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Unraveling the Nexus between Entrepreneurial Orientation, Effect Reasoning, and Digital Transformation in Enterprises

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Abstract

This study investigates the intricate relationship between entrepreneurial orientation (EO), effect reasoning (ER), and digital transformation (DT) in enterprises. Drawing on established literature, it hypothesizes that EO positively influences ER formation, which, in turn, fosters DT. The research employs a quantitative approach, utilizing regression analysis to test the proposed hypotheses. Findings indicate a direct positive relationship between EO and DT, suggesting that enterprises with higher EO are more inclined towards digital initiatives. Additionally, the study reveals that EO promotes the formation of different patterns of ER, including experimental, flexible, pre-commitment, and tolerable loss reasoning. Importantly, ER emerges as a significant predictor of DT, mediating the relationship between EO and DT. These findings underscore the pivotal role of ER as a cognitive mechanism driving digital transformation efforts in enterprises. The study contributes to the literature by providing empirical evidence of the interplay between EO, ER, and DT, offering insights for practitioners seeking to navigate the complexities of digital transformation.

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1. Introduction

1.1 Research Background

Suzhou, located in the central Yangtze River Delta Economic Circle near Shanghai, is a crucial axis within China's top three metropolitan areas, featuring robust economic strength and significant growth potential. In 2024, Suzhou's GDP reached 2.27 trillion yuan, with a per capita GDP of 177,500 yuan, and 2.741 million market entities (Suzhou Municipal Bureau of Statistics, 2024). The private sector is pivotal in Suzhou's local economic development, contributing 2.07 trillion yuan in 2023, accounting for 46.7% of the total industrial output (Suzhou Municipal Bureau of Statistics, 2024). The digital economy, driven by big data, AI, and cloud computing, is an essential component of this growth. Suzhou's municipal government aims to complete the digital transformation of approximately 11,000 large-scale enterprises and achieve full 5G coverage by 2022 (Suzhou Municipal Government, 2021). However, private enterprises in Suzhou face significant challenges in this transformation, including resource constraints and limited integration experience, necessitating a thorough exploration of strategies to expedite digital transformation.

1.2 Problem Statement

Current research predominantly focuses on the application of digital technology and its impact on enterprise performance, with insufficient attention to the internal mechanisms facilitating digital transformation. Effective digital transformation is a comprehensive organizational change involving structural, cultural, leadership, and skill shifts. Previous studies highlight the need for a transformation in management thinking and organizational updates but lack specificity in these strategies (Hanelt et al., 2017). This study examines the impact of entrepreneurial orientation on digital transformation, considering effectuation theory's decision-making logic.

Entrepreneurial orientation, introduced by Miller (1983), involves seeking new opportunities and taking risks. This orientation is seen as a source of sustainable competitive advantage, though its influence on enterprise transformation remains underexplored. Research typically investigates entrepreneurial orientation's effect on performance and growth, neglecting the transformation context. Furthermore, mediating and moderating variables in these studies are fragmented and require integration.

Effectuation theory, which contrasts with traditional causal reasoning, emphasizes flexibility, experimentation, tolerable loss, and prior commitment in decision-making (Qin, 2017). While effectuation's impact on enterprise transformation, particularly in transitional economies like China, has been recognized, research is limited to certain dimensions and lacks organizational-level analysis. Therefore, this study aims to deepen understanding of the antecedents and mechanisms of effectuation and its role in digital transformation.

1.3 Research Question and Objectives

This study aims to answer the following questions:

(1) What is the relationship between entrepreneurial orientation, effectuation, and digital transformation of enterprises?
(2) What is the mediating effect of effectuation?
(3) What is the regulatory role of interface management?

The primary goal of this study is to explore the influence of entrepreneurial orientation on digital transformation, analyze the mediating role of effectuation, and assess the moderating impact of interface management. The specific objectives include:

(1) Verify the relationship between entrepreneurial orientation, effectuation, and digital transformation.
(2) Confirm the mediating effect of effectuation.
(3) Evaluate the moderating role of interface management.

1.4 Research Significance

This research addresses several gaps in the literature on digital transformation, entrepreneurial orientation, and effectuation. Current studies on digital transformation focus primarily on technological adoption, with limited examination of internal mechanisms driving transformation (Sun & Zuo, 2023). This study introduces entrepreneurial orientation and effectuation to provide new insights into the drivers of digital transformation, offering strategies for adjusting management thinking and organizational change. Moreover, while research on entrepreneurial orientation often examines its impact on corporate performance or growth through perspectives like networks and resource capabilities, it rarely addresses corporate transformation. By investigating the relationship between entrepreneurial orientation and digital transformation, this study enriches the application scenarios of entrepreneurial orientation (Law et al., 2019). In the context of effectuation, research often focuses on performance, decision-making, and business model innovation, especially in startups. However, there is limited research on its application in transitional economies and corporate transformation (Qin, 2017). This study expands the research context by examining the relationship between effectuation and digital transformation, responding to calls for more detailed analysis of the conditions under which effectuation forms and functions effectively (Cui et al., 2017).

This research offers practical guidance for Chinese enterprises navigating digital transformation amid a transitional economy. It provides actionable strategies for transforming management thinking and adjusting organizational structures to achieve digital transformation. The study highlights the importance of adopting effectuation principles—experimentation, flexibility, prior commitments, and tolerable losses—to manage uncertainty and enhance responsiveness to environmental changes. Additionally, the findings emphasize the role of entrepreneurial orientation in fostering an organizational culture conducive to digital transformation. By cultivating an orientation characterized by innovation, risk-taking, and proactiveness, enterprises can more effectively embrace digital transformation. Entrepreneurial orientation not only directly influences digital transformation but also shapes decision-making processes, enhancing the overall impact of effectuation (Sun, 2023). Finally, the research underscores the significance of interface management in optimizing digital transformation efforts. Effective coordination and communication across departments are crucial for maximizing the benefits of entrepreneurial orientation and ensuring efficient implementation of digital strategies. By improving interface management, enterprises can better leverage their entrepreneurial orientation to achieve successful digital transformation (Sun & Zuo, 2023).

2. Literature Review

2.1 Enterprise Digital Transformation

Enterprise digital transformation refers to the comprehensive integration of digital technologies into all aspects of an organization, fundamentally altering operations and delivering value to customers. This transformation involves leveraging technologies such as cloud computing, big data analytics, artificial intelligence, and the Internet of Things (IoT) to

create new or modify existing business processes, culture, and customer experiences (Vial, 2019).

Research has highlighted several critical drivers and challenges associated with digital transformation. One significant driver is the increasing pressure to meet evolving customer expectations, which necessitates a more agile and responsive organizational structure (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). Additionally, the competitive advantage provided by digital technologies encourages enterprises to innovate continuously (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2014). However, digital transformation also presents substantial challenges, including the need for significant financial investment, potential resistance from employees, and the requirement for new skills and capabilities within the workforce (Westerman, Bonnet, & McAfee, 2014). The success of digital transformation is often contingent upon the organization's ability to effectively manage change and foster a culture that embraces digital innovation (Warner & Wäger, 2019). Leadership plays a pivotal role in this process, as leaders must not only advocate for digital initiatives but also drive cultural change and inspire a shared vision across the organization (Kane et al., 2015). Furthermore, research has indicated that digital transformation is not merely a technological shift but a strategic one, requiring alignment with overall business goals and objectives (Hess, Matt, Benlian, & Wiesböck, 2016).

Empirical studies have provided insights into the mechanisms through which digital transformation impacts organizational performance. For instance, digitally mature companies tend to exhibit higher levels of efficiency, innovation, and customer satisfaction compared to their less mature counterparts (Westerman et al., 2014). This is attributed to the enhanced capabilities for data-driven decision-making and improved operational processes enabled by digital technologies (Vial, 2019). Moreover, the role of entrepreneurial orientation in facilitating digital transformation has garnered attention in recent research. Entrepreneurial orientation, characterized by innovativeness, proactiveness, and risk-taking, is seen as a critical factor that drives the adoption and successful implementation of digital initiatives (Sun & Zuo, 2023). This strategic posture not only promotes the exploration of new technological opportunities but also fosters a dynamic and adaptive organizational environment conducive to digital transformation.

2.2 Entrepreneurial Orientation

Entrepreneurial orientation (EO) is a vital strategic construct that reflects the processes, practices, and decision-making activities leading to new entry. EO encompasses dimensions such as innovativeness, risk-taking, and proactiveness, which collectively define a firm’s entrepreneurial behavior (Miller, 1983; Covin & Slevin, 1989). This orientation is crucial for fostering an environment conducive to innovation, competitive advantage, and long-term performance (Wiklund & Shepherd, 2005). Innovativeness within EO refers to a firm’s tendency to engage in and support new ideas, novelty, and creative processes that may result in new products, services, or technological processes (Lumpkin & Dess, 1996). It emphasizes the importance of technological leadership and R&D activities, which are critical in rapidly changing markets (Rauch, Wiklund, Lumpkin, & Frese, 2009). Risk-taking involves the willingness to commit resources to opportunities with uncertain outcomes, highlighting a firm’s propensity to invest in ventures that may not have guaranteed returns (Covin & Slevin, 1991). This aspect of EO is particularly relevant in turbulent environments where the ability to navigate uncertainty can determine a firm's success (Kreiser, Marino, & Weaver, 2002). Proactiveness represents a forward-looking perspective characterized by the anticipation and acting on future needs and changes in the market (Lumpkin & Dess, 2001). Firms exhibiting high levels of proactiveness are often first movers, seizing opportunities before competitors, thereby gaining a significant competitive edge (Hughes & Morgan, 2007). This proactive stance is essential for sustaining competitiveness in dynamic industries (Lumpkin & Dess, 1996).

Empirical studies have demonstrated that EO positively impacts firm performance, especially in contexts that demand high levels of adaptability and innovation (Wiklund & Shepherd, 2003). For instance, research has shown that EO contributes to better performance through enhanced capability for innovation and market responsiveness (Rauch et al., 2009). Additionally, EO facilitates the effective utilization of resources and capabilities, which are pivotal in achieving superior organizational outcomes (Covin & Slevin, 1991). The relationship between EO and digital transformation is increasingly recognized in contemporary research. EO serves as a driving force for digital initiatives, enabling firms to adopt and implement new digital technologies effectively (Sun & Zuo, 2023). By fostering an entrepreneurial mindset, firms are better positioned to navigate the complexities of digital transformation, thus enhancing their competitive position in the digital economy (Hess, Matt, Benlian, & Wiesböck, 2016). Moreover, EO is linked to the development of dynamic capabilities, which are critical for responding to rapid technological changes and market shifts (Teece, Pisano, & Shuen, 1997). These capabilities allow firms to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments, thus facilitating successful digital transformation (Warner & Wäger, 2019).

2.3 Effect Reasoning

Effect reasoning, derived from the broader theory of effectuation, is a decision-making framework that emphasizes flexibility, experimentation, and leveraging existing resources rather than relying solely on predictive strategies. This approach, first articulated by Sarasvathy (2001), contrasts with causal reasoning, which focuses on achieving predetermined goals through meticulous planning and prediction. Effect reasoning is particularly relevant in dynamic and uncertain environments where traditional planning methods may fall short. Central to effect reasoning is the principle of "affordable loss," where decision-makers commit only what they are willing to lose, allowing for iterative testing and adaptation (Sarasvathy, 2001). This approach encourages small-scale experiments to explore opportunities, reducing the risk of substantial losses and enabling swift responses to feedback. This aspect of effect reasoning aligns with entrepreneurial contexts, where uncertainty and limited resources often prevail (Wiltbank, Dew, Read, & Sarasvathy, 2006). Another key component of effect reasoning is the leveraging of contingencies. Instead of attempting to predict the future, effectual entrepreneurs exploit unexpected events and opportunities as they arise, making flexible and adaptive strategies critical (Read, Song, & Smit, 2009). This adaptability allows firms to pivot and modify their strategies in response to changing market conditions, enhancing their resilience and capacity for innovation (Dew, Read, Sarasvathy, & Wiltbank, 2008). The role of effect reasoning as a mediating variable is particularly significant in the context of entrepreneurial orientation and digital transformation. Entrepreneurial orientation, characterized by innovativeness, risk-taking, and proactiveness, inherently aligns with the principles of effect reasoning, promoting a culture that supports experimentation and adaptive learning (Sun & Zuo, 2023). This alignment facilitates digital transformation by enabling firms to navigate the complexities and uncertainties associated with adopting new technologies and digital practices (Hess, Matt, Benlian, & Wiesböck, 2016). Empirical research supports the mediating role of effect reasoning in enhancing organizational outcomes. For example, studies have shown that firms employing effectual logic are better positioned to capitalize on emerging opportunities and mitigate risks, leading to improved performance and innovation (Brettel, Mauer, Engelen, & Küpper, 2012). Moreover, effect reasoning fosters a proactive stance toward change, which is essential for successful digital transformation (Warner & Wäger, 2019). By integrating effect reasoning into their strategic processes, firms can more effectively align their entrepreneurial initiatives with the demands of the digital age.

2.5 Management Theory

The foundation of this study rests on several pivotal management theories that provide a robust framework for constructing the conceptual model. Among these, the Resource-Based View (RBV), Dynamic Capabilities Theory, and Institutional Theory stand out as particularly relevant.

The **Resource-Based View (RBV)** posits that a firm's competitive advantage is derived from its unique resources and capabilities (Barney, 1991). These resources must be valuable, rare, inimitable, and non-substitutable (VRIN) to provide sustained competitive advantage. In the context of digital transformation, RBV underscores the importance of leveraging unique technological assets and organizational knowledge to drive innovation and transformation. By emphasizing the strategic role of entrepreneurial orientation in harnessing these resources, the RBV helps explain how firms can effectively navigate digital transformation (Law, Bhaumik, Sun, & Rahman, 2019).

Dynamic Capabilities Theory extends the RBV by focusing on a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments (Teece, Pisano, & Shuen, 1997). This theory is particularly pertinent for understanding digital transformation, which requires firms to continuously adapt their strategies and operations in response to technological advancements and market shifts. Dynamic capabilities, such as sensing opportunities, seizing them, and transforming the organization accordingly, are critical for successful digital transformation (Warner & Wäger, 2019). Entrepreneurial orientation, with its emphasis on innovation, risk-taking, and proactiveness, can be seen as a driver of these dynamic capabilities, facilitating the firm's ability to adapt and transform.

Institutional Theory provides another essential perspective by examining how institutional pressures—such as regulations, norms, and cultural-cognitive elements—shape organizational behavior and practices (DiMaggio & Powell, 1983). In the context of digital transformation, institutional theory highlights how external pressures and expectations drive firms to adopt new technologies and innovate. This theory can help explain why firms with a strong entrepreneurial orientation are more likely to engage in digital transformation, as they are better equipped to respond to and capitalize on these institutional pressures (Sun & Zuo, 2023).

Combining these theoretical perspectives, this study constructs a comprehensive model that links entrepreneurial orientation with digital transformation through the mediating role of effect reasoning. The RBV and Dynamic Capabilities Theory provide insights into the internal mechanisms and capabilities required for digital transformation, while Institutional Theory underscores the external pressures and opportunities that influence this process. Effect reasoning, as a mediating variable, bridges the gap between these internal and external factors, offering a nuanced understanding of how entrepreneurial orientation facilitates digital transformation. By integrating the Resource-Based View, Dynamic Capabilities Theory, and Institutional Theory, this study offers a multifaceted framework for understanding the complex dynamics of digital transformation. These theories collectively illuminate the pathways through which entrepreneurial orientation can drive innovation and adaptation in an increasingly digitalized business environment.

2.6 Hypotheses Statement and Conceptual Model

The hypotheses guiding this investigation are constructed to examine both direct and indirect effects, thereby providing a comprehensive understanding of how these variables interact to influence digital transformation in enterprises.

H1: The higher the entrepreneurial orientation of enterprises, the more it can promote their digital transformation.

This hypothesis posits a direct positive relationship between entrepreneurial orientation and digital transformation. Entrepreneurial orientation, characterized by innovation, proactiveness, and risk-taking, is expected to drive digital initiatives and adoption of new technologies, facilitating overall digital transformation (Law, Bhaumik, Sun, & Rahman, 2019).

H2: The entrepreneurial orientation of enterprises positively promotes the formation of effect reasoning.

This hypothesis suggests that entrepreneurial orientation fosters a decision-making logic centered on effect reasoning, which emphasizes experimentation, flexibility, pre-commitment, and tolerable loss.

(1) H2a: Entrepreneurial orientation can positively promote the formation of experimental patterns in effect reasoning.
(2) H2b: Entrepreneurial orientation can positively promote the formation of flexible habitual patterns in effect reasoning.
(3) H2c: Entrepreneurial orientation can positively promote the formation of pre-commitment habitual patterns in effect reasoning.
(4) H2d: Entrepreneurial orientation can positively promote the formation of tolerable loss habitual patterns in effect reasoning.

These sub-hypotheses detail how different facets of effect reasoning are influenced by entrepreneurial orientation, highlighting the nuanced ways through which entrepreneurial mindset translates into practical decision-making frameworks (Teece, Pisano, & Shuen, 1997).

H3: The application of effect reasoning in enterprises can positively promote their digital transformation.

This hypothesis asserts a direct positive impact of effect reasoning on digital transformation. Effect reasoning, with its principles of experimentation, flexibility, prior commitments, and manageable losses, is expected to drive adaptive and innovative processes crucial for digital transformation.

(1) H3a: The experimental application of effect reasoning can positively promote digital transformation.
(2) H3b: The flexible application of effect reasoning can positively promote digital transformation.
(3) H3c: The pre-commitment application of effect reasoning can positively promote digital transformation.
(4) H3d: The application of tolerable loss reasoning can positively promote digital transformation.

These sub-hypotheses explore specific dimensions of effect reasoning and their individual contributions to digital transformation efforts (Sun & Zuo, 2023).

H4: Effect reasoning mediates the relationship between entrepreneurial orientation and digital transformation of enterprises.

This hypothesis explores the mediating role of effect reasoning in the relationship between entrepreneurial orientation and digital transformation.

(1) H4a: The experimental aspect of effect reasoning mediates the relationship between entrepreneurial orientation and digital transformation.
(2) H4b: The flexibility aspect of effect reasoning mediates the relationship between entrepreneurial orientation and digital transformation.
(3) H4c: The pre-commitment aspect of effect reasoning mediates the relationship between entrepreneurial orientation and digital transformation.
(4) H4d: The tolerable loss aspect of effect reasoning mediates the relationship between entrepreneurial orientation and digital transformation.

These sub-hypotheses suggest that entrepreneurial orientation influences digital transformation indirectly through various dimensions of effect reasoning (Sun, Zuo, Liu, Huang, & Wen, 2024).

H5: Interface management plays a positive regulatory role between entrepreneurial orientation and digital transformation of enterprises.

This hypothesis posits that effective interface management enhances the positive impact of entrepreneurial orientation on digital transformation. Interface management, which involves coordinating and integrating different organizational units and processes, ensures that the innovative and proactive initiatives driven by entrepreneurial orientation are effectively implemented, thus facilitating digital transformation (Warner & Wäger, 2019).

The conceptual model is designed to capture the complex relationships among the variables. Entrepreneurial orientation is positioned as the independent variable, directly influencing digital transformation (the dependent variable) and effect reasoning (the mediating variable). Effect reasoning, in turn, directly impacts digital transformation. Additionally, interface management is posited to moderate the relationship between entrepreneurial orientation and digital transformation, enhancing the overall effectiveness of digital initiatives.

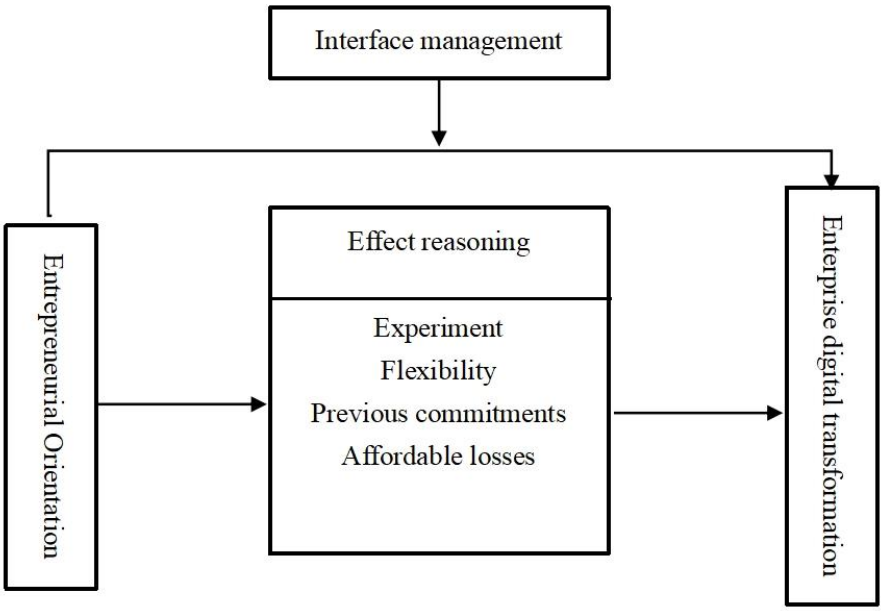

Figure 2-1 Conceptual Model

By integrating these variables, the conceptual model provides a comprehensive framework for understanding the mechanisms through which entrepreneurial orientation drives digital transformation, highlighting the critical roles of effect reasoning and interface management in this process.

3. Methodology

3.1 Research Methods

This study employs a multifaceted approach to examine the relationship between entrepreneurial orientation and digital transformation, incorporating effect reasoning as a mediating variable and interface management as a moderating variable. The research methods adopted include literature review, questionnaire survey, and empirical analysis. The literature review provides a theoretical foundation and informs the design of the study's variables and hypotheses. To gather primary data, a questionnaire survey was conducted, targeting middle and senior managers of enterprises in Suzhou, as well as eligible alumni and MBA students. The survey instrument, developed using the QuestionStar platform, includes scales for

entrepreneurial orientation, effect reasoning, digital transformation, and interface management, adapted from established measures in the literature. Empirical analysis was performed using SPSS. Initial descriptive statistics provided an overview of the sample characteristics. Reliability and validity analyses ensured the measurement scales were robust. Correlation and regression analyses tested the hypothesized relationships among variables. This methodological approach enables a comprehensive examination of the factors influencing digital transformation in enterprises.

3.2 Research Design

This study employs a structured questionnaire design to collect data, informed by established scales from authoritative literature and tailored to the research context. The primary focus is on examining the relationships between entrepreneurial orientation, digital transformation, effect reasoning (with its four dimensions), and interface management. Initially, a preliminary questionnaire was developed, incorporating scales for the core variables. A small-scale pretest was conducted to evaluate the reliability and validity of these scales. This pretesting phase aimed to refine the survey instrument by ensuring clarity, coherence, and the robustness of the measurement items. Adjustments based on pretest feedback were made to produce the final questionnaire. The questionnaire includes two main sections. The first section gathers demographic and organizational information, such as the respondent's gender, education level, position, and company details (age, size, nature, and industry). The second section contains items measuring entrepreneurial orientation, digital transformation, effect reasoning, and interface management. The entrepreneurial orientation scale consists of nine items covering innovation, risk-taking, and proactivity. The digital transformation scale includes five items reflecting the company's engagement with digital technologies and processes. Effect reasoning is measured across four dimensions: experimentation, flexibility, tolerable loss, and previous commitment, initially comprising 13 items but later refined to 10 after pretesting. Interface management is assessed through four items focusing on communication, collaboration, conflict, and resource coordination. All variables are measured using a five-point Likert scale, where 1 indicates "strongly disagree" and 5 indicates "strongly agree." Control variables include enterprise age, size, nature, and industry, segmented into categorical levels with corresponding numerical values for analysis. This rigorous approach ensures that the data collected are both reliable and valid, supporting robust empirical testing of the research hypotheses.

3.3 Pre-Test Analysis

To ensure the reliability and validity of the questionnaire designed for this study, a pre-test was conducted. The survey targeted students from the Suzhou MBA program at Asian City University, primarily consisting of middle and senior managers. A total of 120 questionnaires were distributed, and 105 were collected. After excluding invalid responses due to short answer times or excessive repeated options, 89 valid questionnaires were retained, resulting in a valid response rate of 74.17%. Reliability was assessed using Cronbach's α coefficient, which measures internal consistency. A coefficient above 0.7 is considered acceptable. For entrepreneurial orientation, the overall α coefficient was 0.882, with all item-total correlations (CITC) above 0.4, indicating high reliability. No items required deletion as their removal did not increase the overall α value. Conversely, the effect reasoning dimension had a lower α of 0.662, with item ex3 showing a CITC of only 0.285. Deleting ex3 raised the α to 0.787, suggesting its removal to enhance reliability. Items ex2 and ex3 were both deleted as ex2 was a reverse-scored item. Other dimensions met the reliability standards without modifications. The α coefficient for enterprise digital transformation was exceptionally high at 0.963, and for interface management, it was 0.880, indicating strong reliability in both scales.

Validity was evaluated through factor analysis, specifically examining construct validity. The Kaiser-Meyer-Olkin (KMO) values and Bartlett's test of sphericity were used to determine the suitability for factor analysis. KMO values for entrepreneurial orientation, effect reasoning, enterprise digital transformation, and interface management were 0.843, 0.840, 0.834, and 0.656 respectively, all exceeding the 0.6 threshold. Bartlett's tests were significant ($p < 0.05$), confirming the adequacy for factor analysis. Exploratory factor analysis (EFA) indicated that for entrepreneurial orientation, all item loadings were above 0.5, with a cumulative explained variance of 76.757%. For effect reasoning, despite fx1 not aligning perfectly, the cumulative variance explained was 77.777%. Enterprise digital transformation and interface management showed high factor loadings and cumulative variances of 79.792% and 74.065%, respectively. These results confirmed the strong construct validity of the scales used. The pre-test analysis indicated that the questionnaire is both reliable and valid, with minor adjustments needed for effect reasoning to improve reliability. Further analysis, including confirmatory factor analysis (CFA), will be conducted in subsequent studies to reinforce these findings.

3.4 Data Analysis and Empirical Testing

This section outlines the data analysis and empirical testing procedures conducted in this study to examine the relationships between variables. Initially, the study collected 500 questionnaires, of which 486 were retrieved, and after excluding invalid responses, 450 valid questionnaires were obtained, meeting the study's requirements. Descriptive statistical analyses were then performed to understand the sample characteristics. The sample demographics revealed a balanced gender distribution, with males comprising 50.67% and females 49.33%. Regarding educational background, respondents predominantly held undergraduate (41.78%) and master's degrees (55.56%). In terms of position, 12% were senior managers, 43.11% middle managers, 30.22% had professional or technical roles, and 14.67% held other positions. Regarding company characteristics, the majority of sampled companies (68.89%) had been established for over a decade, with varying sizes and ownership structures across industries.

Reliability and validity tests were conducted to ensure the robustness of the research instruments. Cronbach's α coefficient analysis indicated high reliability, with values exceeding 0.7 for all scales. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were employed to assess validity. EFA results demonstrated satisfactory factor loadings and cumulative explained variances, meeting established criteria. CFA further confirmed the validity of the measurement model, with goodness-of-fit indices indicating excellent model fit. Aggregate validity was assessed by examining factor loadings, composite reliability (CR), and average variance extracted (AVE) for each variable. Results indicated strong correlations between items measuring the same constructs, with CR values exceeding 0.7 and AVE values surpassing 0.5, indicating excellent aggregate validity. Lastly, to address common method bias, Harman's univariate test was conducted, revealing that the variance explained by the first factor without rotation was below 40%, indicating no significant bias in the data. The data analysis and empirical testing procedures employed in this study ensured the reliability and validity of the research findings, providing a robust foundation for subsequent hypothesis testing and result interpretation.

3.5 Correlation Analysis

This study employs Pearson correlation analysis to assess the relationships between variables, with the correlation coefficient (r) indicating the degree of correlation. The coefficient ranges from -1 to 1, signifying positive and negative correlations respectively. Closer to 1 indicates stronger correlation, while closer to 0 suggests weaker correlation. The correlation results reveal significant associations among the variables.

Table 3-1 Correlation Analysis of Various Variables

V.	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Ag	3.450	0.925	1											
2. Si	2.930	1.173	0.419**	1										
3. Na	1.960	0.995	0.061	0.089	1									
4. In	3.210	1.586	0.027	-0.113	-0.351**	1								
5. Eo	3.317	0.884	0.050	0.165*	0.212**	-0.318**	1							
6. Er	3.736	0.626	0.041	0.079	0.210**	-0.213**	0.614**	1						
7. Ex	3.429	0.985	-0.036	0.058	0.190**	-0.286**	0.719**	0.728**	1					
8. To	3.886	0.831	0.131*	0.062	0.080	-0.032	0.052	0.654**	0.140*	1				
9. Fx	3.698	0.771	-0.053	0.070	0.223**	-0.198**	0.683**	0.862**	0.672**	0.333**	1			
10. Pr	3.876	0.816	0.074	0.038	0.136*	-0.142*	0.438**	0.737**	0.418**	0.339**	0.567**	1		
11. Dt	3.688	1.014	0.122	0.341**	0.081	-0.054	0.578**	0.531**	0.500**	0.242**	0.490**	0.370**	1	
12. Im	3.600	0.805	0.041	-0.051	0.124	-0.062	0.393**	0.497**	0.426**	0.230**	0.492**	0.345**	0.309**	1

Notably, entrepreneurial orientation exhibits substantial positive correlations with effect reasoning (r = 0.614 **), dimensional test (r = 0.719 **), flexibility (r = 0.683 **), and previous commitment (0.438 **), albeit not with dimensional Tolerable loss (r = 0.052). Moreover, a significant positive correlation exists between entrepreneurial orientation and enterprise digital transformation (r = 0.578 **). Effect reasoning demonstrates significant positive correlations with entrepreneurial orientation (r = 0.531 **), dimensional test (r = 0.500 **), Tolerable loss (r = 0.242 **), flexibility (r = 0.490 **), and previous commitment (r = 0.370 **), along with a noteworthy positive correlation with enterprise digital transformation. Similarly, interface management exhibits a significant positive correlation with effect reasoning (r = 0.497 **), dimensional test (r = 0.426 **), Tolerable loss (r = 0.230 **), flexibility (r = 0.492 **), and previous commitment (r = 0.345 **), as well as with enterprise digital transformation (r = 0.309 **). These findings validate the correlation between the primary variables, underscoring their interrelatedness and providing essential groundwork for subsequent hypothesis testing within the model.

4. Findings and Discussion

4.1 Findings

4.1.1 Regression Analysis of Entrepreneurial Orientation, Effect Reasoning, and Enterprise Digital Transformation

The regression analysis investigates the relationship between entrepreneurial orientation, effect reasoning, and enterprise digital transformation. Control variables include enterprise age, size, nature of ownership, and industry. Collinearity assessment reveals VIF values below 10 (ranging from 1.074 to 1.735), indicating no significant multicollinearity.

Table 1 Regression Analysis of Entrepreneurial Orientation, Effect Reasoning, and Digital Transformation

Variable	Enterprise Digital Transformation (Dt)				Effect reasoning (Er)	
	M1	M2	M3	M4	M5	M6
Age	-0.029	-0.028	-0.041	-0.035	0.013	0.014
Size	0.301***	0.237***	0.283***	0.247***	0.021	-0.019
Nature	0.054	-0.010	-0.027	-0.037	0.095*	0.054
Industry	0.003	0.103**	0.056	0.102**	-0.062*	0.002
Eo		0.674***		0.465***		0.426***
Er			0.861***	0.491***		
Adjusted R^2	0.104	0.408	0.369	0.463	0.052	0.370
$\triangle R^2$	0.120	0.301	0.263	0.056	0.069	0.316
F-value	7.485***	31.842***	27.161***	33.198***	4.057**	27.365***
$\triangle F$	7.485***	113.909***	93.304***	23.568***	4.057**	112.381***
VIF	1.147~1.236	1.147~1.255	1.074~1.238	1.173~1.735	1.147~1.236	1.147~1.255

Model M2 demonstrates an F value of 31.842***, with entrepreneurial orientation (EO) coefficient of 0.674***, indicating a significant positive impact on digital transformation, supporting H1. Similarly, Model M6 exhibits an F value of 27.365***, with EO coefficient of 0.426***, suggesting a positive correlation between entrepreneurial orientation and effect reasoning formation, endorsing H2. Model M3 showcases an F value of 27.161***, with effect reasoning (Er) coefficient of 0.861***, indicating its positive influence on digital transformation, supporting H3. Additional regression analyses on effect reasoning dimensions confirm hypotheses H2a, H3a, H2b, H3b, H2c, H3c, H2d, and H3d, based on significant coefficients and F values.

Table 2 Regression Analysis of Entrepreneurial Orientation, Experimentation, and Digital Transformation

Variable	Enterprise Digital Transformation (Dt)				Experiment (ex)	
	M1	M2	M7	M8	M9	M10
Age	-0.029	-0.028	0.001	-0.015	-0.057	-0.055
Size	0.301***	0.237***	0.282***	0.246***	0.037	-0.038
Nature	0.054	-0.010	-0.001	-0.017	0.103	0.028
Industry	0.003	0.103**	0.084*	0.111**	-0.151**	-0.035
Eo		0.674***		0.487***		0.786***
Ex			0.534***	0.238**		
Adjusted R^2	0.104	0.408	0.350	0.431	0.078	0.517
$\triangle R^2$	0.120	0.301	0.244	0.025	0.094	0.434
F-value	7.485***	31.842***	25.085***	29.271***	5.705***	48.928***
$\triangle F$	7.485***	113.909***	84.171***	9.927**	5.705***	201.069***
VIF	1.147~1.236	1.147~1.255	1.104~1.238	1.162~2.220	1.147~1.236	1.147~1.255

Table 3 Regression Analysis of Entrepreneurial Orientation, Tolerable Loss, and Digital Transformation

Variable	Enterprise Digital Transformation (Dt)				Tolerable loss (to)	
	M1	M2	M11	M12	M13	M14
Age	-0.029	-0.028	-0.06	-0.057	0.113	0.113
Size	0.301***	0.237***	0.301***	0.238***	0.002	-0.001
Nature	0.054	-0.01	0.038	-0.024	0.057	0.055
Industry	0.003	0.103**	0.005	0.103**	-0.006	-0.001
Eo		0.674***		0.666***		0.030
To			0.274***	0.254***		
Adjusted R^2	0.104	0.408	0.150	0.449	0.005	0.001
$\triangle R^2$	0.120	0.301	0.049	0.042	0.022	0.001
F-value	7.485***	31.842***	8.920***	31.367***	1.266	1.049
$\triangle F$	7.485***	113.909***	13.024***	17.207***	1.266	0.199
VIF	1.147~1.236	1.147~1.255	1.023~1.241	1.024~1.255	1.147~1.236	1.147~1.255

Further analysis reveals that entrepreneurial orientation significantly promotes flexibility formation (F value of 41.125***, EO coefficient of 0.598***), endorsing H2b. Additionally, effect reasoning flexibility positively influences digital transformation (F value of 22.750***, fx coefficient of 0.644***), supporting H3b.

Lastly, while entrepreneurial orientation insignificantly affects prior commitments formation (F value of 1.049, EO coefficient of 0.03), the use of effect reasoning in prior commitments significantly promotes digital transformation (F value of 14.444***, pr coefficient of 0.453***), supporting H2c and H3c respectively.

Table 4 Regression Analysis of Entrepreneurial Orientation, Flexibility, and Digital Transformation

Variable	Enterprise Digital Transformation (Dt)				Flexibility (fx)	
	M1	M2	M15	M16	M17	M18
Age	-0.029	-0.028	0.021	-0.008	-0.078	-0.077+
Size	0.301***	0.237***	0.268***	0.238***	0.052	-0.005
Nature	0.054	-0.010	-0.035	-0.031	0.138*	0.081*
Industry	0.003	0.103**	0.042	0.096**	-0.060+	0.028
Eo		0.674***		0.518***		0.598***
Fx			0.644***	0.260**		
Adjusted R^2	0.104	0.408	0.327	0.426	0.058	0.472
$\triangle R^2$	0.120	0.301	0.222	0.020	0.075	0.409
F-value	7.485***	31.842***	22.750***	28.684***	4.446**	41.125***
$\triangle F$	7.485***	113.909***	73.893***	7.886**	4.446**	173.867***
VIF	1.147~1.236	1.147~1.255	1.081~1.243	1.182~2.057	1.147~1.236	1.147~1.255

Table 5 Regression Analysis of Entrepreneurial Orientation, Previous Commitments, and Digital Transformation

Variable	Enterprise Digital Transformation (Dt)				Previous commitments (Pr)	
	M1	M2	M19	M20	M21	M22
Age	-0.029	-0.028	-0.061	-0.042	0.069	0.070
Size	0.301***	0.237***	0.306***	0.247***	-0.011	-0.049
Nature	0.054	-0.010	0.020	-0.018	0.076	0.038
Industry	0.003	0.103**	0.030	0.103**	-0.058	0.001
Eo		0.674***		0.594***		0.403***
Pr			0.453***	0.199**		
Adjusted R^2	0.104	0.408	0.231	0.426	0.016	0.182
$\triangle R^2$	0.120	0.301	0.128	0.021	0.034	0.166
F-value	7.485***	31.842***	14.444***	28.718***	1.937	19.980***
$\triangle F$	7.485***	113.909***	37.337***	8.003**	1.937	45.581***
VIF	1.147~1.236	1.147~1.255	1.035~1.237	1.163~1.385	1.147~1.236	1.147~1.255

These findings underscore the crucial role of entrepreneurial orientation and effect reasoning in fostering digital transformation within enterprises.

4.1.2 Mediation Effect Testing of Reasoning Impact

This study utilized the traditional causal step method to scrutinize the mediating effect of reasoning impact, consisting of three sequential steps. Initially, the independent variable (entrepreneurial orientation) was individually integrated into the model, and its regression analysis on the dependent variable (digital transformation of enterprises) was executed to ascertain the significance of the independent variable regression coefficient (c). Subsequently, the independent variable (entrepreneurial orientation) was introduced into the model, and regression analysis on the mediator variable (effect reasoning) was conducted to assess the significance of the independent variable regression coefficient (a). Finally, both the independent variable (entrepreneurial orientation) and the mediator variable (effect reasoning) were incorporated into the model for regression analysis of the dependent variable (enterprise digital transformation), evaluating the significance of mediator variable regression coefficient (b) and independent variable regression coefficient (c'). The outcomes revealed significant regression coefficients across all models. Particularly, in Model M4, the coefficient of entrepreneurial orientation (Eo) was 0.465***, indicating a partial mediating role of effect reasoning between entrepreneurial orientation and enterprise digital transformation. These findings support hypothesis H4.

Table 6 Mediation Effect Test (Bootstrap Method)

MV	ET	EV	BootSE	Boot95%CI		REP
				LL	UL	
Effect reasoning (Er)	TE	0.6741	0.0632	0.5496	0.7986	100.00%
	DE	0.4650	0.0740	0.3192	0.6108	68.98%
	IE	0.2091	0.0537	0.1114	0.3293	31.02%
Experiment (Ex)	TE	0.6741	0.0632	0.5496	0.7986	100.00%
	DE	0.4872	0.0857	0.3182	0.6562	72.27%
	IE	0.1869	0.0679	0.0595	0.3270	27.73%
Tolerable loss (To)	TE	0.6741	0.0632	0.5496	0.7986	100.00%
	DE	0.6665	0.0610	0.5463	0.7867	98.87%
	IE	0.0076	0.0226	-0.0333	0.0587	1.13%
Flexibility (Fx)	TE	0.6741	0.0632	0.5496	0.7986	100.00%
	DE	0.5185	0.0833	0.3543	0.6827	76.92%
	IE	0.1556	0.0705	0.0145	0.2916	23.08%
Previous commitments (Pr)	TE	0.6741	0.0632	0.5496	0.7986	100.00%
	DE	0.5939	0.0683	0.4592	0.7286	88.10%
	IE	0.0802	0.0336	0.0212	0.1519	11.90%

Subsequently, the mediating effects of four dimensions of effect reasoning were further explored using the causal step method. For instance, in the mediation effect test of the experimental dimension (ex), all regression coefficients were significant, with a relative effect proportion of 27.73%. Similarly, the flexibility dimension (fx) exhibited a relative effect proportion of 23.08%, affirming its partial mediating role. Conversely, the mediation effect test of the tolerable loss dimension (to) indicated a negligible relative effect proportion of 1.13%, suggesting an insignificant mediating effect. Additionally, the previous commitment dimension (pr) demonstrated a relative effect proportion of 11.90%, indicating a partial mediating effect. These results corroborate the hypotheses H4a, H4b, and H4c, while refuting H4d. Furthermore, to ascertain specific mediation effect values, the asymmetric confidence interval Bootstrap method was employed. The results confirmed the existence of mediation effects for effect reasoning and its dimensions, thereby providing comprehensive insights into the mediation mechanisms underlying entrepreneurial orientation and enterprise digital transformation.

4.1.3 Examination of Interface Management's Moderating Impact

In assessing the moderating effect of interface management, this study initially employed regression analysis, integrating the cross-product term (Eo * Im) of entrepreneurial orientation and interface management into the model. The analysis aimed to determine the significance of the coefficient of the interaction term, thus evaluating the moderating effect. To mitigate multicollinearity, the cross-product term (Eo * Im) was derived through standardization of both entrepreneurial orientation and interface management. The regression analysis results of interface management's moderating effect demonstrated VIF values below 10, indicating the absence of significant multicollinearity. The F-value of Model M26 was 24.658**, with a coefficient of 0.089 for the interaction term (Eo * Im), $p=0.065<0.1$, indicating a substantial marginal moderating effect of interface management between entrepreneurial orientation and enterprise digital transformation.

Subsequently, further exploratory analysis was conducted to address significant edge cases. Removing the industry control variable revealed a significant adjustment effect of interface management, with an F-value of 27.051**, and a coefficient of 0.098 for the interaction (Eo * Im), $p=0.043<0.05$. This suggests that industry differences may significantly influence the adjustment effect of interface management, warranting sub-industry analysis.

Table 7 Regression Analysis of Interface Management Regulation Effect (a)

Variable	Enterprise Digital Transformation (Dt)			
	M23	M24	M25	M26
Age	-0.029	-0.028	-0.039	-0.045
Size	0.301***	0.237***	0.254***	0.254***
Nature	0.054	-0.01	-0.019	-0.015
Industry	0.003	0.103**	0.097**	0.091*
Eo		0.674***	0.612***	0.599***
Im			0.160*	0.157*
Eo*Im				0.089+
Adjusted R^2	0.104	0.408	0.419	0.425
$\triangle R^2$	0.120	0.301	0.013	0.009
F-value	7.485***	31.842***	27.883***	24.658***
$\triangle F$	7.485***	113.909***	5.104*	3.436+
VIF	1.147~1.236	1.147~1.255	1.167~1.366	1.027~1.382

Table 8 Regression Analysis of Interface Management Regulation Effect (b)

Variable	Enterprise Digital Transformation (Dt)			
	M27	M28	M29	M30
Size	0.301***	0.225***	0.244***	0.245***
Age	-0.029	-0.012	-0.024	-0.033
Nature	0.052	-0.059	-0.066	-0.058
Eo		0.629***	0.564***	0.552***
Im			0.175*	0.171*
Eo*Im				0.098*
Adjusted R^2	0.108	0.389	0.403	0.411
$\triangle R^2$	0.120	0.280	0.016	0.011
F-value	10.023***	36.67***	31.187***	27.051***
$\triangle F$	10.023***	102.767***	5.952*	4.137*
VIF	1.009~1.219	1.051~1.246	1.054~1.276	1.021~1.280

To validate these findings, 175 sample data from non-traditional manufacturing industries underwent regression analysis, confirming a significant positive regulatory role of interface management in entrepreneurial orientation and enterprise digital transformation (F-value of Model M34: 21.844**, coefficient of interaction Eo * Im: 0.139**, p=0.007<0.01). Thus, hypothesis H5 is supported.

Table 9 Regression Analysis of Interface Management Regulation Effect (Non-Traditional Manufacturing)

Variable	Enterprise Digital Transformation (Dt)			
	M31	M32	M33	M34
Age	-0.019	-0.021	-0.030	-0.042
Size	0.282***	0.210***	0.224***	0.227***
Nature	0.142+	-0.074	-0.081	-0.069
Eo		0.625***	0.592***	0.571***
Im			0.099	0.096
Eo*Im				0.139**
Adjusted R^2	0.108	0.394	0.396	0.418
$\triangle R^2$	0.124	0.284	0.005	0.025
F-value	8.054***	29.315***	23.839***	21.844***
$\triangle F$	8.054***	81.669***	1.554	7.372**
VIF	1.002~1.215	1.122~1.240	1.127~1.325	1.021~1.340

Additionally, a simple slope analysis was conducted to further elucidate the adjustment effect of interface management. The results indicated a significant effect, with confidence intervals excluding 0, confirming the substantial regulatory impact of interface management. Furthermore, a schematic diagram illustrated the regulatory effect, depicting a steeper

relationship curve between entrepreneurial orientation and digital transformation under high interface management levels, reaffirming the significance of interface management in promoting enterprise digital transformation.

Table 10 Simple Slope Analysis of Interface Management Regulation Effect

lm	Effect	se	t	p	LLCI	ULCI
2.7954	0.4412	0.0897	4.9159	0.0000	0.2643	0.6181
3.6000	0.5524	0.0666	8.3000	0.0000	0.4213	0.6836
4.4046	0.6637	0.0824	8.0569	0.0000	0.5013	0.8260
Eo*Im	0.1382	0.0680	2.0340	0.0432	0.0043	0.2722

4.2 Discussion

The findings presented in this study illuminate nuanced insights into the intricate dynamics between entrepreneurial orientation, effect reasoning, and interface management in driving enterprise digital transformation. Through rigorous analysis, several noteworthy conclusions emerge, shedding light on the multifaceted nature of these relationships. Firstly, the mediation analysis reveals the crucial role of effect reasoning as a partial mediator between entrepreneurial orientation and enterprise digital transformation. The significant regression coefficients and the proportionate mediation effect underscore the importance of cognitive processes in translating entrepreneurial orientation into tangible digital transformation outcomes. Notably, the experimental dimension of effect reasoning emerges as a pivotal mediator, highlighting the experimental mindset's potency in fostering innovative digital initiatives within enterprises. Furthermore, the examination of interface management's moderating impact elucidates its pivotal role in shaping the relationship between entrepreneurial orientation and digital transformation. The significant regulatory effect of interface management underscores its capacity to facilitate or impede the translation of entrepreneurial vision into actionable digital strategies. The observed industry-specific variations accentuate the contextual nuances that influence interface management's efficacy, advocating for tailored approaches to harness its regulatory potential effectively. Moreover, the intricate interplay between entrepreneurial orientation, effect reasoning, and interface management unveils a holistic framework for orchestrating successful digital transformations. It underscores the symbiotic relationship between cognitive processes, strategic orientations, and organizational practices in fostering digital agility and resilience. Importantly, the schematic depiction of interface management's regulatory effect underscores its transformative potential in enabling enterprises to navigate the complexities of digital disruption effectively. Overall, the findings underscore the imperative for organizations to cultivate a synergistic alignment between entrepreneurial vision, cognitive adaptability, and strategic governance to thrive in an increasingly digitized landscape. By fostering a culture of experimentation, bolstered by effective interface management practices, enterprises can harness the transformative power of digital technologies to drive sustainable growth and competitive advantage in the digital era. This holistic perspective emphasizes the need for organizations to embrace digital transformation as a multifaceted journey, underpinned by visionary leadership, adaptive learning, and strategic governance.

5. Conclusion

In conclusion, this study delves into the intricate dynamics of entrepreneurial orientation, effect reasoning, and interface management in driving enterprise digital transformation, offering novel insights and practical implications for organizational strategists and scholars alike. The findings underscore the pivotal role of effect reasoning as a cognitive mechanism mediating the relationship between entrepreneurial orientation and digital transformation. By illuminating the cognitive processes underlying strategic decision-making, this study

emphasizes the importance of fostering an experimental mindset within organizations to navigate the complexities of the digital landscape effectively. Moreover, the study elucidates the moderating effect of interface management in shaping the link between entrepreneurial orientation and digital transformation. By highlighting the regulatory role of interface management in facilitating or impeding strategic adaptation, this research underscores the significance of effective governance mechanisms in driving successful digital transformations. Furthermore, the holistic framework presented in this study emphasizes the interconnectedness of entrepreneurial vision, cognitive adaptability, and strategic governance in fostering digital resilience and agility. By integrating insights from effect reasoning and interface management, organizations can cultivate a culture of innovation and strategic agility, enabling them to thrive amidst digital disruption. Importantly, the findings advocate for tailored approaches to interface management, recognizing the contextual nuances that influence its efficacy across different industry domains. By embracing a context-sensitive approach to governance, organizations can harness the transformative potential of interface management to drive sustainable digital growth and competitive advantage. Overall, this study contributes to the burgeoning literature on digital transformation by offering a comprehensive understanding of the cognitive, strategic, and organizational dimensions underlying successful digital adaptation. By embracing the insights gleaned from this research, organizations can navigate the complexities of the digital landscape with confidence, driving innovation, and sustainable growth in an increasingly digitized world.

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