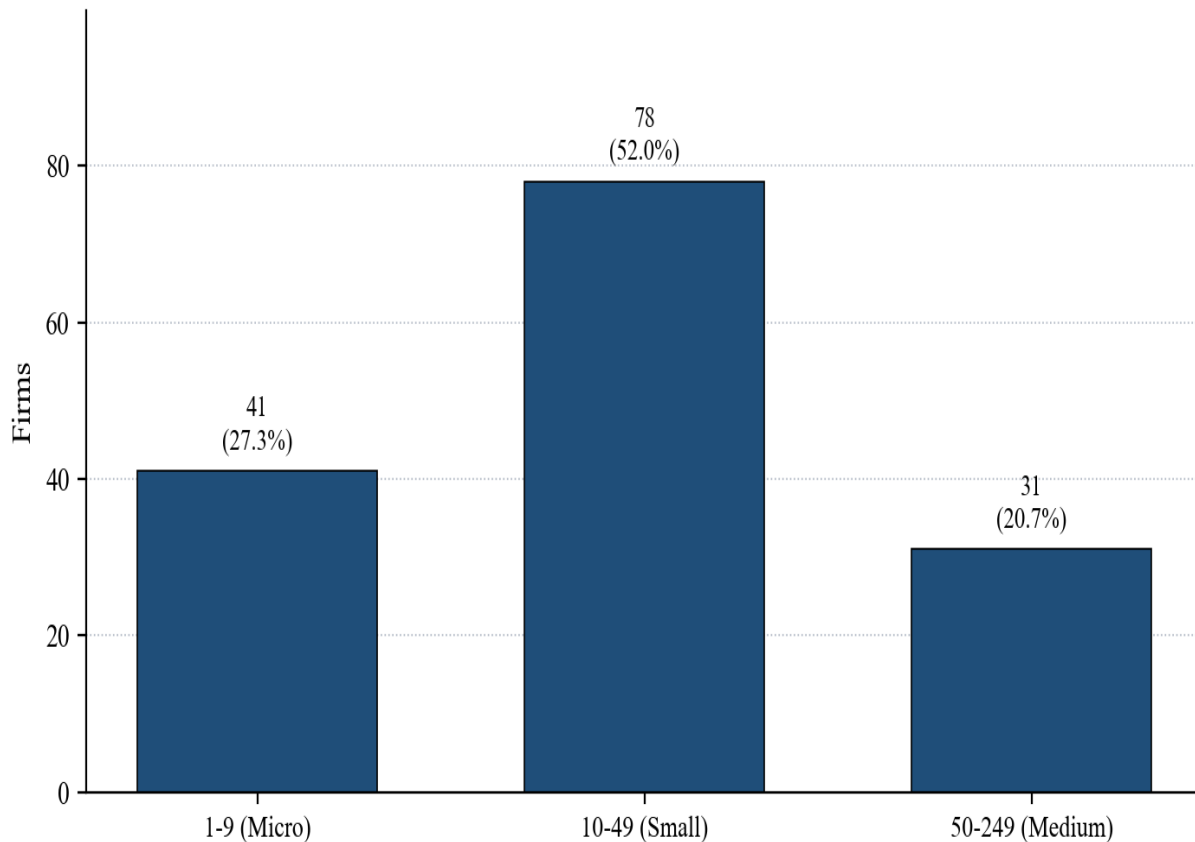


Figure 4: Firm size by number of employees. Small firms of ten to forty-nine employees dominate the sample at 78 of 150 firms, and no firm in the frame exceeds the 249-employee ceiling that defines an SME for this study.

4.2.5 Main Type of Construction Activity

Table 6 and Figure 5 give the main type of construction activity undertaken by each firm.

Table 6: Main type of construction activity.

Activity type	Frequency	Percentage (%)
Building construction	67	44.7
Civil engineering / Infrastructure	38	25.3
Specialized construction activities	35	23.3
Other	10	6.7
Total	150	100.0

Note. $n = 150$ valid responses. Each firm is assigned to the single activity type its respondent identified as the firm's main line of work.

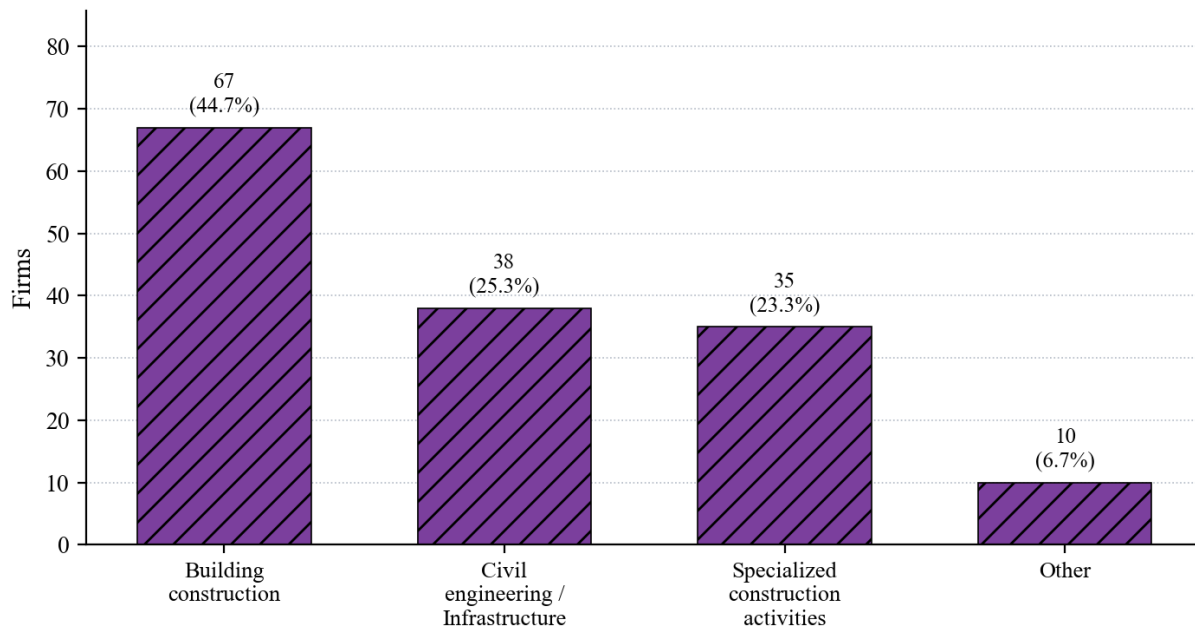


Figure 5: Main type of construction activity across the 150 surveyed firms. Building construction is the largest single category at 67 firms, and civil engineering and specialized trades are close to each other at 38 and 35 firms respectively.

The profile of respondents shows that the majority were owners or senior managers with considerable expertise in the business, and that small enterprises of ten to forty-nine employees were the most representative group in the sample. This distribution is in line with the usual structure of the construction SME sector.

4.3 Descriptive Analysis of Main Variables

Table 7 presents the mean and standard deviation of the composite scores for each construct, and Figure 6 plots them against the agree threshold. Mean scores between 3.50 and 4.49 are interpreted as agreement.

Table 7: Descriptive statistics of the study constructs.

Construct	Mean	Std. deviation	Interpretation
Technological Context	3.71	0.68	Agree
Organizational Context	3.58	0.71	Agree
Environmental Context	3.82	0.64	Agree
Dynamic Capabilities	3.49	0.73	Neutral
Digital Transformation Readiness	3.54	0.69	Agree
Organizational Performance	3.67	0.62	Agree

Note. $n = 150$ valid responses, composite scores on a five-point Likert scale. Mean scores between 3.50 and 4.49 are interpreted as agreement.

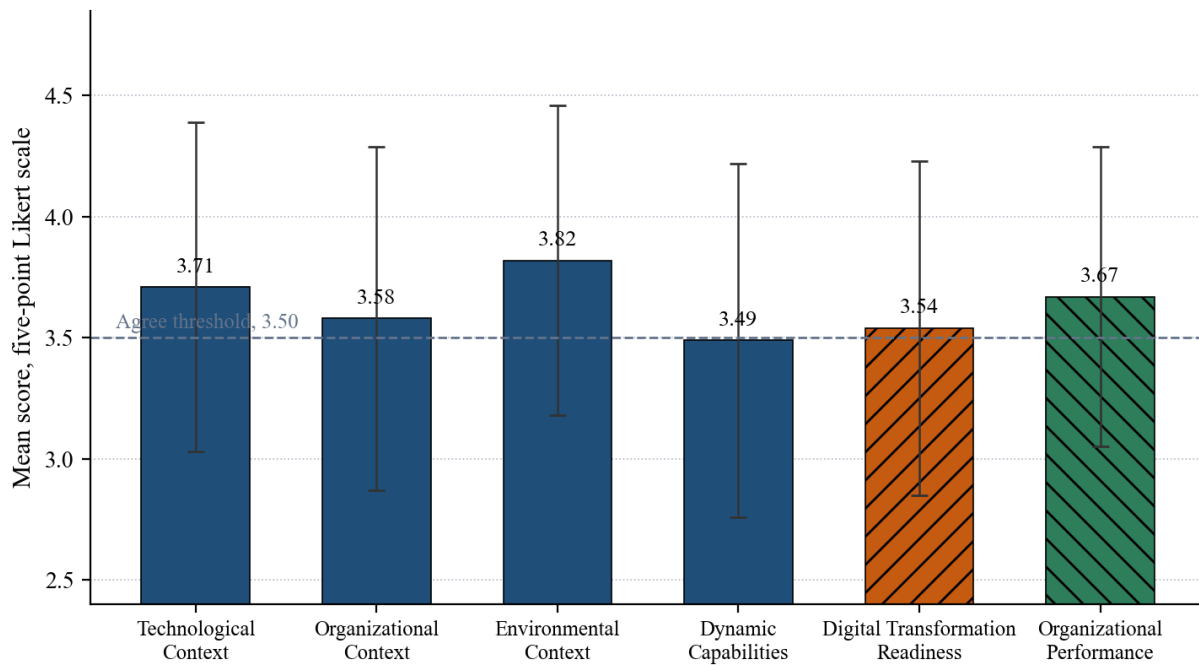


Figure 6. Composite mean scores of the six study constructs on the five-point Likert scale, with error bars spanning one standard deviation either side of the mean and the dashed line marking the 3.50 agree threshold. The four determinant constructs are shown in blue, readiness in orange and performance in green. Environmental Context is highest at 3.82 and Dynamic Capabilities lowest at 3.49, the only construct falling below the threshold, and every mean sits within a narrow band of roughly a third of a scale point.

The respondents feel external pressures from customers, competition and laws strongly, as shown by the highest mean of 3.82 for Environmental Context. Technological Context also received a fairly high score at 3.71. Organizational Context at 3.58 and Digital Transformation Readiness at 3.54 were within the agree band, although more modest, showing that while enterprises acknowledge external causes, internal preparation remains a concern. Dynamic Capabilities

returned the lowest mean score at 3.49, which suggests many construction SMEs have comparatively weak sensing, seizing and reconfiguring capabilities. Organizational Performance had a mean of 3.67, indicating that respondents typically saw modest increases in performance results.

4.4 Regression Analysis

A multiple linear regression analysis was undertaken to explore the influence of the four determinant categories, Technological Context, Organizational Context, Environmental Context and Dynamic Capabilities, on Digital Transformation Readiness. A second regression model explored the impact of Digital Transformation Readiness on Organizational Performance.

4.4.1 Determinants of Digital Transformation Readiness

Table 8 gives the model summary for the first regression. The four determinant groups jointly explain 52.4 percent of the variance in Digital Transformation Readiness, with an adjusted R^2 of 0.511.

Table 8: Model summary, determinants to readiness.

R	R^2	Adjusted R^2	Std. error of the estimate
0.724	0.524	0.511	0.492

Note. $n = 150$ valid responses. The model regresses Digital Transformation Readiness on the four determinant constructs of Table 7.

Table 9 reports the analysis of variance for the same model, which is statistically significant at $F = 39.87, p < 0.001$.

Table 9: Analysis of variance, determinants to readiness.

Source	Sum of squares	df	Mean square	F	Sig.
Regression	38.617	4	9.654	39.87	0.000
Residual	35.108	145	0.242		
Total	73.725	149			

Note. $n = 150$ valid responses. The table gives the analysis of variance for the regression of Digital Transformation Readiness on the four determinant constructs.

Table 10 gives the regression coefficients. All four determinant categories show a statistically significant positive impact on Digital Transformation Readiness at $p < 0.05$. All four were measured on the same five-point scale, so the unstandardized coefficients can be read against one another. On that scale the organizational context carried the largest coefficient at $B = 0.341$, followed by dynamic capabilities at $B = 0.298$ and technological context at $B = 0.287$. Environmental context was significant but carried the smallest coefficient, at $B = 0.156$.

Table 10: Regression coefficients, determinants to readiness.

Variable	Unstandardized <i>B</i>	Std. error	<i>t</i>	Sig.	Significant
(Constant)	0.512	0.241	2.124	0.035	Yes
Technological Context	0.287	0.068	4.221	0.000	Yes
Organizational Context	0.341	0.061	5.590	0.000	Yes
Environmental Context	0.156	0.059	2.644	0.009	Yes
Dynamic Capabilities	0.298	0.057	5.228	0.000	Yes

Note. $n = 150$ valid responses. All four determinant categories show a statistically significant positive effect on Digital Transformation Readiness at $p < 0.05$.

4.4.2 Effect of Digital Transformation Readiness on Organizational Performance

Table 11 gives the model summary for the second regression. Digital Transformation Readiness explains 37.5 percent of the variance in Organizational Performance.

Table 11: Model summary, readiness to performance.

<i>R</i>	R^2	Adjusted R^2	Std. error of the estimate
0.612	0.375	0.371	0.491

Note. $n = 150$ valid responses. The model regresses Organizational Performance on Digital Transformation Readiness alone.

Table 12 reports the analysis of variance for that model, which is statistically significant at $F = 88.71$, $p < 0.001$.

Table 12: Analysis of variance, readiness to performance.

Source	Sum of squares	df	Mean square	<i>F</i>	Sig.
Regression	21.384	1	21.384	88.71	0.000
Residual	35.671	148	0.241		
Total	57.055	149			

Note. $n = 150$ valid responses. The table gives the analysis of variance for the regression of Organizational Performance on Digital Transformation Readiness.

Table 13 gives the coefficients. Digital Transformation Readiness has a strong, positive and statistically significant effect on Organizational Performance, at $B = 0.634$, $p < 0.001$.

Table 13: Regression coefficients, readiness to performance.

Variable	Unstandardized <i>B</i>	Std. error	<i>t</i>	Sig.	Significant
(Constant)	1.428	0.237	6.025	0.000	Yes
Digital Transformation Readiness	0.634	0.067	9.418	0.000	Yes

Note. $n = 150$ valid responses. Digital Transformation Readiness has a strong, positive and statistically significant effect on Organizational Performance at $p < 0.001$.

4.4.3 Multicollinearity Diagnostics

Table 14 reports the variance inflation factors for the four determinants. All values are well below the conservative threshold of 5, indicating no problematic multicollinearity among the independent variables.

Table 14: Variance inflation factors for the four determinant constructs.

Variable	VIF
Technological Context	1.68
Organizational Context	1.92
Environmental Context	1.41
Dynamic Capabilities	1.75

Note. $n = 150$ valid responses. All VIF values are well below the conservative threshold of 5, indicating no problematic multicollinearity among the independent variables.

5. DISCUSSION

This section reads the empirical results of Section 4 against the questions set out in Section 1 and the literature evaluated in Section 2, taking the determinants first, then the level of readiness reached, then what that readiness is worth to performance.

5.1 Determinants of Digital Transformation Readiness

Which characteristics of digital transformation preparedness matter most for small and medium-sized construction enterprises, and how do those characteristics relate to preparedness? The regression results in Table 10 show that all four sets of characteristics have a significant and positive effect on preparation.

The strongest effect came from the organizational environment, at $B = 0.341$, $p < 0.001$. The relevance of company resources, structure, management support and culture in technology-related outcomes is highlighted by Justino *et al.* (2022) and Smit *et al.* (2024). The Technology–Organization–Environment paradigm strongly supports this. It also supports the Resource-Based View, which holds that the competitive advantage of an organization derives from its rare, valuable and distinctive resources and capabilities (Zvarimwa and Zimuto 2022; Hortovanyi *et al.* 2023). Internal organizational characteristics are important for small and medium-sized firms in the construction sector, since owner-managers often have limited financial resources and lack specific digital competence (Nkwinika and Akinola 2023).

The impact of Dynamic Capabilities was a close second, at $B = 0.298$, $p < 0.001$. This study, along with the work of Kero and Bogale (2023), Quansah *et al.* (2022) and Cao *et al.* (2023), confirms that to be ready in a technologically changing environment, a firm has to be able to see chances, exploit them and restructure operations. In the construction business the flexibility to alter digital processes during contracts is particularly crucial, because of the temporary and project-based structure of the work (Tran and Nguyen 2024; Bhattacharya and Chatterjee 2022). The average score for Dynamic Capabilities is rather low, at 3.49 in Table 7, which suggests that there is still opportunity for many SMEs to improve in this area. This is consistent with other studies suggesting that SMEs are not especially change-ready and do not hold strong organizational learning capacities (Lijauco *et al.* 2020; Rupeika-Apoga and Petrovska 2022).

Technological Context also had a significant positive effect, at $B = 0.287$, $p < 0.001$. This result is consistent with the TOE framework's emphasis on relative advantage, compatibility, complexity and existing infrastructure (Shonubi 2024). The conclusion is also consistent with Diffusion of Innovations theory, reinforced by studies showing that people are more inclined to embrace new technologies if those technologies are seen as useful, compatible and trialable (Gondal 2023). Environmental Context, despite its importance at $B = 0.156$, $p = 0.009$, had the lowest coefficient. Institutional theory recognizes that consumers, regulators and competitors may impose coercive, mimetic and normative effects (Dua 2022; Wang *et al.* 2024; Bradač Hojnik and Huek 2023). External pressures are seen as strong, at a mean of 3.82, but they do not necessarily lead to strong internal preparation. That implies that mandates are not adequate without the complementary development of organizational and capability capacities.

In sum, preparation is multi-dimensional in its sources, and internal considerations weigh more heavily on it than external ones do.

5.2 The Current Level of Readiness

Preparedness fell into the agree category with a mean of 3.54, which is closer to the center of the scale than to strong affirmation. That level confirms the argument of Adekunle *et al.* (2024), Wang *et al.* (2024) and Zhang *et al.* (2023) that the construction industry lags behind other industries in digital transformation. External demands are growing and technologies such as BIM, IoT and AI have a great deal of potential, but many SMEs still have a low level of organizational preparation (Ernstsen *et al.* 2021; Sepasgozar *et al.* 2023).

These findings mirror the challenges discussed in Sections 1 and 2: financial and human resource limitations, project-based fragmentation, conservative cultures and subordinate supply-chain roles (Donyavi *et al.* 2022; Nkwinika and Akinola 2023; Bhuiyan *et al.* 2024). Aliu and Oke (2023), Papadonikolaki *et al.* (2022) and Dolla *et al.* (2023) all state that the construction sector is still in the nascent phases of digital transformation, owing to sociotechnical and organizational obstacles. Beyond awareness and certain essential elements, construction SMEs are not yet systematically prepared for the ongoing digital revolution. The intermediate preparedness score gives quantitative substance to the gap set out in the introduction.

5.3 Implications of Readiness for Organizational Performance

The third question concerned the impact of digital transformation preparedness on organizational performance. The study found a strong, positive and statistically significant association at $B = 0.634$, $p < 0.001$, where preparedness explained 37.5 percent of the variation in performance outcomes, including project execution, financial success, customer satisfaction, competitiveness and operational efficiency.

The findings provide empirical support for the Resource-Based View and Dynamic Capabilities perspectives. Conceptualized as a higher-order organizational capability, readiness enables firms to deploy digital resources effectively and reconfigure processes in response to changing demands, generating performance advantages that less prepared rivals struggle to replicate (Hortovanyi *et al.* 2023; Serafimova and Vasilev 2024). It also reflects the proposition that digital transformation may raise productivity, eliminate waste and promote cooperation when organizations are well equipped (Ernstsen *et al.* 2021; Costa 2024; Gfrerer *et al.* 2021; Heubeck 2023).

The conclusion is especially important in the specific situation of construction SMEs. The literature has well established that these enterprises typically have difficulty securing complicated and valuable contracts and face limitations in demonstrating competitiveness (Ali and Hassan 2024; Onuwa *et al.* 2023). The positive association between readiness and performance shows that SMEs which boost their digital preparation would improve their project performance and market position, addressing the performance concerns described by Olaniyi and Adekanmbi (2022) and Alkilani and Loosemore (2022). The result goes beyond descriptive assessments of the hurdles and supplies quantitative evidence that preparation matters for organizational success.

5.4 Theoretical Integration and Contribution to the Literature

The findings indicate the usefulness of the theoretical framework developed in Section 2. Work by Mousavi *et al.* (2024) and Sepasgozar *et al.* (2023) found the TOE framework successful in empirically supporting its claim to arrange elements into technical, organizational and environmental domains. The Resource-Based View and Dynamic Capabilities theory propose that organizational resources and adaptive capacities are more significant than merely having the technology (Zvarimwa and Zimuto 2022; Kero and Bogale 2023). Dua (2022) and Mbatha (2024) referred respectively to Institutional theory, which accounts for the role of outside influences, and Diffusion of Innovations theory, which explains why certain technical aspects increase adoption.

The results contribute to the existing literature by indicating that readiness is impacted by several variables and has a strong effect on performance. This goes further than discussing ideas and examining case studies of larger organizations. It offers an explanatory model that combines several theoretical views and delivers quantitative data from the less-studied construction SME sector. It therefore addresses the knowledge gap identified in the introduction and contributes to the theoretical and empirical understanding of digital transformation readiness and its implications for performance.

6. CONCLUSIONS

This study set out to identify the factors behind digital transformation readiness in construction SMEs and to establish what that readiness is worth to organizational performance. The analysis of 150 replies answers both.

6.1 Summary of Key Findings and Conclusions

The research found that four categories of factors play a key role in digital transformation readiness in construction SMEs: Technological Context, Organizational Context, Environmental Context and Dynamic Capabilities. Collectively, the predictors accounted for 52.4 percent of the variation in preparedness. Organizational Context carried the largest coefficient on the five-point scale common to all four, with Dynamic Capabilities and Technological Context next, and Environmental Context significant but smallest. The overall level of digital transformation

preparation was modest, at a mean of 3.54, showing that despite the existence of awareness and external pressures, internal preparedness remained restricted for many organizations.

Digital transformation readiness was, crucially, highly positively correlated with organizational success, accounting for 37.5 percent of the variation in project execution, financial results, customer satisfaction, competitiveness and operational efficiency. These findings demonstrate that preparation is multi-dimensional in its determinants and consequential for performance.

The determinants of preparation have been identified and their relationships with readiness measured, the present degree of readiness has been evaluated as moderate, and the beneficial impact of preparation on organizational performance has been confirmed. The results support the integrated theoretical framework, comprising the Technology–Organization–Environment model, the Resource-Based View, Dynamic Capabilities theory, Institutional theory and Diffusion of Innovations theory, and supply context-specific data from construction SMEs.

6.2 Theoretical Implications

The paper leverages an under-researched setting to illustrate the empirical robustness of an integrated multi-theoretical perspective on digital transformation preparation. This result enhances the Technology–Organization–Environment framework and provides support for the Resource-Based View and Dynamic Capabilities perspectives, under which internal organizational resources and capabilities are more significant than external pressures. The substantial readiness–performance link advances the understanding of readiness as a higher-order capability that offers performance benefits. The results move the study emphasis from characterizing impediments and technology adoption to an explanatory model of preparation and outcomes in small and medium-sized construction enterprises.

6.3 Practical Recommendations for SME Managers

Creation of internal organizational conditions conducive to digital preparedness should be a priority for owners and managers of construction SMEs. Specific measures are:

1. Secure more buy-in from top leadership for digital change, and inform all employees of the goals.
2. Set aside some funds, however little, for digital resources, training and process development.
3. Promote experimentation, learn from successes and failures, and invest in upskilling the existing workforce's digital capabilities.
4. Develop flexible abilities by keeping up with technological advances, trying new tools out on particular projects, and tailoring methods as required.
5. Run regular internal digital preparedness exercises to identify knowledge, skills and process gaps.

To improve project performance, competitiveness and long-term sustainability, SMEs are called on to work these internal levers to raise their preparation.

6.4 Recommendations for Policymakers and Industry Stakeholders

Policymakers and industry groupings have a key role in accelerating the digital transformation of construction SMEs. These are some measures to consider:

1. Dedicated support programs combining financial incentives, such as grants and subsidized software and training, with capacity-building interventions on digital skills and business change.
2. Realistic techniques for assessing preparedness that take into consideration the resource constraints and project type of SMEs.
3. Structured support and knowledge transfer from larger clients and main contractors to SME supply-chain partners, rather than the mere upholding of digital norms.
4. Industry associations making low-cost technology solutions accessible, by sharing experiences and by arranging demonstration projects.
5. Alignment of regulatory and procurement frameworks, so that support mechanisms and realistic timelines for digital demands are accessible to smaller enterprises.

These efforts may assist in bridging the digital gap between big contractors and SMEs and can be used to promote a more inclusive industrial transformation.

6.5 Limitations of the Study

Two limits bear on how these results should be read. The achieved sample of 150 usable responses falls below the minimum of 200 generally recommended for stable estimation of a measurement and structural model of this size, so the confirmatory factor analysis, discriminant validity checks and mediation tests the design provided for were not estimated, and the evidence reported here speaks to direct effects only. Common method bias was addressed procedurally, through the anonymity assurance and the separation of the predictor and criterion items within the instrument, but was not diagnosed statistically after the fact, so some inflation of the observed associations cannot be ruled out.

6.6 Directions for Future Research

Future studies may use longitudinal designs to investigate changes in preparation and performance over time. For a better understanding of the processes by which organizational and dynamic capacities impact preparedness, mixed methods techniques combining survey data with in-depth case studies are recommended. Cross-country or cross-segment comparative study within the construction sector, for instance building against civil engineering, would assess the transferability of the results. Future research might further address the moderating impacts of firm size, age or particular digital technologies, and evaluate the function of inter-organizational cooperation in developing SME preparedness. Generalizability would be strengthened by quantitative research on larger, randomly chosen samples.

6.7 Concluding Remarks

Digital transformation brings important prospects and considerable problems for construction SMEs. The research has shown that technical, organizational, environmental and capability-related elements affect readiness, and that greater readiness translates into better organizational performance. Construction SMEs may improve their readiness, and reap the performance advantages of digital transformation, by concentrating on internal organizational growth and adaptive capacities and by drawing on well-tailored external help. The evidence offered here provides a basis for managers, policymakers and academics aiming to promote digital readiness in this important part of the construction industry.

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