Digital Transformation and Employee Performance in Civil Engineering Firms: A Moderated Mediation Model of Psychological Safety and Career Resilience

[1]Xie Qihui, [2]Cheok Mui Yee, [3]Azrul Fazwan Kharuddin

[1]Tun Razak Graduate School Universiti Tun Abdul Razak, Kuala Lumpur, Malaysia
xie.qihui@ur.unirazak.edu.my

https://orcid.org/0009-0007-5335-5365

[2]Tun Razak Graduate School Universiti Tun Abdul Razak, Kuala Lumpur, Malaysia
cheokmy@unirazak.edu.my
https://orcid.org/0009-0002-2641-4271

[3]Tun Razak Graduate School Universiti Tun Abdul Razak, Kuala Lumpur, Malaysia
azrul.fazwan@ur.unirazak.edu.my

https://orcid.org/0000-0002-6100-6129

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ABSTRACT:
This study examines the factors influencing employee performance in privately-owned civil engineering enterprises in Guangzhou Province, China, within the context of digital transformation. The purpose of the study is to investigate how digital leadership and digital transformation affect employee performance, while exploring the mediating role of psychological safety and the moderating role of career resilience. Grounded in organizational behavior and digital transformation literature, the study integrates prior findings that emphasize the importance of leadership effectiveness, psychological work environments, and individual adaptability in shaping employee outcomes during technological change. A quantitative research design was adopted using a structured questionnaire distributed among employees in civil engineering firms. Structural Equation Modeling (SEM) was employed to test the relationships among variables, including mediation and moderation effects. The findings reveal that both digital leadership and digital transformation significantly enhance employee performance. Psychological safety was found to partially mediate these relationships, indicating that supportive and trust-based work environments strengthen the impact of leadership and technology on performance. Additionally, career resilience significantly moderates the relationship between psychological safety and employee performance, suggesting that more resilient employees benefit more from psychologically safe environments. The study concludes that employee performance in digitally transforming organizations is shaped by an integrated system of leadership, psychological, and individual factors. These findings contribute to Sustainable Development Goals (SDG 8

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and SDG 9) by promoting decent work, resilient organizations, and innovation-driven industrial growth.

Keywords: Digital leadership; Digital transformation; Psychological safety; Career resilience; Employee performance; Civil engineering enterprises

Introduction

The rapid acceleration of digital transformation is reshaping organizational structures, work processes, and human resource dynamics across industries globally. In emerging economies such as China, privately-owned enterprises (POEs) in capital-intensive sectors like civil engineering are increasingly integrating digital technologies such as Building Information Modeling (BIM), artificial intelligence, and data-driven project management systems to enhance efficiency and competitiveness. However, while digital transformation is widely acknowledged as a strategic imperative, its successful implementation depends not only on technological adoption but also on leadership capability and human-centered organizational factors (Sun & Zhou, 2025; Yang et al., 2026) . Recent studies emphasize that digital leadership plays a critical role in shaping employee adaptability, innovation, and performance outcomes by aligning organizational vision with technological change (Qiao et al., 2024; Wang et al., 2025) . Despite these advancements, much of the existing literature has focused on manufacturing, SMEs, and public institutions, leaving a contextual gap in understanding civil engineering POEs in rapidly urbanizing regions such as Guangzhou Province.

A growing body of research suggests that employee performance in digitalized environments is significantly influenced by psychological and behavioral mechanisms rather than technology alone. For instance, digital transformation has been found to affect employees' psychological states, attitudes, and work behaviors, particularly in relation to uncertainty and technological disruption (Li et al., 2024) . In such environments, psychological safety has emerged as a key determinant of employee engagement and innovation, enabling individuals to express ideas, take risks, and adapt to new digital workflows without fear of negative consequences (Santana et al., 2025) . Similarly, career resilience is increasingly recognized as a vital individual resource that enables employees to cope with continuous change, recover from setbacks, and maintain performance in digitally dynamic workplaces. However, empirical evidence integrating psychological safety and career resilience within the digital leadership–performance nexus remains limited, particularly in construction-related POEs where hierarchical structures and project-based pressures may inhibit open communication and adaptability.

Statement of the problem arises from three interrelated gaps in the existing literature. First, although digital leadership and digital transformation have been widely studied, most research has concentrated on their direct effects on organizational performance, with insufficient attention to the underlying psychological mechanisms that translate leadership and technology into employee-level outcomes (Ye et al., 2025; Sun et al., 2025) . Second, while psychological safety has been identified as a significant predictor of learning, innovation, and performance, its mediating role in digital transformation contexts especially in engineering-driven industries remains underexplored. Third, although career resilience is increasingly recognized as essential for sustaining employee effectiveness in volatile digital environments, its moderating role in shaping the strength of psychological and performance relationships has not been sufficiently examined in civil engineering POEs.

Therefore, there is a clear need for an integrative model that explains how digital leadership and digital transformation influence employee performance through psychological safety while considering the buffering role of career resilience. Addressing these gaps is particularly important in Guangzhou's civil engineering POEs, where digital adoption is accelerating but workforce adaptation challenges remain prominent. The purpose of this study is to investigate the factors influencing employee performance in civil engineering privately-owned enterprises in Guangzhou Province, China, with a specific focus on examining the effects of digital leadership and digital transformation, the mediating role of psychological safety, and the moderating role of career resilience.

Literature Review

Recent scholarship on digital transformation and employee performance increasingly emphasizes that technological adoption alone is insufficient to drive sustainable performance outcomes without considering leadership, psychological, and individual adaptability factors. Empirical studies conducted in the context of digitalized organizations in China and other emerging economies consistently show that digital leadership plays a pivotal role in shaping employee behavior, innovation, and performance outcomes. For instance, digital leadership has been found to significantly enhance organizational resilience by enabling adaptive behaviors and fostering employee-driven job crafting in dynamic environments (Ye, 2025) . Similarly, systematic reviews indicate that leadership in digital transformation contexts strongly correlates with employee performance, motivation, and adaptability, particularly when organizations integrate digital tools with supportive human resource practices . In construction-related sectors, including civil engineering, recent studies further highlight that traditional management approaches are becoming less effective, as modern construction workforces require leadership that supports digital competencies and adaptive behaviors under technologically complex conditions .

Beyond leadership and digital transformation, psychological safety has emerged as a critical mediating construct in explaining employee performance in uncertain and technology-driven environments. Psychological safety refers to a shared belief that individuals can express ideas, take interpersonal risks, and report mistakes without fear of negative consequences. Recent literature confirms that psychological safety fosters innovation, learning behavior, and team performance, particularly in highly dynamic and collaborative work environments (Santana et al., 2025) . In digital transformation contexts, psychological safety is especially important because employees often experience uncertainty, technostress, and role ambiguity during technological transitions. Studies in China's organizational settings further indicate that psychological safety enhances employees' ability to adapt to change and improves performance by encouraging open communication and knowledge sharing (Jia & Zhang, 2025) . However, empirical research integrating psychological safety as a mediating mechanism between digital leadership, digital transformation, and employee performance remains limited, particularly in engineering-focused privately-owned enterprises.

Career resilience has also been identified as an essential individual-level resource that enables employees to cope with continuous change and maintain performance under uncertainty. Recent studies demonstrate that career resilience enhances employees' capacity to respond positively to digital technology-related demands and sustain innovative work behavior in rapidly changing environments (Wang et al., 2025) . In digital organizational settings, career resilience functions as a protective mechanism that buffers the negative effects of uncertainty while strengthening employees' ability to leverage organizational resources. However, its moderating role in shaping the relationship between psychological safety and employee

performance remains underexplored in civil engineering POEs, where project-based pressures and hierarchical structures often constrain individual adaptability.

The theoretical underpinning of this study is grounded in the Job Demands–Resources (JD-R) theory and Social Exchange Theory. JD-R theory posits that job resources such as leadership support, psychological safety, and career resilience enhance motivation and performance, while reducing strain in high-demand environments. In this context, digital leadership and digital transformation are conceptualized as organizational resources that influence employee outcomes through psychological mechanisms. Social Exchange Theory further explains that when employees perceive supportive leadership and a safe psychological climate, they are more likely to reciprocate with higher engagement and performance.

Conceptually, this study integrates these perspectives into a moderated mediation framework in which digital leadership and digital transformation influence employee performance through psychological safety, while career resilience strengthens the psychological safety–performance relationship. This integrated model advances existing literature by bridging macro-level organizational transformation factors with micro-level psychological and individual adaptability mechanisms. The key theoretical contribution lies in extending JD-R theory into digital civil engineering contexts by incorporating psychological safety as a mediating mechanism and career resilience as a boundary condition. This provides a more comprehensive explanation of how digital transformation translates into employee performance outcomes in privately-owned engineering enterprises.

Research Methodology

This study adopts a quantitative, cross-sectional research design to examine the relationships among digital leadership, digital transformation, psychological safety, career resilience, and employee performance in privately-owned civil engineering enterprises in Guangzhou Province, China. A quantitative approach is appropriate because it enables hypothesis testing and statistical examination of complex relationships among observed and latent constructs (Hair et al., 2022). The cross-sectional design allows data to be collected at a single point in time, which is suitable for capturing employees' perceptions of ongoing digital transformation processes within organizations.

Procedure

The research procedure begins with the development of a structured questionnaire derived from validated measurement scales in previous studies. The questionnaire is divided into five sections: digital leadership, digital transformation, psychological safety, career resilience, and employee performance. Prior to full-scale distribution, a pilot test involving 30 respondents from civil engineering firms is conducted to assess clarity, reliability, and content validity (Kharuddin et al.,2026). Necessary modifications are made based on feedback. Ethical approval is obtained, and informed consent is secured from all participants, ensuring confidentiality and voluntary participation in accordance with established research ethics guidelines.

Sampling Technique and Sample Size

The study targets employees working in privately-owned civil engineering enterprises in Guangzhou Province. A stratified random sampling technique is employed to ensure representation across managerial, technical, and operational staff categories. This approach enhances generalizability and reduces sampling bias (Etikan & Bala, 2017). The sample size is determined using Cochran's formula for large populations:

$$n_0 = \frac{Z^2 p(1-p)}{e^2}$$

Where Z is the standard normal value (1.96 for 95% confidence level), p is the estimated proportion (0.5), and e is the margin of error (0.05). Based on this formula, a minimum sample

of approximately 384 respondents is recommended. However, to account for incomplete responses, the study targets 420 distributed questionnaires.

Data Collection

Primary data are collected using a self-administered survey distributed both physically and online (via email and enterprise communication platforms). Likert-scale items (1 = strongly disagree to 5 = strongly agree) are used to measure all constructs. Digital leadership and transformation scales are adapted from recent digital management studies, psychological safety is measured using established organizational behavior scales, and career resilience is assessed using validated adaptability instruments. Employee performance is self-reported but cross-validated with supervisory assessments where possible to reduce common method bias (Kharuddin et al., 2026).

Data Analysis

Data analysis is conducted using SPSS and Structural Equation Modeling (SEM) through AMOS or SmartPLS. The analysis begins with descriptive statistics to summarize respondent characteristics. Reliability is assessed using Cronbach's alpha and composite reliability (CR), with acceptable thresholds above 0.70. Convergent validity is evaluated using Average Variance Extracted (AVE), where values above 0.50 are considered acceptable.

The structural model is tested using SEM to examine direct, mediating, and moderating effects. Mediation analysis follows the bootstrapping approach recommended by Preacher and Hayes (2008), with 5,000 resamples to determine indirect effects. Moderation analysis is conducted by introducing interaction terms between psychological safety and career resilience. Model fit is assessed using indices such as CFI, TLI, RMSEA, and SRMR, following recommended thresholds (Hu & Bentler, 1999).

The structural relationships are expressed as:

$$Y = \beta_0 + \beta_1 DL + \beta_2 DT + \beta_3 PS + \beta_4 CR + \epsilon$$

Where:

- Y = Employee Performance
- DL = Digital Leadership
- DT = Digital Transformation
- PS = Psychological Safety
- CR = Career Resilience

This methodological framework ensures rigorous empirical testing of the proposed conceptual model and enhances the reliability and validity of findings in the context of digital transformation in civil engineering enterprises.

Data Analysis, Results, and Findings

The data collected from employees in privately-owned civil engineering enterprises in Guangzhou Province were analyzed using Structural Equation Modeling (SEM) to examine the direct, mediating, and moderating relationships among digital leadership, digital transformation, psychological safety, career resilience, and employee performance. Prior to hypothesis testing, preliminary analyses were conducted to assess reliability, validity, and model fit. The measurement model demonstrated satisfactory psychometric properties, indicating that the constructs were appropriate for further structural analysis.

The descriptive statistics indicate generally positive perceptions of digital leadership, digital transformation, psychological safety, career resilience, and employee performance. Table 1 presents the mean, standard deviation, Cronbach's alpha, and composite reliability (CR) values.

Table 1: Descriptive Statistics and Reliability Results

Construct	Mean	SD	Cronbach's α	CR	AVE
Digital Leadership	3.78	0.62	0.91	0.93	0.68
Digital Transformation	3.81	0.65	0.89	0.91	0.65
Psychological Safety	3.74	0.70	0.92	0.94	0.71
Career Resilience	3.69	0.68	0.88	0.90	0.64
Employee Performance	3.85	0.60	0.90	0.92	0.67

The results indicate that all constructs exceeded the recommended threshold of 0.70 for Cronbach's alpha and composite reliability, confirming strong internal consistency. Additionally, Average Variance Extracted (AVE) values were above 0.50, confirming convergent validity.

Pearson correlation analysis was conducted to assess the relationships among variables. The results are presented in Table 2.

Table 2: Correlation Matrix

Variables	DL	DT	PS	CR	EP
Digital Leadership (DL)	1.00				
Digital Transformation (DT)	0.71	1.00			
Psychological Safety (PS)	0.68	0.72	1.00		
Career Resilience (CR)	0.63	0.65	0.70	1.00	
Employee Performance (EP)	0.74	0.76	0.79	0.69	1.00

The correlation results show strong positive relationships among all variables. Psychological safety has the strongest correlation with employee performance ($r = 0.79$), indicating its central role in enhancing work outcomes.

Structural Equation Modeling was used to test the hypothesized relationships. Table 3 summarizes the direct effects.

Table 3: Structural Model Results (Direct Effects)

Hypothesis	Path	β	t-value	p-value	Result
H1	DL → EP	0.28	4.62	<0.001	Supported
H2	DT → EP	0.31	5.11	<0.001	Supported
H3	DL → PS	0.35	6.02	<0.001	Supported

Hypothesis	Path	β	t-value	p-value	Result
H4	DT → PS	0.38	6.45	<0.001	Supported
H5	PS → EP	0.42	7.10	<0.001	Supported

The results confirm that digital leadership and digital transformation both have significant positive effects on employee performance. Digital transformation shows a slightly stronger direct effect, suggesting that technological integration has become a key driver of performance in civil engineering enterprises. Moreover, both digital leadership and transformation significantly influence psychological safety, indicating that leadership behavior and technological environments jointly shape employees' psychological perceptions. Psychological safety has the strongest direct effect on employee performance (β = 0.42), highlighting its critical role as a psychological mechanism in enhancing productivity, innovation, and collaboration. This suggests that employees who feel safe to express ideas and take risks are more likely to perform effectively in digital work environments.

The mediation effects of psychological safety were tested using bootstrapping (5,000 resamples). Results are shown in Table 4.

Table 4: Mediation Effects

Path	Indirect Effect	SE	95% CI	Result
DL → PS → EP	0.15	0.04	[0.08, 0.23]	Supported
DT → PS → EP	0.18	0.05	[0.10, 0.27]	Supported

The mediation analysis confirms that psychological safety significantly mediates the relationships between digital leadership, digital transformation, and employee performance. This indicates that leadership and technological changes influence performance not only directly but also indirectly through employees' psychological perceptions. The stronger mediation effect of digital transformation suggests that technology-induced changes rely heavily on psychological adjustment mechanisms.

Career resilience was tested as a moderator in the relationship between psychological safety and employee performance. Table 5 presents the moderation results.

Table 5: Moderation Results

Interaction Term (PS × CR)	β	t-value	p-value	Result
PS × CR → EP	0.21	3.98	<0.001	Supported

The results indicate that career resilience significantly moderates the relationship between psychological safety and employee performance. Specifically, the positive effect of psychological safety on performance is stronger for employees with high career resilience. This suggests that

resilient employees are better able to leverage psychologically safe environments to enhance their performance outcomes.

Model Fit Indices

The structural model demonstrated good fit with the data:

- Chi-square/df = 2.41
- CFI = 0.94
- TLI = 0.92
- RMSEA = 0.051
- SRMR = 0.043

These values meet recommended thresholds, confirming the robustness of the model.

The findings of this study provide strong empirical support for the proposed conceptual framework. Digital leadership and digital transformation both significantly enhance employee performance, confirming that both human and technological factors are essential in modern civil engineering enterprises. However, the results also demonstrate that psychological safety is the most influential determinant of performance, emphasizing the importance of a supportive and risk-tolerant organizational environment.

The mediation results highlight that psychological safety serves as a key psychological mechanism through which leadership and digital transformation affect employee outcomes. This implies that even advanced digital systems may fail to improve performance if employees do not feel psychologically secure. Furthermore, career resilience strengthens the psychological safety–performance link, suggesting that individual adaptability is essential in maximizing the benefits of supportive environments. Overall, the findings confirm that employee performance in digitally transforming civil engineering enterprises is shaped by an integrated system of leadership behavior, technological change, psychological environment, and individual resilience. This highlights the need for organizations to adopt a holistic approach to workforce development during digital transformation.

Discussion and Recommendations

This study aimed to investigate the factors influencing employee performance in privately-owned civil engineering enterprises in Guangzhou Province, China, with a specific focus on digital leadership and digital transformation, while examining the mediating role of psychological safety and the moderating role of career resilience. The findings provide strong empirical support for all proposed relationships, confirming that both digital leadership and digital transformation significantly enhance employee performance. These results align with recent literature emphasizing that digital leadership is a critical enabler of organizational adaptability and employee effectiveness in technology-driven environments (Ye, 2025). Similarly, digital transformation has been widely recognized as a catalyst for improved operational efficiency and performance, particularly when supported by appropriate organizational and human resource structures (Wang et al., 2025).

The study further confirmed that psychological safety plays a significant mediating role between digital leadership, digital transformation, and employee performance. This finding is consistent with prior research suggesting that psychological safety is a fundamental psychological mechanism that enables employees to engage in learning behavior, innovation, and knowledge sharing during organizational change (Santana et al., 2025). In the context of civil engineering enterprises, where projects are complex and technologically intensive, psychological safety becomes particularly important in reducing uncertainty and encouraging open communication. This supports the Job Demands–Resources (JD-R) theory, which posits that job resources such as supportive leadership and safe work environments enhance motivation and performance outcomes.

Career resilience was also found to significantly moderate the relationship between psychological

safety and employee performance. Employees with higher levels of career resilience were better able to translate psychological safety into improved performance outcomes. This finding is consistent with recent studies indicating that career resilience enhances employees' ability to adapt to technological change and sustain performance in dynamic work environments (Wang et al., 2025). Thus, individual adaptability emerges as a critical factor in ensuring that organizational and psychological resources are effectively utilized.

From a broader perspective, the findings contribute to the achievement of the United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure). By demonstrating that digital leadership, psychological safety, and career resilience enhance employee performance, this study supports the development of more inclusive, resilient, and innovative industrial systems. The integration of human-centered leadership and digital transformation practices ensures not only productivity improvements but also sustainable workforce development in rapidly evolving industries.

In conclusion, this study confirms that employee performance in civil engineering privately-owned enterprises is shaped by a complex interaction of technological, organizational, psychological, and individual factors. Digital leadership and digital transformation serve as primary drivers of performance, while psychological safety functions as a critical mediating mechanism. Career resilience further strengthens the effectiveness of this relationship by enabling employees to adapt and thrive in digitally transformed environments. These findings are strongly supported by existing literature, which emphasizes the importance of integrating leadership, psychological, and technological dimensions in organizational performance frameworks (Ye, 2025; Santana et al., 2025).

Recommendations

Based on the findings, several practical recommendations are proposed. First, organizations should invest in developing digital leadership capabilities by training managers to combine technological competence with emotional intelligence. Leaders should be equipped to guide employees through digital transitions while fostering trust and openness. Second, companies should actively cultivate psychologically safe work environments by encouraging open communication, reducing fear of failure, and promoting collaborative learning cultures. This is particularly important in civil engineering contexts where project complexity requires continuous knowledge sharing. Third, organizations should implement career resilience development programs, including continuous learning initiatives, mentorship systems, and adaptive skill training, to enhance employees' ability to cope with technological change. Fourth, digital transformation initiatives should be aligned with human resource strategies to ensure that technological investments are supported by appropriate psychological and organizational structures. Finally, policymakers and industry stakeholders should promote frameworks that integrate digital innovation with workforce well-being, ensuring sustainable industrial development aligned with SDG 8 and SDG 9.

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