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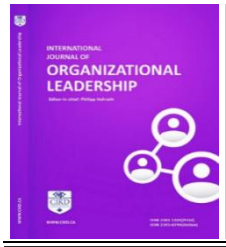

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Unleashing Innovative Potential through Digital Leadership: A Moderated Mediation Model of Work Engagement and Psychological Safety

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ABSTRACT

Grounded in the Job Demands–Resources (JD-R) framework, this research proposes and empirically examines a moderated mediation model to clarify how digital leadership shapes employees' innovation outcomes. The study explores the mediating role of work engagement and the boundary role of psychological safety within this mechanism. Using survey data from 349 full-time employees working in various Chinese enterprises, structural equation modeling and moderated mediation analyses were applied to test the proposed relationships. The results indicate that digital leadership has a direct positive impact on employees' innovative performance, while also indirectly enhancing it through increased work engagement. Furthermore, psychological safety strengthens the link between digital leadership and work engagement, thereby magnifying its indirect effect on innovation. From the lens of intrinsic motivation, the present research deepens the understanding of how high-quality leadership contributes to innovation and offers actionable insights for organizations navigating digital transformation.

Over the past decade, advances in digital technologies such as Artificial Intelligence (AI), big data analytics, and cloud computing have profoundly reshaped the landscape of global business. This transformation has led to increased market uncertainty and heightened

competitive pressure. Without sustained high performance in innovation, companies may struggle to differentiate themselves and achieve long-term growth in this dynamic and unpredictable environment (Zhang et al., 2025). Innovation performance is essential for building organizational resilience and effectively responding to external challenges. Organizations with strong innovation capabilities typically show greater adaptability and recovery when facing unexpected disruptions (Awad & Martín-Rojas, 2024). Moreover, innovation performance impacts the speed and quality of new product development, which subsequently impacts a firm's financial performance and market position. Driven by the ideas of "human–machine collaboration" and "open innovation", the significance of innovation performance has become increasingly evident.

However, while there is a general consensus on the importance of innovation, existing empirical studies reveal considerable variation in how organizations achieve innovative outcomes under conditions of digital transformation. For example, some organizations benefit significantly from the adoption of digital leadership, whereas others struggle to leverage technology for innovative purposes (Chen & Kim, 2023). This inconsistency underscores the need to investigate the mechanisms by which digital leadership influences employee-level innovation performance.

Digital leadership has emerged as a critical leadership style in the era of digital transformation. It emphasizes leaders' ability to articulate a digital vision, encourage technology adoption, and foster innovative thinking (Hassan et al., 2024). Recent empirical studies confirm a positive association between digital leadership and innovation performance (Cheng & Miao, 2025; Ghobakhloo & Iranmanesh, 2021). For instance, Cheng and Miao (2025) demonstrate that firms led by digital leaders tend to exhibit greater speed and quality in new product development, while Ghobakhloo and Iranmanesh (2021) find that digital leadership enhances organizational agility, which in turn improves innovation outcomes. Despite these promising findings, the majority of existing research has concentrated on the organizational or strategic level, such as digital strategy adoption, IT infrastructure, and platform ecosystems (Kohli & Melville, 2019; Sebastian et al., 2020). In contrast, relatively few empirical studies have examined how digital leadership behaviors directly influence employees' psychological states and innovation-related behaviors at the individual level. For example, Chen and Kim (2023) noted that while digital leadership creates technological opportunities, little is known about whether employees are sufficiently motivated or psychologically safe to transform these resources into innovative contributions.

Furthermore, recent reviews (Espina-Romero et al., 2023; Sousa & Rocha, 2019) highlight a critical gap: the lack of empirical investigations connecting digital leadership to micro-level mechanisms such as employee engagement, motivation, and psychological safety. These factors are especially salient in uncertain, knowledge-intensive environments, where innovation depends not only on access to digital resources but also on employees' willingness to experiment, share ideas, and take risks.

In recent years, an increasing number of empirical studies grounded in the Job Demands–Resources (JD-R) model have confirmed that work engagement plays a crucial mediating role between job resources and positive work outcomes. According to the JD-R model (Demerouti et al., 2001), job demands such as heavy workloads and time pressures can exhaust employees' energy. Conversely, job resources, such as supervisory support and opportunities for

development, can motivate employees and enhance their work engagement. Empirical studies provide robust evidence for this mechanism. Rai and Chawla (2022) demonstrate that leadership support and career development opportunities significantly increase employee engagement, which in turn fosters higher job satisfaction and organizational commitment. Similarly, Ghani et al. (2023) confirm that work engagement fully mediates the relationship between job resources and innovative work behavior, suggesting that engaged employees are more likely to invest energy in creative problem-solving.

Within digital contexts, recent evidence also suggests that digital leadership may function as a crucial job resource. Li et al. (2024) found that digital leaders who provide a clear vision, technological training, and real-time feedback enhance employees' digital engagement, which subsequently promotes innovative behaviors. Likewise, Wang et al. (2025) report that leadership-driven digital empowerment enhances work engagement, resulting in stronger innovative performance. These findings support the view that digital leadership enriches job resources, thereby enabling employees to transform their energy and motivation into innovative contributions. Nevertheless, most prior empirical studies have not explicitly connected digital leadership with work engagement as a mediating mechanism. While there is evidence that digital leaders influence organizational performance, the specific process through which they stimulate employee-level innovation via engagement remains underexplored. This study addresses this gap by incorporating work engagement as a mediating variable, clarifying the motivational pathway from digital leadership to innovation performance.

According to the JD-R model, psychological safety is recognized as a crucial job resource that enables employees to express themselves without fear of negative consequences (Edmondson, 1999). It reduces the negative effects of job stress in high-demand environments and promotes recovery, thereby increasing engagement and innovation (Ito et al., 2022). Empirical studies consistently support this perspective. Huang and Hsieh (2017) find that team-level psychological safety fosters information sharing and collaboration, both of which enhance innovation. More recent studies (Elsayed et al., 2023; Fu et al., 2022) demonstrate that psychological safety enhances the positive impact of leadership support on employee creativity by mitigating the fear of failure and fostering experimentation. In digital transformation contexts, psychological safety becomes even more critical. Jin and Peng (2024) demonstrate that employees who perceive psychological safety are more willing to adopt digital tools and suggest innovative improvements. Similarly, Ito et al. (2022) show that psychological safety moderates the relationship between digital engagement and innovation, indicating that employees are more likely to sustain engagement when they feel safe to voice ideas. Despite these findings, few empirical studies have examined psychological safety as a boundary condition in the digital leadership–innovation relationship. Existing literature often treats psychological safety as a general antecedent of creativity but neglects its moderating role in leadership-driven motivational processes. This study, therefore, introduces psychological safety as a moderator that shapes the extent to which digital leadership enhances work engagement, ultimately influencing innovation performance.

Building on the above discussion, several shortcomings in prior research can be identified. First, although earlier studies have established a link between digital leadership and innovation outcomes, the majority of evidence has been situated at the organizational or strategic level. Much less is known about the individual-level mechanisms through which digital leaders affect

employees' psychological conditions and innovative behaviors. Second, while the JD-R model suggests that work engagement is a critical pathway connecting job resources with performance outcomes, few empirical works have explicitly examined work engagement as the underlying mechanism between digital leadership and innovation performance. Third, although psychological safety has long been acknowledged as an essential resource fostering creativity, limited empirical attention has been paid to its potential moderating role in the relationship between digital leadership and work engagement.

This study seeks to address these gaps and contribute to the literature in three main ways. From a theoretical perspective, it advances digital leadership research by embedding the JD-R framework, thereby clarifying how leadership behaviors translate into individual-level innovation.

From an empirical perspective, it examines a moderated mediation model using survey data collected from 349 employees, providing evidence for both the mediating role of work engagement and the moderating function of psychological safety. From a practical standpoint, it offers guidance for organizations navigating digital transformation, highlighting how digital leaders can enhance employee engagement and innovation through the cultivation of psychological safety.

Grounded in the JD-R model, this study proposes a moderated mediation framework: digital leadership is expected to promote employee innovation performance by strengthening work engagement, while psychological safety is posited to amplify this process.

Research Hypotheses and Theoretical Framework

Digital Leadership and Employee Innovation Performance

Within digitalized contexts, digital leadership refers to the ability of leaders to harness technological innovations for resource coordination and strategic renewal (Cortellazzo et al., 2019). Leaders in this domain demonstrate technological foresight and cultivate a culture that is open, collaborative, and centered on human experiences. This approach enhances adaptability and innovation within their organizations. Employee innovative performance includes individual behaviors such as generating ideas, developing solutions, and implementing innovations within their work roles (Anderson et al., 2014; Zhu et al., 2022).

According to the JD-R model, employees' work experiences are influenced by the interaction between job demands, such as high workload and time pressure, and job resources, including leadership support, feedback, and technological tools (Bakker & Demerouti, 2007; Schaufeli, 2017). Among these factors, job resources are vital for driving motivation, as they foster higher levels of employee engagement and creative performance. From the viewpoint of the JD-R framework, digital leadership emerges as a multifaceted and valuable job resource that not only motivates employees but also boosts their innovation performance.

Digital leadership has a positive impact on employees' innovation performance by transforming work environments through advanced technologies and supportive leadership practices. First, digital leaders introduce tools such as AI and collaborative platforms to reduce task complexity and information overload. This approach increases employees' perceived competence and efficiency, which are essential structural job resources that support innovation (Bawono et al., 2022). Additionally, digital leaders encourage collaboration across

different departments and promote knowledge sharing, which enhances employees' problem-solving abilities (Khaw et al., 2022). Providing a clear digital vision and setting strategic goals helps enhance employees' objectives and boosts their intrinsic motivation. This effort strengthens their sense of meaning and responsibility, thereby supporting creative behaviors (Schaufeli, 2017). Research has also shown that digital leadership enhances creative performance, particularly in high-tech positions, by promoting organizational learning, knowledge flow, and increased autonomy (Benitez et al., 2022; Kraus et al., 2022; Schwarzmüller et al., 2018). Accordingly, the present research proposes the following hypothesis:

H1: Digital leadership has a notably positive effect on employees' innovation performance.

The Mediating Role of Work Engagement

Characterized as a motivating psychological state that integrates employees' goals with those of the organization, work engagement is widely regarded as a key conduit linking organizational resources to employee performance (Schaufeli, 2017). It is defined as a state in which employees exhibit vigor, dedication, and absorption in their work (Bakker & Demerouti, 2017). This state reflects the emotional, cognitive, and behavioral resources that individuals invest in accomplishing their job tasks. Defined by its three core dimensions—vigor, dedication, and absorption—work engagement indicates the degree to which employees experience high energy levels, strong psychological involvement, and focused attention while fulfilling their responsibilities (Schaufeli et al., 2006).

According to the JD-R framework, employees are more likely to engage in a motivational process in environments rich in resources. The availability of job resources enhances work engagement, which ultimately leads to improved performance outcomes (Bakker et al., 2011). The JD-R framework suggests that work engagement is a crucial motivational pathway that connects digital leadership with employee innovation performance. Digital leaders provide both technological and emotional resources, such as advanced tools, a culture of knowledge sharing, and timely feedback. This support increases employees' confidence and their willingness to tackle complex tasks (Salanova & Schaufeli, 2008). Research findings show that digital leadership enhances creative output by improving employees' work engagement (Torres et al., 2017). Moreover, a high level of work engagement encourages employees' creative thinking and proactive behavior.

Highly engaged employees are recognized for their enhanced focus, persistence, and psychological resilience, especially in difficult and uncertain work environments (Lesener et al., 2020). Work engagement also fosters risk-taking and proactive experimentation, which are essential for individual-level innovation (Siyal, 2023). Additionally, engaged employees exhibit positive emotions and sustained energy, which further drives innovative behavior in complex and technology-oriented settings (Bakker et al., 2011). Through encouraging intrinsic motivation and emotional commitment, digital leadership indirectly contributes to innovation performance by strengthening employees' engagement. Consistent with the motivational mechanism emphasized in the JD-R framework, the present research formulates the hypothesis that:

H2: Work engagement mediates the relationship between digital leadership and employee innovation performance.

The Moderating Role of Psychological Safety

Psychological safety is a key contextual factor in organizational behavior and human resource management. It reflects employees' belief that they are able to raise concerns, acknowledge missteps, and attempt innovative practices under conditions that minimize personal risk (Edmondson, 1999). This environment fosters voice behavior, cross-functional collaboration, and stimulates innovation by supporting intrinsic motivation (Frazier et al., 2017). Nevertheless, ensuring effective communication channels. If individuals perceive a strong sense of psychological safety, they are likely to interpret digital leadership behaviors as supportive and empowering, which encourages them to participate actively, experiment, and take risks during digital transformation (Gao & Gao, 2024). Perceptions of enhanced psychological safety increase the likelihood that employees will view digital leadership behaviors as supportive and empowering. As a result, they demonstrate a greater willingness to engage, experiment, and take risks during the digital transformation process (Xu & Zhang, 2022).

As a prototypical social job resource, psychological safety plays a key moderating role within the JD-R framework (Bakker & Demerouti, 2017). This model suggests that employees' capacity to engage in meaningful work is influenced not only by the availability of structural job resources, such as leadership and technological infrastructure, but also by social and psychological resources, including trust, support, and psychological safety (Hobfoll et al., 2018). Digital leadership provides employees with a clear vision, facilitates information sharing, and enables technological support. These represent crucial structural resources that empower employees and reduce uncertainty (Schiuma et al., 2022). However, employees' ability to transform resources provided by leadership into increased engagement largely relies on their psychological safety. In this sense, psychological safety operates as a cognitive channel through which the benefits of digital leadership can be internalized and acted upon.

Psychological safety enhances employees' ability to recognize supportive leadership cues and reduces the apprehensions related to interpersonal risks that come with trying new methods (Sharma & Mehta, 2023). This environment enables employees to perceive challenges as opportunities rather than threats, which subsequently boosts their motivation and encourages greater mental and emotional involvement in their work (Gao & Gao, 2024). Viewed through the lens of the JD-R framework, psychological safety facilitates employees' recognition of accessible resources and strengthens the alignment between job resources and job demands. This alignment strengthens the motivational impact of digital leadership on work engagement (Bakker & Demerouti, 2017). Therefore, it plays a critical moderating role in influencing how leadership resources are translated into proactive work behavior. Drawing upon this theoretical rationale, we advance the following hypothesis:

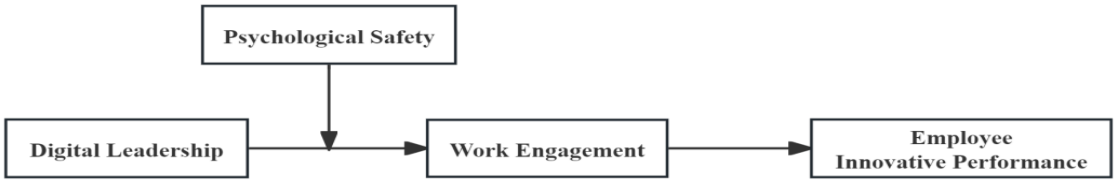
H3: Psychological safety serves as a positive moderator in the linkage between digital leadership and employees' work engagement, such that the effect becomes more pronounced under conditions of high psychological safety..

Following the theoretical assumptions, the study develops a moderated mediation approach in which digital leadership contributes to innovative performance indirectly via employees' engagement, whereas the presence of psychological safety shapes the intensity of this indirect effect. Within the JD-R framework, work engagement operates as an essential channel that translates available resources into motivational outcomes. This construct plays a mediating role in connecting leaders' actions to employees' performance levels (Bakker & Demerouti, 2017). By providing clear goals, technological support, and facilitating knowledge sharing, digital leaders enhance employees' proactivity and immersion. This, in turn, boosts their cognitive, emotional, and behavioral engagement (Gao & Gao, 2024).However, the strength of this mediation pathway depends on employees' psychological safety. As a critical contextual resource, psychological safety amplifies how individuals perceive and utilize other resources (Hobfoll et al., 2018). A strong sense of psychological safety enables employees to regard digital leadership behaviors as supportive and empowering. This perception subsequently drives greater engagement and improves innovation outcomes (Torres et al., 2017). In light of the above discussion, we advance the following hypothesis:

H4: Psychological safety conditions the mediated relationship between digital leadership and employees' innovative performance through work engagement, such that this indirect linkage becomes more pronounced when psychological safety is high.

Although psychological safety may also affect the relationship between work engagement and innovation, the present research specifically investigates its moderating role at the initial stage—between digital leadership and work engagement. This choice is based on two reasons. First, according to the JD-R framework's motivational pathway, employees tend to perceive leadership resources more favorably when they experience high levels of psychological safety, which in turn enhances their engagement (Hobfoll et al., 2018). Second, psychological safety influences employees' willingness to embrace empowerment and adapt to technological changes. This makes it essential for transforming resources into motivation. In contrast, the impact of work engagement on innovation is more internally driven and less shaped by contextual factors. The present research establishes a moderated mediation framework (see Figure 1).

Figure 1
Research Framework



Method

Sample and Procedure

For this research, the primary source of empirical evidence was a carefully designed survey administered via questionnaires. We designed the questionnaire after carefully

synthesizing prior studies and aligning it with the theoretical framework of this research. The instrument was structured into two parts. The initial part collected respondents' background characteristics—including variables such as sex, age, educational attainment, and years of work experience. The subsequent part comprised measurement scales for the central constructs of the study.

The survey was conducted online, distributing a total of 380 questionnaires. During the data screening process, we applied strict criteria to exclude invalid responses. First, incomplete questionnaires, specifically those with more than 20% unanswered items, are classified as invalid. Second, the logical consistency of responses is examined, with particular attention to reverse-coded items. If a respondent's answers to reverse-coded items and regular items appeared to be contradictory, we excluded that questionnaire. Additionally, we assessed response time to identify inattentive or unusual behavior. Questionnaires completed in an unreasonably short time (e.g., less than one minute) or excessively long time are also eliminated. Following the screening, 349 valid questionnaires were collected, yielding a valid response rate of 91.8%. The final sample size meets the basic requirements for statistical analysis and provides a robust basis for empirical investigation.

To ensure reliability and validity, a pilot test was conducted prior to the survey. A total of 80 pilot responses were analyzed to evaluate the internal consistency and construct validity of the questionnaire, during which several items with low standardized factor loadings (<0.50) or high cross-loadings were identified as problematic. To improve the measurement model, two items from the Digital Leadership Scale and one item from the Work Engagement Scale were removed. After these revisions, the remaining items showed strong internal consistency and satisfactory construct validity. During the data processing phase, Mplus software was used to perform statistical analyses, which included descriptive statistics, reliability testing, and factor analysis. Moreover, to minimize potential biases and enhance internal validity, reverse-coded items were incorporated into the questionnaire design. Outliers were also carefully addressed during data analysis. These procedures collectively ensured the quality of the dataset and laid a solid foundation for subsequent empirical research. Among the 349 valid samples, the demographic characteristics were distributed as follows（For details, see Table 1)

Table 1 presents the descriptive statistics of the respondents (N = 349). The sample consisted of 165 males (47.3%) and 184 females (52.7%). In terms of age, the majority were born in the 1980s (36.1%) and 1990s (48.1%), followed by a smaller proportion from the 1970s (7.5%), the post-2000s decade (14.6%), and the 1960s (4.3%). With respect to educational attainment, most participants held a bachelor's degree (63.9%) or a master's degree (23.2%), while 6.6% had an associate degree or below and 6.3% held a doctoral degree. Regarding work experience, 31.8% had 3–5 years of tenure, 20.9% had 1–3 years, 13.2% had less than one year, 33.5% had 5–10 years, and only 13.8% had more than 10 years. In terms of job level, nearly half (48.1%) were regular employees, while 24.6% were frontline managers, 20.6% were middle managers, and 6.9% were senior managers. Finally, job types were distributed across sales (27.8%), marketing (21.8%), R&D (14.0%), technical (4.6%), and other functions (4.6%).

Table 1

Descriptive Statistics (N = 349)

Variables		N	Percent
Gender	Male	165	47.28%
	Female	184	52.72%
Age	Post-2000s	51	14.61%
	1990s	168	48.14%
	1980s	89	25.50%
	1970s	26	7.45%
	1960s	15	4.30%
Educational Level	Associate Degree or Below	23	6.59%
	Bachelor's Degree	228	65.33%
	Master's Degree	81	23.21%
	Doctoral Degree	17	4.87%
Years of Work Experience	Less than 1 Year	34	9.74%
	1-3 Years (inclusive of 1 year)	85	24.36%
	3-5 Years (inclusive of 3 years)	73	20.92%
	5-10 Years (inclusive of 5 years)	109	31.23%
	10 Years and Above	48	13.75%
Job Level	Regular Employee	168	48.14%
	Frontline Manager	86	24.64%
	Middle Manager	71	20.34%
	Senior Manager	24	6.88%
Job Type	Functional	137	39.26%
	R&D	49	14.04%
	Marketing	43	12.32%
	Sales	28	8.02%
	Technical	76	21.78%
	Other	16	4.58%

Instruments

To ensure the reliability and validity of the measurement scales, the present research utilizes established instruments that have undergone extensive validation. All items are rated on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Digital Leadership. This variable is measured using a 6-item scale developed by AlNuaimi et al. (2022). An example item is: "*The leader provides organizational members with a clear vision for digital transformation.*" .

Work Engagement. To evaluate employees' work engagement, we employed the 17-item instrument originally introduced by Schaufeli et al. (2006). A representative statement is "*Our leaders value our creative abilities.*" .

Innovative Performance. Employees' innovative performance was captured using the 6-item measure from Scott and Bruce. (1994). One illustrative item is "*Our leaders acknowledge our capacity for creativity*.".

Psychological Safety. Perceptions of psychological safety were assessed through a five-item scale developed by Liang et al. (2012). An example statement reads "*Within my team, I feel comfortable sharing my genuine thoughts.*".

Results

Confirmatory Factor Analysis

To evaluate whether the four focal constructs—digital leadership, psychological safety, work engagement, and innovative performance—are empirically distinct, we performed a Confirmatory Factor Analysis (CFA) with Mplus 7.0. The results presented in Table 2 suggest that the hypothesized four-factor model fits the data well, with satisfactory indicators of model fit (χ^2/df = 2.09, RMSEA = .05, CFI = .96, TLI = .93), thereby supporting the discriminant validity of the constructs.

Table 2

Confirmatory Factor Analysis Results (N = 349)

Model	χ^2	*df*	χ^2/df	CFI	TLI	RMSEA
Four-factor mode (D、W、P、I)	421.78	201	2.10	.96	.93	.053
Three-factor mode (D+W、P、I)	855.02	204	4.19	.89	.87	.10
Two-factor model (D+W、P+I)	1687.99	206	8.19	.77	.75	.13
One-factor model (D+W+P+I)	2835.09	207	13.7	.53	.50	.17

Note. D= represents digital leadership, W=work engagement, P= psychological safety, and I=innovation performance. The symbol "+" signifies the combination of two factors into a single composite factor.

To assess the measurement properties, we calculated Composite Reliability (CR), Average Variance Extracted (AVE), cross-loadings, the Fornell–Larcker criterion, and the HTMT ratio. As shown in Table 3, all CR values exceeded the recommended threshold of .70 and AVE values were above 0.50, indicating good convergent validity.

Table 3

Composite Reliability (CR) and Average Variance Extracted (AVE)

Construct	Cronbach's α	CR	AVE
Digital leadership	.89	.92	.65
Work engagement	.85	.90	.58
Psychological safety	.74	.83	.52
Innovation performance	.78	.85	.55

Note. All CR values exceed the recommended threshold of 0.70, and all AVE values are above 0.50, indicating good convergent validity.

Table 4 reports the Fornell–Larcker test, where the square roots of AVE (diagonal values) were greater than the corresponding inter-construct correlations, supporting discriminant validity.

Table 4

Fornell–Larcker Criterion

	Digital leadership	Work engagement	Psychological safety	Innovation performance
Digital leadership	**.81**	.58	.52	.55
Work engagement	.58	**.76**	.49	.6
Psychological safety	.52	.49	**.72**	.47
Innovation performance	.55	.60	.47	**.74**

Note. The diagonal elements represent the square roots of the AVE, which are all greater than the corresponding inter-construct correlations. This result supports discriminant validity.

Table 5 shows the HTMT ratios, all of which were below the conservative threshold of 0.85, providing further evidence for discriminant validity. Collectively, these results confirm that the measurement model demonstrates satisfactory reliability, convergent validity, and discriminant validity.

Table 5

HTMT Ratios

	Digital leadership	Work engagement	Psychological safety	Innovation performance
Digital leadership	—	.68	.63	.66
Work engagement	.68	—	.57	.71
Psychological safety	.63	.57	—	.59
Innovation performance	.66	.71	.59	—

Note. All HTMT values are below the conservative threshold of 0.85, indicating that the constructs demonstrate adequate discriminant validity.

Descriptive Statistics Analysis

Table 6 presents the descriptive statistics, along with the correlation coefficients, for the major constructs and control factors. The analysis reveals a significant positive relationship between digital leadership and work engagement (r = .38, p < .01), as well as with innovative performance (r = .45, p < .01).Moreover, employees' work engagement also demonstrates a significant positive linkage with their innovative performance (r = .31, p < .01).These findings offer preliminary evidence in favor of Hypotheses 1 and 2.

Upon further analysis, we observe a modest negative correlation between educational background and innovative performance (r = –.13, p < .05). This finding deviates from the conventional assumption that higher educational attainment enhances employees' innovative potential. We propose that highly educated employees may focus more on normative or analytical tasks, which could be restricted by organizational processes, ultimately limiting their opportunities for creative expression. Another explanation is that these individuals can be more adapted to the organizational environment, becoming more sensitive to barriers that hinder innovation.

Moreover, years of work experience are negatively correlated with innovative performance (r = –.18, p < .01). This finding may indicate that long-serving employees experience innovation fatigue or develop path dependency. It suggests that having significant work experience can lead to rigid thinking patterns and a lower willingness to adopt new ideas, ultimately resulting in a decline in innovative behaviors.

Table 6

Descriptive Statistics and Correlation Analysis Results (N = 349)

Variable	M	SD	1	2	3	4	5	6	7	8
1.Gender	1.43	0.5	1							
2.Age	2.18	0.49	-.11*	1						
3.Educational Background	2.04	0.66	-.18**	-.004	1					
4.Position Level	3.1	1.83	-.02	.01	-.04	1				
5.Years of Work Experience	3.38	0.59	-.13*	.06	.05	-.12*	1			
6.Digital Leadership	3.69	0.56	-.03	-.03	.08	.20*	.18*	1		
7.Work Engagement	3.5	0.64	-.10	.09	.06	.03	.12*	.39**	1	
8.Psychological Safety	3.63	0.66	-.05	.02	.07	-.09	.09	.34**	.27**	1
9.Innovation Performance	3.28	0.77	-.07	.11	-.13*	.07	-.18**	.45**	.32**	.21**

Note.$*p < .05$,$**p < .01$. This notation is used consistently throughout the manuscript.

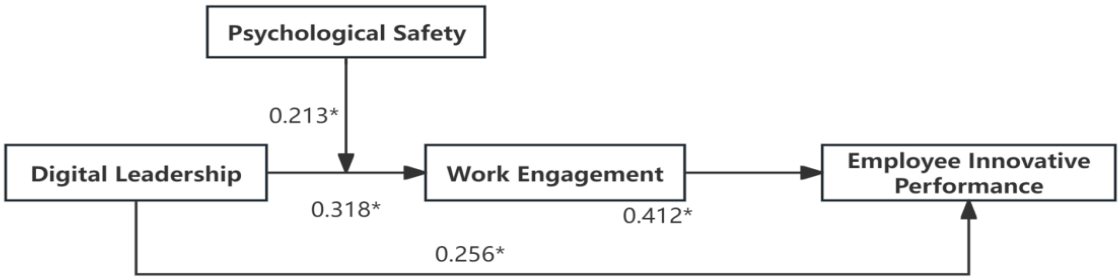
Hypothesis Testing

Testing of Main Effects and Mediation Effects

This research utilizes Mplus 7.0 for structural path analysis to examine the hypothesized relationships. The path coefficients and their significance levels for the complete model are illustrated in Figure 2. Findings from the structural equation modeling indicate that digital leadership positively and significantly predicts employees' innovative performance ($\beta = .26$, $p < .05$), thereby confirming Hypothesis 1.In addition, bootstrapping results suggest that digital leadership influences innovation performance indirectly through the mediating role of work engagement. The estimated indirect effect was .14, with a 95% confidence interval ranging from .01 to .09. Since the interval excludes zero, the mediation is statistically significant, lending support to Hypothesis 2. Importantly, both the direct and mediated pathways from digital leadership to innovation were significant, indicating that work engagement partially mediates this linkage. These findings are consistent with the JD-R model, which posits that resources trigger motivational processes and shape performance outcomes via both direct and mediated channels.

Figure 2

Path Coefficients of the Full Structural Model



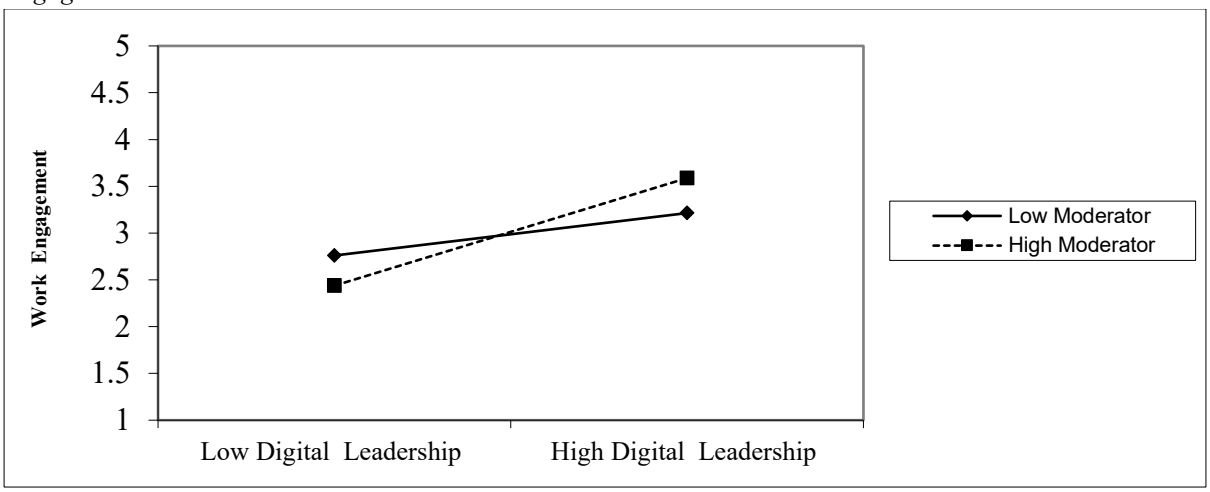
Moderation Effect Testing

To examine the moderating effect of psychological safety on the mediated relationship, the present research employs structural equation path analysis using Mplus. Specifically, an interaction term between digital leadership and psychological safety is created after mean-centering the variables, which is then used to predict work engagement. A bootstrap resampling procedure with 5,000 iterations is conducted to enhance the robustness and confidence level of the estimates.

The findings indicate that the interplay between digital leadership and psychological safety has a significant positive influence on employees' work engagement (β = .22, *SE* = .04, $p < .05$), supporting Hypothesis 3. To corroborate this result, the interaction was visualized in Figure 3, where employees were divided into groups with higher and lower levels of psychological safety. Under conditions of low psychological safety, digital leadership shows a positive association with work engagement (β = .35, $p < .05$). In contrast, at higher levels of psychological safety, this association not only remains significant but also strengthens (β = .59, $p < .05$).Under conditions of low psychological safety, digital leadership shows a positive association with work engagement (β = .35, $p < .05$). In contrast, at higher levels of psychological safety, this association not only remains significant but also strengthens (β = .59, $p < .05$). The contrast between the two conditions is statistically meaningful (β = .29, $p < .01$), further reinforcing Hypothesis 3.

Figure 3

Moderating Role of Psychological Safety in the Relationship Between Digital Leadership and Work Engagement



Discussion

The findings of this study contribute to the growing body of research on digital leadership and employee innovation performance. First, the results demonstrate that digital leadership has both direct and indirect effects on employees' innovation performance through work engagement. This finding is consistent with prior empirical research, which has demonstrated that leadership behaviors can enhance employees' intrinsic motivation and innovative outcomes (Li et al., 2024; Rai & Chawla, 2022). At the same time, our findings extend earlier studies that have examined digital leadership at the organizational or strategic level (Cheng

& Miao, 2025), by providing evidence at the individual employee level. In this way, the present research deepens understanding of the micro-level mechanisms through which digital leadership fosters innovation.

Second, the results highlight the moderating role of psychological safety. This finding aligns with studies that regard psychological safety as a crucial contextual resource facilitating innovation and engagement (Ito et al., 2022). However, the present study advances the literature by empirically demonstrating that psychological safety strengthens the positive pathway from digital leadership to work engagement, thereby amplifying its indirect effect on innovation performance. This complements previous research, which has often discussed psychological safety as a general antecedent of innovation but has not explicitly tested its interaction with leadership in digital contexts. Taken together, these findings enrich the Job Demands–Resources (JD-R) framework by positioning digital leadership and psychological safety as key job resources that motivate employees and foster innovation. The results also highlight the boundary conditions under which digital leadership is most effective, thus offering a more nuanced understanding of leadership effectiveness in digital transformation environments.

Practical Implications

The study provides several actionable insights for organizations undergoing digital transformation. First, organizations should recognize the pivotal role of digital leadership in cultivating an innovative workforce. Leaders who articulate a clear digital vision, provide technological support, and give timely feedback can substantially enhance employees' work engagement and innovation outcomes. Second, managers need to foster a climate of psychological safety. Encouraging open communication, tolerating mistakes, and supporting experimentation can magnify the positive effects of digital leadership on employee engagement and innovation. Finally, human resource practices should be aligned with digital leadership behaviors—for example, by offering training programs that strengthen both digital competencies and interpersonal skills of leaders—so that the motivational pathways identified in this study can be effectively leveraged in practice.

Limitations and Future Research

Despite its contributions, this study has several limitations. First, the cross-sectional survey design restricts the ability to draw firm causal inferences. Future studies could adopt longitudinal or time-lagged research designs to capture the dynamic effects of digital leadership on employee innovation performance over time. Second, while this study focused on psychological safety as a boundary condition, other contextual factors such as organizational trust, team diversity, or cultural context may further shape the effectiveness of digital leadership. Examining these variables could provide a more comprehensive framework. Third, the data were collected from enterprises in China, which may limit the generalizability of the findings. Replicating this research in different cultural or industrial settings would enrich understanding of the universal versus context-specific aspects of digital leadership.

Conclusion

Grounded in the JD-R framework, this study develops and empirically tests a moderated mediation model linking digital leadership to employee innovation performance. The findings confirm that digital leadership not only has a direct positive impact on innovation performance but also enhances it indirectly through increased work engagement, with psychological safety strengthening this mediating pathway. The study makes three primary contributions. Theoretically, it extends the JD-R framework by identifying digital leadership and psychological safety as critical job resources that jointly stimulate engagement and innovation at the individual level. Empirically, it provides robust evidence from 349 employee responses, thereby enriching current understanding of the micro-level mechanisms of digital leadership. Practically, it offers actionable insights for organizations undergoing digital transformation, demonstrating how leaders can foster innovation by simultaneously promoting engagement and creating a psychologically safe climate. In sum, this research adds new knowledge by elucidating the interactive mechanisms through which digital leadership shapes employee innovation. It highlights that leadership effectiveness in digital environments depends not only on the provision of resources but also on the creation of a supportive psychological climate, thereby contributing to both leadership theory and organizational practice.

Declarations

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