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Strategic Orientation and Economic Performance of Construction Enterprises in Guangdong Province: The Moderating Effect of Digital Technology Adoption

Hongbo Zhou[1], Ye Zhang[2], Muneera Binti Esa[1,*]

[1] Department of Project Management, Faculty of School of Housing, Building and Planning, University Sains, Malaysia
[2] Department of Educational Management, Planning and Policy, Faculty of Education, University Malaya, Malaysia

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ABSTRACT

This study examines how digital technology adoption moderates the relationship between strategic orientation and economic performance in construction enterprises. Drawing on the resource-based view and dynamic capabilities theories, we surveyed 193 construction firms in Guangdong Province, China, to investigate the economic effects of market orientation, entrepreneurial orientation, and technology orientation on performance, with digital technology adoption as a boundary condition. Using partial least squares structural equation modeling (PLS-SEM), our findings reveal differential impacts of strategic orientations on performance. Technology orientation emerges as the strongest predictor of economic performance ($\beta = 0.246$, $p < 0.01$), followed by market orientation ($\beta = 0.187$, $p < 0.05$), while entrepreneurial orientation shows no significant direct effect. Critically, digital technology adoption significantly moderates both the market orientation–performance ($\beta = 0.134$, $p < 0.05$) and technology orientation–performance ($\beta = 0.198$, $p < 0.01$) relationships, amplifying their economic value creation under conditions of high digital adoption. The model explains 38.4% of performance variance, with simple slope analysis revealing that strategic orientations generate substantial performance benefits only when supported by adequate digital infrastructure. These findings challenge the universal applicability of entrepreneurial frameworks in traditional industries and suggest that digital transformation fundamentally reconceptualizes which strategic orientations remain economically viable in increasingly digitized business environments.

1. Introduction

Construction sector acts as a primary support base for world economic growth, contributing to approximately 13% of the global gross domestic product and being a primary sector for both economic growth and job creation. Strategic orientation, including market orientation,

* *Corresponding author.*
E-mail address: zaya.zhang0812@gmail.com

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entrepreneurial orientation, and technological orientation, has become a primary factor that influences firm performance in a range of sectors [1, 2]. Nonetheless, strategic orientation and firm performance connections in construction enterprises are complicated and situation-specific, particularly in emerging economies where digitalization has been comparatively quickly transforming the environment of traditional business. Economically, it is essential to comprehend these connections as construction enterprises aim to enhance resource allocation and create sustainable competitive advantages in the context of increasing competition in markets. Conservative thinking of the construction sector, as well as the unwillingness of affiliated enterprises to implement innovations, has opposed efficient application of strategic orientation; therefore, it is crucial to identify how the application of digital technologies can become an accelerator of strengthening strategic orientation-performance connections.

The aim to carry out this research comes from both theoretical shortcomings and real-world economic issues of the construction sector. Though much research has been done on strategic orientations and digital transformation separately, little attention has been devoted to exploring their interactive impacts toward firm performance, especially in construction markets where project-oriented activities and resource shortages bring specific strategic challenges. Recent evidence in the empirical literature of the Chinese construction sector shows that constructing strategic orientation alone does not enable firms to achieve sustainable competitive advantages in hypercompetitive markets [3]. Existing studies have determined that there are positive correlations between various strategic orientations and firm performance, but paths of these positive correlations, particularly among digital transformation, are incomplete [4]. Recent meta-analytic evidence shows that digital transformation generates remarkable economic value, and the greatest positive effects are found to be on economic performance, but the mechanisms how this works beneath conventional industries, including construction, are still not clear [5]. Rapid advancement of digitally enabled technologies, e.g., Building Information Modeling (BIM), Internet of Things (IoT), and Artificial Intelligence (AI) appeared to restructure the construction sector's operating environment, and thus building new prospects for organizations to utilize more effectively their strategic orientations [6, 7]. Following the resource-based firm and dynamic capabilities theories, adoption of digital technologies can be framed as a strategic resource to exploit the firms' capacities to sense, exploit, and reconfigure their capabilities when facing environment changes [8, 9].

Based on the identified research gaps and practical needs, this study addresses the following key research questions:

RQ1: How do different strategic orientations (market orientation, entrepreneurial orientation, and technology orientation) affect construction enterprise performance?

RQ2: How does digital technology adoption moderate the relationships between strategic orientations and construction enterprise performance?

RQ3: Do different strategic orientations exhibit varying degrees of performance enhancement when combined with digital technology adoption?

These research questions help us with our study and theory building.

This paper employs a number-based approach to examine the impact of utilizing information technology on strategy-performance relationships in construction organizations. Practical objectives include determining which strategies achieve the best performance when aligned with information technologies, ascertaining how strong these impacts are in aiding decisions concerning investments, and providing evidence-based recommendations to construction leaders. To conduct their study, researchers utilize partial least squares structural equation modeling (PLS-SEM) incorporating interaction terms to provide robust statistical evidence for the effects of moderation and accounting for the complex relationships that are prevalent in construction sector studies.

This research aims to fill this missing link by investigating how the moderation effect of digital technology adoption on the strategic orientation – firm performance relationship exists in the construction organizations. The study makes several key contributions to both strategic management theory and construction industry practice. Theoretically, it extends the resource-based view by demonstrating how digital technologies function as complementary assets that amplify the value-creation potential of strategic orientations, challenging assumptions about universal strategic orientation effects. From a practical perspective, the research provides empirical evidence quantifying the economic returns to different strategic orientation-digital technology combinations, offering guidance for resource allocation decisions in construction enterprises. The results contribute to theoretical developments released their hold on the field by showing how new technologies frame established strategy-performance relationships in a project-based sector and offer practical implications to construction executives who are facing the challenge of digital transformation.

The rest of the paper has the following format. Section 2 contains a detailed literature review and theoretical background, and it lays out the hypotheses. Section 3 describes the methods of the research, including details of the sample and data analysis. Section 4 reports the research findings and discusses moderation analysis. Section 5 discusses the implication of the findings and their limitations. Section 6 concludes with important insights and recommendations to practitioners and policy makers.

2. Literature Review and Theoretical Development

2.1 Literature Review

2.1.1 Strategic orientation and firm performance

Strategic orientation is a crucial term, which implies a form's fundamentals philosophy in strategic direction directing the management's decision-making behavior and resource allocations [10]. Strategic orientation's literature has, to a great extent, focused on three primary dimensions: market orientation, entrepreneurial orientation, and technology orientation, which in turn have various impacts on organizational performance.

Market orientation involves a firm's focus and emphasis on developing, disseminating, and responding to marketing information. It has been discovered to have a positive correlation with business improvement in every sector [11]. New evidence supports that a company's implementation and internalization of market orientation impacts its own performance, especially in digitally volatile environments. In these, organizations are required to maintain a balance between past market competencies and new opportunities based on technology advances. Recent surveys from manufacturing organizations suggest that market orientation has a positive and significant influence on marketing and interfacing the market. Marketing competency influences how market orientation impacts performance [12]. This evidence highlights a focus on organizations to gain related competencies to harvest firm-level returns of market orientation, a situation more imperative for construction organizations looking to improve their market understanding capability.

Entrepreneurial orientation involves innovativeness, proactiveness, and a willingness to take risks. Those dimensions themselves affect firm performance based on several situations and types of industry [13]. Research based on Chinese entrepreneurial firms suggests that entrepreneurial orientation may directly positively affect how a firm views the market and positively affect a firm's performance through complex mediation effects. Whereas uncertainty in the environment may have both positive and negative influences toward this relationship, it may have a nonsystematic impact.

Studies of family-owned organizations also identified significant strategic orientation effects for sustainable competitive performance, and the strategic orientation effects being strongly mediated by strategic flexibility, thus further suggesting a more complicated form of strategic orientation-performance relationship than hitherto taken for granted [14]. Construction sector's unique character as a specific implementation and strategy operation setting further suggests that more standardized project orientation based working and parsimonious organizational culture may restrict the degree to which strategic orientation benefits will become fully realized.

2.1.2 Digital technology adoption in construction industry

In the past few years, the digitalization of construction industry has speeded up due to the evolution of modern technologies, and the reasonable requirement of high efficacy, quality and sustainability [15]. Digital technology adoption encompasses a broad range of technologies including Building Information Modeling (BIM), Internet of Things (IoT), artificial intelligence, and cloud computing platforms that fundamentally alter how construction projects are planned, executed, and managed. Recent comprehensive analysis of construction industry digital transformation identifies three distinct maturity levels: traditional DT (basic technology adoption), niche DT (specialized applications), and advanced DT (comprehensive integration), with BIM technology dominating firms' approaches, followed by cloud computing and IoT [16]. Studies that investigate the impact of the adoption of digital technology on sustainability performance indicate that these technologies generate direct positive effects on the dimensions of economic, environmental and social performance, promoting still the collaboration among stakeholders, in order to better achieve gains of project [17]. The mediating role of stakeholder collaboration highlights how digital technologies not only provide technical solutions but also transform organizational processes and inter-firm relationships within construction supply chains.

Evidence from other service sectors offers lessons to which organizational drivers of digital transformation may apply in construction situations. Small-to-medium-sized service firm research indicates that IT infrastructural availability and investment in digital innovations are strong organizational drivers that have direct connections to attitude towards integration of digital innovations, while IT competencies, digital innovations management, and digital innovations knowhow have non-significant impacts [18]. This evidence indicates that infrastructure and investment, and not just knowhow and competencies, may form primary digital adoption barriers, a pattern that may hold a specific relevance to construction enterprises that have similar resource limitations. Recent research in a variety of sectors has listed five key digital transformation barriers: ambiguous and fuzzy objectives, inadequate workforce, challenges of integration of digital innovations with current systems, uncertainty related to the point of implementation origin, and ambitious cost outlays, which have specific relevance for construction enterprises that are working under limited resource conditions [19].

Strategic leadership has been identified as a key success factor in digital transformation of the construction sector. Analysis of Chinese construction companies based on a 12-year period of 861 cases utilizing machine learning shows that a digital-innovation mindset among senior managers prevails in digital transformation success, followed by collaboration across organizations and boundary transcending [20].

Yet, the positive effect of the adoption of the digital technology on firm performance is not homogeneous as indicated by the so-called "digitalization paradox" where substantial digital technology investment might not necessarily bring equivalent performance returns [21]. Studies focusing on Chinese manufacturing firms have found that U-shaped relationships between digital technology integration and financial performance are observed, which highlight that the firms need to achieve certain thresholds of digital capabilities before enjoying the performance virtues. Recent comprehensive evidence from Chinese listed companies demonstrates that digital transformation positively moderates the relationship between ESG performance and firm performance by enhancing enterprises' innovation capabilities, with this effect being particularly pronounced in non-state-owned, high-tech, and non-heavily polluting enterprises [22]. This suggests that digital transformation's effectiveness varies significantly across different organizational and industry contexts, indicating that construction enterprises may experience similar contextual variations in digital transformation outcomes.

The security aspect is a highly important consideration for construction organizations undertaking digital transformation. It has been researched that sustainable digitalization must include consideration of cyber security, since cyber threats have the potential to disrupt sustainability initiatives and lead to serious economic and social disruptions, necessitating flexible security policies that are able to adapt to quickly shifting digital environments [23]. For an effective implementation of digital transformation in the construction industry, it relies upon a range of variables, some of which include the backing of the top leadership, supporting policies, as well as the organizational change-readiness. Furthermore, construction industry-specific digital skill taxonomies indicate that the effective integration of digital technologies demands aligned efforts in technical, organizational, and human resources dimensions [7]. Development of digital skills has been further highlighted by education-oriented research, which shows that successful digitization necessitates recurring initiatives of upskilling and reskilling to facilitate efficient use of digital tools [24].

2.1.3 Research gaps and theoretical integration

Even if strategic orientation and digital adoption of technologies have been extensively researched in isolation, much has not been invested in understanding how these constructs intersect to affect firm performance, particularly in the construction sector. While the previous research has aimed principally to examine the direct relationships between strategic orientations and performance It has neglected to address the potential moderating role of digital capabilities [25]. While the prior work concerning the role of IT adoption capability as a mediator between strategic orientations and firm performance indicates that digital technologies are of crucial importance as enablers that trigger or inhibit the efficiency of strategic orientations, the previous studies did not investigate to what extent numerous types of digital technologies may have differing moderating impacts to differ along dimensions of strategic orientations.

The complexity of strategic orientation-performance relationships becomes more apparent when considering environmental and capability interactions. Recent evidence indicates that environmental dynamism significantly influences the indirect relationships between market and technology orientations and firm performance through their corresponding strategic capabilities, with technology orientation showing strong associations with both technology and information technology capabilities that mediate performance relationships [12]. This suggests that the strategic orientation-performance relationship is contingent not only on digital capabilities but also on environmental conditions and complementary organizational capabilities, creating multiple layers of complexity that require integrated theoretical frameworks.

Furthermore, contemporary research has expanded the conceptualization of strategic orientations beyond traditional market, entrepreneurial, and technology dimensions. For instance, strategic social value orientation, comprising behavioral components such as leading business with purpose, stakeholder support, and focus on consequences, has emerged as a significant predictor of sustainability performance [26]. While this extends beyond the core orientations examined in construction research, it illustrates the evolving nature of strategic orientation concepts and the need for comprehensive frameworks that can accommodate diverse strategic foci.

The construction industry's unique characteristics, including project-based operations, fragmented supply chains, and risk-averse culture, create specific conditions that may influence how strategic orientation-digital technology interactions affect performance outcomes [27]. Studies on the attributes of innovation performance in construction firms show the necessity for the good match between strategic orientation and technological capabilities and organizational innovation processes for successful digital transformation. In addition, modern research on intellectual capital and digital transformation in Chinese construction companies shows that digital technology has effects on the interaction between the different dimensions of intellectual capital and organizational performance; hence, similar moderating impacts are expected in the context of strategic orientation [28].

The resource-based conceptualization of digital transformation requires deeper integration with strategic orientation theory. While digital technologies function as strategic resources for value creation, existing literature lacks comprehensive frameworks that explore organizations' strategic resources concerning digital orientations and transformation initiatives [18]. This theoretical gap is particularly evident in emerging economy contexts where infrastructure constraints and institutional factors may significantly influence the strategic orientation-digital technology nexus, suggesting that construction enterprises in such contexts may face unique challenges in leveraging digital technologies to enhance strategic orientation effectiveness. The disparities in understanding highlight the requirement for integrating the entire framework of strategic orientation theory and available digital transformation writings to capture the different outcomes of different construction companies.

2.2 Theoretical Development

2.2.1 Resource-based view theory

The resource-based view theory is one of the theoretical frameworks used to explain how organizational competitive advantages get established and sustained by strategic resource deployment considered to be valuable, rare, inimitable, and non-substitutability [29]. Assets in the construction industry associated with strategic orientation apply to intangible ideas whose organizational decision-making and resource allocation processes they impact significantly. The value attached to these assets for orientation stems from socially complex features, causal linkages uncertainty, and profound organizational routine and culture integration, making them difficult to duplicate by competitors. The differential deployment of strategic orientation skills by construction firms explains industry performance differentials because firms endowed with sharper market sensing, entrepreneurial, or technology orientation skills show greater expertise in detecting and exploiting competitive opportunities.

Adoption of digital technology as an extra layer of strategic resources can multiply the spectrum of the value-creating potential, not only reinforce the strategic orientations of specific value-creating dimensions. From an RBV point of view, digital technologies are complementary assets that will enhance the effectiveness of the existing strategic orientation resources of the firm, by allowing better sensing, faster decision-making processes, and more efficient coordination mechanisms. When resources are combined with digital technologies and strategic orientations, they form resource configurations that are more hard to imitate than resources alone and enhance sustainable competitive advantage. Yet the value-creation potential of these sets of resources is conditional upon organizational capabilities to successfully blend and to deploy them in ways that satisfy market demands and competitive threats.

2.2.2 Dynamic capabilities theory

Dynamic capabilities theory further develops the RBV by highlighting firms' capacity to sense, seize and reconfigure resources in response to changing environmental conditions [30]. This theoretical focus is especially useful to assess the way in which construction companies handle digitalization with an eye to the continuity of their strategies. Dynamic capabilities include sensing capabilities (which allow firms to sense opportunities and threats), seizing capabilities (which help them to capture value from new technology) and reconfiguring capabilities (which enable transformation of the resource base and organizational structure in line with digital initiatives) [31]. The project-based nature of the construction industry implies that high levels of dynamic capabilities are necessary for firms to accommodate changing project needs, technological advances, and customer preferences. Recent empirical validation demonstrates that dynamic capabilities comprising digital orientation, digital capability, and willingness to change serve as key facilitators of digital innovation and responsible innovation, with their joint impact significantly enhancing competitiveness and providing pathways to sustainable competitive advantage [32].

The interplay between strategic orientations and digital technology adoption can be interpreted as a dynamic capability development process, where companies draw in their both orientation-based sensing mechanisms to identify digital technologies, seize these capabilities to implement such technologies efficiently, and reconfigure capabilities to integrate digital tools into their extant strategic practices [33]. Studies of sensing, seizing and reconfiguring capabilities in entrepreneurial firms found that strategic leadership is a key moderating factor and that its distinct types suit better each of the dynamic capabilities. For the construction sector, it indicates the digital technology adoption's moderation of the strategic orientation–performance link is contingent on dynamic capability development and leadership styles of firms.

2.2.3 Conceptual model and research hypotheses

Based on the theoretical foundations provided by the resource-based view and dynamic capabilities theories, the current study proposes a conceptual model to consider both the direct influence of strategic orientations on firm performance and the moderating impact of digital technology adoption. As illustrated in Figure 1, the proposed framework integrates three key strategic orientation dimensions with digital technology adoption as a boundary condition that influences the strength of strategic orientation-performance relationships in construction enterprises.

The direct impacts of strategic orientation toward a firm's good performance are described by a theory known as RBV. It asserts that organizations which are strong in strategic capacity ought to perform better and compete better if they utilize resources intelligently. Market orientation enables construction organizations to fulfill the needs of the customer, become aware of changes in the market, and adapt their services to deliver higher value to the customer. Focus on the market makes projects better, client relations better, and a company's competitive position better if a company carries out projects. Hence:

H1: *Market orientation positively affects construction enterprise performance.*

Entrepreneurial orientation refers to how a company thinks and does things in a manner that indicates it has a willingness to be innovative, take the lead, and take intelligent risks. Construction enterprises that have entrepreneurial orientation are likely to innovate new methods of project delivery, seek new markets, and develop novel competencies that give them uniqueness compared to other players. Thinking this way assists them in performing better as they identify more opportunities and build value. So:

H2: *Entrepreneurial orientation positively affects construction enterprise performance.*

Technology orientation indicates how much a firm is willing to get, develop, and exploit the use of technologies to become more efficient and competitive against rivals. In building construction, technology-oriented companies are able to leverage advanced methods of building construction, implement emerging technologies, and enhance project procedures from a technological point of view. By being technology-oriented, projects are of higher quality, more efficient, and more competitive in the market. Hence:

H3: *Technology orientation positively affects construction enterprise performance.*

The effects of adopting digital technologies are based on a theory known as dynamic capabilities theory. It shows how a firm's ability to sense, seize, and reconfigure resources affects its performance in uncertain environments. A firm's dynamic capabilities are boosted when it adopts digital technologies since it offers better tools to process information, make strategic decisions, and coordinate resources. Those improvements make existing strategies perform better. For construction companies, digital technologies like building information modeling, project management information systems, and data analysis tools help them perform their strategies better. It improves the positive association between those strategies and their consequent performances. It creates the primary moderation hypothesis:

H4a-c: *Digital technology adoption positively moderates the relationships between strategic orientations (market orientation, entrepreneurial orientation, and technology orientation) and construction enterprise performance.*

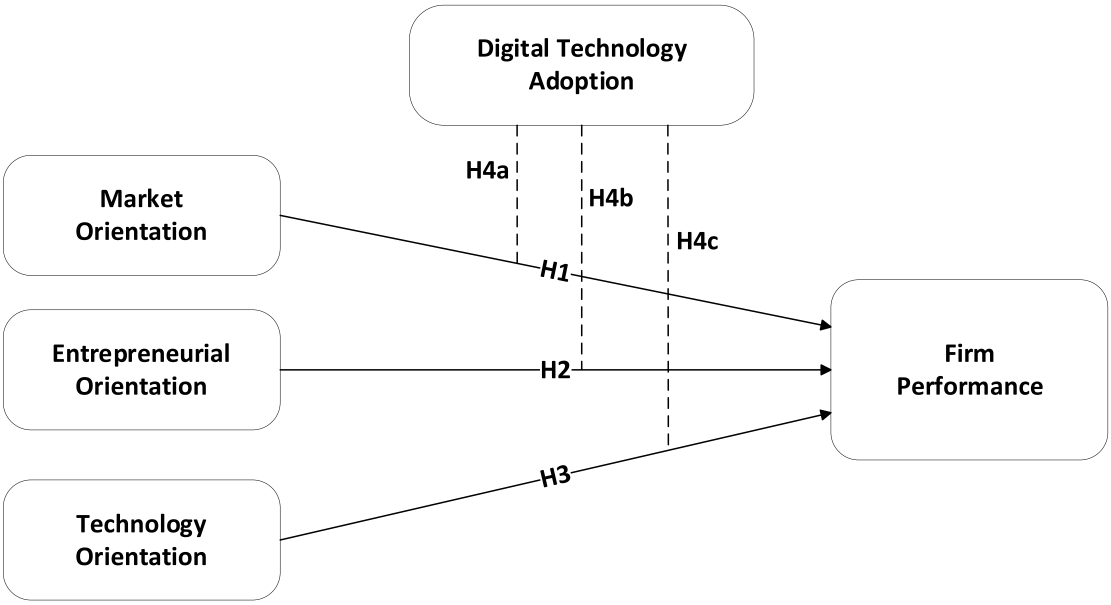

Fig. 1. Conceptual framework

3. Research Methodology

3.1 Research Design and Data Collection

3.1.1 Research approach and sampling strategy

This study adopts a cross-sectional quantitative survey design based on a structured survey methodology to examine interdependencies between strategic orientation, digital technology adoption, and firm performance among Guangdong Province construction firms. Following conventional practice among construction management research, a stratified convenience sampling approach has been implemented to affordance representation based on differing firm sizes and construction subsectors [34]. A stratified convenience sampling approach has been adopted to strike a balance between sophisticated methodology and real-world practicability, facilitating meaningful statistical comparisons while affording accessibility to respondents based on differing organizational settings.

The Guangdong Province was chosen for the study because it has the largest economy in China among the provinces. It accounts for more than 10% of China's total construction output value and has the highest level of building digital infrastructure and Industry 4.0 projects in the country. It thus provides a good example to explore how construction business are digitally transforming and how the evidence can help inform the wider development of the construction sector in China.

The target enterprises were Guangdong Province construction firms. These consisted of general, specialty, and construction service contractors that generated over 20 million RMB annually. Such firms ought to be mature and competent enough to formulate strategies. Revenue ceiling guarantees that the firms are complex and have planning expertise required in successful implementation of strategic intentions and adopting digital technologies. It further aligns with Chinese standards to characterize medium-sized construction enterprises.

The sampling frame was generated based on databases from the Guangdong Construction Industry Association and provincial government records. Stratified sampling was used to ensure that we sampled various firm sizes based on their annual incomes and provincial locations. It will help us understand the variance between the market conditions of the construction markets among the cities within the province, so we will make sure that our sample will take this variance between the market conditions and developments of the digital infrastructure into account. It should, however, be noted that, as a matter of fact, even if we are able to provide a good representation, we are aware that our findings may be limited once we generalize them into other provinces, as China may have other developments with regards to economic development and the construction industry.

3.1.2 Data collection procedure

The study relied on a comprehensive web-based survey instrument, which took a period of six weeks between October and November 2024 to collect the data. The research instrument was developed against scales of measurement, and piloted among 30 practitioners to identify the level of content validity, appropriateness, and clarity among the questions [35]. The bias related to the research instrument was reduced by applying the principles of procedure remedies, including procedures related to an item, by applying an element related to the procedure remedy, which involves reconstructing the procedure related to the constructed industry study methodology [36]. Additionally, multiple contacts, having the researched-executives approved and nominated by the respective industry, a follow-up reminder sent once every 1 week, and a personalized invitation letter, helped enhance the response rates significantly. The response rate was, therefore, finally achieved at 49.9% response rate, out of an initial list of 387 companies contacted initially, which justifies the response rates among various surveys categorized under the constructed industry surveys.

3.1.3 Sample characteristics

A cumulative total of 193 construction companies was finally selected as a sample, and their demographic statistics are given in Table 1. The demographic structure of the sample represents a well-balanced mix, as 26.4% are state, 61.7% are private, and 11.9% are mixed-ownership enterprise response submissions. Geographically, the sample represents major zones involved with the construction industry in Guangdong Province, including 29.5% from Shenzhen, 31.1% from Guangzhou, 17.6% from Dongguan, and 21.8% representing other cities.

Table 1
Sample Characteristics

Characteristic	Category	Frequency	Percentage
Firm Size (Revenue)	Small (20-100M RMB)	47	24.4%
	Medium (100-500M RMB)	82	42.5%
	Large (>500M RMB)	64	33.1%
Ownership Type	State-owned	51	26.4%
	Private	119	61.7%
	Mixed ownership	23	11.9%
Business Focus	General contracting	108	55.9%
	Specialty contracting	57	29.5%
	Construction services	28	14.6%
Years in Operation	<10 years	39	20.2%
	10-20 years	87	45.1%
	>20 years	67	34.7%
Geographic Location	Shenzhen	57	29.5%
	Guangzhou	60	31.1%
	Dongguan	34	17.6%
	Other cities	42	21.8%

3.2 Variables and Measurement
3.2.1 Strategic orientation scales

The measurement scale used for market orientation included 12 items, developed by adapting the market orientation scale – MARKOR, consisting of intelligence generation, intelligence dissemination, and responsiveness scales, each with 4 items, which have all been previously validated in a building construction context [29]. The scale related to entrepreneurial orientation included 8 items: 3 regarding innovate, 3 related to proactiveness, and 2 related to risk-taking, and this scale has been validated a priori in other studies related to construction business ventures [37]. Technology orientation included a 6-item scale, which measured company beliefs related to innovation, R&D, and adopting technology related to other studies related to strategic orientation. All strategy orientation scales used seven-point Likert scales, starting from “strongly disagree” (1) to “strongly agree” (7). The response scales were designed to offer a sufficiently wide variation to ensure a substantial amount of statistical power to be gained later by the structural equation model tests.

3.2.2 Digital technology adoption index

The operationalization of digital technology adoption included an extensive index that accounted for both the breadth and depth aspects of technology adoption, as suggested by recent methodology developments focusing on the study of digital technology in the construction sector [38]. The measurement instrument included 10 types of digital technology widely used in the construction industry: (1) Building Information Modeling, (2) Internet of Things sensors and monitoring systems, (3) Artificial intelligence and machine learning applications, (4) Cloud computing and data storage, (5) Mobile applications for project management, (6) Drone and UAV technology for land surveying, (7) Virtual Reality and Augmented Reality technology, (8) Digital project management software, (9) Automated equipment and robotics, and finally, (10) Big data analytics and business intelligence applications. The level of adoption, by category of technology, was measured using a five-point scale: (1) not adopted, (2) planning to adopt, (3) pilot implementation, (4) partial implementation, and (5) fully integrated. The overall index of digital technology adoption was derived from the formula:

$$DTA = \frac{\sum_{i=1}^{10} T_i}{10} \tag{1}$$

Where T_i represents the adoption level for technology category i, providing a standardized measure ranging from 1.0 to 5.0.

3.2.3 Firm performance measures

Construction firm performance was assessed with a technique that accounted for industry-related financial, operational, and market performance indicators as a conventional approach to construction management research [39]. Financial performance comprised indicators of profitability (return on assets, revenue growth, and profit margins), operational performance comprised project delivery metrics (cost control efficiency, quality scores, and completion rate of projects on time), and market performance comprised competitive positioning, repeat business rate, and customer satisfaction indicators. Each aspect of firm performance consisted of 4-5 indicators that were scaled along a seven-point scale ranging from "much worse than competitors" (1) to "much better than competitors" (7), and some objective financial indicators supplemented perceptual ones when possible from respondents.

3.2.4 Control variables

Control variables were introduced to account for other potential explanations and to enhance the accuracy of the model, typical to construction management research [40]. Size of the firm was captured both in terms of annual revenue (converted to a log) and number of employees to gain insight into how size impacts strategy implementation. Age of the firm (number of years since inception) accounted for experience and learning effects in the firm. Industry focus (general contracting, specialty contracting, construction services) was used to measure industry specialization. Geographic position in Guangdong Province was controlled in terms of regional dummy variables that account for local economic conditions, infrastructure build, and market competition levels. Ownership status (state-owned, private, mixed) was represented due to its significant impact on strategic flexibility and digital adoptive capacities in the Chinese context.

3.3 Data Analysis Methods

3.3.1 Preliminary analysis

Data preparation and initial analysis followed conventional protocols for application of partial least squares structural equation modeling (PLS-SEM) in construction management research. Specific emphasis was placed in testing data quality and testing assumptions [41]. Testing for missing data revealed that less than 3% of data went missing across different variables, which were addressed using listwise deletion to make the sample complete. For testing normality, both Shapiro-Wilk and visual checks were carried out. It was determined that it was possible to use PLS-SEM despite the fact that some strategic orientation measures had non-normal distributions. For the detection of outliers, Cook's distance and standardized residual analysis were used, which led to the deletion of four extreme cases to ensure consistency and stability of the model.

3.3.2 Structural equation modeling

Partial least squares structural equation modeling (PLS-SEM) was chosen as the main analytical methodology because of its suitability in exploratory research settings, capacity to accommodate models with many constructs and interaction effects and relaxed distributional assumptions that reflect the nature of construction industry data [42]. SmartPLS 4.0 software was used for the analysis, with consistent PLS algorithm and path weighting scheme used for model estimation, as well as 5,000 bootstrap samples for testing the significance. Measurement model assessment included reliability evaluation through Cronbach's alpha (>0.70) and composite reliability measures (>0.80), convergent validity through average variance extracted (AVE >0.50), and discriminant validity using Fornell-Larcker criterion and heterotrait-monotrait (HTMT) ratios (<0.85). Structural model evaluation encompassed path significance testing, effect size assessment using Cohen's f^2 guidelines (small=0.02, medium=0.15, large=0.35), and predictive relevance evaluation through Stone-Geisser's Q^2 statistics.

3.3.3 Moderation analysis

Moderation effects were looked at using the product indicator method in PLS-SEM. This created interaction terms between strategic orientation ideas and digital technology adoption measures. The process for moderation analysis included mean-centering predictor variables to lessen issues with multicollinearity. After that, interaction terms were created by multiplying elements together and re-estimating the structural model. Simple slope analysis was carried out to determine significant interaction effects. It indicated the relationships at high level (+1 SD) and low level (-1 SD) of the moderator variable. Bootstrapping confidence intervals, which were adjusted to correct for bias, helped to check if the conditional effects were significant statistically at different levels of the moderator. It provided a clear understanding of the boundary in the inter-relationship between strategic orientation and performance in the scenario of digital transformation of construction enterprises.

4. Results

4.1 Descriptive Statistics and Correlations

The final sample size of 193 members of construction companies supplied full data for analysis. Summary statistics and correlations between study variables are as follows (Table 2). Technology orientation obtained the highest average score (M = 4.73, SD = 1.31), followed by market orientation (M = 4.49, SD = 1.25) and entrepreneurial orientation (M = 4.18, SD = 1.42). Adoption of digital technologies was moderate (M = 3.28, SD = 0.94), that is, most members of construction companies are still in initial to moderate stages of digital transformation. Firm performance averaged 4.41 (SD = 1.14) along the seven-point scale.

Table 2 shows that the distribution of digital technology adoption is positively skewed (0.89), and a few firms have intensive levels of digital integration. There are positive relationships between every strategic orientation and firm performance, and the highest relationship between firm performance and technology orientation ($r = 0.53$, $p < 0.001$). State ownership positively correlates with digital adoption ($r = 0.28$, $p < 0.01$), and it may thus be that government initiatives are encouraging digitalization among government-held firms.

Table 2
Descriptive Statistics and Correlation Matrix

Variable	Mean	SD	Skew	Kurt	1	2	3	4	5	6	7	8	9
1. Firm Size (ln)	4.56	1.97	0.34	-0.67	1.00								
2. Firm Age	15.8	8.71	0.45	-0.12	.29**	1.00							
3. State Ownership	0.26	0.44	1.09	-0.81	.33***	.41***	1.00						
4. Market Orientation	4.49	1.25	-0.23	-0.56	.24**	.16*	.18*	(.78)					
5. Entrepreneurial Orientation	4.18	1.42	-0.15	-0.43	.19*	.08	-.12	.58***	(.73)				
6. Technology Orientation	4.73	1.31	-0.31	-0.28	.31***	.19*	.21**	.52***	.61***	(.81)			
7. Digital Technology Adoption	3.28	0.94	0.89	1.24	.38***	.23**	.28**	.47***	.43***	.56***	(.86)		
8. Firm Performance	4.41	1.14	-0.18	-0.37	.27**	.21**	.19*	.51***	.46***	.53***	.42***	(.89)	
9. Business Focus	1.59	0.74	0.67	-0.58	.15*	.04	.09	.11	.13	.17*	.22**	.16*	1.00

Note: N = 193. Values in parentheses are Cronbach's alpha coefficients. State Ownership coded as 1 = state-owned, 0 = non-state-owned. Business Focus coded as 1 = general contracting, 2 = specialty contracting, 3 = construction services. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.2 Measurement Model Assessment

The measurement model needed to improve some items to have good psychometric properties. Nine items were kept for market orientation, six for entrepreneurial orientation, five for technology orientation, eight for digital technology adoption, and eleven for firm performance after taking out items with factor loadings lower than 0.60 or cross-loadings higher than 0.40.

As indicated in Table 3, there are no unreliable and invalid constructs since factor loading ranges between 0.58 and 0.91 and composite reliability exceeds 0.80. Entrepreneurial orientation encountered measurability challenges, as AVE (0.48) narrowly fell below the criterion of 0.50 and the lowest reliability (0.73). Composite reliability, nevertheless, exceeds 0.80, thus warranted to maintain the construct. All HTMT ratios are below 0.85, confirming discriminant validity in spite of strategic orientation conceptual overlaps.

Table 3
Reliability and Validity Assessment

Construct	Final Items	Factor Loading Range	Cronbach's α	Composite Reliability	AVE	HTMT Range
Market Orientation	9	0.62-0.84	0.78	0.84	0.51	0.54-0.69
Entrepreneurial Orientation	6	0.58-0.79	0.73	0.82	0.48	0.58-0.74
Technology Orientation	5	0.66-0.88	0.81	0.87	0.57	0.61-0.78
Digital Technology Adoption	8	0.61-0.86	0.86	0.89	0.53	0.44-0.71
Firm Performance	11	0.59-0.91	0.89	0.91	0.56	0.48-0.67

Note: All factor loadings significant at $p < 0.001$. HTMT = Heterotrait-Monotrait ratio. All HTMT values < 0.85 indicate discriminant validity.

Harman's single-factor test revealed the first unrotated factor to account for 32.6% of variance, which was below the cutoff for 50% but did suggest some potential method variance. Testing of the common latent factor indicated minimal change in path coefficients (<0.08), and marker variable correlations between 0.06 and 0.18, which in turn indicate that common method bias is not severely undermining validity in the outcome.

4.3 Structural Model Results

4.3.1 Model fit and quality criteria

Figure 2 shows the essential structure of relationships and how they influence each other. The model fits very well (SRMR = 0.089, NFI = 0.81) and explains 38.4% of the variation in performance. Significant interaction effects include the following: digital adoption having a significant role in both market orientation (β = 0.134*) and technology orientation (β = 0.198**) towards performance.

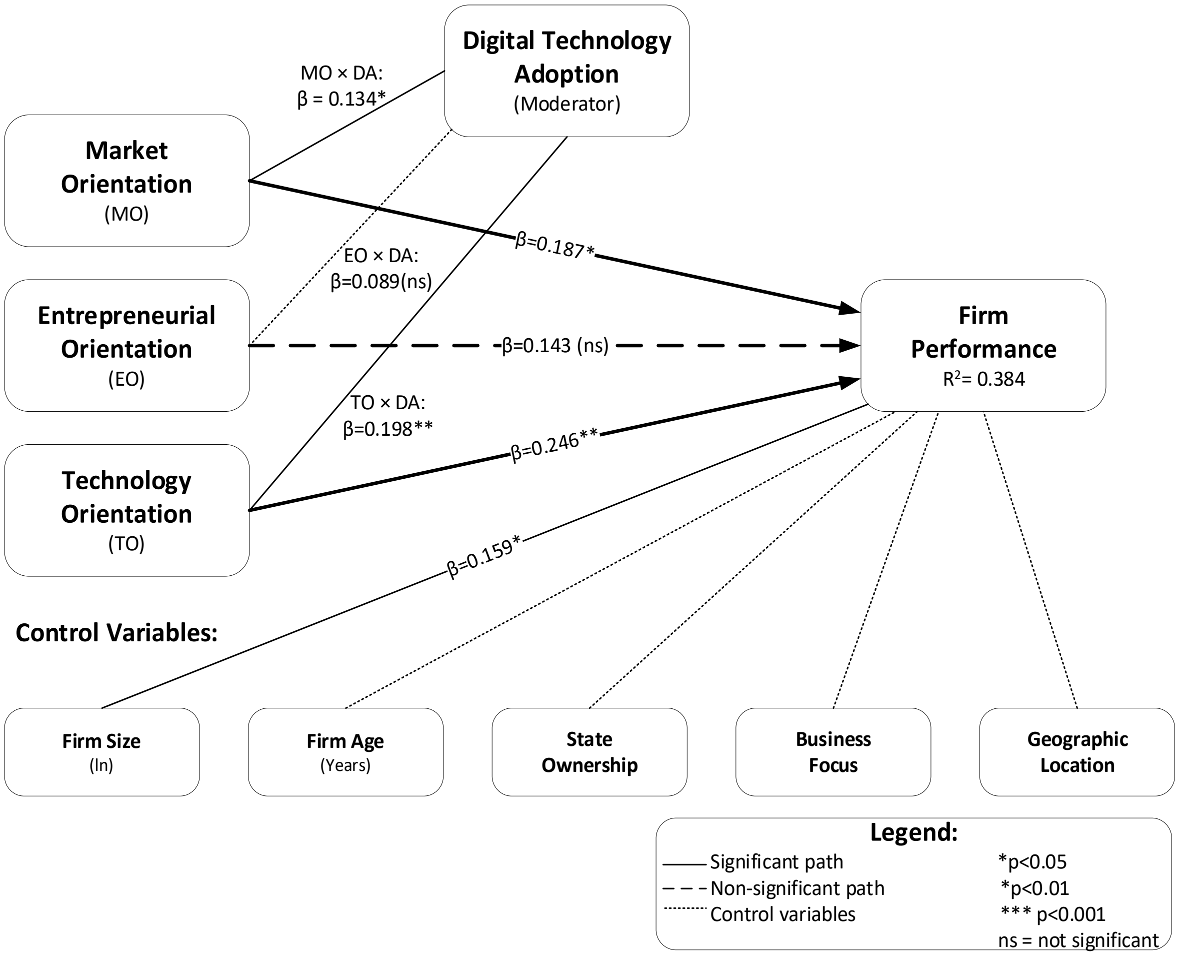

Fig. 2. Structural model results

4.3.2 Direct effects testing

Table 4 presents direct effects testing results and control variable impacts. Technology orientation emerges as the strongest predictor of firm performance, while entrepreneurial orientation fails to achieve significance.

Table 4
Structural Model Results - Direct Effects and Control Variables

Variables	Beta	SE	t-value	p-value	95% CI	Effect Size (f^2)
Direct Effects (Hypotheses)						
H1: Market Orientation → Performance	0.187	0.074	2.527	0.012	[0.041, 0.333]	0.052
H2: Entrepreneurial Orientation → Performance	0.143	0.081	1.765	0.078	[-0.016, 0.302]	0.029
H3: Technology Orientation → Performance	0.246	0.079	3.114	0.002	[0.091, 0.401]	0.088
Control Variables						
Firm Size (ln)	0.159	0.071	2.239	0.025	[0.020, 0.298]	0.043
Firm Age	0.087	0.069	1.261	0.208	[-0.048, 0.222]	0.015
State Ownership	0.034	0.078	0.436	0.663	[-0.119, 0.187]	0.002
Business Focus	0.076	0.072	1.056	0.291	[-0.065, 0.217]	0.011
Shenzhen Location	0.121	0.084	1.440	0.150	[-0.044, 0.286]	0.025
Dongguan Location	0.098	0.089	1.101	0.271	[-0.076, 0.272]	0.018
Other Cities Location	0.065	0.087	0.747	0.455	[-0.106, 0.236]	0.008
Model Statistics						
R^2 for Firm Performance	0.384					
Adjusted R^2	0.352					
Q^2 (Predictive Relevance)	0.259					

Note: Bootstrap results based on 5,000 subsamples. Effect sizes: $f^2 \geq 0.02$ (small), $f^2 \geq 0.15$ (medium), $f^2 \geq 0.35$ (large). Geographic variables use Guangzhou as reference.

Market orientation is a significant predictor of performance (β = 0.187, $p < 0.05$), supporting H1. Technology orientation has the greatest impact (β = 0.246, $p < 0.01$), strongly supporting H3. Entrepreneurial orientation, however, does not demonstrate a significant association to performance (β = 0.143, p = 0.078), rejecting H2. This unexpected finding suggests that entrepreneurial behavior may not have superior performance in China's construction sector, probably due to the fact that the sector aims to eschew risks and has a tendency to prioritize efficiency over innovating.

Of control variables, firm size significantly affects performance (β = 0.159, $p < 0.05$), and larger firms outperform, and it can be explained due to resource superiority and economies of scale. Geographic position and ownership types are not observed to significantly affect.

4.3.3 Effect sizes and predictive relevance

All significant effects fall within the small range (f^2 = 0.043-0.088), which is typical for complex organizational phenomena. The Stone-Geisser Q^2 value of 0.259 confirms adequate predictive relevance, indicating the model can predict new observations with moderate accuracy.

4.4 Moderation Analysis

4.4.1 Interaction effects testing

Digital technology adoption serves as a boundary condition influencing strategic orientation effectiveness. Table 5 presents moderation analysis results, revealing differential patterns across strategic orientations.

Table 5
Moderation Effects Testing

Hypothesis	Interaction Term	Beta	SE	t-value	p-value	95% CI	ΔR²	Decision
H4a	Market Orientation × Digital Adoption	0.134	0.068	1.971	0.049	[0.001, 0.267]	0.018	Supported
H4b	Entrepreneurial Orientation × Digital Adoption	0.089	0.072	1.236	0.217	[-0.052, 0.230]	0.008	Not Supported
H4c	Technology Orientation × Digital Adoption	0.198	0.071	2.789	0.005	[0.059, 0.337]	0.032	Supported

Note: ΔR^2 represents additional variance explained by interaction terms.

Digital technology changes the market orientation-performance relationship (β = 0.134, $p < 0.05$), adding 1.8% to variance explained and supporting H4a. By far, the greatest shift applies to technology orientation (β = 0.198, $p < 0.01$), adding a further 3.2% to variance and strongly supporting H4c. No entrepreneurial orientation impact on moderation appears significant (β = 0.089, p = 0.217), and therefore H4b is rejected, as with its nonsignificant direct impact.

4.4.2 Simple slope analysis for significant interactions

Simple slope analysis examined conditional effects at high (+1 SD) and low (-1 SD) digital adoption levels for significant interactions, with results presented in Figure 3.

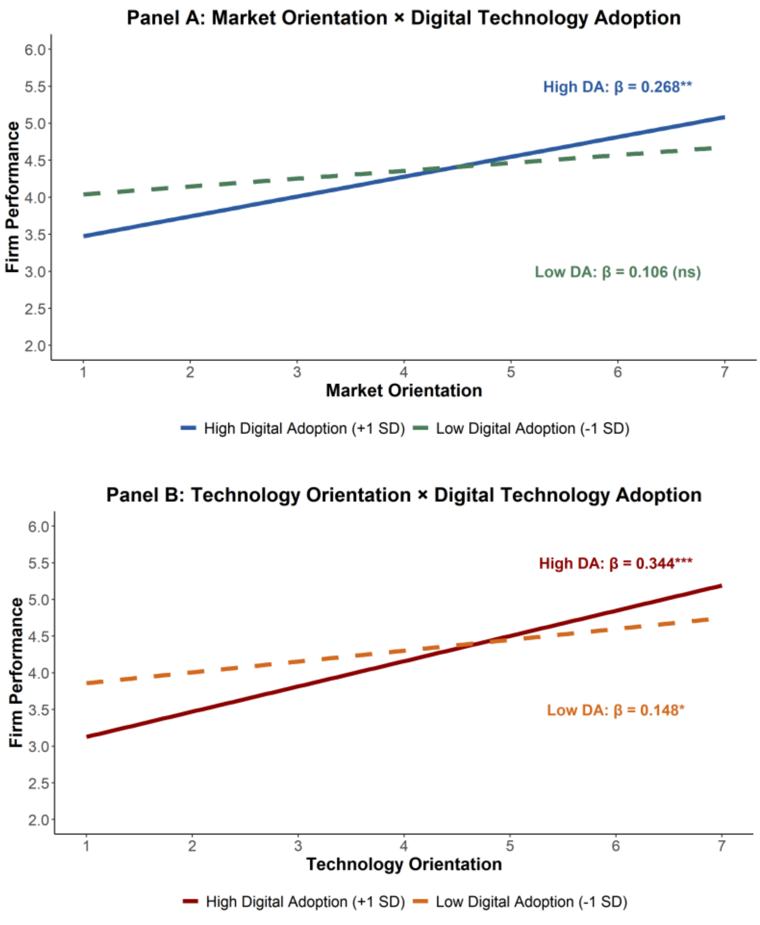

Fig. 3. Interaction effects of digital technology adoption

For market orientation, the connection to performance also gets significantly higher under high use of digital (β = 0.268, $p < 0.01$) than under low use (β = 0.106, $p = 0.218$) of digital. This indicates that market orientation improves performance only if there is proper digital support since digital supports gathering better information from the market and fulfilling customer demands better.

Technology orientation has a clear-cut pattern. High use of digital tools amplifies the impact of technology orientation (β = 0.344, $p < 0.001$), but low use diminishes it but does not erase it (β = 0.148, $p < 0.05$). It implies that technology orientation has intrinsic value but best performs when there is high digital use. It indicates the strong positive relation between emphasizing technology strategy and possessing actual digital skills.

4.5 Robustness Checks

Various models were attempted to see if they fit. A model treating strategic orientations as a composite did a poorer job (SRMR = 0.106) and explained less (R^2 = 0.321). Industry specialization as an aspect did not show any noteworthy differences between general and specialty contractors (all $\Delta \beta < 0.05$, $p > 0.20$). A model that included innovation capability found poor fit and nonsignificant paths.

Bootstrap resampling with 5,000 tests showed that the relationships were stable. Analyzing different groups showed some differences based on firm sizes, with large firms having stronger effects from technology orientation (β = 0.312 compared to 0.184 for small firms, $p < 0.05$ for the difference). Geographic groups kept the same patterns, but firms in Shenzhen showed a bit stronger effects of digital adoption, which reflects the city's technology progress.

4.6 Summary of Results

Table 6 shows the results of hypothesis testing and provides some support for the theory. Technology-related factors often show the strongest links to performance. The surprising lack of importance of entrepreneurial orientation suggests that features of the construction industry may restrict how much entrepreneurial behaviors directly impact performance, possibly needing more time or different ways to be put into action. The use of digital technology appears to be an important factor, especially enhancing the benefits of technology orientation and making market orientation work better.

Table 6
Summary of Hypothesis Testing Results

Hypothesis	Description	Result	Key Finding
H1	Market Orientation → Performance	Supported	$\beta = 0.187$, $p < 0.05$
H2	Entrepreneurial Orientation → Performance	Not Supported	$\beta = 0.143$, $p = 0.078$
H3	Technology Orientation → Performance	Supported	$\beta = 0.246$, $p < 0.01$
H4a	Digital Adoption moderates MO-Performance	Supported	$\beta = 0.134$, $p < 0.05$
H4b	Digital Adoption moderates EO-Performance	Not Supported	$\beta = 0.089$, $p = 0.217$
H4c	Digital Adoption moderates TO-Performance	Supported	$\beta = 0.198$, $p < 0.01$

Note: MO = Market Orientation, EO = Entrepreneurial Orientation, TO = Technology Orientation.

5. Discussion

5.1 Interpretation of Findings

The findings indicate that a few of these strategies make a difference in how construction firms perform. Technology orientation impacts the most, and entrepreneurial orientation makes no difference. Market orientation positively impacts it (β = 0.187, $p < 0.05$). This confirms previous research that indicates that market-oriented companies perform better due to effective customer satisfaction [3]. Technology orientation has the greatest direct relationship with performance (β = 0.246, $p < 0.01$). This shows that the construction sector places importance in technology skills to differentiate themselves from other industry players, which concurs with research that indicates that tech-savvy companies perform better in projects due to improved efficiency and innovations [43].

The insignificant link between entrepreneurial orientation and firm performance constitutes an unexpected outcome challenging conventional entrepreneurial behavior as a driver of performance. This outcome could be a manifestation of the building sector characteristics, in which risk-averse culture, regulative limitations, and project-oriented mode of activity hinder the direct translation of entrepreneurial efforts in terms of short-run performance gain [44]. The outcome finds support in Guangdong enterprises studies that indicate entrepreneurial orientation effects as being environment- and institution-dependent [37].

Using digital technology is important because it makes some strategies work better. The biggest effect happens with technology focus (β = 0.198, $p < 0.01$), showing that focusing on technology helps with actual use of digital tools. This supports new studies that show the link between using digital technology and innovation is complicated, with digital skills helping to boost how effective strategies are [45]. The pattern for market focus shows that digital tools help gather better market information and provide quicker services, which matches findings on digital change in construction companies [46].

5.2 Theoretical Implications

The paper's findings narrow the strategic orientation theory to how absorption of digital technology constitutes a key boundary condition, heterogeneously impacting the efficacy of various strategic orientations. Research provides evidence against the assumption that has been found in the field literature that various orientations perform similar activities in various environments, thus uncovering the dynamics of complicated interactions that are moderated by the capability of the technological infrastructure [47]. Different patterns of moderation that are observed have theoretical implications for various effects of digital technology upon strategic success, as market orientation and technology orientation are benefited from digital additions, but entrepreneur orientation has none of the equivalent amplifying effects.

From a resource perspective, implementation of digital technology acts as a set of complementary assets which increase the value-adding potential of resources aligned to strategic orientation. The concerned digital technologies act as multiplicative amplifiers in the context that the resultant combinations of the resources, as a consequence of the addition, become harder to be imitated compared to the separate components. Introduction of digital technologies, being a contextual factor, acts to grasp the effects of technological change on strategic management, as the digital implements add to the benefits arising out of certain orientation uses, and have negligible impacts on the others.

5.3 Practical Implications

Construction company managers should focus on developing technology skills because it is the most important strategic ability. This is due to its strong direct effects and significant boost from using digital technology. The way market orientation works suggests that companies with limited digital skills should first build their technology infrastructure before spending a lot on market-focused projects. The low success of entrepreneurial orientation shows that construction managers need to think carefully about the specific challenges in their industry before using entrepreneurial strategies.

Digital transformation programs need to be framed as strategic enablers and not as a series of operational improvements, including specific attention to how the capability of technologies increases strategic orientation effectiveness [43]. Amplification effects indicate that companies have to achieve high levels of digital integration to gain meaningful levels of performance improvement, which argues in favor of holistic and not piecemeal digital transformation strategies. Governments need to facilitate construction sector digitalization adopting policies which focus both on technological infrastructure and strategic capability building, and which may include reforms of the regulation allowing more entrepreneurial behavior, but controlling sector-specific constraints [48].

Investment decisions should include the complementarities between strategic orientations and digital technologies, and firms should avoid solo investments in both areas absent corresponding support in the other. Diffusion of digital technologies across an industry and constructing strategic orientation has been discovered to require collaborative efforts overcoming technical, organizational, and environmental challenges [49].

5.4 Limitations and Future Research

Cross-sectional design limits causal inference and does not provide an opportunity to examine temporal dynamics underlying strategic orientation-performance connections. It is best that later research employ longitudinal designs and examine how strategic orientation building and digital technologies adoption are intertwined over time, particularly as digital technologies are fast emerging. Geographic focus in Guangdong Province limits generalizability to other regions and international settings, and therefore cross-regional comparison studies are best to examine potential variations in patterns and mechanisms.

Self-reported methods are susceptible to errors in measurement, despite corrections. Future research needs to employ objective performance measures, historical data, and multi-source measures to increase the reliability of findings. Studies that investigate how construction organizations employ strategic plans and digital technologies may provide insight behind observed relationships. Inter-industry comparisons may establish whether findings are specific to the building sector or general to organizations. Further research examining how embracing digital technologies enhances strategic effectiveness may provide certain ways and competencies that enable digital tools to yield strategic outcomes.

6. Conclusions

This study shows a remarkable change in the functioning of strategic orientations in digitally leveraging construction environments. Classic strategic management thought assumes that orientation effects are universal, but evidence from 193 Guangdong construction enterprises shows that it increases certain effects when utilizing digital technology. It increases technology orientation effects by 83% (from β = 0.148 to β = 0.344) and increases market orientation effects by 152% (from β = 0.106 to β = 0.268) when digital adoption levels are established as high, but does not have effects on entrepreneurial orientation relationships.

The complete failure of entrepreneurial orientation to produce performance benefits, even though there is strong theoretical support, suggests that the characteristics of the construction industry clash with entrepreneurial strategies. This finding questions whether entrepreneurship-based frameworks can be applied everywhere and shows that we may need specific strategies for different industries. At the same time, the link between technology orientation and digital adoption (with an increase of 3.2%) points to a new strategic approach where focusing on technology and adopting digital solutions are not separate choices but essential parts of a strategy.

These patterns show that changing to digital in traditional industries like construction is not just about using new tools. It is also about rethinking which strategies can still work well. The selective amplification effects seen here might indicate larger changes in how companies use their skills to create value in more digital business settings.

This work advances these findings and makes three crucial additions to strategic management and construction management inquiry. First, it makes the first actual measure of how selective digital amplification impacts strategic orientations in construction. Second, it demonstrates the industry-specific limits of entrepreneurial orientation that challenge conventional strategic models. Third, it advances resource-based view theory by considering digital technologies to multiply strategic assets, rather than to add to them. These conclusions represent several avenues for further research. This involves observing how strategic orientation and digital technology evolve together longitudinally, examining inter-industrial variations in selective amplification effects, and analyzing the organizational approaches that enable conventional industries to embed digital strategy effectively.

Author Contributions

Conceptualization: H.Z., and Y.Z.; Methodology: H.Z., and Y.Z.; Software: M.B.E., H.Z., and Y.Z.; Validation: M.B.E., H.Z., and Y.Z. Data curation: H.Z., and Y.Z.; Writing-original draft preparation: H.Z., and Y.Z.; Writing-review and editing: M.B.E.; Supervision: M.B.E.; All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The raw data supporting the conclusions of this article are not publicly available due to confidentiality agreements with participating construction enterprises and privacy considerations regarding sensitive business information. Aggregated results and statistical outputs are available from the corresponding author upon reasonable request and subject to appropriate data sharing agreements.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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