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Research paper



Fostering Sustainable Innovation Through Digital Competence: The Effect of Generation Z's Work Engagement and Inclusive Leadership in Technology Companies

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Abstract

This study explores the impact of digital competence on the innovation behavior of Generation Z employees in Chinese technology firms, emphasizing the mediating role of work engagement and the moderating influence of inclusive leadership. Drawing on Social Cognitive Theory, the research develops and tests a model to explain how technological capabilities lead to innovative outcomes. Data were collected from 406 Generation Z employees in R&D departments of leading Chinese technology firms. The results revealed that digital competence positively influences innovation behavior, both directly and indirectly, by enhancing work engagement, which in turn boosts innovation. Work engagement was found to be a partial mediator, suggesting that digital competence promotes innovation by increasing employees' vigor, dedication, and absorption in their tasks. Additionally, inclusive leadership was shown to moderate the relationship between digital competence and work engagement, with stronger effects observed when inclusive leadership practices were high. This study highlights the importance of integrating human capital development, psychological resources, and organizational practices to foster innovation. For firms seeking sustainable competitive advantage in dynamic technological environments, the findings suggest strategies focusing on digital skills, work engagement, and inclusive leadership.

Keywords: *Digital Competence, Employee Innovation Behavior, Gen Z, Inclusive Leadership, Work Engagement*

1. Introduction

Amidst accelerating technological progress and continuous shifts toward digitalization, innovation has emerged as a cornerstone of sustained competitive advantage for organizations across sectors. This trend is particularly pronounced within the technology industry, where accelerated change necessitates continual adaptation and innovation [1]. Simultaneously, the global workforce is undergoing a notable generational shift, with Generation Z (individuals born between 1997 and 2006) increasingly occupying key roles in technology-driven organizations [2]. As digital natives, members of Generation Z (Gen Z) bring distinct attitudes, competencies, and expectations that are reshaping organizational dynamics and innovation trajectories [3].

The intersection of digital transformation and generational change presents both opportunities and challenges for sustainable organizational development. Among the critical competencies in this context is digital competence, which is defined as the knowledge, skills, and attitudes required to effectively engage with digital tools and environments [4]. While prior studies have linked digital competence with various organizational outcomes, its specific influence on innovation behavior at the individual level, particularly among Gen Z employees in high-tech sectors, remains insufficiently examined [5].

Innovation behavior refers to the process through which employees generate, advocate for, and implement novel ideas that contribute to organizational effectiveness [6]. As firms strive to maintain competitiveness and pursue sustainable development, understanding the antecedents of such behavior is of paramount importance [7]. Although digital competence is increasingly regarded as a foundational capability for employee innovation, the underlying mechanisms through which it translates into innovative outcomes warrant further exploration [8]. To this end, Social Cognitive Theory (SCT) provides a pertinent theoretical lens. SCT posits that human behavior is shaped by the dynamic interplay of personal factors, behavioral patterns, and environmental conditions [9]. Within this conceptual model, work engagement—characterized by high levels of energy, commitment, and immersion in work tasks [10]—serves as a key intermediary linking digital competence to innovation behavior. Individuals with high levels of digital competence are likely to experience enhanced self-efficacy and

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lower cognitive demands when interacting with digital technologies, which in turn may foster greater engagement and subsequently higher levels of innovation behavior [11].

Moreover, contextual variables such as leadership style are instrumental in shaping employee experiences and behaviors [12]. Inclusive leadership has gained traction as a leadership approach that cultivates psychological safety and encourages diverse contributions [11, 13]. Within the context of digital transformation, inclusive leadership may moderate the link between digital competence and work engagement by fostering an environment in which employees feel empowered to leverage their digital capabilities [14].

Despite the theoretical relevance of these constructs, empirical research examining the interrelationships among digital competence, work engagement, innovation behavior, and inclusive leadership remains limited, particularly in the context of Gen Z employees within high-tech industries. This gap is especially salient in the Chinese technology sector, which has emerged as a global innovation hub [15]. As Chinese technology firms grapple with challenges related to talent management and innovation acceleration amidst rapid growth and market competition, this context offers a valuable setting for investigating these dynamics [16].

Against this backdrop, the present study explores the influence of digital competence on innovation behavior among Gen Z employees in leading Chinese technology enterprises. Specifically, it examines the mediating role of work engagement and the moderating effect of inclusive leadership. This study seeks to answer the following research questions:

1. How does digital competence influence innovation behavior among Gen Z employees in Chinese technology companies?
2. Does work engagement mediate the relationship between digital competence and innovation behavior?
3. How does inclusive leadership moderate the relationship between digital competence and work engagement?

This study contributes to the literature by clarifying how digital competence fosters innovation behavior among Gen Z employees through work engagement, thereby extending Social Cognitive Theory. It also highlights inclusive leadership as a key contextual factor that strengthens this relationship. By focusing on the Chinese technology sector, the research adds a valuable non-Western perspective. Practically, the findings inform more effective talent and leadership strategies to enhance innovation and support sustainable organizational development.

The paper proceeds with a literature review and the development of hypotheses in the following section. This is followed by a detailed explanation of the research methodology, including sampling, measurement instruments, and data analysis techniques. Subsequently, the findings from empirical analysis are reported, accompanied by a discussion of their theoretical and practical significance. The paper concludes by outlining its limitations and offering directions for future research.

2. Literature Review

2.1 Social Cognitive Theory

Social Cognitive Theory (SCT), originally proposed by Bandura [9], offers a robust framework for explaining human behavior through the dynamic interplay of personal factors, environmental conditions, and behavioral responses. It emphasizes that individuals' cognitive resources—such as knowledge, skills, and competencies—interact with their surrounding environment to influence behavioral outcomes [17]. This theoretical lens is particularly suitable for exploring innovation behavior in organizational settings, as it accounts for both individual-level capabilities (e.g., digital competence) and contextual influences (e.g., leadership) that shape employee engagement and innovation.

A central construct within SCT is self-efficacy, defined as individuals' confidence in their ability to carry out specific tasks to achieve desired results [18]. Higher self-efficacy enhances motivation, persistence, and task performance, especially under challenging conditions [19]. In digitalized work environments, employees with strong digital competence are more likely to exhibit high technological self-efficacy, which can foster greater work engagement and, in turn, innovation behavior [20].

Moreover, SCT underscores the influence of environmental and social factors, such as leadership, on shaping individual cognition and behavior [21]. Through mechanisms like observational learning and social modeling, employees often internalize behavioral norms and expectations modeled by leaders [22]. In this context, inclusive leadership can be seen as an enabling environmental condition that facilitates the translation of digital competence into work engagement and subsequent innovative actions.

Drawing on SCT, this study develops an integrated conceptual model that examines how digital competence contributes to innovation behavior among Gen Z employees in Chinese technology firms. It further investigates work engagement as a mediating process and inclusive leadership as a moderating contextual factor influencing this relationship.

2.2 Digital Competence and Employee Innovation Behavior

Digital competence involves the confident, critical, and creative utilization of information and communication technologies (ICTs) to meet targets associated with work, employability, learning, leisure, integration, and participation in society [4]. While definitions vary across frameworks, such as the widely used digital education framework in education settings and other models emphasizing workplace-specific digital literacies, this study adopts a broader perspective that integrates technical proficiency, cognitive skills, and appropriate attitudes necessary for effective engagement with digital technologies [23]. In today's workplace, digital competence has transitioned from a niche technical skill to an essential capability across a wide range of professional roles [24]underscoring its relevance beyond specific sectors or narrowly defined contexts.

Employee innovation behavior is characterized by the intentional generation and implementation of new ideas across roles, teams, or organizations, to advance individual, group, or organizational outcomes [25]. This behavior typically includes several phases, such as identifying opportunities, generating ideas, advocating for them, and putting them into practice [26]. As firms increasingly depend on employee-initiated innovation to sustain competitive advantage, identifying its key predictors has become a priority [7].

In a highly digitalized R&D environment, Z-generation employees with strong digital competence are more confident in using digital tools for innovative attempts. Lei, Tang [27] found that the level of digital competence is significantly positively correlated with employees' innovative behavior, and this relationship is particularly evident in the R&D departments of technology-intensive enterprises. Wang, Niu [28] also confirmed that employees with strong digital capabilities are more inclined to propose and implement innovative solutions.

The reciprocal determinism in SCT emphasizes the interface of individual competencies and the environment. Against the backdrop of digital transformation, strong digital competence enables Gen Z R&D personnel to better grasp the innovation opportunities brought by digital technology. Huu [12] found that in organizations with a high degree of digitalization, employees' digital competence has a more

significant role in promoting innovative behavior. This relationship is particularly important in R&D departments because innovative work increasingly relies on complex digital tools and platforms.

Among Gen Z employees, their digital fluency enables more efficient use of technological tools in innovation-related tasks [12]. For Chinese technology enterprises, where rapid digital transformation and market competition prevail, digital competence likely plays a pivotal role in driving innovation [29]. Based on the above theoretical perspectives and empirical findings, the following hypothesis is proposed:

H1: Digital competence is positively associated with innovation behavior among Gen Z employees in Chinese technology firms.

2.3 Mediating Role of Work Engagement

Work engagement has been conceptualized to be a positive, enriching, and job-related state of mind marked by vitality, dedication, and absorption [30]. Vigor reflects high-energy levels and mental toughness at work; dedication implies a powerful feeling of meaning, enthusiasm, and challenge; and absorption denotes deep attention and immersion in work activities [31]. This construct has emerged as a central theme in organizational behavior, often associated with positive employee outcomes.

The Job Demands–Resources (JD-R) model suggests that personal resources, such as competencies and perceived self-efficacy, enhance work engagement by improving employees' ability to cope with job demands and utilize available resources effectively [32]. Digital competence, as a valuable personal resource, supports task efficiency, mitigates technology-related stress, and strengthens perceived control over digital work processes [33].

In highly digitalized work environments, Gen Z employees with strong digital competence can enhance their work confidence and willingness to engage. Sang, Wang [34] found that the level of digital competence is significantly and positively correlated with employee work engagement, and that this relationship is particularly evident in technology-intensive firms. For Gen Z R&D employees growing up in the digital era, digital competence has become a core competence of their work, which directly affects their level of work engagement.

In addition, SCT states that the use and development of competence is a cyclical and cumulative process. In a digital work environment, the successes gained by Gen Z employees in utilizing digital competence will further enhance their work engagement, creating a virtuous cycle. Rubel, Kee [35] revealed that the enhancement of digital competence can sustainably contribute to the enhancement of work engagement, especially in innovation-oriented R&D teams. Based on these arguments, it is proposed that:

H2: Digital competence is positively associated with work engagement among Gen Z employees in Chinese technology firms.

Work engagement is also likely to enhance innovative behavior through various psychological pathways. Employees with high work engagement show greater vigor, dedication, and absorption, which can expand their cognitive and behavioral scope. Koroglu and Ozmen [36] found that employees with high levels of work engagement are more likely to generate innovative ideas and put them into practice. In a digital work environment, this broadening effect may be more significant because the Z generation employees can make full use of digital tools to expand their innovation boundaries. Ali, Li [37] confirmed that work engagement significantly promotes innovative behavior by enhancing employees' cognitive flexibility in multinational corporations.

It is worth noting that in the context of R&D work, the impact of work engagement on innovative behavior may be unique. Lee and Choi [38] found that in the R&D department, work engagement not only affects the quantity of innovation, but also the quality of innovation. This relationship may be more prominent among Gen Z R&D personnel because they tend to have higher expectations and enthusiasm for work, and this sense of engagement can be transformed into more valuable innovative results.

Finally, the unique innovation-oriented culture of Chinese technology companies may strengthen the relationship between work engagement and innovative behavior. Koroglu and Ozmen [36] indicated that in an organizational culture that emphasizes innovation, work engagement is more easily transformed into specific innovative actions. For Gen Z employees, this cultural atmosphere is consistent with their pursuit of self-realization, further promoting the transformation of work engagement into innovative behavior. Accordingly, the following hypotheses are proposed:

H3: Work engagement is positively associated with innovation behavior among Gen Z employees in Chinese technology firms.

H4: Work engagement mediates the relationship between digital competence and innovation behavior among Gen Z employees in Chinese technology firms.

2.4 Moderating Role of Inclusive Leadership

Inclusive leadership is defined as a leadership style marked by openness, accessibility, and availability in leader–follower interactions [39]. Such leaders are characterized by behaviors that welcome diverse input, foster a sense of belonging while appreciating individual uniqueness, and cultivate psychological safety that encourages risk-taking and learning [40].

From the perspective of SCT, leadership functions as a crucial environmental determinant that influences employees' cognitive appraisals and behavioral patterns [17]. The extent to which personal resources, such as digital competence, are transformed into motivational states such as work engagement may depend on the leadership environment, which can facilitate or constrain resource activation [41].

Inclusive leadership may enhance the impact of digital competence on work engagement through several pathways. First, inclusive leadership creates favorable conditions for employees to exert their digital competence by encouraging digital innovation and experimentation. Atiku, Itembu-Naunyango [42] found that digital competence has a stronger positive impact on work engagement in a highly inclusive leadership environment. This may be because inclusive leadership provides employees with more opportunities to use and demonstrate digital capabilities. Borisov and Vinogradov [43] confirmed in a study of Visegrad countries that when leaders show high inclusiveness, employees are more likely to actively use digital skills and maintain high work engagement.

Second, the psychological safety environment created by inclusive leadership helps employees boldly try new technologies in digital work. Boccoli, Gastaldi [44] showed that in teams with high psychological safety, employees are more willing to use digital skills to try new working methods, thereby showing a higher level of work engagement. This sense of security is particularly important for R&D work that often requires trying new technologies.

In addition, in the context of the rapid digital transformation of Chinese technology companies, inclusive leadership's supportive attitude towards innovation may further strengthen this moderating effect. Chatterjee, Chaudhuri [45] showed that in organizations with a high degree of digital transformation, inclusive leadership has a more significant moderating effect on the relationship between digital competence and work engagement. This effect is more obvious in R&D departments that emphasize innovation. Based on these theoretical insights and empirical findings, the following hypothesis is proposed:

H5: Inclusive leadership moderates the relationship between digital competence and work engagement among Gen Z employees in Chinese technology firms.

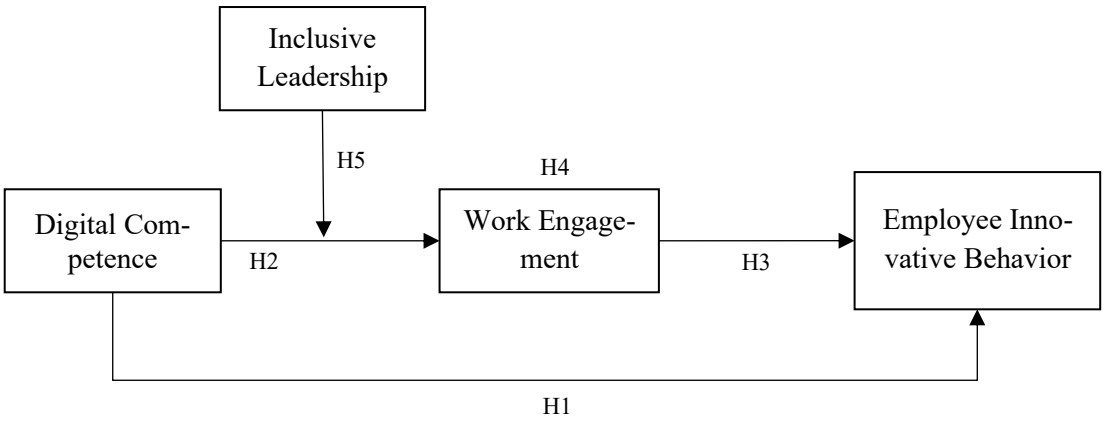


Fig. 1: Research Model

3. Methodology

3.1 Research Design

This study employs a quantitative research design using a cross-sectional survey to investigate the impact of digital competence on innovation behavior among Gen Z employees in Chinese technology companies, with a particular focus on the mediating role of work engagement and the moderating effect of inclusive leadership. Data were collected from employees working in the R&D departments of the top ten technology companies in China. The survey instrument was developed based on established theoretical frameworks and validated measurement scales to ensure the reliability and validity of the data. Structural Equation Modeling (SEM) was utilized as the primary analytical technique, enabling the simultaneous examination of multiple relationships and the assessment of both direct and indirect effects, including mediation and moderation, as specified in the research model. This methodological approach ensures a comprehensive and rigorous analysis of the proposed hypotheses.

3.2 Sample and Participants

The sample consisted of 406 valid responses collected from Gen Z employees (born between 1997 and 2006) working in the R&D departments of leading Chinese technology companies. These companies were selected due to their prominent role in technological innovation and digital transformation. Gen Z employees were chosen as the focus of the study because they are digital natives, with high levels of digital competence, and are increasingly occupying critical roles in innovation processes within technology firms. The respondents were stratified by their roles within the R&D departments to ensure a diverse representation of positions, ranging from entry-level employees to mid-level professionals. This stratified random sampling technique ensured that the findings would reflect the broader population of Gen Z employees in similar settings.

3.3 Measurement Instruments

The study used several well-established measurement scales to assess the key constructs. Digital competence was measured using the scale developed by Antonietti, Cattaneo [46] and Redecker [47], which evaluates the ability to use digital tools effectively, engage critically with digital content, and apply digital skills creatively in problem-solving. Work engagement was assessed using the Work Engagement Scale from Wang, Yang [48]. Innovation behavior was measured with a scale adapted from Wang, Yang [48]capturing the generation, promotion, and implementation of new ideas. Inclusive leadership was assessed using the Inclusive Leadership Scale, adapted from Fang, Chen [49], which evaluates leaders' openness, accessibility, and support for diverse contributions in the workplace. All scales utilized a Likert-type response format, ranging from strongly disagree to strongly agree, with adaptations made where necessary for the Chinese context.

3.4 Data Collection Procedure

Data was collected using an online survey distributed to employees in the R&D departments of the selected technology companies. An invitation letter was sent to participants explaining the study's purpose, assuring them of confidentiality, and informing them of their voluntary participation. The survey was conducted over four weeks, with reminders sent periodically to ensure a sufficient response rate. Before the main data collection, a pilot test was conducted with 30 employees from a similar sector to assess the clarity of the questions and the reliability of the measurement scales. Based on the results of the pilot test, minor adjustments were made to the survey to improve its readability and clarity.

3.5 Data Analysis

The collected data were analyzed using Structural Equation Modeling (SEM) with maximum likelihood estimation to test the hypothesized relationships between the variables. First, Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model and ensure that the constructs were measured accurately. The model fit is evaluated with several fit indices, including CFI, TLI, RMSEA, and SRMR. Once the measurement model was validated, SEM was used to test the hypothesized direct effects, as well as the mediating and moderating effects. Mediation analysis was conducted to examine the role of work engagement in linking digital competence to innovation

behavior, while moderation analysis was used to assess the moderating effect of inclusive leadership on the relationship between digital competence and work engagement.

4. Results

4.1 Descriptive Statistics and Sample Characteristics

A total of 406 valid responses were collected from Gen Z employees working in the R&D departments of leading Chinese technology companies. Table 1 presents the demographic profile of the respondents. The average age of participants was 24.52 years, with a relatively balanced gender distribution (50.7% female and 49.3% male). In terms of educational background, most respondents held a bachelor's degree (47.5%), followed by those with college degrees or lower (34.5%) and those with master's degrees or above (18%). Regarding work experience, 40.4% of the respondents worked for 0-5 years, 39.7% for 6-10 years, and 20% for over 10 years.

Table 1: Demographic Characteristics of Respondents

Variables	Items	Frequency	Percent
Age	Average	24.52	100
Gender	Female	206	50.7
	Male	200	49.3
Education	College degree or lower	140	34.5
	Bachelor’s degree	193	47.5
	Master’s degree or above	73	18
Working years	0-5 years	164	40.4
	6-10 years	161	39.7
	Over 10 years	81	20

4.2 Measurement Model Assessment

The psychometric properties of the measurement scales were assessed through confirmatory factor analysis (CFA). Table 2 presents the results of the measurement model, including factor loadings, reliability, and validity measures. All factor loadings ranged from 0.787 to 0.837, exceeding the recommended threshold of 0.70, which indicates good indicator reliability [50].

Internal consistency was measured using Cronbach’s alpha and composite reliability (CR), with values for all constructs falling between 0.920 and 0.956, surpassing the recommended minimum of 0.70 [51]. These results indicate excellent internal consistency and reliability for all measurement scales.

Convergent validity was assessed using the average variance extracted (AVE). The AVE values for all constructs ranged from 0.647 to 0.663, exceeding the recommended threshold of 0.50 [52], which suggests that the scales demonstrated adequate convergent validity.

Table 2: Measurement Model Results

Variables	Items	Factor Loading	Cronbach α	CR	AVE
Digital Competence	DC1	0.801	0.920	0.920	0.656
	DC2	0.790			
	DC3	0.825			
	DC4	0.827			
	DC5	0.813			
	DC6	0.802			
Working Engagement	WE1	0.787	0.946	0.946	0.661
	WE2	0.815			
	WE3	0.816			
	WE4	0.800			
	WE5	0.810			
	WE6	0.815			
	WE7	0.809			
	WE8	0.828			
	WE9	0.836			
Employee Innovative Behavior	EIB1	0.799	0.948	0.948	0.647
	EIB2	0.812			
	EIB3	0.81			
	EIB4	0.791			
	EIB5	0.806			
	EIB6	0.811			
	EIB7	0.818			
	EIB8	0.795			
	EIB9	0.802			
	EIB10	0.801			
Inclusive Leadership	IL1	0.799	0.956	0.956	0.663
	IL2	0.809			
	IL3	0.824			
	IL4	0.804			
	IL5	0.816			
	IL6	0.825			
	IL7	0.799			
	IL8	0.819			
	IL9	0.798			
	IL10	0.837			
	IL11	0.826			

4.3 Discriminant Validity and Correlation Analysis

Table 3 presents the correlations among the study variables and the assessment of discriminant validity. The diagonal elements in bold represent the square root of AVE for each construct, while the off-diagonal elements represent the correlations between constructs. For all construct pairs, the square root of AVE was greater than the corresponding correlation coefficient, confirming adequate discriminant validity [52].

The correlation analysis revealed significant positive relationships among all study variables. Digital competence was positively correlated with work engagement ($r = 0.448$, $p < 0.001$) and employee innovative behavior ($r = 0.402$, $p < 0.001$). Work engagement showed a positive correlation with employee innovative behavior ($r = 0.457$, $p < 0.001$). Inclusive leadership was positively correlated with digital competence ($r = 0.225$, $p < 0.001$), work engagement ($r = 0.127$, $p < 0.05$), and employee innovative behavior ($r = 0.142$, $p < 0.01$). These significant correlations provided preliminary support for the proposed hypotheses and justified further examination of structural relationships.

Table 3: Discriminant Validity and Correlation Analysis

	DC	WE	EIB	IL
Digital Competence (DC)	0.656			
Working Engagement (WE)	0.448***	0.661		
Employee Innovative Behavior (EIB)	0.402***	0.457***	0.647	
Inclusive Leadership (IL)	0.225***	0.127*	0.142**	0.663

Note: * p<0.05, ** p<0.01, *** p<0.001. Values on the diagonal represent the average variance extracted (AVE) for each construct.

4.4 Hypothesis Testing

An evaluation of the structural model was conducted to test the hypothesized relations. Models fit indices revealed a good fit between the theoretical model and empirical data: $\chi^2/df = 1.209$ (< 3), RMSEA = 0.023 (< 0.08), GFI and AGFI were both greater than 0.8, and IFI, TLI, and CFI were all greater than 0.9. These results suggest that the proposed model adequately represented the data structure.

4.4.1 Direct Effects

The results from the direct effects test are listed in Table 4. Consistent with H1, digital competence had a clear positive correlation with employee innovative behavior ($\beta = 0.193$, $p < 0.001$), supporting the notion that employees with higher digital competence demonstrate more innovative behavior. In support of H2, digital competence showed a clear positive correlation with work engagement ($\beta = 0.222$, $p < 0.001$), suggesting that higher digital competence contributes to increased work engagement among Gen Z employees. Additionally, work engagement had a clear positive correlation with employee innovative behavior ($\beta = 0.243$, $p < 0.001$), confirming H3 and demonstrating that the greater the level of work engagement, the more innovative behavior.

Table 4: Direct Effects Testing Results

Path	Estimate	S.E.	C.R.	P
H1: Digital Competence->Employee Innovative Behavior	0.193	0.053	3.62	0.000
H2: Digital Competence->Work Engagement	0.222	0.05	4.46	0.000
H3: Work Engagement-> Employee Innovative Behavior	0.243	0.06	4.062	0.000

4.4.2 Mediating Effect of Work Engagement

To test the mediating effect of work engagement on the relationship between digital competence and employee innovative behavior (H4), a bootstrap analysis with 5,000 resamples was conducted. The indirect effect of digital competence on employee innovative behavior through work engagement was 0.055, with a 95% confidence interval of [0.021, 0.112] that did not include zero. This result indicates a significant mediating effect, supporting H4. The presence of both significant direct and indirect effects suggests that work engagement partially mediates the relationship between digital competence and employee innovative behavior.

4.4.3 Moderating Effect of Inclusive Leadership

The moderating effect of inclusive leadership on the relationship between digital competence and work engagement (H5) was tested using hierarchical regression analysis. Table 5 presents the results of this analysis. In Model 1, only digital competence was entered as a predictor of work engagement, showing a significant positive effect ($\beta = 0.448$, $p < 0.001$, $R^2 = 0.201$). In Model 2, inclusive leadership was added as a predictor, but its effect was not significant ($\beta = 0.028$, $p = 0.543$), while digital competence remained significant ($\beta = 0.442$, $p < 0.001$, $R^2 = 0.202$).

In Model 3, the interaction term between digital competence and inclusive leadership was introduced, revealing a significant positive effect ($\beta = 0.347$, $p < 0.001$). The addition of the interaction term increased the explained variance significantly ($R^2 = 0.305$, $\Delta R^2 = 0.103$), indicating that inclusive leadership moderates the relationship between digital competence and work engagement. The positive coefficient of the interaction term suggests that the positive effect of digital competence on work engagement is stronger when inclusive leadership is high.

To further interpret of moderating effect, a simple slopes analysis was conducted, and the results are illustrated in Figure 2. The figure shows that the positive relationship between digital competence and work engagement is stronger at high levels of inclusive leadership compared to low levels of inclusive leadership. This finding confirms that inclusive leadership enhances the positive effect of digital competence on work engagement, thus supporting H5.

Table 5: Moderating Effect Testing Results

	Model 1					Model 2					Model 3				
	B	SE	t	p	β	B	SE	t	p	β	B	SE	t	p	β
Constant	3.405	0.041	83.045	0.000***	-	3.405	0.041	82.981	0.000***	-	3.342	0.039	85.291	0.000***	-
DC	0.441	0.044	10.079	0.000***	0.448	0.435	0.045	9.676	0.000***	0.442	0.554	0.045	12.379	0.000***	0.562
IL						0.027	0.044	0.609	0.543	0.028	0.054	0.041	1.315	0.189	0.056
DC*IL											0.313	0.04	7.731	0.000***	0.347
R^2			0.201					0.202					0.305		
Adjust R^2			0.199					0.198					0.3		
F	F (1,404)=101.580,p=0.000					F (2,403)=50.897,p=0.000					F (3,402)=58.802,p=0.000				

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

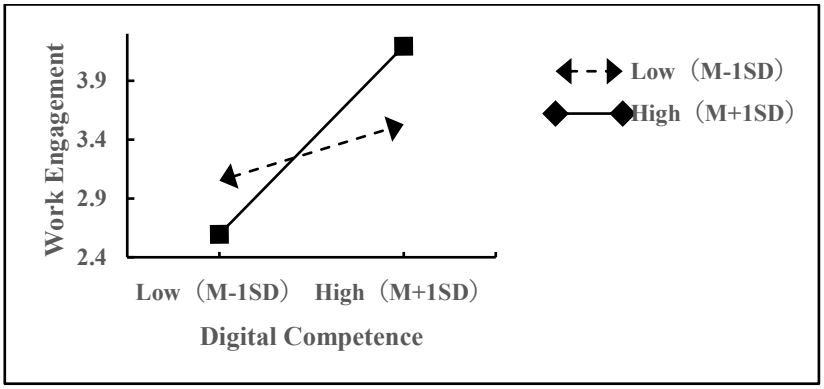


Fig. 2: Moderating Effect of Inclusive Leadership

5. Discussion

5.1 Discussion

The results offer robust evidence that digital competence significantly influences innovation behavior among Gen Z employees in Chinese technology firms, with work engagement serving as a key mediator and inclusive leadership as a moderator. These findings provide actionable insights for organizations aiming to drive sustainable innovation by leveraging the digital strengths of their youngest workforce segment.

Digital competence was found to positively predict innovation behavior (H1), aligning with Social Cognitive Theory [9], which posits that stronger competence enhances individuals' beliefs in their ability to innovate. As digital natives, Gen Z employees leverage their fluency not only in general ICTs but also in specific technical skills and platforms relevant to R&D contexts, such as AI-assisted development tools, cloud computing platforms (e.g., AWS, Azure), and collaborative coding environments. These capabilities enable them to identify opportunities, generate creative solutions, and implement innovations efficiently, particularly within China's rapidly evolving tech sector, thereby extending prior research [12, 29].

Organizations can implement the proposed strategies by offering specific training programs to enhance digital competence, such as workshops focused on advanced digital tools and creative applications of emerging technologies. Additionally, leadership workshops promoting inclusivity can help cultivate an environment where employees feel empowered to contribute their digital skills, boosting engagement and fostering innovation.

A significant positive link between digital competence and work engagement (H2) was also established. This suggests that digital skills act as personal resources that ease cognitive load and enable deeper task immersion. For Gen Z employees in technology-intensive roles, fluency in advanced digital tools—such as automated testing frameworks, DevOps pipelines, or data analytics platforms—reduces friction in digital workflows and supports seamless collaboration in distributed R&D teams. Such specific competencies enhance psychological availability for meaningful and creative work [35]. In digitally intensive environments, these advanced capabilities are vital for sustainable workforce engagement, reflecting the multi-dimensional nature of digital competence in tech-driven organizations [24].

The positive impact of work engagement on innovation behavior (H3) is consistent with prior findings [36, 53]. Engaged employees exhibit greater energy, dedication, and focus—traits that foster innovative action. This implies that engagement, driven by intrinsic motivation, serves as a sustainable foundation for innovation, especially under the high demands of China's tech industry.

Furthermore, work engagement was shown to partially mediate the relationship between digital competence and innovation behavior (H4), revealing a key psychological pathway. While digital competence directly fosters innovation, its influence is also channeled through elevated engagement. This insight deepens Social Cognitive Theory by emphasizing motivational processes as bridges between capabilities and outcomes. For practice, this means upskilling must be paired with strategies that enhance engagement to maximize innovation impact.

Most notably, inclusive leadership was found to moderate the effect of digital competence on work engagement (H5), amplifying the positive relationship under high inclusion. This underscores the critical role of leadership context in activating employee resources, aligning with earlier research [44, 45]. In hierarchical environments like many Chinese tech firms, inclusive leadership fosters psychological safety and recognition, empowering Gen Z employees to fully utilize their digital expertise in engaging with their work.

Finally, the findings should also be interpreted considering the Chinese cultural context, characterized by strong collectivist values and relatively high power distance. In such an environment, Gen Z employees may feel a greater sense of obligation to contribute to collective innovation goals and may rely more on guidance from inclusive leaders, amplifying the observed effects of digital competence, work engagement, and leadership. In contrast, in Western contexts where individualism and lower power distance prevail, employees might

place more emphasis on personal autonomy and self-directed innovation, potentially moderating the strength of these relationships. Similarly, other Asian contexts with varying degrees of collectivism and hierarchy could exhibit different dynamics.

5.2 Theoretical Implications

First, this study advances the application of SCT to the field of workplace innovation within digitally transformed settings. By revealing how digital competence serves as a personal resource that directly and indirectly (via motivation) influences innovation behavior, the research deepens our understanding of the cognitive-behavioral mechanisms driving innovation. The findings underscore SCT's relevance in explaining how technological capabilities lead to innovative outcomes, particularly among digital-native employees in knowledge-driven industries, thereby broadening its theoretical scope in the digital era.

Second, this study enriches the emerging literature on Gen Z by empirically examining the link between their digital fluency and innovation behavior. While prior research has often described Gen Z through generalized traits [54]Empirical insights into how their technological skills impact specific work outcomes remain scarce. By focusing on Gen Z in Chinese tech firms, this study offers context-specific evidence of how generational characteristics shape innovation, informing strategies for sustainable talent development in technology-intensive sectors.

Third, identifying work engagement as a partial mediator refines the Job Demands-Resources model by positioning digital competence as a personal resource that facilitates engagement. Unlike earlier studies that emphasized broader antecedents [32]This research highlights how digital proficiency reduces cognitive load from tech use, thereby enhancing psychological readiness for engagement. This insight adds theoretical depth to understanding sustainable engagement in digital workplaces.

Fourth, the moderating role of inclusive leadership provides important nuance to leadership theory by clarifying how contextual support enhances the positive impact of digital competence on engagement. Although the general benefits of inclusive leadership are well documented [40]This study highlights its specific value in leveraging technological skills among Gen Z employees. Inclusive practices that foster psychological safety and embrace diverse perspectives appear essential for translating digital potential into meaningful engagement and innovation.

Finally, this research contributes to sustainable development discourse by integrating digital competence, work engagement, and inclusive leadership as complementary elements for fostering innovation. This integrated perspective aligns with holistic approaches to sustainable organizational growth [55], suggesting that long-term innovation depends not solely on skill-building, but also on supporting employee wellbeing and inclusive leadership practices.

5.3 Practical Implications

First, the results underscore the strategic necessity of cultivating digital competence among employees as a critical driver of innovation. For technology firms, this entails designing structured upskilling programs that go beyond fundamental technical training to cover advanced digital literacy, creative application of emerging technologies (e.g., AI, cloud computing, data analytics), and adaptive learning capabilities. These programs can include hackathons, innovation labs, and rotational assignments across product, engineering, and customer-facing teams to foster cross-functional digital fluency. Sustainable development can be supported through digital mentoring by senior engineers, technology-focused communities of practice (e.g., internal developer forums), and dedicated innovation sprints that allocate time for experimentation, constructing a long-term investment in human capital and innovation potential.

Second, the observed partial mediating role of work engagement suggests that enhancing technical competence alone is insufficient. Technology firms should simultaneously create conditions that stimulate engagement by designing roles that provide autonomy over projects, visibility of impact (e.g., contributing to flagship products), and clear developmental pathways into specialized or leadership roles. Both physical and virtual workspaces should support creative collaboration (e.g., through agile war rooms or collaborative coding environments), while feedback systems should recognize both individual and team contributions to innovation pipelines. Importantly, digital tools themselves should be employed to facilitate, rather than hinder, engagement. Preventing digital fatigue and ensuring human-centered technology use are vital for maintaining sustained engagement.

Third, the moderating effect of inclusive leadership highlights its pivotal role in fostering innovation-supportive environments. In technology firms, where teams often comprise diverse professionals (e.g., engineers, designers, data scientists) and global talent, managers must develop inclusive leadership qualities at all levels. Leadership training should emphasize active listening to technical and non-technical voices, valuing unconventional ideas, fostering psychological safety during code reviews or sprint planning, and ensuring transparency in technical decision-making. Performance appraisals should incorporate inclusivity indicators such as team psychological safety and diversity of idea contributions. Long-term leadership development may be enhanced through peer coaching, inclusion-oriented action learning, and structured feedback mechanisms from team members.

Finally, the characteristics of Gen Z necessitate customized strategies for attraction, development, and retention, particularly relevant in technology firms competing for young digital-native talent. Recruitment and onboarding efforts should highlight opportunities to work with cutting-edge technologies and contribute to meaningful, socially responsible innovation. Career development should leverage their digital proficiency while offering growth in areas such as cross-functional product development, ethical AI design, and sustainable technology solutions. Retention strategies must reflect Gen Z's preference for meaningful work, lifelong learning, and work-life harmony. Building multi-generational teams can further strengthen organizational capability by encouraging intergenerational knowledge sharing and reciprocal learning.

5.4 Limitations and Future Research

First, the transect design of this study precludes definitive conclusions about causality among the variables. While the proposed relationships are theoretically justified, the temporal sequencing cannot be established conclusively. Future research would benefit from longitudinal designs that track changes in digital competence, work engagement, and innovation behavior over time. Such designs would provide stronger evidence regarding causal relationships and could also reveal how these relationships evolve as employees gain experience and organizations undergo digital transformation. Panel studies that follow Gen Z employees from early career stages through progressive responsibility levels would be particularly valuable for understanding how the influence of digital competence on innovation may change with professional development.

Second, the study relied exclusively on self-reported measures, which introduces the potential for common method bias despite the statistical precautions taken. Future studies should incorporate multiple data sources, such as supervisor ratings of innovation behavior, objective

assessments of digital competence, or organizational records of implemented innovations. Physiological measures of engagement (e.g., heart rate variability) or behavioral indicators (e.g., digital interaction patterns) could provide complementary perspectives on engagement levels. Multi-source data would strengthen confidence in the observed relationships and potentially reveal nuances not captured by self-reports alone.

Finally, while the study focused on Gen Z employees in Chinese technology companies, the generalizability of the findings to other generations, industries, or cultural contexts remains uncertain. Future research should examine these relationships across different generational cohorts to determine whether the patterns observed are unique to Gen Z or reflect broader psychological processes. Comparative studies across industries with varying levels of digital intensity would clarify the boundary conditions of the model. Cross-cultural investigations could reveal how national or regional cultural factors influence the relationships among digital competence, engagement, and innovation, particularly the moderating role of inclusive leadership in different power distance contexts.

6. Conclusion

This study investigated the impact of digital competence on innovation behavior among Gen Z employees in Chinese technology companies, examining the mediating role of work engagement and the moderating effect of inclusive leadership. The findings demonstrated that digital competence positively influences innovation behavior both directly and indirectly through enhanced work engagement. Inclusive leadership significantly strengthens the relationship between digital competence and work engagement, highlighting the importance of supportive leadership contexts in activating employees' digital capabilities. These results extend Social Cognitive Theory by clarifying how individual capabilities translate into innovative outcomes through motivational processes. The study contributes to sustainable development literature by illustrating how human capital development, psychological resources, and organizational practices can be integrated to foster innovation sustainably. For organizations seeking competitive advantage in rapidly evolving technological landscapes, developing digital competence, fostering work engagement, and cultivating inclusive leadership represent complementary strategies for building sustainable innovation capacity.

References

[1] Tsou, H.-T. and J.-S. Chen, How does digital technology usage benefit firm performance? Digital transformation strategy and organisational innovation as mediators. Technology Analysis & Strategic Management, 2023. 35(9): p. 1114-1127.
[2] Rehman, H.M., N. Adnan, and S. Moffett, Innovation bloom: nurturing sustainability in urban manufacturing transformation amidst Industry 4.0 and aging workforce dynamics. Annals of Operations Research, 2024.
[3] Yang, H. and D. Zhou, Perceived Organizational Support and Creativity of Science-Technology Talents in the Digital Age: The Effects of Affective Commitment, Innovative Self-Efficacy and Digital Thinking. Psychology Research and Behavior Management, 2022. 15(null): p. 2421-2437.
[4] Falloon, G., From digital literacy to digital competence: the teacher digital competency (TDC) framework. Educational Technology Research and Development, 2020. 68(5): p. 2449-2472.
[5] Benítez-Márquez, M.D., et al., Generation Z Within the Workforce and in the Workplace: A Bibliometric Analysis. Frontiers in Psychology, 2022. 12.
[6] Scott, S.G. and R.A. Bruce, Determinants of Innovative Behavior: A Path Model of Individual Innovation in the Workplace. Academy of Management Journal, 1994. 37(3): p. 580-607.
[7] Anderson, N., K. Potočnik, and J. Zhou, Innovation and Creativity in Organizations:A State-of-the-Science Review, Prospective Commentary, and Guiding Framework. Journal of Management, 2014. 40(5): p. 1297-1333.
[8] Parker, S.K. and G. Grote, Automation, Algorithms, and Beyond: Why Work Design Matters More Than Ever in a Digital World. Applied Psychology, 2022. 71(4): p. 1171-1204.
[9] Bandura, A., Social foundations of thought and action. Englewood Cliffs, NJ, 1986. 1986(23-28).
[10] Schaufeli, W.B., A.B. Bakker, and M. Salanova, Utrecht work engagement scale-9. Educational and Psychological Measurement, 2003.
[11] Cai, W., et al. Optimizing Employee Creativity in the Digital Era: Uncovering the Interactional Effects of Abilities, Motivations, and Opportunities. International Journal of Environmental Research and Public Health, 2020. 17, DOI: 10.3390/ijerph17031038.
[12] Huu, P.T., Impact of employee digital competence on the relationship between digital autonomy and innovative work behavior: a systematic review. Artificial Intelligence Review, 2023. 56(12): p. 14193-14222.
[13] Cortellazzo, L., E. Bruni, and R. Zampieri, The Role of Leadership in a Digitalized World: A Review. Frontiers in Psychology, 2019. 10.
[14] Heim, I. and N. Sardar-Drenda, Assessment of employees' attitudes toward ongoing organizational transformations. Journal of Organizational Change Management, 2021. 34(2): p. 327-349.
[15] Leonidou, E., et al., An integrative framework of stakeholder engagement for innovation management and entrepreneurship development. Journal of Business Research, 2020. 119: p. 245-258.
[16] Li, M. and Y. Liu, The influence of digital innovation ecosystem of high-end equipment manufacturing on the intelligent maturity of enterprise – an empirical study on the configuration of the "three-layer core-periphery" structure. Business Process Management Journal, 2024. 30(1): p. 199-221.
[17] Bandura, A., Social Cognitive Theory in Cultural Context. Applied Psychology, 2002. 51(2): p. 269-290.
[18] Bandura, A., Toward a Psychology of Human Agency. Perspectives on Psychological Science, 2006. 1(2): p. 164-180.
[19] Chughtai, M.S. and Y. Khalid, Learning Organizations and Innovative Work Behaviors: A Moderated Mediation Model of Creative Self-Efficacy and Self-Leadership from the Perspective of Social Cognitive Theory and Social Schema Theory. Journal of Innovative Research in Management Sciences, 2022: p. 22-41.
[20] Al-Dokhny, A., et al., Students' Intentions to Use Distance Education Platforms: An Investigation into Expanding the Technology Acceptance Model through Social Cognitive Theory. Electronics, 2021. 10(23).
[21] Carillo, K., Understanding IS Theory: An Interpretation of Key IS Theoretical Frameworks Using Social Cognitive Theory, in Information Systems Theory: Explaining and Predicting Our Digital Society, Vol. 2, Y.K. Dwivedi, M.R. Wade, and S.L. Schneberger, Editors. 2012, Springer New York: New York, NY. p. 241-280.
[22] Bai, Y., L. Li, and J.T. and Liu, Leveraging the employee voice: a multi-level social learning perspective of ethical leadership. The International Journal of Human Resource Management, 2019. 30(12): p. 1869-1901.
[23] Gómez-Trigueros, I.M., M. Ruiz-Bañuls, and D. Ortega-Sánchez, Digital Literacy of Teachers in Training: Moving from ICTs (Information and Communication Technologies) to LKTs (Learning and Knowledge Technologies). Education Sciences, 2019. 9(4).
[24] Sánchez-Canut, S., et al., Professional Digital Competence: Definition, Frameworks, Measurement, and Gender Differences: A Systematic Literature Review. Human Behavior and Emerging Technologies, 2023. 2023(1): p. 8897227.
[25] Janssen, O., Job demands, perceptions of effort-reward fairness and innovative work behaviour. Journal of Occupational and Organizational Psychology, 2000. 73(3): p. 287-302.
[26] Yuan, F. and R.W. Woodman, Innovative Behavior in the Workplace: The Role of Performance and Image Outcome Expectations. Academy of Management Journal, 2010. 53(2): p. 323-342.

[27] Lei, H., et al., Enterprise digitalization, employee digital literacy and R&D cooperation: the moderating role of organizational inertia. Chinese Management Studies, 2024. 18(2): p. 479-505.
[28] Wang, G., et al., Unlocking digital potential: Exploring the drivers of employee dynamic capability on employee digital performance in Chinese SMEs-moderation effect of competitive climate. Heliyon, 2024. 10(4).
[29] Trieu, H.D.X., et al., Organisational resilience, ambidexterity and performance: the roles of information technology competencies, digital transformation policies and paradoxical leadership. International Journal of Organizational Analysis, 2024. 32(7): p. 1302-1321.
[30] Welch, M., The evolution of the employee engagement concept: communication implications. Corporate Communications: An International Journal, 2011. 16(4): p. 328-346.
[31] Jenaro, C., et al., Vigour and dedication in nursing professionals: towards a better understanding of work engagement. Journal of Advanced Nursing, 2011. 67(4): p. 865-875.
[32] Mazzetti, G., et al., Work Engagement: A meta-Analysis Using the Job Demands-Resources Model. Psychological Reports, 2023. 126(3): p. 1069-1107.
[33] Trenerry, B., et al., Preparing Workplaces for Digital Transformation: An Integrative Review and Framework of Multi-Level Factors. Frontiers in Psychology, 2021. 12.
[34] Sang, G., et al., Effort expectancy mediates the relationship between instructors' digital competence and their work engagement: evidence from universities in China. Educational technology research and development, 2023. 71(1): p. 99-115.
[35] Rubel, M.R.B., D.M.H. Kee, and N.N. Rimi, Promoting technology innovation performance through high involvement HRM, technology adaptation and innovativeness. Business Process Management Journal, 2023. 29(5): p. 1277-1302.
[36] Koroglu, Ş. and O. Ozmen, the mediating effect of work engagement on innovative work behavior and the role of psychological well-being in the job demands–resources (JD-R) model. Asia-Pacific Journal of Business Administration, 2022. 14(1): p. 124-144.
[37] Ali, H., M. Li, and X. Qiu, Employee Engagement and Innovative Work Behavior Among Chinese Millennials: Mediating and Moderating Role of Work-Life Balance and Psychological Empowerment. Frontiers in Psychology, 2022. Volume 13 - 2022.
[38] Lee, K.-J. and S.-Y. Choi, Resourceful and demanding attributes of organisational culture, employee satisfaction, and organisational performance of large R&D intensive firms in the US. Technology Analysis & Strategic Management, 2024. 36(11): p. 3187-3200.
[39] Nembhard, I.M. and A.C. Edmondson, Making it safe: the effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. Journal of Organizational Behavior, 2006. 27(7): p. 941-966.
[40] Randel, A.E., et al., Inclusive leadership: Realizing positive outcomes through belongingness and being valued for uniqueness. Human Resource Management Review, 2018. 28(2): p. 190-203.
[41] Wu, W.-L. and Y.-C. Lee, Do Work Engagement and Transformational Leadership Facilitate Knowledge Sharing? A Perspective of Conservation of Resources Theory. International Journal of Environmental Research and Public Health, 2020. 17(7).
[42] Atiku, S.O., K.A. Itembu-Naunyango, and O.M. Oladejo Inclusive Leadership and Employee Engagement as Critical Drivers of Sustainability in Telecommunication Companies. Administrative Sciences, 2024. 14, DOI: 10.3390/admsci14060126.
[43] Borisov, I. and S. Vinogradov, Inclusiveness as a key determinant of work engagement: evidence from V4 countries. Equilibrium. Quarterly Journal of Economics and Economic Policy, 2022. 17(4): p. 1015-1050.
[44] Boccoli, G., L. Gastaldi, and M. Corso, Transformational leadership and work engagement in remote work settings: the moderating role of the supervisor's digital communication skills. Leadership & Organization Development Journal, 2024. 45(7): p. 1240-1257.
[45] Chatterjee, S., et al., Digital workplace and organization performance: Moderating role of digital leadership capability. Journal of Innovation & Knowledge, 2023. 8(1): p. 100334.
[46] Antonietti, C., A. Cattaneo, and F. Amenduni, Can teachers' digital competence influence technology acceptance in vocational education? Computers in Human Behavior, 2022. 132: p. 107266.
[47] Redecker, C., European framework for the digital competence of educators: DigCompEdu. 2017.
[48] Wang, Y.-X., et al., The mediating role of inclusive leadership: Work engagement and innovative behaviour among Chinese head nurses. Journal of Nursing Management, 2019. 27(4): p. 688-696.
[49] Fang, Y.-C., et al., The Impact of Inclusive Leadership on Employees' Innovative Behaviors: The Mediation of Psychological Capital. Frontiers in Psychology, 2019. 10.
[50] Hair, J.F., et al., An Introduction to Structural Equation Modeling, in Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook, J.F. Hair Jr, et al., Editors. 2021, Springer International Publishing: Cham. p. 1-29.
[51] Nunnally, J. and I. Bernstein, Psychometric Theory 3rd edition (MacGraw-Hill, New York). 1994.
[52] Fornell, C. and D.F. Larcker, Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. Journal of Marketing Research, 1981. 18(3): p. 382-388.
[53] Ali, H., M. Li, and X. Qiu, Employee Engagement and Innovative Work Behavior Among Chinese Millennials: Mediating and Moderating Role of Work-Life Balance and Psychological Empowerment. Frontiers in Psychology, 2022. 13.
[54] Saha, P., A. Sengupta, and P. Gupta, Influence of personality traits on generation Z consumers' click-through intentions towards personalized advertisements: A mixed-methods study. Heliyon, 2024. 10(15).
[55] Banmairuroy, W., T. Kritjaroen, and W. Homsombat, The effect of knowledge-oriented leadership and human resource development on sustainable competitive advantage through organizational innovation's component factors: Evidence from Thailand 's new S- curve industries. Asia Pacific Management Review, 2022. 27(3): p. 200-209.