



Received: 31 March 2025

Revised: 21 June 2025

Accepted: 22 June 2025

# DIGITAL LEADERSHIP IN CHINA: FOSTERING INNOVATION THROUGH LEARNING AND IDENTIFICATION

Guo HUI<sup>1</sup> and Chidchanok INTHONG<sup>1</sup>

<sup>1</sup> Faculty of Business Administration, Mahanakorn University of Technology,  
Thailand; 729294855@qq.com (G. H.); chidchanok@mut.ac.th (C. I.)

**Handling Editor:**

Professor Dr. Wing-Kueng WONG

Asia University, Taiwan

(This article belongs to the Theme 1: Business &amp; Economic in Industry 5.0)

**Reviewers:**

- 1) Assistant Professor Dr. Busakorn WATTHANABUT NBU, Thailand
- 2) Assistant Professor Dr. Chanchai BUNCHAPATTANASAKDA STIU, Thailand
- 3) Dr. Tosaporn MAHAMUD Krirk University, Thailand

**Abstract**

This study examines the role of digital leadership in driving innovation performance within Chinese enterprises, with a focus on the mediating effects of organizational learning and organizational identification. Using a quantitative research design with data from 331 employees across various industries in Shandong Province, the analysis reveals that digital leadership has a positive influence on organizational learning and identification, which, in turn, enhances innovation performance. Specifically, the findings indicate that leaders who demonstrate digital thinking, adaptability, and interpersonal skills are more effective in cultivating a learning environment and fostering a sense of shared identity among employees. These dynamics are crucial for fostering innovation in China's rapidly evolving digital economy. The research underscores the importance of developing digital leadership competencies and leveraging organizational culture to support sustainable innovation outcomes. The study emphasizes the importance for organizations in China to strategically invest in developing digital capabilities and cultivating a collaborative, inclusive organizational culture to drive successful digital transformation.

**Keywords:** Digital Leadership, Innovation Performance, Organizational Learning, Organizational Identification, China

**Citation Information:** Hui, G., & Inthong, C. (2025). Digital Leadership in China: Fostering Innovation through Learning and Identification. *Asian Administration and Management Review*, 8(2), Article 13. <https://doi.org/10.14456/aamr.2025.38>

## **Introduction**

The rapid advancement of digital technologies, including artificial intelligence (AI), big data, and blockchain, is dramatically reshaping the global business landscape. These innovations bring both unprecedented opportunities and complex challenges to organizations worldwide. Between 2006 and 2019, approximately 50% of the Fortune 500 companies disappeared, primarily due to failure to adapt to digital change (Berman, 2019). Similarly, the average lifespan of S&P 500 companies dropped from 61 years in 1958 to less than 18 years by 2022 (Statista, 2023). This accelerated shift places enormous pressure on leaders to navigate digital transformation effectively. Despite widespread recognition of the importance of digital transformation, only 7% of organizations worldwide have achieved full digital maturity (Hofbauer et al., 2019; Demsetz, 2021). One of the most significant barriers to progress is the lack of leaders equipped with a digital mindset and the ability to foster innovative cultures (Khin & Ho, 2020). Digital transformation is not solely a technological upgrade—it demands organizational change, cultural adaptation, and, most importantly, strategic leadership.

In China, Shandong Province has emerged as a pioneer in promoting digital transformation. Designated as China's first digital transformation facilitation center, the region has taken significant steps to support enterprise-level innovation. As of September 2023, there were 4.39 million enterprises in the province, reflecting rapid digital development. In November 2023, 118 enterprises were selected as pilots for digital transformation initiatives across diverse industries (Shandong Provincial People's Government, 2023). These developments make Shandong a meaningful context for exploring how leadership drives organizational transformation. Recent studies indicate that organizations with strong digital leadership are more likely to achieve successful transformation, while inadequate leadership contributes to digital initiative failure rates as high as 70% (Bartsch et al., 2020). Digital leaders are expected to demonstrate agility, systems thinking, interpersonal skills, and a clear vision to guide their organizations through uncertainty.

Although digital leadership has gained scholarly attention, empirical research examining its direct and indirect effects—particularly within the context of Chinese enterprises—is still limited. In particular, the mechanisms through which digital leadership influences innovation performance remain underexplored. Two potential mediating factors—organizational learning and organizational identification—have been identified as critical elements in organizational adaptation, but their roles in digital transformation processes require further empirical validation. The research pursues the following objectives: (1) To explore the components of digital leadership within the context of digital transformation in Shandong enterprises. (2) To investigate the impact of digital leadership on innovation performance. (3) To analyze the mediating effects of organizational learning and organizational identification in the relationship between digital leadership and innovation performance.

## **Literature Review and Hypotheses**

### **Digital Leadership**

Digital technologies are having a profound impact on organizations, accelerating their digital transformation and altering traditional leadership structures (Avolio et al., 2014; Sook, 2017). For this reason, scholars' focus on leadership has shifted from classical personal traits to a broader understanding of leadership, with increasing attention paid to its interactions within the internal and external environments of organizations. The concept of digital leadership was developed to address emerging leadership needs (Larson & DeChurch, 2020).

Digital leadership belongs to the category of transformational leadership. The emergence of digital leadership is a result of the development of transformational leadership. Bass (1995) argues that transformational leadership is a process that enhances employees' sense of belonging and motivation by recognizing the tasks of subordinates. Digital leadership is an

emerging concept that has emerged in the digital era (Roman et al., 2019; Sasmoko et al., 2019; Stjepić et al., 2020; Vrontis et al., 2021).

Mihardjo et al. (2019) stated that digital leadership is the integration of digital culture and digital competence. Digital leadership leverages the capabilities of digital technology as part of its leadership style to create value for the company. Benitez et al. (2022) stated that digital leadership is the ability of digital leaders within an organization to utilize digital, marketing, business, and strategic leadership skill sets to lead and manage interdisciplinary staff in digitally transforming the organization.

Digital leadership is divided into four dimensions: digital thinking power, digital detective power, digital social power, and digital reserve power (Alnuaimi et al., 2022; Avolio et al., 2014; Brett, 2019; Martins, 2019; Sasmoko et al., 2019; Sheninger, 2019; Sandel, 2013). Organizational change in enterprises in the digital era is fast. Business leaders value and tap into digital technology. Digital leaders use digital means to encourage innovation (Larson & DeChurch, 2020; Roman et al., 2019; Sasmoko et al., 2019; Stjepić et al., 2020; Vrontis et al., 2021). Digital leaders enhance employee belonging. Digital leaders effectively promote the digital transformation of enterprises and improve digital transformation performance.

While the existing literature provides a foundational understanding of digital leadership, most studies have focused on Western contexts, potentially overlooking cultural factors that may influence leadership behaviors in Asian organizations. Research from Thailand, for instance, highlights how digital leadership interacts with cultural expectations of hierarchy and collective behavior (Srimata et al., 2019). Their study demonstrates that the effectiveness of digital leadership is mediated by school climates and engagement, suggesting contextual factors may play a role in Chinese enterprises. Additionally, Suksai et al. (2021) proposed a digital leadership development model aligned with Thailand's 4.0 national policy, emphasizing the importance of policy-level support and localized leadership training. These findings suggest that regional digital transformation efforts, such as those in Shandong Province, may benefit from culturally specific leadership frameworks. Therefore, this study extends previous models by testing digital leadership within China's unique socio-economic and policy environment.

### **Organizational Learning**

Organizational learning is of paramount importance and serves as the foundation of an organization's competitiveness (Inthavong et al., 2023). The types of concepts in organizational learning include improving behavior, environmental interaction, process level, experience generating knowledge, accumulation, and transformation (Chen et al., 2023).

Argote & Epple (1990) hold the view that organizational learning can be understood as the introduction of more appropriate knowledge and skills to carry out error correction activities. Organizational learning achieves positive adjustments to organizational outcomes. Holmqvist (1999) states that learning organizations have a significant advantage in creating, absorbing, and transferring knowledge. Organizational learning refers to the cognitive and behavioral changes within an organization. The necessary components of organizational learning are cognitive and behavioral (Bingham & Haleblian, 2012). Huber (2019) states that both cognitive and behavioral elements are important components of organizational learning.

Organizational learning is an adaptive behavior of an organization (Sancho-Zamora et al., 2022). Organizational learning enhances knowledge, deepens experience, sharpens perceptions, refines behaviors, and strengthens an organization's ability to adapt to its environment. Research on the relationship between active learning and leadership indicates that leaders can enhance the learning atmosphere by fostering a sense of trust within the team (Holmqvist, 1999). An organizational learning culture serves as a bridge between empowering leadership and open innovation (Abbas et al., 2020). Organizational learning is a key part of the entrepreneurial orientation and dynamic capability process. Market orientation influences

organizational learning, which in turn affects innovativeness. Research confirms the role of organizational learning as a bridge between collaborative culture and firm performance.

Organizational learning will bring a series of effects to the organization. Scholars have conducted extensive research on the relationship between organizational learning and corporate innovation (Liao & Wu, 2010). Organizational learning encourages enterprises to achieve innovative breakthroughs in products, technology, and other aspects (Noruzi et al., 2012). Research confirms that innovation occurs when a company can conduct more efficient organizational learning activities (Abbas et al., 2020). Organizational learning activities undertaken by a company can have a positive impact on innovation in the company.

Despite extensive exploration of organizational learning, most existing frameworks emphasize universal behavioral processes without fully considering national or organizational culture as influencing variables. In East Asian contexts, including China, Confucian cultural values such as respect for hierarchy and emphasis on collective goals may influence how organizations absorb and disseminate knowledge. Studies suggest that in Chinese firms, trust and loyalty are critical in shaping a learning culture, and leaders play a significant role in legitimizing knowledge-sharing behaviors. Consequently, organizational learning in China may rely more heavily on top-down support than on flatter organizational cultures.

### **Organizational Identification**

Organizational identification refers to the mental state and cognitive association in which individuals perceive themselves as part of the organization (Dutton et al., 1994; Rousseau, 1998). Organizational identification includes four attributes: cognitive, affective, evaluative, and behavioral (van Dick et al., 2008), which can be further divided into situational and deep identity.

Organizational identity is a comprehensive concept that refers to the consistency of organizational members' behaviors and perceptions towards the organization (Pham, 2020). Leadership has a significant influence on the emergence of organizational identification (Amiot et al., 2007; Bartel, 2001; Epitropaki & Martin, 2005; Olkkonen & Lipponen, 2006; Smidts et al., 2001). Organizational identification is significantly influenced by digital leadership, creating a supportive environment for digital transformation. When employees feel a strong connection to their organization, they are more likely to embrace and drive digital initiatives (Lipponen et al., 2003).

Regarding the results produced by organizational identification, numerous studies have demonstrated that organizational identification has a positive impact on employee input and innovation performance (Yuan et al., 2016). This collective commitment enhances innovation and adapts to new digital technologies, fostering a culture that supports continuous improvement and technological advancement.

Employees are likely to share digital insights and practices, leading to improved digital competence and agility across the organization (Pham, 2020). Employees' organizational identification behaviors may facilitate the reinforcement of the organization's innovation performance, enhance its reputation, and make it easier for organizational identification to emerge in intergroup comparisons (Sook, 2017). However, much of the research on organizational identification has centered on individual psychology and Western management practices, with limited focus on collective identity in Asian settings. In collectivist societies such as China, organizational identification is influenced by shared goals, in-group loyalty, and alignment with national development narratives. For example, studies in Asian firms show that employees' identification is strengthened when their work is positioned as contributing to broader societal or technological progress (Pham, 2020). This reinforces the need to explore how digital leadership fosters collective identification under national policy initiatives, such as "Made in China 2025," or provincial programs in Shandong.

### **Innovation Performance**

Innovation performance refers to an enterprise's performance in innovation, serving as a means to evaluate the efficiency and effectiveness of its innovation activities. Existing studies have delineated enterprise innovation in four aspects: manifestation, degree, involvement, and type of innovation (Ghoshal, 2020). Alegre & Chiva (2013) defined innovation performance as the improvement in effectiveness and efficiency achieved by enterprises after investing certain resource elements in the innovation system.

The innovation performance generated based on new products and technologies is also known as radical innovation performance (Chang et al., 2012). Innovation performance includes the development and successful launch of new products, services, processes, or business models (Sun et al., 2020), as well as innovative performance in competitive markets.

Shandong Province is a particularly relevant setting for this research due to its unique role in China's digital transformation agenda. As the first province officially designated as a digital transformation facilitation center, it has rapidly developed a comprehensive ecosystem supporting digital infrastructure, innovation incubation, and policy guidance. The province's industrial diversity and extensive participation in pilot transformation programs provide a context for examining how digital leadership manifests in organizational practices. Moreover, Shandong's strong alignment with national policy initiatives makes it a valuable case for exploring the interaction between leadership, organizational learning, and identification.

Digital leadership can effectively guide corporate innovation. Entrepreneurs can develop a clear vision and strategy to guide their teams in innovation (Guisado-González et al., 2017). Leaders adopt an open communication approach, listen to team members' opinions and suggestions, and encourage an open communication atmosphere. The leader creates an environment that enables experimentation with new approaches and learning, encouraging team members to discover innovative solutions in practice (Li et al., 2021; Liao et al., 2023).

The acquisition of external knowledge contributes to a firm's innovation performance. Learning content, learning levels, and learning sources have a positive impact on corporate innovation performance. The conditions under which the dimensions of exploitative and exploratory learning have an impact on firms' innovation performance are different (Abbas et al., 2020; Ahmad et al., 2020; Kun, 2022). An organization's learning capability influences innovation, while incremental innovation is impacted by both the firm's knowledge accumulation capability and its organizational size (Abbas et al., 2019).

Organizational identity encompasses the collective beliefs, values, and norms that define an organization and shape its culture. When employees strongly identify with their organization, they feel a deep sense of belonging and alignment with its goals and objectives. Employees with a strong organizational identity understand and align with the organization's mission and strategic direction (Abbas et al., 2020; Ahmad et al., 2020; Chen et al., 2023).

Organizational identity fosters high levels of employee engagement and motivation (Hu et al., 2023; Inthavong et al., 2023). Employees who identify with their organization are committed to its success and are willing to go above and beyond their formal roles to contribute innovative ideas and solutions. Organizations with a strong identity are more adaptable and agile in responding to market changes and technological advancements. This adaptability enables them to innovate rapidly, introducing new products or improving existing processes to meet evolving customer needs and competitive pressures (Hu et al., 2023; Inthavong et al., 2023). Organizational identity shapes the culture and mindset within an organization, influencing how employees perceive their roles, contribute to innovation, and drive performance improvements.

According to the proposed research objectives, the following hypotheses were tested:

Hypothesis 1: Digital leadership has a positive impact on Organizational learning.

Hypothesis 2: Organizational learning has a positive impact on Innovation performance.

Hypothesis 3: Digital leadership has a positive impact on Innovation performance.

Hypothesis 4: Digital leadership has a positive impact on Organizational identification.

Hypothesis 5: Organizational identification has a positive impact on Innovation performance.

Hypothesis 6: Organizational learning has a mediating effect between Digital leadership and Innovation performance.

Hypothesis 7: Organizational identification has a mediating effect on the relationship between Digital leadership and Innovation performance.

## **Research Methodology**

### **Population and Sample**

In November 2023, the Shandong Provincial government announced the list of the first batch of enterprises participating in the digital transformation pilot in Shandong Province. The list includes 118 digital transformation companies. Enterprise types include manufacturing, new energy companies, biotechnology companies, the chemical industry, and modern service enterprises. Among the digital transformation pilot enterprises in Shandong Province, there are 7 biotechnology enterprises, 20 new energy enterprises, 59 manufacturing enterprises, 26 chemical enterprises, and 6 modern services. The digital transformation pilot enterprises in Shandong Province have a total of about 120,000 employees.

The stratified sampling approach was applied based on the type and size of the pilot enterprises. Each industry category—manufacturing, new energy, biotechnology, chemical, and modern services—was proportionally represented in the sample to reflect the diversity of the population. Furthermore, enterprises were selected from multiple cities across Shandong Province to ensure regional diversity. Within each selected enterprise, respondents were chosen from different functional departments and organizational levels, including top management, middle managers, and frontline staff, to capture a comprehensive range of perspectives on digital leadership and innovation practices. Participants were assured anonymity and confidentiality, and participation was entirely voluntary. These measures were designed to enhance the representativeness and generalizability of the sample while reducing the risk of systematic bias in the data.

### **Measurement**

Digital leadership is divided into four dimensions: digital thinking power, digital detection power, digital social power, and digital reserve power. There are 20 digital leadership measurement items. This scale is used to measure employees' perception of digital leadership in digital transformation pilot enterprises in Shandong Province.

Digital thinking power refers to the leader's ability to integrate digital thinking into the enterprise's sustainable development strategy, establish a long-term strategic pattern, gain insight into the future, and outline the ecosystem. Leaders need to develop strategies that are tailored to the business's growth. Leaders encourage employees to work towards a shared vision to achieve organizational goals. Digital thinking ability is an integral part of digital leadership and the basis for distinguishing leaders.

Digital detective power means that leaders possess a certain level of digital literacy, enabling them to gain timely insights into the trends of scientific and technological development and environmental policies, and to make informed decisions and deployments in the face of changing environments. Leaders need to grasp the trends in the world economy and adapt to the trend of industry progress.

Digital social power is the foundation for leaders to adapt to their environment and drive the continuous development of their organization. Digital social power refers to the ability of leaders to actively learn and utilize digital tools, enhance the efficiency of communication and collaboration with employees, provide employees with space for innovation and communication, and improve the organization's operational effectiveness (Benitez et al., 2022).

Digital reserve power refers to the ability of leaders to utilize digital technology to manage talent, create a digital learning environment within the enterprise, and establish a digital talent hierarchy. Leaders reward and recognize employees for their efforts and achievements (Brett, 2019).

Organizational learning is divided into three aspects: learning orientation, innovation culture, and learning and sharing. Organized learning measurement items 13. To measure the status quo of organizational learning in enterprises and employees' views on organizational learning. Organizational learning is comprised of three key aspects: learning orientation, innovation culture, and learning and sharing (Abdi et al., 2018). Learning orientation indicates that enterprise leaders prioritize employee participation in key decisions.

Learning orientation indicates that enterprise leaders prioritize employee participation in key decisions. Leaders see employee learning as both an expense and an investment. This attitude reflects the leadership's emphasis on change to adapt to shifting circumstances. They view employees' ability to learn as a key factor in the company's success and encourage innovative thinking (Abdi et al., 2018; Liao & Wu, 2010).

Innovation culture refers to leaders who advocate for experimentation and innovation to improve work processes and learn from the best practices of others in the industry. Experiences and ideas provided by external resources, such as consultants, clients, and training companies, are viewed as valuable learning tools. Employees are encouraged to provide comments and suggestions on the procedures and methods used for task execution (Abdi et al., 2018).

Learning and sharing are where mistakes and failures are discussed and analyzed at all levels of the business, and employees have the opportunity to discuss new ideas, initiatives, and activities that are useful to the company (Abdi & Senin, 2015). Teamwork is a common approach to working, and leaders provide tools to facilitate the practical application of what is learned. These dimensions form the basis of corporate learning culture and provide a theoretical basis for studying and evaluating organizational learning.

Organizational identity can be divided into three primary aspects: survival-oriented, belonging-oriented, and success-oriented organizational identities. 15 items were measuring organizational identification. This scale was used to measure employees' perceptions of organizational identity in digital transformation pilot enterprises in Shandong Province. Organizational identity can be divided into three categories: survivability, belongingness, and success organizational identities (Brown, 2017). Organizational identity is a comprehensive concept that refers to the consistency of an organization's members' behaviors and cognition toward the organization they join, as well as the rational sense of contract and responsibility, the irrational sense of belonging and dependence, and the behavioral results and commitment to the organization based on this psychological foundation.

Innovation involves two dimensions: social innovation and technological innovation. Technological innovation performance refers to the change in product technology and process. In contrast, social innovation performance refers to the emergence of new social systems, such as the patent system, which are innovation performance measurement items. Innovation performance refers to an enterprise's performance in innovation, which serves as a means to evaluate the efficiency and effectiveness of its innovation activities (Ghasemaghaei & Calic, 2019; Goh, 2005). Linton (2009) emphasizes that innovation generally involves two major dimensions: social innovation and technological innovation. Technological innovation performance refers to changes in product technology and process, whereas social innovation performance refers to the generation of new social systems, such as the patent system.

## Research Results

### Respondents' Profiles and Studied Variables

The study analyzed demographic data from 331 respondents who provided valid information. The gender distribution was relatively balanced, with 51.7% of participants being male and 48.3% female. Most respondents were between 26 and 35 years old (42.9%), representing the core workforce in digital transformation settings. In the educational background, bachelor's (48.0%) and master's degrees (25.1%) indicate a well-educated sample suitable for leadership and innovation studies. The respondents primarily held operational roles (65.0%), with a significant portion also in management or training positions, reflecting varied organizational perspectives. Most participants had 6-15 years of work experience (68.2%), ensuring adequate professional exposure for evaluating digital leadership and organizational change.

### Reliability Analysis

The data presents the Cronbach's Alpha reliability coefficients for various variables and their dimensions, serving as a measure of the internal consistency of the measurement instruments. All variables exhibit Alpha values above 0.8, indicating a high degree of reliability in the scales. Within the dimension of digital leadership, digital thinking capacity (0.901) boasts the highest reliability, signifying robust stability in this measurement item. Digital probing ability (0.881), digital social competence (0.857), and digital reserve capacity (0.866) also demonstrate commendable internal consistency. In terms of organizational learning, learning orientation (0.898) possesses high reliability, while innovative culture (0.823) and learning and sharing (0.830) exhibit solid measurement stability. All three measurements within the organizational identification dimension exhibit high reliability, with existential organizational identification (0.894), belonging organizational identification (0.859), and successful organizational identification (0.883) demonstrating excellent internal consistency. In innovation performance, social innovation (0.903) exhibits the highest reliability, highlighting the strong stability of this measurement, while technological innovation (0.852) meets a commendable reliability standard. The reliability coefficients of all variables surpass 0.8, indicating that the measurement instruments employed in this study possess strong internal consistency.

### Validity Analysis

Confirmatory factor analysis (CFA) is used to assess the fit of the measurement model, ensuring that the instruments accurately reflect the research variables. Convergent validity is established when factor loadings exceed 0.7, indicating statistical significance. Composite reliability (CR) should exceed 0.7 to ensure internal consistency (Fornell & Larcker, 1981). The Average Variance Extracted (AVE), which measures explanatory power, should be above 0.5 for strong reliability and validity (Hair et al., 2010). The CFA model fit indices indicate a good fit of the model. The chi-square statistic (CMIN) is 82.446, with 48 degrees of freedom (DF), resulting in a CMIN/DF ratio of 1.718, which is below 3, meeting the criteria for excellent fit. The GFI and AGFI values are 0.960 and 0.935, respectively, exceeding 0.9, indicating a high overall model fit.

**Table 1** AVE and CR of Confirmatory Factor Analysis

Path Relationship	Estimate	S.E.	C.R.	P	Factor Loading	AVE	CR
DTP <--- DL	1.000				0.741		
DDP <--- DL	0.975	0.074	13.26	***	0.783	0.584	0.849
DSP <--- DL	0.948	0.071	13.39	***	0.784		
DRP <--- DL	0.883	0.069	12.757	***	0.748		
LO <--- OL	1.000				0.818		
IC <--- OL	0.787	0.06	13.167	***	0.779	0.584	0.807
LS <--- OL	0.778	0.067	11.694	***	0.689		
SUOI <--- OI	1.000				0.754	0.538	0.776

Path Relationship	Estimate	S.E.	C.R.	P	Factor Loading	AVE	CR
BOI <--- OI	0.744	0.071	10.417	***	0.666		
SCOI <--- OI	0.972	0.081	11.997	***	0.775		
SI <--- IP	1.000				0.784	0.569	0.725
TI <--- IP	0.803	0.07	11.534	***	0.724		

**Related Analysis**

The study employed the square root of AVE ( $\sqrt{AVE}$ ) values to verify discriminant validity. Digital Leadership (DL) exhibited the highest correlation coefficient, as shown in Table 2.

**Table 2** Results of Pearson's Correlation Analysis for Each Variable

Variables	$\sqrt{AVE}$	DL	OL	OI	KS
DL	0.764	0.764			
OL	0.764	0.426***	0.764		
OI	0.733	0.483***	0.286***	0.733	
IP	0.755	0.543***	0.512***	0.506***	0.755

Note: \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001

**Results of Structural Equation Modeling**

The CMIN/DF value is 1.697, which is well below the threshold of 5, indicating a good model fit. The GFI = 0.960 and AGFI = 0.936, both above 0.9, indicate a high overall model fit. The RMSEA = 0.046, less than 0.08, further supports the rationality of the model. The values of Incremental Fit Index (IFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), and CFI all exceed 0.95, meeting the criteria for excellent fit, demonstrating a stable model structure with strong explanatory power. The Standardized Root Mean Square Residual (SRMR) = 0.035, below 0.05, indicates small model residuals and an ideal fit. All indicators meet the requirements, suggesting a well-fitted model.

The results of the Structural Equation Modeling (SEM) for direct effect verification reveal the path analysis outcomes among Knowledge Management (KM), Organizational Learning (OL), and Organizational Innovation (OI). The research findings encompass path estimates, standard errors (SE), critical ratios (CR), and significance levels (P-values), which are used to validate the causal relationships and their significance among variables. The path estimate for the influence of KM on OL is 0.607, with a C.R. of 7.713 and a significant P-value ( $p < 0.001$ ). This indicates a significant positive impact of KM on OL. The path estimate for the influence of KM on OI is 0.477, with a C.R. of 5.394 and a significant P-value ( $p < 0.001$ ). This demonstrates a significant positive effect of KM on OI, highlighting its active role in driving corporate innovation. The path estimate for the influence of OL on OI is 0.165, with a C.R. of 2.098 and a significant P-value of 0.036 ( $p < 0.05$ ). This suggests a significant positive contribution of OL to OI. The results of the internal control indirect effects tests in Table 3.

**Table 3** Results of Internal Control Indirect Effects Tests

Path	Effect	SE	Bias Corrected (95%)		%
			LLCI	ULCI	
DL---> IP Direct Effect	0.292	0.048	0.197	0.387	52.40%
DL---> OL ---> IP Indirect Effect	0.124	0.023	0.083	0.173	22.30%
DL---> OI ---> IP Indirect Effect	0.141	0.026	0.093	0.194	25.30%
DL---> IP Total Indirect Effect	0.265	0.036	0.199	0.34	47.60%

Path	Effect	SE	Bias Corrected (95%)		%
			LLCI	ULCI	
DL---> IP Total Effect	0.557	0.045	0.469	0.645	100%

Note: \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001 KM is knowledge management. OL is organizational learning. OI is organizational innovation.

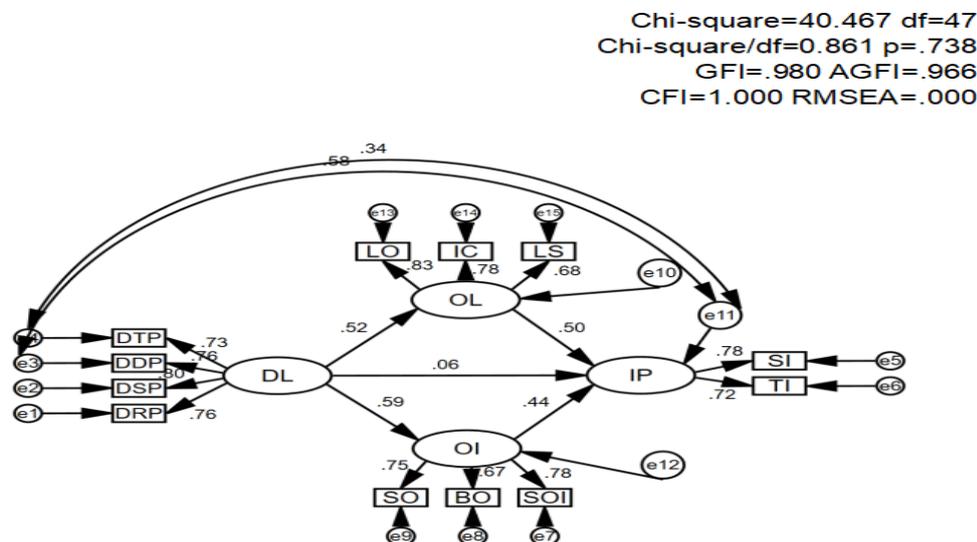


Figure 1 The Modified Structural Equation Model

## Conclusion and Discussion

This study explored the impact of digital leadership on innovation performance, with organizational learning and organizational identification as mediating variables, based on data collected from digitally transforming enterprises in Shandong Province. The results offer several theoretical and practical insights into how digital leadership operates in organizational contexts marked by rapid technological change.

In terms of theoretical contributions, the study enriches the existing literature by providing empirical support for the four-dimensional structure of digital leadership, comprising digital thinking power, detective power, social power, and reserve power (Vrontis et al., 2021). These dimensions encompass the strategic and interpersonal competencies necessary for effective leadership in digital environments. The findings also validate and extend earlier work by Avolio et al. (2014), Mihardjo et al. (2019), and Larson & DeChurch (2020), confirming that digital leadership is not only conceptually aligned with transformational leadership but also uniquely shaped by digital culture and the integration of technology. Furthermore, by examining the mediating roles of organizational learning and organizational identification, the study sheds light on the underlying mechanisms through which leadership influences innovation. This complements prior research by Abbas et al. (2020), Liao et al. (2023), and Hu et al. (2023), suggesting that effective digital leaders foster a dual dynamic: knowledge sharing and identity alignment, both of which contribute to performance outcomes.

From a practical perspective, the study suggests that organizations, particularly those in developing economies like China, should adopt a more nuanced approach to leadership development. Leaders should be trained in technical skills, strategic thinking, cross-functional collaboration, and emotional intelligence. For instance, digital thinking power helps leaders formulate vision-driven digital strategies, while digital detective power enables a timely response to market and technological shifts. In Shandong Province, where industries such as manufacturing, logistics, and agriculture are undergoing large-scale transformation, these

leadership qualities are crucial. Companies with strong digital leadership tend to excel in innovation-related outcomes, including product development and market responsiveness.

While the findings offer valuable insights, several limitations should be acknowledged. The study is cross-sectional in design, which limits the ability to draw causal inferences. Longitudinal studies could better capture the dynamic interaction between leadership behavior and innovation performance. The data were collected from enterprises in Shandong Province, which—although a representative and policy-driven region—may not fully reflect digital transformation experiences in other Chinese provinces or global contexts. Third, the self-reported nature of the survey may introduce bias, such as social desirability effects.

Future research could extend this study in several ways. Comparative studies across provinces or countries would help determine the cultural or institutional boundary conditions of digital leadership effectiveness. Furthermore, qualitative or mixed-method research could deepen understanding of how leaders enact digital strategies. It would also be valuable to investigate potential moderating variables, such as organizational size, innovation climate, or employee digital literacy.

In conclusion, this study demonstrates that digital leadership has a significant impact on innovation performance, mediated by the effects of organizational learning and organizational identification. As digital technologies continue to reshape industries, leaders who foster learning-oriented and identity-rich organizational cultures will be better positioned to achieve sustainable innovation outcomes. These insights offer theoretical grounding and actionable guidance for practitioners navigating digital transformation in China and beyond.

### **Management Implications**

#### **Enhancing Digital Competencies of Corporate Leaders**

This research highlights the importance of digital leaders' decision-making, technological capabilities, knowledge management, change management, and culture-building capabilities in driving organizational innovation performance. Digital transformation organizations need to identify the components of digital leadership and strategically cultivate leaders' digital literacy. To achieve this, a comprehensive digital leadership training system should be developed, integrating digital technologies, data-driven decision-making, good management, and creative thinking into training. These organizational practices can enhance leaders' decision-making by integrating data analytics and intelligent decision-making tools, leveraging AI and big data.

#### **Enhancing Enterprise Innovation Capabilities through Organizational Learning and Identity Alignment**

A strong organizational identity among employees can significantly enhance the innovation efficiency of enterprises in the digital era. Shandong's digital transformation enterprises should establish an open and transparent communication mechanism to enhance interaction between top management and employees, promote a deeper understanding of digital strategies, and foster a stronger sense of identity. Cultivating a teamwork culture and establishing cross-departmental innovation teams will help improve innovation efficiency through collaboration. In addition, defining the organization's mission through social responsibility and sustainable development strategies will make employees feel more connected to the company's values and innovation goals.

Furthermore, this study offers significant implications for cross-cultural management and entrepreneurship in a region undergoing rapid industrial transformation. Pimsuwan et al.'s (2023) study of Thai start-ups highlights that entrepreneurial behavior, when supported by a strong internal identity and alignment with innovation performance, increases new venture survival. Similarly, in Shandong's digitally transformed enterprises, fostering employee identification through inclusive leadership, purpose-driven missions, and open innovation channels can contribute to organizational resilience and long-term success.

## **Synergizing Organizational Learning and Identity to Enhance Digital Innovation Capability**

Organizational learning and organizational identity strengthen and drive organizational innovation performance. Organizations undertaking digital transformation should integrate learning into culture building to ensure that employees identify with the company's values as they learn. By allowing employees to learn and innovate independently, these organizations can foster a sense of belonging and identification with the organization. Integrating organizational learning, teamwork, and innovation capabilities into performance appraisal standards provides tangible benefits to employees, thereby strengthening the organizational identity. Organizations in Shandong need to prioritize developing digital leadership, enhancing learning, and strengthening their organizational identity to promote continuous innovation.

## **References**

- Abbas, J., Hussain, I., Hussain, S., Akram, S., Shaheen, I., & Niu, B. (2019). The Impact of Knowledge Sharing and Innovation on Sustainable Performance in Islamic Banks: A Mediation Analysis through a SEM Approach. *Sustainability*, *11*(15), 4049.
- Abbas, J., Zhang, Q., Hussain, I., Akram, S., Afaq, A., & Shad, M. (2020). Sustainable Innovation in Small Medium Enterprises: The Impact of Knowledge Management on Organizational Innovation through a Mediation Analysis by Using SEM Approach. *Sustainability*, *12*(6), 2407.
- Abdi, K., & Senin, A. (2015). The Impact of Knowledge Management on Organizational Innovation: An Empirical Study. *Asian Social Science*, *11*(23), 153-168.
- Abdi, K., Mardani, A., Senin, A., Tupenaite, L., Naimaviciene, J., Kanapeckiene, L., & Kutut, V. (2018). The effect of knowledge management, organizational culture and organizational learning on innovation in automotive industry. *Journal of Business Economics and Management*, *19*(1), 1-19.
- Ahmad, F., Widén, G., & Huvila, I. (2020). The impact of workplace information literacy on organizational innovation: An empirical study. *International Journal of Information Management*, *51*, 102041.
- Alegre, J., & Chiva, R. (2013). Linking entrepreneurial orientation and firm performance: The role of organizational learning capability and innovation performance. *Journal of Small Business Management*, *51*(4), 491-507.
- Alnuaimi, B., Singh, S., Ren, S., Budhwar, P., & Vorobyev, D. (2022). Mastering digital transformation: The nexus between leadership, agility, and digital strategy. *Journal of Business Research*, *145*, 636-648.
- Amiot, C., Terry, D., & Callan, V. (2007). Status, equity and social identification during an intergroup merger: A longitudinal study. *British Journal of Social Psychology*, *46*(3), 557-577.
- Argote, L., & Epple, D. (1990). Learning curves in manufacturing. *Science*, *247*(4945), 920-924.
- Avolio, B., Sosik, J., Kahai, S., & Baker, B. (2014). E-leadership: Re-examining transformations in leadership source and transmission. *The Leadership Quarterly*, *25*(1), 105-131.
- Bartel, C. (2001). Social comparisons in boundary-spanning work: Effects of community outreach on members' organizational identity and identification. *Administrative Science Quarterly*, *46*(3), 379-413.
- Bartsch, S., Weber, E., Büttgen, M., & Huber, A. (2020). Leadership matters in crisis-induced digital transformation: How to lead service employees effectively during the COVID-19 pandemic. *Journal of Service Management*, *32*(1), 71-85.

- Bass, B. (1995). Theory of transformational leadership redux. *The Leadership Quarterly*, 6(4), 463-478.
- Benitez, J., Arenas, A., Castillo, A., & Esteves, J. (2022). Impact of digital leadership capability on innovation performance: The role of platform digitization capability. *Information & Management*, 59(2), 103590.
- Berman, R. (2019). *Return on courage*. Texas: Greenleaf Book Group.
- Bingham, C., & Haleblian, J. (2012). How firms learn heuristics: Uncovering missing components of organizational learning. *Strategic Entrepreneurship Journal*, 6(2), 152-177.
- Brett, J. (2019). *Evolving digital leadership: How to be a digital leader in tomorrow's disruptive world*. New York: Apress.
- Brown, A. (2017). Identity work and organizational identification. *International Journal of Management Reviews*, 19(3), 296-317.
- Chang, Y., Chang, H., Chi, H., Chen, M., & Deng, L. (2012). How do established firms improve radical innovation performance? The organizational capabilities view. *Technovation*, 32(7-8), 441-451.
- Chen, M., Mi, X., Xue, J., Li, Y., & Shi, J. (2023). The impact of entrepreneurial team psychological capital on innovation performance: The mediating role of knowledge sharing and knowledge hiding. *Frontiers in Psychology*, 14, 1133270.
- Demsetz, H. (2021). The structure of ownership and the theory of the firm. *The Journal of Law and Economics*, 26(2), 375-390.
- Dutton, J., Dukerich, J., & Harquail, C. (1994). Organizational images and member identification. *Administrative Science Quarterly*, 39(2), 239-263.
- Epitropaki, O., & Martin, R. (2005). The moderating role of individual differences in the relation between transformational/transactional leadership perceptions and organizational identification. *The Leadership Quarterly*, 16(4), 569-589.
- Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50.
- Ghasemaghaei, M., & Calic, G. (2019). Does big data enhance firm innovation competency? The mediating role of data-driven insights. *Journal of Business Research*, 104, 69-84.
- Ghoshal, S. (2020). Bad management theories are destroying good management practices. *Academy of Management Learning & Education*, 4(1), 75-91.
- Goh, A. (2005). Harnessing knowledge for innovation: An integrated management framework. *Journal of Knowledge Management*, 9(4), 6-18.
- Guisado-González, M., González-Blanco, J., & Coca-Pérez, J. (2017). Analyzing the relationship between exploration, exploitation and organizational innovation. *Journal of Knowledge Management*, 21(5), 1142-1162.
- Hair, J., Black, W., Babin, B., & Anderson, R. (2010). *Multivariate Data Analysis* (7<sup>th</sup> ed). New York: Pearson.
- Hofbauer, G., Sangl, A., & Engelhardt, S. (2019). The digital transformation of the product management process: Conception of digital twin impacts for the different stages. *International Journal of Innovation and Economic Development*, 5(2), 74-86.
- Holmqvist, M. (1999). Learning in imaginary organizations: Creating inter organizational knowledge. *Journal of Organizational Change Management*, 12(5), 419-438.
- Hu, R., Li, Y., Huang, J., Zhang, Y., Jiang, R., & Dunlop, E. (2023). Psychological capital and breakthrough innovation: The role of tacit knowledge sharing and task interdependence. *Frontiers in Psychology*, 14, 1097936.
- Huber, G. (2019). Organizational learning: The contributing processes and the literatures. *Organization Science*, 2(1), 88-115.

- Inthavong, P., Rehman, K., Masood, K., Shaukat, Z., Hnydiuk-Stefan, A., & Ray, S. (2023). Impact of organizational learning on sustainable firm performance: Intervening effect of organizational networking and innovation. *Heliyon*, 9(5), e16177.
- Khin, S., & Ho, T. (2020). Digital Technology, Digital Capability and Organizational Performance: A Mediating Role of Digital Innovation. *International Journal of Innovation Science*, 11, 177-195.
- Kun, M. (2022). Linkages between knowledge management process and corporate sustainable performance of Chinese small and medium enterprises: Mediating role of frugal innovation. *Frontiers in Psychology*, 13, 850820.
- Larson, L., & DeChurch, L. (2020). Leading teams in the digital age: Four perspectives on technology and what they mean for leading teams. *The Leadership Quarterly*, 31(1), 101377.
- Li, J., Wu, N., & Xiong, S. (2021). Sustainable innovation in the context of organizational cultural diversity: The role of cultural intelligence and knowledge sharing. *PLoS ONE*, 16(5), e0250878.
- Liao, S., & Wu, C. (2010). System perspective of knowledge management, organizational learning, and organizational innovation. *Expert Systems with Applications*, 37(2), 1096-1103.
- Liao, S., Wei, J., & Hu, Q. (2023). Politics or markets: The dual role of the motivation to achieve organizational legitimacy in the development of knowledge management capabilities and business model innovation. *Frontiers in Psychology*, 14, 1112240.
- Linton, J. (2009). De-babelizing the language of innovation. *Technovation*, 29(11), 729-737.
- Lipponen, J., Helkama, K., & Juslin, M. (2003). Subgroup identification, superordinate identification and intergroup bias between the subgroups. *Group Processes & Intergroup Relations*, 6(3), 239-250.
- Martins, H. (2019). Digital transformation and digital leadership. *Healthcare Informatics Research*, 25(4), 350-351.
- Mihardjo, L., Sasmoko, Alamsjah, F., & Elidjen. (2019). Digital leadership impacts on developing dynamic capability and strategic alliance based on market orientation. *Polish Journal of Management Studies*, 19(2), 39.
- Noruzi, A., Dalfard, V., Azhdari, B., Nazari-Shirkouhi, S., & Rezazadeh, A. (2012). Relations between transformational leadership, organizational learning, knowledge management, organizational innovation, and organizational performance: an empirical investigation of manufacturing firms. *The International Journal of Advanced Manufacturing Technology*, 64(5-8), 1073-1085.
- Olkkonen, M., & Lipponen, J. (2006). Relationships between organizational justice, identification with organization and work unit, and group-related outcomes. *Organizational Behavior and Human Decision Processes*, 100(2), 202-215.
- Pham, M. (2020). The effect of professional identification and organizational identification on career satisfaction, job satisfaction and organizational commitment. *Management Science Letters*, 34(33), 2683-2694.
- Pimsuwan, H., Phosaard, S., & Sungsanit, M. (2023). Effects of Entrepreneurial Behaviors and Product Innovation Performance Towards Start-Up Business Survival in Thailand. *Asian Administration and Management Review*, 6(2), 141-157.
- Roman, A., van Wart, M., Wang, X., Liu, C., Kim, S., & McCarthy, A. (2019). Defining E-leadership as Competence in ICT-Mediated Communications: An Exploratory Assessment. *Public Administration Review*, 79(6), 853-866.
- Rousseau, D. (1998). Why workers still identify with organizations. *Journal of Organizational Behavior*, 19(3), 217-233.

- Sancho-Zamora, R., Hernández-Perlines, F., Peña-García, I., & Gutiérrez-Broncano, S. (2022). The Impact of Absorptive Capacity on Innovation: The Mediating Role of Organizational Learning. *International Journal of Environmental Research and Public Health*, 19(2), 842.
- Sandel, S. (2013). *Digital leadership: How creativity in business can propel your brand and boost your results*. London: Fast-Print Publishing.
- Sasmoko, S., Mihardjo, L., Alamsjah, F., & Elidjen, E. (2019). Dynamic capability: The effect of digital leadership on fostering innovation capability based on market orientation. *Management Science Letters*, 6(1), 1633-1644.
- Shandong Provincial People's Government. (2023). *Shandong*. Retrieved from [www.shandong.gov.cn/](http://www.shandong.gov.cn/).
- Sheninger, E. (2019). *Digital leadership: Changing paradigms for changing times*. California: Corwin Press.
- Smidts, A., Pruyn, A., & van Riel, C. (2001). The impact of employee communication and perceived external prestige on organizational identification. *Academy of Management Journal*, 44(5), 1051-1062.
- Sook, S. (2017). The effect of leadership on organizational identification and organizational commitment. *Culinary Science & Hospitality Research*, 23(3), 186-195.
- Srimata, T., Niyamabha, A., Wichitputchraporn, W., Piyaphimonsit, C., Prachongchit, S., & Koedsuwan, S. (2019). A Causal Model of Digital Leadership and School Climates with Work Engagement as Mediator Affecting Effectiveness of Private Schools in Bangkok, Thailand. *Asian Administration and Management Review*, 2(2), 290-297.
- Statista. (2023). *Average company lifespan 2020*. London: Statista.
- Stjepić, A., Ivančić, L., & Vugec, D. (2020). Mastering digital transformation through business process management: Investigating alignments, goals, orchestration, and roles. *Journal of Entrepreneurship, Management and Innovation*, 16(1), 41-74.
- Suksai, T., Suanpang, P., & Thangchitharoenkhul, R. (2021). A Digital Leadership Development Model for School Administrators in Basic Education to Fulfill the Thailand 4.0 Policy. *PSAKU International Journal of Interdisciplinary Research*, 10(2), 11-20.
- Sun, L., Jiang, X., Ren, H., & Guo, Y. (2020). Edge-Cloud computing and artificial intelligence in internet of medical things: Architecture, technology and application. *IEEE Access*, 8, 101079-101092.
- van Dick, R., van Knippenberg, D., Hägele, S., Guillaume, Y., & Brodbeck, F. (2008). Group diversity and group identification: The moderating role of diversity beliefs. *Human Relations*, 61(10), 1463-1492.
- Vrontis, D., Christofi, M., Pereira, V., Tarba, S., Makrides, A., & Trichina, E. (2021). Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review. *The International Journal of Human Resource Management*, 33(6), 1237-1266.
- Yuan, G., Jia, L., & Zhao, J. (2016). Organizational identification moderates the impact of organizational justice on job satisfaction. *Work*, 54(1), 189-195.

**Data Availability Statement:** The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

**Conflicts of Interest:** The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

**Publisher's Note:** All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.



**Copyright:** © 2025 by the authors. This is a fully open-access article distributed under the terms of the Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0).