



Impact of Digital Leadership on Innovation Performance: Mediating Role of AI Capability and Moderating Role of Technological Turbulence

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Abstract: The changes brought about by digital transformation have shifted the landscape in which companies generate value and compete, making creativity and originality more important than ever before and making leadership skills more crucial to achieving organizational performance. This study examined how digital leadership affects innovation performance through the mediating role of AI capability and the moderating role of technological turbulence. Digital leadership is the strategic competency of leaders in digital adoption, data-driven decision-making, and the development of an innovation-oriented culture. AI capability refers to an organization's capacity to acquire, integrate, and leverage AI technologies to enhance organizational performance, while technological turbulence refers to the speed and unpredictability of technological changes within an organization's external environment. The findings revealed a significant positive impact of digital leadership on innovation performance, both directly and indirectly through AI capability. Furthermore, technological turbulence significantly moderated the relationship between digital leadership and innovation performance by strengthening this relationship under dynamic technological conditions. The study contributes to the existing body of knowledge on digital transformation and innovation by providing an integrated framework for understanding the interplay between digital leadership, AI capability, and technological turbulence in enhancing innovation performance.

“Index Terms — Digital Leadership, Innovation Performance, Artificial Intelligence Capability, Technological Turbulence, Digital Transformation, PLS-SEM.”

1. INTRODUCTION

Organizations face dramatic transformation in their operations, competitiveness, and value creation in today's business environment as a result of the rapid advancement of digital technology. Digital transformation is a growing trend among organizations, with the goal of enhancing decision-making, increasing operational efficiency, engaging customers, and ensuring future competitiveness. Digital transformation has accelerated across many sectors and is changing leadership from traditional approaches to digital leadership, enabling organizations to drive digitalization and organizational change [1], [2]. Digital leadership has therefore emerged as a key competency for leveraging technology, fostering an innovation culture, and maintaining a competitive advantage in a rapidly changing market.

Digital leadership is the capacity of organizational leaders to utilize digital technologies, foster digital mindsets, and align technological initiatives with business objectives. Digital leadership represents a new paradigm characterized by agility, data-driven decision-making, continuous learning, and support for innovative initiatives [1]. Current research has identified leaders who actively promote experimentation and digital readiness as important drivers of organizational transformation and innovation performance [3]. While modern enterprises operate in increasingly technology-driven environments, the ability to manage digital resources and foster innovation performance is closely linked to leadership effectiveness.

Innovation performance is the capacity to create, develop, and commercialize innovative ideas, products, services, and processes for sustainable organizational growth. With changing customer needs and continuous technological advancements, digital innovation has become a critical determinant of organizational success [4]. However, technology adoption alone is insufficient to improve innovation performance. Organizations must



possess internal capabilities that enable them to utilize knowledge effectively, make intelligent decisions, and continuously adapt to changing environments.

AI capability has gained significant attention as an important organizational capability. AI capability is the ability of an organization to acquire, deploy, integrate, and effectively utilize AI technologies to improve business operations and strategic outcomes [5]. A higher level of AI capability provides organizations with a competitive advantage by enabling them to leverage digital investments for developing innovative products and improving operational efficiency. Thus, AI capability serves as a powerful organizational resource for enhancing innovation performance.

Organizations operate in environments characterized by rapid technological change and uncertainty. Technological turbulence refers to the speed and unpredictability of technological changes within an organization's external environment [7]. Under conditions of high technological turbulence, organizations must continuously adapt to emerging technologies and changing market opportunities. The preparedness and agility of an organization can significantly influence the effectiveness of digital leadership and technological capabilities.

Previous studies have examined digital leadership, innovation performance, and technological capability separately. However, limited research has investigated the relationship between digital leadership and innovation performance through AI capability under varying levels of technological turbulence. Furthermore, there is limited empirical evidence examining both the mediating and moderating effects within a single integrated framework. Accordingly, this study developed an integrated conceptual research model based on Dynamic Capability Theory, which emphasizes an organization's ability to recognize opportunities, acquire resources, and reconfigure capabilities in dynamic environments [6]. The findings contribute to the existing literature on digital transformation and innovation while providing practical insights for organizations seeking to enhance innovation performance in rapidly evolving technological environments.

2. LITERATURE REVIEW

Organizations operating in today's digitally evolving environment are increasingly dependent on leadership capabilities and technological resources to innovate and remain competitive. Innovation performance is no longer determined solely by management practices but also by leadership behavior, intelligent technologies, and environmental adaptability. Thus, the present study investigates the relationship among Digital Leadership, AI Capability, Innovation Performance, and Technological Turbulence from an integrated theoretical perspective.

Digital leadership is a key organizational capability that enables organizations to lead digital transformation initiatives and foster innovative cultures. In digitally mature organizations, experimentation is encouraged, technology is embraced, and strategic goals are aligned with digital opportunities. Research on organizational transformation highlights that effective digital leadership enhances organizational flexibility, employee engagement, and innovation by creating an environment that supports organizational learning and technology adoption [8]. As organizations continue to digitize their business processes, leadership plays an increasingly important role in establishing decision-making environments that foster innovation.

Moreover, organizations require strong internal technological capabilities in addition to effective leadership to translate digital initiatives into tangible outcomes. AI capability has emerged as a major strategic resource that enables organizations to analyze data, automate decision-making, and generate insights for new innovation opportunities. Previous empirical research has found that organizations with higher AI capability and data-driven competencies achieve better innovation performance because of improved operational intelligence and more effective resource utilization [9]. As AI capabilities continue to advance, organizations become more responsive and better positioned to generate innovative outcomes from their digital investments.

The relationship between digital transformation and innovation is well explained by Dynamic Capability Theory, which emphasizes an organization's ability to integrate, build, and reconfigure resources in rapidly changing environments. Dynamic capabilities enable organizations to sense opportunities, reconfigure resources, and sustain competitive advantage over time [10]. From this perspective, digital leadership serves as an organizational mechanism that leverages AI capability to drive continuous innovation. Organizations that successfully align leadership strategies with technological capabilities are better able to translate digital resources into innovation outcomes.



Innovation performance refers to an organization's ability to develop and implement innovative products, services, processes, and business models. Existing literature indicates that knowledge integration and technology-enabled organizational processes significantly enhance innovation performance by strengthening both exploratory and exploitative capabilities [11]. Organizations with advanced technological infrastructure and strong leadership support are therefore better positioned to achieve sustainable and scalable innovation outcomes.

Recent research suggests that AI capability acts as a mediator between strategic leadership and organizational innovation. AI-enabled processes enhance knowledge creation, shorten decision-making cycles, and improve organizational flexibility, thereby contributing to higher innovation performance [12]. Likewise, organizations with more advanced AI capability achieve superior innovation performance through enhanced learning, automation, and strategic responsiveness [13]. These findings suggest that the relationship between digital leadership and innovation performance can be explained through AI capability, which transforms strategic intent into innovation capabilities.

Technological turbulence refers to the speed and unpredictability of technological changes within an organization's external environment. Previous studies have reported significant differences in innovation outcomes among organizations operating under high technological turbulence, depending on their ability to adapt and reconfigure internal resources [15]. Under such conditions, the effectiveness of digital leadership and technological readiness becomes increasingly important for achieving innovation success.

Methodologically, empirical studies investigating multidimensional organizational relationships commonly employ Partial Least Squares Structural Equation Modeling (PLS-SEM) because of its ability to examine mediation and moderation effects in complex research models [14]. Based on existing theoretical and empirical evidence, digital leadership positively influences innovation performance through AI capability, while technological turbulence strengthens this relationship under dynamic business conditions.

3. METHODOLOGY

This study adopted an empirical quantitative research approach to examine the relationship between Digital Leadership and Innovation Performance, considering the mediating role of AI Capability and the moderating role of Technological Turbulence. The conceptual research model was developed based on existing theoretical and empirical literature and was empirically validated using survey data analysis. The research methodology was designed to examine the direct and indirect relationships among the organizational constructs within dynamic technological environments.

A) Research Design

The study employed a cross-sectional research design, and data were collected from organizational respondents at a single point in time. Since the study aimed to statistically examine the causal relationships among latent variables through structural equation modelling, a quantitative research approach was adopted. The research model consisted of one independent variable (Digital Leadership), one dependent variable (Innovation Performance), one mediating variable (AI Capability), and one moderating variable (Technological Turbulence).

B) Population and Sampling

The target population consisted of employees, team leaders, managers, and decision-makers working in organizations actively involved in digital transformation initiatives. Respondents were selected from technology-enabled enterprises, service organizations, and digitally active corporations.

The participants were selected using purposive and convenience sampling techniques to ensure that they possessed adequate knowledge of digital processes and innovative organizational practices. A total of 350 questionnaires were distributed. After data screening and completeness checks, 312 valid responses were retained for empirical analysis.

C) Data Collection Instrument

Primary data were collected using a structured questionnaire developed from previously validated measurement scales reported in the literature on Digital Leadership, AI Capability, Innovation Performance, and Technological Turbulence. The questionnaire consisted of two sections.

The first section collected respondents' demographic information, including gender, age, educational qualification, organizational role, and years of work experience.

The second section contained measurement items representing the research constructs.

All construct items were measured using a 5-point Likert scale:

1 – Strongly Disagree



- 2 – Disagree
- 3 – Neutral
- 4 – Agree
- 5 – Strongly Agree

The questionnaire consisted of approximately 20 measurement items distributed across the four research constructs.

D) Variable Measurement

The research model comprised four constructs.

Digital Leadership (DL): Measures leadership capability in promoting technology adoption, strategic thinking, knowledge sharing, and an innovation-oriented culture.

AI Capability (AIC): Measures an organization's ability to acquire, integrate, and effectively utilize AI technologies and intelligent business processes.

Innovation Performance (IP): Measures the development, implementation, and commercialization of innovative products, services, and process improvements within the organization.

Technological Turbulence (TT): Measures the degree of technological change and environmental uncertainty experienced by organizations.

E) Data Analysis Procedure

The collected data were analysed using IBM SPSS Statistics and SmartPLS software. Data cleaning and descriptive statistical analysis were first performed to identify missing values and detect potential outliers. Reliability was assessed using Cronbach's Alpha and Composite Reliability (CR) to evaluate the internal consistency of the measurement scales.

Average Variance Extracted (AVE), outer loadings, and discriminant validity analysis were employed to assess the validity of the measurement model.

Finally, the hypotheses were tested using Partial Least Squares Structural Equation Modeling (PLS-SEM). Path coefficients, t-values, p-values, and the coefficient of determination (R^2) were used to evaluate the structural relationships among the constructs. Mediation analysis was performed to examine the indirect effect of AI Capability, whereas moderation analysis was conducted to determine whether Technological Turbulence moderated the relationship between Digital Leadership and Innovation Performance.

This analytical procedure provided a structured framework for examining the combined influence of Digital Leadership, AI Capability, and Technological Turbulence on Innovation Performance.

4. PROPOSED CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

This study developed an integrated conceptual research model to examine the effects of Digital Leadership on Innovation Performance through AI Capability under varying levels of Technological Turbulence. The model is grounded in leadership theory, Dynamic Capability Theory, and innovation literature to explain how digital leadership translates into innovation outcomes within organizations.

The conceptual research model considers Digital Leadership (DL) as the independent variable that directly and indirectly influences Innovation Performance (IP) through AI Capability (AIC). Additionally, Technological Turbulence (TT) moderates the relationship between Digital Leadership and Innovation Performance by strengthening or weakening the relationship under different technological environments.

A) Conceptual Research Model

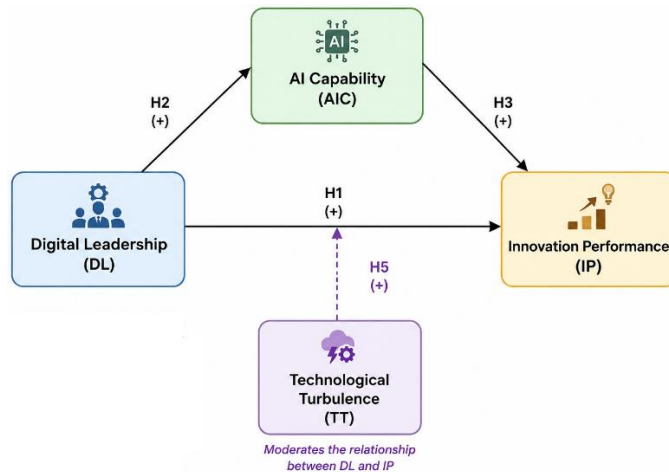


Fig.2 Conceptual Research Model

The conceptual research model suggests that organizations demonstrating stronger digital leadership are more likely to develop AI capabilities, thereby enhancing innovation performance. Furthermore, technological turbulence influences the strength of the relationship between digital leadership and innovation performance.

B) Hypothesis Development

H1: Digital Leadership → Innovation Performance

Digital leadership is instrumental in promoting organizational innovation by encouraging digital adoption, experimentation, and strategic alignment between technology and business objectives. Leaders who emphasize technological readiness and continuous development create environments that foster innovative thinking and accelerate the implementation of new ideas. These leadership practices enhance organizational agility and improve innovation performance.

H1: Digital Leadership positively influences Innovation Performance.

H2: Digital Leadership → AI Capability

Strategic leadership support, investment decisions, employee development, and a strong digital culture are essential for developing AI capability. Digital leaders play a critical role in promoting the adoption of AI technologies and intelligent systems within organizations. Effective leadership enhances an organization's readiness to implement AI and strengthen its AI capability.

H2: Digital Leadership positively influences AI Capability.

H3: AI Capability → Innovation Performance

AI capability enables organizations to process information efficiently, automate operations, and generate valuable insights that support innovation. Organizations possessing stronger AI capability can accelerate product development, optimize business processes, and improve organizational adaptability. Therefore, AI capability is an important driver of innovation performance.

H3: AI Capability positively influences Innovation Performance.

H4: Mediating Effect of AI Capability

Although Digital Leadership directly influences Innovation Performance, organizations require strong internal capabilities to transform leadership initiatives into innovation outcomes. AI Capability serves as the organizational mechanism through which digital leadership enhances innovation performance. Therefore, AI Capability is expected to mediate the relationship between Digital Leadership and Innovation Performance.

H4: AI Capability mediates the relationship between Digital Leadership and Innovation Performance.

H5: Moderating Effect of Technological Turbulence

Technological Turbulence refers to the speed and unpredictability of technological changes within an organization's external environment. Under conditions of high technological turbulence, organizations with strong digital leadership are better positioned to respond rapidly to technological change and exploit emerging opportunities. Consequently, technological turbulence is expected to strengthen the relationship between Digital Leadership and Innovation Performance.

H5: Technological Turbulence moderates the relationship between Digital Leadership and Innovation Performance.



The conceptual research model served as the theoretical foundation for the empirical analysis conducted using PLS-SEM to examine the direct, indirect, and moderating relationships among the study constructs.

5. EXPERIMENTAL RESULTS / DATA ANALYSIS

This section presents the empirical analysis conducted to examine the relationships among Digital Leadership (DL), AI Capability (AIC), Innovation Performance (IP), and Technological Turbulence (TT). The data were analysed using IBM SPSS Statistics and SmartPLS. The analysis included descriptive statistics, reliability analysis, validity assessment, structural model evaluation, mediation analysis, and moderation analysis. The analysis was performed using 312 valid responses.

A) Demographic Analysis

Incomplete questionnaires were excluded, and the final analysis included 312 valid responses.

Table 1. Demographic Profile of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	184	59.0
	Female	128	41.0
Age	21–30	112	35.9
	31–40	126	40.4
	41–50	58	18.6
	Above 50	16	5.1
Experience	<5 Years	82	26.3
	5–10 Years	141	45.2
	>10 Years	89	28.5

The demographic distribution indicated sufficient variation among the respondents to support a reliable empirical analysis.

B) Reliability and Internal Consistency Analysis

Cronbach's Alpha and Composite Reliability (CR) were used to assess the internal consistency of the measurement constructs.

Table 2. Reliability Analysis

Construct	Cronbach Alpha	Composite Reliability
Digital Leadership	0.918	0.936
AI Capability	0.904	0.926
Innovation Performance	0.897	0.921
Technological Turbulence	0.886	0.914

All constructs exceeded the recommended threshold value of 0.70, indicating good internal consistency.

C) Convergent Validity Assessment

Average Variance Extracted (AVE) was used to evaluate convergent validity.

Table 3. Convergent Validity

Construct	AVE
Digital Leadership	0.711
AI Capability	0.687
Innovation Performance	0.702
Technological Turbulence	0.674

All AVE values exceeded the recommended threshold of 0.50, confirming satisfactory convergent validity.

D) Structural Model Evaluation and Hypothesis Testing

PLS-SEM was employed to test the hypothesized relationships.

Table 4. Hypothesis Testing Results

Hypothesis	Relationship	β	t-value	p-value	Decision
H1	DL → IP	0.321	5.864	<0.001	Supported
H2	DL → AIC	0.648	11.392	<0.001	Supported
H3	AIC → IP	0.452	7.781	<0.001	Supported
H4	DL → AIC → IP	0.293	6.145	<0.001	Supported



H5	$TT \times DL \rightarrow IP$	0.186	3.882	<0.001	Supported
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The results revealed that Digital Leadership significantly influenced Innovation Performance both directly and indirectly through AI Capability.

E) Coefficient of Determination (R^2)

Table 5. Explained Variance

Endogenous Variable	R^2
AI Capability	0.420
Innovation Performance	0.673

The results indicated that the research model explained 42.0% of the variance in AI Capability and 67.3% of the variance in Innovation Performance, demonstrating good predictive capability.

F) Mediation Analysis

The mediation effect was examined using the bootstrapping procedure.

Table 6. Mediation Effect

Path	Indirect Effect	Result
$DL \rightarrow AIC \rightarrow IP$	0.293	Partial Mediation

The indirect effect was statistically significant, confirming that AI Capability partially mediated the relationship between Digital Leadership and Innovation Performance.

G) Moderation Analysis

Technological Turbulence was examined as a moderating variable.

Table 7. Moderation Effect

Interaction	β	p-value
$TT \times DL \rightarrow IP$	0.186	<0.001

The positive interaction coefficient indicated that higher levels of Technological Turbulence strengthened the positive relationship between Digital Leadership and Innovation Performance.

H) Discussion of Findings

The findings revealed that Digital Leadership is a strategic organizational capability that enhances innovation performance. Leaders who promote digital initiatives and technology adoption establish conditions that strengthen AI Capability and improve organizational innovation performance.

AI Capability was found to be a significant mediator, indicating that the positive influence of Digital Leadership on Innovation Performance became stronger through enhanced AI Capability.

Technological Turbulence was found to significantly moderate the relationship between Digital Leadership and Innovation Performance, indicating that the positive influence of Digital Leadership on Innovation Performance became stronger under conditions of high technological turbulence.

Overall, the findings supported the conceptual research model and confirmed the importance of Digital Leadership, AI Capability, and Technological Turbulence in enhancing sustainable innovation performance.

6. CONCLUSION

The aim of this study was to investigate how Digital Leadership influences Innovation Performance through the mediating role of AI Capability and the moderating role of Technological Turbulence in the context of organizational digital transformation. The study adopted an empirical quantitative research approach, and the collected data were analysed using PLS-SEM based on survey responses. The results showed that Digital Leadership had a significant positive influence on Innovation Performance, both directly and indirectly through AI Capability. The findings also indicated that AI Capability served as an important organizational mechanism through which digital leadership translated into measurable innovation outcomes. Furthermore, Technological Turbulence was found to significantly moderate the relationship between Digital Leadership and Innovation Performance, indicating that organizations operating in highly dynamic technological environments benefited more from strong digital leadership.

The study provides a holistic perspective on the relationship among digital leadership, AI Capability, and environmental factors in explaining innovation performance. The conceptual research model provides practical guidance for organizations seeking to achieve sustainable innovation and competitive advantage through strategic digital transformation.

Future Scope



Future research may consider collecting larger multi-industry and cross-country datasets to improve the generalizability of the findings. Additional organizational factors, such as digital culture, organizational agility, knowledge management capability, and digital competence, may also be incorporated to enhance the explanatory power of the research model. Longitudinal studies could further examine how the relationships among Digital Leadership, AI Capability, and Innovation Performance evolve over time. Moreover, advanced analytical approaches, including covariance-based SEM, machine learning techniques, and hybrid predictive models, may provide deeper insights into the dynamics of digital leadership and organizational innovation performance.

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