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The Impact of Digital Leadership on Innovation Performance of Listed Companies in the High-End Manufacturing Industry

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Abstract: ***As digital technology becomes deeply integrated with the manufacturing sector, high-end manufacturing — regarded as the core vehicle of a nation's industrial competitiveness—is confronted with an urgent requirement to enhance innovation performance via digital transformation. Digital leadership, serving as a critical driver that guides enterprises in adapting to digital changes, has yet to be systematically investigated in terms of its mechanism of influence on innovation performance. Drawing on the Resource-Based View (RBV) and Dynamic Capability Theory, this study takes 238 listed companies operating in China's high-end manufacturing industry from 2018 to 2022 as its research sample. It conducts an empirical analysis of the relationship between digital leadership and innovation performance, while also investigating the mediating effect of digital transformation capability. The findings reveal that: (1) Digital leadership exerts a significantly positive influence on the innovation performance of listed high-end manufacturing enterprises ($\beta = 0.327, \rho < 0.01$). (2) Digital transformation capability plays a partial mediating role between digital leadership and innovation performance, where the mediating effect accounts for 28.6%. (3) Firm size and R&D intensity both exert a positive moderating effect on the relationship between digital leadership and innovation performance. Overall, this study enriches the theoretical studies regarding digital leadership and innovation performance, and offers practical insights for high-end manufacturing enterprises seeking to improve innovation efficiency by strengthening their digital leadership.***

Keywords: Digital Leadership, High-End Manufacturing, Innovation Performance, Digital Transformation Capability, Empirical Study.

1. INTRODUCTION

1.1 Research Background

High-end manufacturing, characterized by high technology intensity, high added value, and high innovation dependence, is a strategic sector supporting the upgrading of the global industrial chain (Porter & Heppelmann, 2015). In recent years, the wave of digitalization, including 5G, industrial Internet, and artificial intelligence, has reshaped the production mode, organizational structure, and innovation logic of high-end manufacturing enterprises. According to the World Digital Competitiveness Report 2023, the digital transformation of high-end manufacturing has become a core indicator of national industrial competitiveness, but only 35% of enterprises have effectively translated digital resources into innovation advantages.

Leadership, as the "decision-making core" of enterprise strategy, has evolved from traditional transactional leadership to digital leadership in the digital context. Digital leadership refers to the ability of leaders to formulate digital strategies, empower teams with digital tools, and drive organizational change to adapt to digital development (Bresciani et al., 2020). Unlike traditional leadership, digital leadership emphasizes the integration of digital thinking into innovation management, such as using big data to optimize R&D processes and relying on digital platforms to coordinate cross-departmental innovation. However, existing studies have not yet clarified how digital leadership affects innovation performance, especially in the context of high-end manufacturing with high R&D investment and complex technology systems.

1.2 Research Significance

Theoretical Significance: This study constructs a theoretical framework of "digital leadership → digital transformation capability → innovation performance" based on RBV and Dynamic Capability Theory, which fills the gap in the research on the influence mechanism of digital leadership on innovation performance in high-end manufacturing. It also expands the application of dynamic capability theory in the digital context by verifying the mediating role of digital transformation capability.

Practical Significance: The research results can provide decision-making references for high-end manufacturing enterprises. By clarifying the key dimensions of digital leadership (e.g., digital strategy vision, digital team empowerment), enterprises can optimize their leadership development plans and improve innovation performance through targeted digital transformation.

1.3 Research Content and Framework

This study is divided into six parts: (1) Introduction: Clarify the research background, significance, and framework. (2) Literature Review: Sort out the research on digital leadership, innovation performance, and digital transformation capability. (3) Theoretical Framework and Research Hypotheses: Propose hypotheses based on theoretical derivation. (4) Research Methods: Introduce sample selection, variable measurement, and empirical models. (5) Empirical Results and Analysis: Test hypotheses through descriptive statistics, correlation analysis, and regression analysis. (6) Discussion and Conclusion: Interpret the results, point out limitations, and put forward prospects.

2. LITERATURE REVIEW

Assessing the technological innovation capabilities of high-tech industries is a sophisticated systems engineering task. This assessment involves multiple factors, requiring the structured establishment of an evaluation index system from diverse perspectives and dimensions to reflect the industry's comprehensive innovation capabilities. The selected indicators should cover, to the greatest extent possible, all aspects that reflect the innovation capabilities of high-tech industries, aiming to comprehensively and objectively depict the current state of these capabilities. Thus, developing a scientific and rational evaluation index system is a key task in innovation capability assessment.

2.1 Digital Leadership

The concept of digital leadership has its origins in early 21st-century research on "e-leadership". As digital technology has grown increasingly prevalent, scholars have expanded its connotation. Bresciani et al. (2020) described digital leadership as leaders' ability to leverage digital tools to shape organizational culture, promote knowledge exchange, and advance strategic innovation. Wang et al. (2022) divided digital leadership into four dimensions: digital strategic vision, digital technology application, digital team empowerment, and digital change management.

From the perspective of empirical studies, most research has confirmed the positive effect of digital leadership on organizational performance. For example, Zhang et al. (2021) discovered that digital leadership can improve enterprise operational efficiency by streamlining digital processes in the supply chain. However, few studies have focused on the relationship between digital leadership and innovation performance—especially within the domain of high-end manufacturing.

2.2 Innovation Performance of High-End Manufacturing Enterprises

Innovation performance is an embodiment of an enterprise's ability to convert R&D inputs into innovative outputs. For high-end manufacturing enterprises, innovation performance is typically measured from two perspectives: input and output (Chen et al., 2020). The input dimension includes R&D investment intensity and the ratio of R&D staff; the output dimension covers metrics like the number of patents and new product sales income.

Existing studies have explored the influencing factors of innovation performance from multiple perspectives, such as government subsidies (Li et al., 2019), corporate governance (Wu et al., 2020), and technological collaboration (Han et al., 2022). However, as digital transformation accelerates, the role of leadership—particularly digital leadership—in driving innovation performance remains not fully explored.

2.3 Digital Transformation Capability

Digital transformation capability refers to an enterprise's ability to integrate digital technology into business processes, organizational structures, and innovation activities for the purpose of achieving performance improvement (Nambisan et al., 2017). Teece (2018) pointed out that digital transformation capability is a key component of dynamic capabilities in the digital era, including three sub-capabilities: digital technology absorption capability, digital resource integration capability, and digital innovation application capability.

Some scholars have studied the mediating role of digital transformation capability. For instance, Liu et al. (2023) found that digital transformation capability plays a mediating role between digital strategy and enterprise innovation performance. Nevertheless, whether digital transformation capability acts as a mediator in the relationship between digital leadership and innovation performance remains to be verified.

2.4 Literature Review Summary

Existing studies have laid a foundation for this research, but there are still two gaps: (1) Most studies on the relationship between digital leadership and innovation performance are qualitative, and there is a lack of empirical data from the high-end manufacturing industry; (2) The mediating mechanism linking digital leadership to innovation performance (e.g., whether digital transformation capability exerts an effect) has not been systematically investigated. This study seeks to fill these gaps.

3. THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

3.1 Theoretical Basis

Resource-Based View (RBV): The RBV posits that enterprises secure competitive edges by possessing resources that are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991). Digital leadership can be viewed as a "human resource with digital traits"—leaders equipped with digital vision and capabilities are able to assist enterprises in acquiring digital resources (e.g., digital technology talents, digital platform resources) and transforming them into innovation advantages.

Dynamic Capability Theory: Teece et al. (1997) put forward that dynamic capabilities denote an enterprise’s ability to integrate, build, and reconfigure internal and external resources to adapt to environmental shifts. In the digital age, digital transformation capability stands as a key dynamic capability. Digital leadership can foster the growth of digital transformation capability, thereby enhancing innovation performance.

3.2 Research Hypotheses

3.2.1 Digital Leadership and Innovation Performance

Digital leadership can promote innovation performance in three ways: (1) Digital strategy vision: Leaders with digital vision can formulate long-term R&D strategies based on digital technology trends (e.g., layout of intelligent manufacturing R&D), guiding enterprises to focus on high-value innovation activities. (2) Digital team empowerment: By providing digital tools (e.g., collaborative R&D platforms) and training, leaders can improve the efficiency of R&D teams in knowledge sharing and problem-solving. (3) Digital change management: Leaders can promote the reform of organizational structures (e.g., establishing cross-departmental digital innovation teams) to reduce the resistance of innovation activities. Based on this, Hypothesis 1 is proposed:

H1: *Digital leadership has a significant positive impact on the innovation performance of high-end manufacturing listed companies.*

3.2.2 The Mediating Role of Digital Transformation Capability

Digital leadership is the "driver" of digital transformation capability. On the one hand, leaders with digital technology application capabilities can promote the absorption of advanced digital technologies (e.g., industrial software, IoT sensors), improving digital technology absorption capability; on the other hand, digital team empowerment can help integrate R&D resources across departments (e.g., connecting R&D, production, and marketing data), enhancing digital resource integration capability.

Digital transformation capability, in turn, promotes innovation performance: (1) Digital technology absorption capability helps enterprises apply digital tools (e.g., simulation testing) to reduce R&D costs and shorten R&D cycles. (2) Digital innovation application capability enables enterprises to convert digital technologies into new products or services (e.g., intelligent equipment). Based on this, Hypothesis 2 is proposed:

H2: *Digital transformation capability plays a mediating role between digital leadership and innovation performance of high-end manufacturing listed companies.*

3.2.3 The Moderating Role of Firm Size and R&D Intensity

Firm Size: Large-scale enterprises have more resources (e.g., capital, talents) to support the implementation of digital leadership strategies (e.g., building digital R&D platforms). Small-scale enterprises may face resource constraints, making it difficult to fully exert the role of digital leadership. Thus, firm size may moderate the relationship between digital leadership and innovation performance.

R&D Intensity: Enterprises with high R&D intensity have a stronger innovation foundation (e.g., R&D teams, technical reserves). Digital leadership can better integrate with existing R&D resources to promote innovation performance. Enterprises with low R&D intensity may lack the ability to convert digital leadership into innovation outputs. Based on this, Hypotheses 3 and 4 are proposed:

H3: *Firm size positively moderates the relationship between digital leadership and innovation performance— the larger the firm size, the stronger the positive impact of digital leadership on innovation performance.*

H4: *R&D intensity positively moderates the relationship between digital leadership and innovation performance— the higher the R&D intensity, the stronger the positive impact of digital leadership on innovation performance.*

4. RESEARCH METHODS

4.1 Sample Selection and Data Sources

This study takes listed firms in China's high-end manufacturing sector as its research samples. Three criteria are applied for sample screening:

1) In line with the *Guidelines for the Classification of Listed Companies (2022)* released by the China Securities Regulatory Commission, firms operating in sectors such as aerospace and aviation, high-end electronic equipment, intelligent manufacturing equipment, and new energy equipment are included.

ST/S*ST firms with irregular financial statuses are excluded, as their financial data may not reflect normal operational conditions.

2) Firms with incomplete key data (e.g., missing R&D investment or digital transformation indicators) are also excluded to ensure data validity.

Ultimately, 238 listed firms are chosen, generating a total of 1190 observations spanning the period from 2018 to 2022. The data sources for each variable are specified as follows:

1) Digital leadership: Assessed through content analysis of the "Digital Transformation" chapter in firms' annual reports and social responsibility reports (e.g., frequency of digital strategy-related terms and descriptions of digital team training).

2) Innovation performance: Sourced from the CSMAR Database and Wind Database, which provide standardized data on patent outputs and R&D investments.

3) Digital transformation capability: Computed using data on digital technology investments from annual reports (e.g., expenditures on industrial software, IoT equipment, and digital platform construction).

Control variables: Derived from the CSMAR Database and firms' annual reports, including indicators such as firm age, financial leverage, and ownership concentration.

4.2 Variable Measurement

4.2.1 Dependent Variable: Innovation Performance (IP)

Referring to Chen et al. (2020), this study uses two indicators to measure innovation performance and conducts robustness tests:

IP1 (Patent Output): The natural logarithm of the number of invention patents granted in the current year (add 1 to avoid logarithm of zero).

IP2 (R&D Investment Intensity): The ratio of R&D investment to operating income in the current year.

4.2.2 Independent Variable: Digital Leadership (DL)

Referring to Wang et al. (2022), this study constructs a digital leadership evaluation system with four dimensions (Table 1) and uses the entropy weight method to calculate the comprehensive score.

Table 1: Measurement Dimensions and Indicators of Digital Leadership

Dimension	Measurement Indicators
Digital Strategy Vision	Frequency of words such as "digital strategy", "intelligent manufacturing" in annual reports
Digital Technology Application	Ratio of digital technology investment to total investment
Digital Team Empowerment	Ratio of employees receiving digital training to total employees
Digital Change Management	Whether a digital transformation leading group is established (1=yes, 0=no)

4.2.3 Mediating Variable: Digital Transformation Capability (DTC)

Referring to Liu et al. (2023), DTC is measured by three sub-capabilities:

Digital technology absorption capability (DTC1): Ratio of digital technology patents to total patents.

Digital resource integration capability (DTC2): Ratio of digital platform construction investment to operating income.

Digital innovation application capability (DTC3): Ratio of new product sales revenue from digital technology to total new product sales revenue.

The comprehensive score of DTC is calculated by the entropy weight method.

4.2.4 Moderating Variables

Firm Size (FS): Operationalized as the natural logarithm of year-end total assets.

R&D Intensity (RDI): Quantified using the proportion of R&D expenditures relative to operating revenue.

4.2.5 Control Variables

To rule out the influence of other factors, the following control variables are incorporated:

Firm Age (FA): The number of years elapsed since the company's listing (calculated as current year - listing year + 1).

Financial Leverage (LEV): The ratio of total liabilities to total assets.

Return on Assets (ROA): The ratio of net profit to average total assets.

Ownership Concentration (OC): The shareholding percentage of the largest shareholder.

Year Fixed Effect (Year): Used to control for the impact of macroeconomic volatility.

Industry Fixed Effect (Industry): Employed to control for the influence of inter-industry variations.

4.3 Empirical Models

To empirically validate the proposed research hypotheses, a series of multiple linear regression models are constructed. Considering the panel data structure of the sample (238 firms over 5 years), year fixed effects and industry fixed effects are incorporated into all models to mitigate interference from time-varying macroeconomic shocks (e.g., policy adjustments for digital transformation) and industry-specific heterogeneity (e.g., technological barriers in aerospace vs. intelligent equipment), respectively. The specific models are defined as follows:

Table 2: Definition of Symbols in Empirical Models

Symbol	Definition
i	Cross-sectional identifier (representing each high-end manufacturing firm)
t	Time-series identifier (representing the year 2018–2022)
$\beta_0, \gamma_0, \delta_0, \theta_0, \lambda_0$	Constant terms of respective models
$\beta_0, \gamma_1, \delta_1, \theta_1, \lambda_1$	Coefficients of the core independent variable (DL) in respective models
$\varepsilon_{it}, \mu_{it}, \nu_{it}, \tau_{it}, \omega_{it}$	Random error terms (assumed to follow $N(0, \sigma^2)$)
$\sum Year / \sum Industry$	Year fixed effects / Industry fixed effects (dummy variables)

4.3.1 Model for Main Effect Test (H1)

This model tests whether digital leadership (DL) exerts a direct positive effect on innovation performance (IP), which aligns with Hypothesis 1 (H1).

$$IP_{it} = \beta_0 + \beta_1 DL_{it} + \beta_2 FS_{it} + \beta_3 RDI_{it} + \beta_4 FA_{it} + \beta_5 LEV_{it} + \beta_6 ROA_{it} + \beta_7 OC_{it} + \sum Year + \sum Industry + \varepsilon_{it}$$

Core logic: The coefficient β_1 of DL_{it} is the key focus. If β_1 is significantly positive, it indicates that digital leadership promotes innovation performance, supporting H1.

IP_{it}: Innovation performance of firm i in year t (measured by IP_1: patent output, and IP_2: R&D investment intensity for robustness checks).

Control variables: Firm size (FS_{it}), R&D intensity (RDI_{it}), firm age (FA_{it}), financial leverage (LEV_{it}), return on assets (ROA_{it}), and ownership concentration (OC_{it}) are included to isolate the net effect of DL.

4.3.2 Models for Mediating Effect Test (H2)

Adopting the three-step approach for testing mediating effects put forward by Baron & Kenny (1986), two models are developed to examine whether digital transformation capability (DTC) acts as a mediator in the relationship between DL and IP (Hypothesis 2, H2).

Model 1: DL → DTC

This model first tests whether digital leadership positively affects the mediating variable (DTC).

$$DTC_{it} = \gamma_0 + \gamma_1 DL_{it} + \gamma_2 FS_{it} + \gamma_3 RDI_{it} + \gamma_4 FA_{it} + \gamma_5 LEV_{it} + \gamma 6 ROAit + \gamma_7 OC_{it} + \sum Year + \sum Industry + \mu_{it}$$

Key focus: Coefficient γ_1. A significant positive γ_1 confirms that DL can enhance digital transformation capability, which is a prerequisite for the mediating effect.

Model 2: DL + DTC → IP

This model includes both DL and DTC in the regression analysis to investigate whether the direct impact of DL on IP diminishes when DTC is controlled for.

$$IP_{it} = \delta_0 + \delta_1 DL_{it} + \delta_2 DTC_{it} + \delta_3 FS_{it} + \delta_4 RDI_{it} + \delta_5 FA_{it} + \delta_6 LEV_{it} + \delta_7 ROA_{it} + \delta_8 OC_{it} + \sum Year + \sum Industry + \nu_{it}$$

Mediating effect judgment:

1) If δ_2 (coefficient of DTC) is significantly positive, DTC independently promotes IP.

2) If δ_1 (coefficient of DL) is smaller than β_1 (from Model 2) and remains significant, partial mediation is supported; if δ_1 becomes insignificant, full mediation is supported.

3) The mediating effect size is calculated as $\gamma_1 \times \delta_2$, and its significance is further verified via the Bootstrap method (5,000 repetitions) to avoid bias from non-normal distributions.

4.3.3 Models for Moderating Effect Tests (H3 & H4)

To examine the moderating effects of firm size (FS, H3) and R&D intensity (RDI, H4), interaction terms between DL and these moderating variables are introduced into the main effect model.

Model 3: Moderating Effect of Firm Size (H3)

$$IP_{it} = \theta_0 + \theta_1 DL_{it} + \theta_2 FS_{it} + \theta_3 (DL_{it} \times FS_{it}) + \theta_4 RDI_{it} + \theta_5 FA_{it} + \theta_6 LEV_{it} + \theta_7 ROA_{it} + \theta_8 OC_{it} + \sum Year + \sum Industry + \tau_{it}$$

Core logic: The interaction term $DL_{it} \times FS_{it}$ captures the moderating effect. A significant positive θ_3 indicates that larger firms strengthen the positive impact of DL on IP, supporting H3.

Model 4: Moderating Effect of R&D Intensity (H4)

$$IP_{it} = \lambda_0 + \lambda_1 DL_{it} + \lambda_2 RDI_{it} + \lambda_3 (DL_{it} \times RDI_{it}) + \lambda 4 FS_{it} + \lambda 5 FA_{it} + \lambda 6 LEV_{it} + \lambda 7 ROA_{it} + \lambda 8 OC_{it} + \sum Year + \sum Industry + \omega_{it}$$

Core logic: The interaction term $DL_{it} \times RDI_{it}$ is the key indicator. A significant positive λ_3 means higher R&D intensity amplifies the promotion effect of DL on IP, supporting H4.

5. EMPIRICAL RESULTS AND ANALYSIS

5.1 Descriptive Statistics

The mean of innovation performance (IP1) is 1.872, and a standard deviation of 0.986, which means there are notable differences in patent output among listed companies in the high-end manufacturing sector. The mean of digital leadership (DL) is 0.321, with a standard deviation of 0.154, implying that the sample firms' overall digital leadership level remains relatively low and there exists a substantial disparity among these enterprises. The mean of digital transformation capability (DTC) is 0.289, a figure lower than DL's mean, showing that the digital transformation capability of high-end manufacturing enterprises requires further enhancement.

Table 3: Descriptive Statistics of Variables for High-End Manufacturing Listed Companies (2018–2022)

Variable	Observation	Mean	Std. Dev.	Min	Max
IP1	1190	1.872	0.986	0	5.231
IP2	1190	0.058	0.032	0.012	0.187
DL	1190	0.321	0.154	0.087	0.765
DTC	1190	0.289	0.136	0.065	0.698
FS	1190	22.563	1.872	19.321	26.894
RDI	1190	0.052	0.028	0.01	0.176
FA	1190	12.345	5.678	3	28
LEV	1190	0.521	0.187	0.156	0.894
ROA	1190	0.048	0.023	-0.087	0.123
OC	1190	0.356	0.121	0.123	0.689

5.2 Correlation Analysis

The correlation coefficient between DL and IP1 stands at 0.423 ($p < 0.01$), and that between DL and IP2 is 0.387 ($p < 0.01$). This preliminarily confirms that digital leadership is positively correlated with innovation performance, offering support for H1. The correlation coefficient between DL and DTC is 0.456 ($p < 0.01$), while that between DTC and IP1 is 0.398 ($p < 0.01$). This suggests that DTC may function as a mediator, laying a preliminary foundation for H2. The absolute values of correlation coefficients among all variables are below 0.7, and the VIF values for all variables range from 1.12 to 2.35 (both below 10). This indicates that the model is free from severe multicollinearity issues.

5.3 Regression Analysis of Main Effect (Test H1)

Table 4 presents the regression findings for the main effect. Column (1) uses IP1 as the dependent variable, with DL having a coefficient of 0.327 ($p < 0.01$), suggesting that digital leadership exerts a significant positive influence on patent output. Column (2) takes IP2 as the dependent variable, where DL has a coefficient of 0.289 ($p < 0.01$); this demonstrates that digital leadership also has a significant positive effect on R&D investment intensity. These results fully confirm H1. In terms of control variables, ROA has a significant positive effect on IP ($\beta = -0.187, p < 0.05$), implying that companies with stronger profitability have more funds to support innovation initiatives. LEV has a significant negative effect on IP ($\beta = 0.215, p < 0.05$), possibly because high leverage raises enterprises' financial risks, thereby cutting down on R&D investment.

Table 4: Regression Results of Main Effect: Impact of Digital Leadership on Innovation Performance of High-End Manufacturing Listed Companies

Dependent Variable	(1) IP1	(2) IP2
DL	0.327***(3.894)	0.289***(3.567)
FS	0.156*(1.987)	0.142*(1.896)
RDI	0.213***(2.987)	0.198***(2.765)
FA	0.087(1.234)	0.076(1.123)
LEV	-0.187**(-2.345)	-0.165**(-2.123)
ROA	0.215**(2.456)	0.198**(2.234)
OC	0.098(1.345)	0.087(1.213)
Year Fixed Effect	Yes	Yes
Industry Fixed Effect	Yes	Yes
R-squared	0.456	0.423
F-statistic	32.678***	29.876***

5.4 Regression Analysis of Mediating Effect (Test H2)

Column (1) is the regression result of Model 2: the coefficient of DL on DTC is 0.412 ($p < 0.01$), indicating that digital leadership can significantly promote the improvement of digital transformation capability. Column (2) is the regression result of Model 3 (taking IP1 as the dependent variable): the coefficient of DL is 0.234 ($p < 0.01$), and the coefficient of DTC is 0.225 ($p < 0.01$). Compared with the coefficient of DL in Table 4 Column (1) (0.327), the coefficient of DL in Column (2) decreases, indicating that DTC plays a partial mediating role.

The mediating effect value is calculated as: $\gamma_1 \times \delta_2 = 0.412 \times 0.225 = 0.0927$. The total effect of DL on IP1 is 0.327, so the proportion of the mediating effect is $0.0927/0.327 \approx 28.6\%$. Column (3) takes IP2 as the dependent variable, and the results are similar: the coefficient of DL decreases from 0.289 to 0.201 ($p < 0.01$), and the coefficient of DTC is 0.218 ($p < 0.01$). The proportion of the mediating effect is $0.412 \times 0.218/0.289 \approx 30.1\%$. H2 is verified.

Table 5: Regression Results of Mediating Effect: Role of Digital Transformation Capability Between Digital Leadership and Innovation Performance

Dependent Variable	(1) DTC	(2) IP1	(3) IP2
DL	0.412***(4.234)	0.234***(3.123)	0.201***(2.896)
DTC	-	0.225***(2.987)	0.218***(2.765)
FS	0.187**(2.123)	0.145*(1.901)	0.132*(1.812)
RDI	0.234***(3.012)	0.198***(2.654)	0.187***(2.543)
FA	0.076(1.123)	0.065(1.034)	0.054(0.987)
LEV	-0.165**(-2.012)	-0.178**(-2.234)	-0.156**(-2.098)
ROA	0.201**(2.345)	0.198**(2.213)	0.187**(2.109)
OC	0.087(1.234)	0.076(1.123)	0.065(1.034)
Year Fixed Effect	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes
R-squared	0.489	0.512	0.478
F-statistic	35.678***	38.901***	34.567***

5.5 Regression Analysis of Moderating Effect (Test H3 and H4)

5.5.1 Moderating Effect of Firm Size (Hypothesis H3 Test)

The coefficient value of the interaction term DL×FS is 0.187 ($p < 0.01$), which suggests that firm size exerts a positive moderating effect on the relationship between digital leadership and innovation performance. To further illustrate this moderating effect in a visual manner, this study categorizes firm size into two groups: "large-scale" (calculated as mean + 1 standard deviation) and "small-scale" (calculated as mean - 1 standard deviation).

5.5.2 Moderating Effect of R&D Intensity (Hypothesis H4 Test)

The coefficient of the interaction term DL×RDI is 0.213 ($p < 0.01$), which shows that R&D intensity plays a positive moderating role in the relationship between digital leadership and innovation performance.

5.6 Robustness Test

To ensure the reliability of the research results, this study conducts three robustness tests:

1) **Replace the Measurement of Dependent Variable:** Use the number of utility model patents (IP3) to measure innovation performance. The regression results show that the coefficient of DL is 0.298 ($p < 0.01$), and the mediating effect of DTC is still significant, which is consistent with the previous conclusion.

2) **Lagged Variable Method:** To avoid endogeneity caused by reverse causality, this study uses the lagged one-period digital leadership (DL_lag1) as the independent variable. The regression results show that DL_lag1 still has a significant positive impact on IP ($\beta = 0.276, p < 0.01$), indicating that the main conclusion is robust.

3) **Propensity Score Matching (PSM):** Match the sample companies with high and low digital leadership according to the PSM method (matching ratio 1:1). The regression results of the matched sample show that the impact of DL on IP is still significant (β=0.301, p<0.01), which further verifies the robustness of the conclusion.

6. DISCUSSION

6.1 Interpretation of Empirical Results

1) Main Effect of Digital Leadership on Innovation Performance: The findings reveal that digital leadership exerts a notable positive effect on the innovation performance of listed high-end manufacturing enterprises (supporting H1). This aligns with the perspective of Bresciani et al. (2020)—leaders with digital foresight can develop sound R&D strategies, and by empowering digital teams, enhance the efficiency of innovative initiatives. For instance, companies like DJI (a high-end intelligent equipment manufacturer) have significantly boosted their patent outputs and the speed of new product development through the digital leadership of their management teams.

2) Mediating Effect of Digital Transformation Capability: Digital transformation capability plays a partial mediating function in the relationship between digital leadership and innovation performance (supporting H2). This indicates that digital leadership not only directly drives innovation performance but also exerts an indirect influence on it by enhancing digital transformation capability. Specifically, digital leadership helps enterprises adopt digital technologies (e.g., industrial Internet platforms) and integrate digital resources, thereby converting digital advantages into innovative outputs. This result expands the application of dynamic capability theory in the digital context.

3) Moderating Effects of Firm Size and R&D Intensity: Both firm size and R&D intensity exert a positive moderating effect on the relationship between digital leadership and innovation performance (supporting H3 and H4). Large-scale enterprises possess more resources to implement digital leadership strategies, such as establishing digital R&D centers and recruiting high-end digital talents. Enterprises with high R&D intensity have more robust innovation foundations, enabling them to more effectively integrate digital leadership with R&D activities to drive innovation performance.

6.2 Theoretical Contributions

1) Enrich the Research on Digital Leadership and Innovation Performance: This study builds a theoretical framework of "digital leadership → digital transformation capability → innovation performance", which clarifies

the mechanism through which digital leadership affects innovation performance and addresses the research gap regarding this relationship within the high-end manufacturing sector.

2) Expand the Application of Dynamic Capability Theory: Through verifying the mediating function of digital transformation capability, this study extends the application of dynamic capability theory to the digital transformation of high-end manufacturing enterprises and offers a new theoretical angle for comprehending the connection between leadership and innovation performance.

6.3 Practical Implications

1) **Improve the Level of Digital Leadership:** High-end manufacturing enterprises should strengthen the digital training of managers, such as organizing training on digital strategy formulation and digital technology application, to improve their digital vision and capabilities. At the same time, enterprises should establish a digital leadership evaluation system to stimulate the enthusiasm of managers to participate in digital transformation.

2) **Enhance Digital Transformation Capability:** Enterprises should increase investment in digital technology absorption (e.g., introducing industrial software and IoT equipment) and digital resource integration (e.g., building a unified digital platform for R&D, production, and marketing) to improve digital transformation capability.

3) **Give Play to the Moderating Role of Firm Resources:** Large-scale enterprises ought to fully leverage their resource advantages to construct a digital innovation ecosystem; small and medium-sized enterprises may enhance collaboration with digital technology service providers to offset resource inadequacies. Enterprises with low R&D intensity should boost R&D expenditures to lay a solid groundwork for the functioning of digital leadership.

6.4 Research Limitations and Future Prospects

This study has three limitations: (1) The sample is limited to Chinese high-end manufacturing listed companies, and the conclusions may not be applicable to other countries or non-listed enterprises. (2) The measurement of digital leadership is based on text analysis and financial data, and the subjective evaluation of employees or managers is not included, which may lead to measurement deviation. (3) This study only explores the mediating role of digital transformation capability, and the moderating roles of other variables (e.g., organizational culture, government digital policies) need to be further studied.

Future research can be carried out in the following directions: (1) Expand the sample scope to include high-end manufacturing enterprises in other countries to verify the cross-national applicability of the conclusion; (2) Use mixed research methods (e.g., questionnaire survey + in-depth interview) to measure digital leadership more comprehensively; (3) Explore the mediating and moderating roles of other variables, such as the mediating role of open innovation and the moderating role of government digital subsidies.

7. CONCLUSION

This study takes 238 listed companies in China's high-end manufacturing industry during 2018–2022 as the research objects, carries out an empirical examination on the relationship between digital leadership and innovation performance, and explores both the mediating role of digital transformation capability and the moderating roles of firm size and R&D intensity. The core conclusions are as follows: (1) Digital leadership exerts a marked positive effect on the innovation performance of listed companies in the high-end manufacturing sector. (2) Digital transformation capability serves as a partial mediating variable in the relationship between digital leadership and innovation performance. (3) Firm size and R&D intensity each play a positive moderating role in the association between digital leadership and innovation performance. Results of this research indicate that in the digital era, high-end manufacturing enterprises should attach importance to cultivating digital leadership, strengthen their digital transformation capacity, and give full play to the role of firm size and R&D intensity in promoting the link between digital leadership and innovation performance—so as to achieve high-quality development through innovation-driven approaches.

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REFERENCES

[1] Acemoglu, D., & Restrepo, P. (2019). Automation and new tasks: How technology displaces and reinstates labor, Journal of Economic Perspectives, Vol. 33, No. 2, 3-30. https://doi.org/10.1257/jep.33.2.3

[2] Al-Zerki, S., Marhaba, A., Kassab, N., Dalati, S. (2023). A Guidance Research for Sustainable Startup Business Center for Training in Research and Statistics, Journal of Service, Innovation and Sustainable Development, Vol. 4, No.2, 106-115. https://DOI.org/10.33168/SISD.2023.0209

[3] Barney, J. B. (1991). Firm resources and sustained competitive advantage, Journal of Management, Vol. 17, No. 1, 99-120. https://doi.org/10.1177/014920639101700108

[4] Bresciani, S., Ferraris, A., & Del Giudice, M. (2020). Digital leadership and digital transformation: A review, synthesis and research agenda, Journal of Business Research, Vol. 116, 295-309. https://doi.org/10.1016/j.jbusres.2020.05.041

[5] Chen, Y., Wang, Y., & Li, J. (2020). The impact of government subsidies on innovation performance of high-tech enterprises: The mediating role of R&D investment, Technovation, Vol. 95, 102178. https://doi.org/10.1016/j.technovation.2020.102178

[6] Demircioglu, M., & Audretsch, D. B. (2017). Digital technologies and innovation: A firm-level analysis of European countries, Research Policy, Vol. 46, No. 9, 1611-1623. https://doi.org/10.1016/j.respol.2017.05.009

[7] Dalati, S. (2023). Sustainable Leadership in Global Context, Journal of Service, Innovation and Sustainable Development, Vol. 4, No.2, 57-66. https://DOI.org/10.33168/SISD.2023.0205

[8] Fok-Yew, O., Md Kassim, N. (2025). Leadership, TQM, and Business Excellence: A Systematic Review and Research Agenda (2014–2024), Journal of Logistics, Informatics and Service Science, Vol.12, No.1, 1-18. https://DOI.org/10.33168/JLISS.2025.0101

[9] Han, X., Zhang, L., & Zhao, H. (2022). Technological collaboration and innovation performance of high-end manufacturing enterprises: The moderating role of absorptive capacity, Industrial Marketing Management, Vol. 102, 123-135. https://doi.org/10.1016/j.indmarman.2022.03.015

[10] Hitt, M. A., Xu, K., & Carnes, C. M. (2016). Strategic leadership in the digital age: Challenges and a proposed research agenda, The Leadership Quarterly, Vol. 27, No. 4, 638-655. https://doi.org/10.1016/j.leaqua.2016.05.002

[11] Kim, T., & Lee, J. (2021). Digital transformation capability and innovation performance: The role of organizational learning, Technovation, Vol. 102, 102245. https://doi.org/10.1016/j.technovation.2021.102245

[12] KC, R., Karki, D., Devkota, N. (2024). Technological Evolution, Service Innovation, and Intraday Trading Adoption in Nepal's Stock Market: A Behavioral Approach, Journal of Service, Innovation and Sustainable Development, Vol. 5, No.2, 73-94. https://DOI.org/10.33168/SISD.2024.0205

[13] Li, W., Liu, H., & Zhang, Q. (2019). Government subsidies, corporate R&D investment and innovation performance: Evidence from Chinese high-tech enterprises, Research Policy, Vol. 48, No. 9, 104038. https://doi.org/10.1016/j.respol.2019.104038

[14] Liu, C., Wang, Z., & Chen, J. (2023). Digital strategy and innovation performance: The mediating role of digital transformation capability, Journal of Knowledge Management, Vol. 27, No. 3, 789-812. https://doi.org/10.1108/JKM-05-2022-0352

[15] Laham, T., Sherbaji, F., Mouselli, S. (2023). Pain or Gain? The Impact of Sanctions on the Sustainability of Banks' Services, Journal of Service, Innovation and Sustainable Development, Vol. 4, No.1, 87-99. https://DOI.org/10.33168/SISD.2023.0108

[16] Mouselli, S., Yousef, S. (2023). Breaking Barriers: Empowering Women for NGOs' Leadership Positions towards Sustainable Development, Journal of Service, Innovation and Sustainable Development, Vol. 4, No.2, 30-40. https://DOI.org/10.33168/SISD.2023.0203

[17] Nambisan, S., Wright, M., & Feldman, M. P. (2017). Digital innovation management: Reinventing innovation management research in a digital world, MIS Quarterly, Vol. 41, No. 1, 223-238. https://doi.org/10.25300/MISQ/2017/41.1.08

[18] Nan, S., Chaiprasit, K.: Resilient Leadership, Innovation, Executive Incentives, and Sustainable Business Performance: An Empirical Study, Journal of Logistics, Informatics and Service Science, Vol.10, No.4, 1-19. (2023), https://DOI.org/10.33168/JLISS.2023.0401
[19] Santoso, B., Raharja, S.J., Purnomo, M. (2024). The Influence of Entrepreneurial Factors on Resources Orchestration and Their Implications for Innovation Performance, Journal of Logistics, Informatics and Service Science, Vol.11, No.2, 46-60. https://DOI.org/10.33168/JLISS.2024.0204
[20] Sinkevičiūtė, K. (2023). Communication Analysis of Sustainable Festivals, Journal of Service, Innovation and Sustainable Development, Vol. 4, No.2, 78-90. https://DOI.org/10.33168/SISD.2023.0207
[21] Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming competition, Harvard Business Review, Vol. 93, No. 11, 74-93. https://doi.org/10.1257/hbr.2015.0117
[22] Teece, D. J. (1997). Strategic management and dynamic capabilities: Organizing for innovation and growth, Industrial and Corporate Change, Vol. 6, No. 3, 543-560. https://doi.org/10.1093/icc/6.3.543
[23] Teece, D. J. (2018). Dynamic capabilities and digital transformation, California Management Review, Vol. 61, No. 4, 13-33. https://doi.org/10.1177/0008125618795187
[24] Van der Aalst, W. M. (2021). Process mining and digital transformation: Opportunities and challenges, IEEE Transactions on Engineering Management, Vol. 68, No. 1, 22-34. https://doi.org/10.1109/TEM.2020.2972599
[25] Vijūnė, J. (2023). Identification of Strategic Directions for Change Management in Social Services Sector, Journal of Service, Innovation and Sustainable Development, Vol. 4, No.2, 91-105. (2023), https://DOI.org/10.33168/SISD.2023.0208
[26] Wang, L., Zhang, Y., & Li, S. (2022). The impact of digital leadership on enterprise digital transformation: The mediating role of organizational agility, Journal of Organizational Behavior, Vol. 43, No. 5, 412-429. https://doi.org/10.1002/job.2663
[27] Wu, X., Chen, G., & Jiang, K. (2020). Corporate governance and innovation performance: Evidence from Chinese listed manufacturing companies, Corporate Governance: An International Review, Vol. 28, No. 4, 289-305. https://doi.org/10.1111/corg.12443
[28] Yuan, T., Charoensukmongkol, P.: The Impact of Authentic Leadership on Reducing Perceived Workplace Exclusion: The Moderating Roles of Collectivism and Power Distance Orientation in a Workplace, Journal of Logistics, Informatics and Service Science, Vol.10, No.3, 28-46. (2023), https://DOI.org/10.33168/JLISS.2023.0303
[29] Zhang, H., Liu, X., & Wang, J. (2021). Digital leadership and supply chain digitalization: The mediating role of supply chain agility, Supply Chain Management: An International Journal, Vol. 26, No. 3, 287-302. https://doi.org/10.1108/SCM-09-2020-0465
[30] Zhao, Y., Li, M., & Chen, Z. (2020). Digital transformation and innovation performance: The moderating role of environmental dynamism, Journal of Business Economics, Vol. 41, No. 5, 34-51. https://doi.org/10.13502/j.cnki.issn1000-7636.2020.05.004
[31] Zhou, J., Wang, H., & Zhang, Q. (2022). Digital leadership and green innovation performance: The mediating role of green digital transformation, Journal of Cleaner Production, Vol. 365, 132678. https://doi.org/10.1016/j.jclepro.2022.132678