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Digital transformation and organizational resilience in manufacturing firms considering the roles of innovation culture and ESG practices

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Research Article

Keywords:

Posted Date: November 17th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11445951/v1

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Additional Declarations: No competing interests reported.

Abstract

The relationship between digital transformation and organizational resilience remains fervently debated due to the "digital paradox". Drawing on dynamic capability theory (DCT), this study examines the relationships among digital transformation (DT), innovation culture (IC), environmental, social, and governance (ESG) practices, and organizational resilience (ORS) in Vietnamese manufacturing firms. Using a quantitative survey approach, partial least squares structural equation modeling (PLS-SEM) was employed to analyze data from 700 top-level executives across manufacturing enterprises. The empirical findings reveal that while DT exerts a direct positive effect on ORS, its standalone effect size is relatively small. Crucially, IC positively mediates the DT–ORS relationship, demonstrating that digital technologies enhance resilience capabilities primarily by fostering an innovation-supportive internal environment. Furthermore, ESG practices positively moderate the DT–ORS nexus: DT strongly promotes ORS when ESG practices are high, whereas this positive effect becomes statistically non-significant when ESG practices are low. These findings resolve the digital paradox by showing that manufacturing firms cannot rely solely on technological deployment; instead, they must orchestrate a sequential capability-building process that pairs internal innovation culture with external ESG legitimacy to thrive amidst disruptions.

1. Introduction

Under the influence of Industry Revolution 4.0, applying digital technologies is gradually changing from a trend to a vital activity for enterprises around the world (Priyono et al., 2020). This is due to enterprises facing economic shocks, broken supply chains, and rapidly changing technology (Georgescu et al., 2024). Especially in an era of intensifying environmental turbulence and technological disruptions, digital capabilities are more crucial for organizational survival and sustainable development (Warner & Wäger, 2019).

Digital transformation (DT) represents a capability to drive firms to reconfigure processes, optimize resources, and increase awareness of external environments (Sleep et al., 2023). Moreover, integrating digital technologies into firm performance drives the creation of an interconnected network that enhances operational efficiency and fosters an innovation-supportive environment for understanding market dynamics (Guo et al., 2025).

Organizational resilience (ORS) is defined as a firm’s ability to anticipate potential threats, cope effectively with disruptions, and adapt to changing conditions (Lengnick-Hall et al., 2011; Sajko et al., 2021; Sawik, 2013). The resilience capability enables a firm to resist to challenging situations and emerge stronger when facing disruptions (Lengnick-Hall et al., 2011). Recently, ORS has become an essential strategy that companies must develop to anticipate, adapt to, respond to, and recover rapidly from unexpected events (Xie et al., 2022).

Prior studies on the DT-ORS relationship remain divided on whether DT’s influence on resilience capability is negative or positive. Several authors concluded that this relationship is positive (Jervier & Lin, 2026; Z. Wang & Jia, 2025). However, some researchers also emphasized the paradox of DT

affecting ORS negatively (Chi et al., 2025). These contrasting viewpoints indicate that the DT–ORS link involves more than technological deployment alone. The critical issue is how complementary organizational mechanisms and boundary conditions shape this association.

Although DT is expected to increase responsiveness with risk (Cyfert et al., 2025) by building stability, mitigating systemic risks (Guan et al., 2023), detecting operational threats (Modgil et al., 2022), and converting change-related risks into developmental opportunities (Z. Wang & Jia, 2025). However, Malewska et al. (2024) concluded that investing in digital facilities does not independently transform an organization's resilience capability. This limitation indicates why enterprises experienced failure during DT (Velyako & Musa, 2024). This is due to internal resistance and a lack of a culture of connection (Malewska et al., 2024). Thus, exploring the relationship between DT and ORS is necessary to understand how integrating culture and digital technologies can drive performance.

In addition, previous studies have also argued that the DT-ORS linkage is influenced by boundary conditions from micro factors. On the other hand, scholars are increasingly focusing on ESG practices to identify organizations' responsiveness strategies (S. Wang & Esperança, 2023). More recently, studies have explored the influence of social impact on the relationship between ESG practices and DT or ORS. However, using ESG practices as a boundary condition has still received a lack of attention from researchers. Thus, this is a gap that needs deeper investigation by researchers to explore the bottlenecks of the DT-ORS linkage.

To address these theoretical and empirical constraints, this study investigates the mediating role of innovation culture (IC) and the moderating role of ESG practices in the DT–ORS nexus. Specifically, this study addresses three research questions:

- **RQ1.** *To what extent is digital transformation directly associated with organizational resilience in manufacturing firms?*
- **RQ2.** *How does innovation culture mediate the relationship between digital transformation and organizational resilience?*
- **RQ3.** *How do ESG practices moderate the relationship between digital transformation and organizational resilience?*

By answering these questions, this study makes three primary contributions to the literature. First, we help resolve the "digital paradox" by demonstrating that while DT exerts both direct and indirect positive effects on ORS, its standalone direct effect size is relatively modest. This indicates that technological deployment alone does not automatically guarantee organizational resilience; rather, DT requires complementary internal cultural mechanisms and external stakeholder alignment to fully realize its potential. Second, drawing on dynamic capability theory (DCT), we open the organizational "black box" by establishing how digitalization efforts translate into ORS through an innovation-supportive culture. From a DCT perspective, DT functions not merely as an infrastructure investment, but as a strategic stimulus that nurtures an innovation culture capable of reconfiguring resources during disruptions. Finally, we

identify ESG practices as a critical boundary condition governing the DT–ORS relationship, demonstrating that digital investments do not uniformly enhance ORS across all firms. While strong ESG practices amplify the positive impact of DT on ORS through stakeholder trust and resource support, weak ESG practices neutralize the resilience benefits of digitalization.

The remainder of this paper is structured as follows. Section 2 reviews the theoretical foundation and develops the research hypotheses. Section 3 details the methodology, sampling procedures, construct measurements, and analytical approach. Section 4 reports the empirical findings. Finally, Sections 5 and 6 discuss the theoretical and managerial implications, acknowledge study limitations, and outline future research directions.

2. Literature review

2.1. Dynamic capability theory

Dynamic capability theory (DCT) has emerged as a pivotal theoretical framework in strategic management, particularly suited for analyzing how businesses adapt to rapid environmental change (Schilke et al., 2018; Teece, 2007). DCT explains how organizations adapt to rapidly changing environments by developing, integrating, and reconfiguring internal and external resources and competencies (Teece & Pisano, 1994). Rather than relying solely on static resource endowments, DCT posits that sustained adaptation depends on three core clusters of organizational processes: sensing environmental opportunities and threats, seizing strategic possibilities by mobilizing resources, and reconfiguring organizational assets and routines (Teece, 2007). First, sensing refers to a capability of a firm to scan, interpret, and learn from its environment to identify opportunities as well as potential threats (Teece, 2007). Next, seizing is a capability to mobilize resources to enable a firm to capitalize on identified opportunities effectively and create value (Teece, 2007, 2014). Finally, transforming is considered a capability to continuously renew, recombine, and reconfigure its tangible and intangible assets (Teece, 2007).

Under the DCT perspective, DT is considered a tool to enable firms to acquire real-time information and coordinate cross–functional activities by state-of-the-art digital technologies (Warner & Wäger, 2019). In this framework, DT does not automatically constitute a dynamic capability; rather, it functions as an information transformation process carried out by digital tools within the organization. Specifically, digital technologies strengthen environmental sensing by enhancing information accessibility and early threat detection (Hanelt et al., 2021; Verhoef et al., 2021), while creating opportunities to adjust resource configurations during disruptions (Warner & Wäger, 2019).

Notably, DCT emphasizes that digital technologies do not, by themselves, guarantee organizations' adaptation capability. It also requires combining with micro-foundations such as the organization’s culture to transform the potential of digital technologies to organizational resilience. Thus, rather than considering IC as a dynamic capability, it is conceptualized as an intangible asset for reconfiguring

resources within organizations and exchanging them for ORS through a process of collective learning, experimentation, and deployment of adaptive practices. Consequently, IC serves as a “black box” mechanism to convert information from digital technologies into innovation initiatives to solve problems and strengthen ORS.

2.2. The relationship between digital transformation and organizational resilience

Under the DCT lens, DT is considered a tool to enable firms to acquire real-time information and coordinate cross–functional activities by state-of-the-art digital technologies (Warner & Wäger, 2019). Up-to-the-minute data enables firms to identify stakeholder needs (Cardinali & De Giovanni, 2022) and opportunities to optimize their processes (Lanzolla et al., 2021). Thus, digital technologies improve core business operations by enhancing information flow quality and decision-making accuracy (Ghosh et al., 2022; Verhoef et al., 2021). Moreover, DT can enhance their environmental sensing capabilities by enabling them to rapidly identify vital market signals (Lenka et al., 2017) and track industry shifts (Gupta & George, 2016; M. Liu et al., 2023). Beyond collected information, firms can modify business models and operational routines to adapt to market perspectives (AlNuaimi et al., 2022). Thus, DT equips manufacturing firms to maintain operational continuity and adapt to unexpected disruptions. Accordingly, we propose:

H1

Digital transformation is positively associated with organizational resilience.

2.3. The mediating role of innovation culture on the relationship between digital transformation and organizational resilience

2.3.1. Digital transformation and innovation culture

Innovation culture (IC) refers to shared organizational values, beliefs, and practices that encourage the generation, consideration, and implementation of new ideas (Škerlavaj et al., 2010). IC is a mentality that encourages employees in an organization to be open to experimentation, acceptance of risks, knowledge exchange, and developing innovative initiatives (Martín-de Castro et al., 2013).

Based on the DCT perspective, DT is a tool to create an environment that supports innovation activities within organizations (Bindel Sibassaha et al., 2025; Singh et al., 2022). The internal organization in enterprises will be flattened based on the degree of digital technologies’ influence (T. Liu et al., 2025). This helps firms create rapid connections across departments within organizations and break traditional barriers (Hansen & Sia, 2015). The transition in communication within an organization helps employees access knowledge easily and enhances creativity in their work (Zoppelletto et al., 2023). In addition, the

internal network helps data flow automatically within an organization (T. Liu et al., 2025). This process encourages a culture of cooperation, improves beliefs, and creates an open environment between members. Consequently, DT creates psychological safety as well as releases a fear-of-failure mindset in employees; furthermore, it leads them to proactively propose initiatives without judgment. In summary, these characteristics strengthen an innovation culture, improving flexibility to adapt to changing market conditions. Accordingly, we propose:

H2

Digital transformation is positively associated with innovation culture.

2.3.2. Innovation culture and organizational resilience

IC is an intangible capability to help firms build ORS and overcome disruption (S. Su et al., 2022; Velyako & Musa, 2024). Change and experimentation are considered a natural part of innovation culture (Zhen et al., 2021). Thus, IC helps members within an organization leave their comfort zones and encourages them to face risks as well as propose new initiatives. This helps a firm catch opportunities proactively to overcome disruptions (S. Su et al., 2022). Thus, IC creates a new mindset for members within an organization to encourage them to explore alternatives, exchange knowledge, and adapt their behavior when existing practices become ineffective. Accordingly, we propose the following hypothesis:

H3

Innovation culture is positively associated with organizational resilience.

2.3.3. The mediating role of innovation culture

In this research, the mediating role of IC in the relationship between DT and ORS is explained through a process that transforms digital technologies into resilience capability through IC capital. First, DT is not considered an investment in technological facilities, it is a tool to create new platforms through digital technologies to change the way of working within firms (T. Liu et al., 2025). By optimizing the cost of experimentation, digital platforms create a quick trial-and-error mechanism as well as encourage an innovation mindset within the organization (Bindel Sibassaha et al., 2025; Guo et al., 2025). From these characteristics, DT facilitates the development of an innovative culture where innovation and change are viewed as natural and ongoing within the enterprise (Malewska et al., 2024).

Next, IC plays a direct role in nurturing resilience capability within the organization. First, IC creates psychological safety and a proactive mindset by encouraging employees to seek new solutions without fear of failure (T. Liu et al., 2025). This helps the firm ensure stability in the organization as well as having a proactive mentality when facing disruptions (Rodríguez-González et al., 2023). Besides, a firm with an innovation-supportive environment also increases knowledge transformation capability; it enables the firm to be more adaptive to rapid changes in the external environment (Guo et al., 2025).

The relationship between DT and ORS is not direct; it depends on the mechanism of IC. Because possessing digital technologies does not provide influence independently (Hautala-Kankaanpää, 2022). If a firm applies digital technologies to its activities without a culture-supportive perspective, it will face resistance from employees, operational rigidity, and a high risk of failure (Malewska et al., 2024). Thus, IC becomes a lubricant to transform the potential of digital technologies into operational capabilities for the firm (T. Liu et al., 2025).

In the DCT perspective, ORS is a dynamic capability that requires a serial process to create (Guo et al., 2025). Specifically, digital technologies provide the facilities, data, and digital tools needed to develop an innovation-supportive environment. When a firm prioritizes innovation, it is more likely to adapt through innovation initiatives and experimentation, further reconfiguring necessary resources to create resilience capability when facing disruptions (Guo et al., 2025). Accordingly, we propose the following hypothesis:

H4

Innovation culture mediates the relationship between digital transformation and organizational resilience.

2.4. The moderating role of ESG practices on the relationship between digital transformation and organizational resilience

Environmental, social and governance (ESG) practices are considered an evolution, expansion, and enrichment of the concept of corporate social responsibility (Luo et al., 2025; H. Wang et al., 2024; Yang & Han, 2023). Functioning as a comprehensive governance framework, ESG enables firms to balance economic imperatives with long-term societal value (H. Wang et al., 2024). Specifically, ESG encompasses institutional standards across environmental stewardship, social responsibility, and corporate governance designed to mitigate negative operational externalities while fostering transparent stakeholder communication (European Banking Authority, 2021).

Under the DCT lens, DT equips organizations with real-time information processing and cross-functional coordination capabilities (Warner & Wäger, 2019). These digital infrastructures allow firms to sense shifting stakeholder expectations (Cardinali & De Giovanni, 2022), regulatory compliance risks (Luo et al., 2025), and emerging environmental vulnerabilities (Ding et al., 2024). Furthermore, advanced digital analytics provide managers with predictive risk assessments to anticipate and preempt operational disruptions before they escalate (Ma et al., 2024). However, possessing digital sensing tools alone is insufficient to guarantee ORS if a firm lacks external legitimacy and stakeholder trust during a crisis.

We posit that ESG practices serve as a critical boundary condition that governs how effectively DT translates into ORS. Robust ESG practices cultivate reputational and social capital, garnering sustained support and trust from key stakeholders (Luo et al., 2025). When environmental disruptions occur, strong ESG performance acts as an institutional buffer that absorbs exogenous shocks and secures vital

external resources from stakeholders (H. Wang et al., 2024). While digital technologies generate diverse strategic options and informational insights, ESG practices align these digital initiatives with sustainable operational goals and green innovation (X. Su et al., 2023). Consequently, the synergy between digital technology and corporate responsibility instills a sustainable strategic orientation (Luo et al., 2025) and reconfigures organizational competencies (X. Su et al., 2023), thereby accelerating post-disruption recovery and amplifying the positive impact of DT on ORS.

Conversely, in firms characterized by weak ESG practices, the potential benefits of DT on ORS are severely constrained. Without a foundation of social and environmental responsibility, digital transparency and heightened stakeholder visibility may expose the firm to stricter public scrutiny and skepticism regarding how digital data and operations are managed. This legitimacy deficit impedes the firm's ability to mobilize external stakeholder support during crises, neutralizing the resilience-enhancing potential of digital investments. Accordingly, we propose the following hypothesis:

H5

ESG practices positively moderate the relationship between digital transformation and organizational resilience, such that the positive effect of digital transformation on organizational resilience is stronger when ESG practices are high rather than low.

3. Methodology

3.1. Sample and data collection

This study employs a quantitative survey approach to empirically examine the relationships among DT, IC, ESG, and ORS within Vietnamese manufacturing enterprises. Given the strategic nature of these constructs, we targeted top-level executives—specifically business owners, directors, and deputy directors—who possess comprehensive knowledge of their firms' digitalization strategies, ESG practices, organizational culture, and resilience capabilities.

Prior to data collection, the minimum required sample size was determined through an a priori power analysis using G*Power software. With a medium effect size ($f^2 = 0.15$), a significance level of $\alpha = 0.05$, a statistical power of 0.95, and four structural predictors pointing at the endogenous construct, the estimation indicated a minimum required sample size of 129 observations.

To ensure high data quality and overcome the typically low response rates of executive surveys, we implemented a multi-stage purposive sampling procedure between April and June 2026. First, we formally collaborated with local industrial authorities to explain the academic objectives of the study and obtain official directories of registered manufacturing enterprises. Second, we sent formal invitation letters via email to these manufacturers to introduce the research and solicit their voluntary participation. Only enterprises that explicitly agreed to participate were compiled into our target sampling frame of 800 consenting firms. Third, we distributed the online questionnaire to one key

informant per consenting firm, along with screening questions to verify the respondent's familiarity with the firm's digital transformation initiatives. Thanks to institutional endorsement, pre-commitment prior to survey distribution, and follow-up reminders, we received 700 valid responses out of the 800 distributed questionnaires after excluding incomplete responses and straight-lining patterns, yielding an effective completion rate of 87.5% among pre-consented firms.

The final sample comprises limited liability companies (70.86%) and joint-stock companies (29.14%) operating across six key manufacturing subsectors: food and beverage (22.49%); textiles and related products (20.42%); paper and related products (20.30%); chemicals, pharmaceuticals, rubber, and plastics (10.83%); metals, electronics, computers, and machinery (14.36%); and other manufacturing industries (11.60%). Regarding respondent demographics, 72.80% were male and 27.20% were female. All respondents held senior leadership positions, including business owners (47.02%), directors (33.88%), and deputy directors (19.10%).

3.2. Measurement

This study uses primary sources to quantitatively validate the research model. We design a rigorous process to validate the scales used to measure the research constructs. First, we adapted scales measuring the research constructs from established sources to ensure content validity. Second, two social science experts translated the English questionnaire into Vietnamese to ensure linguistic and contextual equivalence. Next, we conducted a pilot test with a representative sample (n = 100). To reduce social desirability bias, we assured respondents of anonymity and clarified that there were no right or wrong answers (Gordon, 1987). In addition, we also used Harman's single-factor approach to check common method bias (CMB). Third, we used pilot test results to assess the scales' reliability. After removing failed items, the data passed the reliability and validity tests (Cronbach's Alpha > 0.7, KMO > 0.7). These results prove that the scales were suitable for formal surveys.

All construct items were measured on a five-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). Digital transformation (DT) was measured by a scale adapted from Nasiri et al. (2020) and Aral and Weill (2007). Innovation culture (IC) was measured using a scale adapted from Škerlavaj et al. (2010). Organizational resilience (ORS) was measured using a scale adapted from Rai et al. (2021). ORS was operationalized as a reflective–reflective higher-order construct (HOC) comprising three lower-order dimensions: organizational robustness (ORB), recoverability (REC), and crisis anticipation (ANTI) (Rai et al., 2021). ESG practices were modeled as a reflective – formative higher-order construct (HOC), composed of three dimensions: environmental, social, and governance practices. Environmental practice was measured using a scale adapted by Chow and Chen (2012) and Judge and Douglas (1998), whereas social practice was measured using a scale adapted by Turker (2009), Chow and Chen (2012) and Reverte et al. (2016). Finally, governance practice was measured using a scale adapted by Zhu and Huang (2023).

3.3. Common method bias (CMB)

Because data were collected simultaneously from single informants, both procedural and statistical remedies were implemented to mitigate common method bias (Podsakoff et al., 2003). Procedurally, respondents were guaranteed strict anonymity and confidentiality and informed that there were no right or wrong answers to minimize evaluation apprehension and social desirability bias. Next, psychological separation was introduced by varying the sequence of measurement scales in the questionnaire to prevent hypothesis guessing. Finally, expert reviews and pilot testing eliminated ambiguous jargon, reducing respondent cognitive fatigue.

Statistically, we first conducted Harman's single-factor test via unrotated principal component analysis, which revealed that the first factor accounted for 46.481% of total variance, below the 50% threshold. Second, following Kock (2015), we performed a full collinearity assessment in PLS-SEM; all inner variance inflation factor (VIF) values remained below the conservative 3.3 threshold (Table 6), confirming that CMB is not a substantive threat to our findings.

3.4. Data analysis

We analyzed the research model using partial least squares structural equation modeling (PLS-SEM), which is well-suited for estimating complex hierarchical component models, mediation pathways, and conditional moderation effects. A disjoint two-stage approach was adopted to estimate lower-order construct (LOC) scores before assessing the higher-order construct (HOC) measurement and structural models. Hypothesis testing was conducted using non-parametric bootstrapping with 10,000 subsamples (Henseler et al., 2016).

4. Results

4.1. Measurement models

Table 1 reports the indicator loadings, internal consistency reliability, and average variance extracted (AVE) for both LOC and HOC measurement models. After removing failed indicators, most outer loadings exceeded the threshold of 0.708 (Hair et al., 2016), whereas others were retained because the AVEs surpassed 0.50 (Hair et al., 2016). Across all LOCs and the reflective HOC, composite reliability values (rho_a and rho_c) ranged from 0.8 to 0.945 (exceeding 0.5), establishing robust internal consistency and convergent validity (Guenther et al., 2023).

Table 1
Constructs and their corresponding measures

Constructs	Code	Loadings	rho_a	rho_c	AVE
LOC measurement model					
Digital transformation (DT)	**DT_1**	0.732	0.8	0.861	0.554
	DT_2	0.731			
	DT_3	-			
	DT_4	-			
	DT_5	0.751			
	DT_6	0.747			
	DT_7	-			
	DT_8	0.76			
Innovation culture (IC)	**IC_1**	0.704	0.826	0.872	0.532
	IC_2	0.729			
	IC_3	0.748			
	IC_4	0.752			
	IC_5	0.702			
	IC_6	0.739			
ESG practices (ESG)	**ESG_E_1**	0.742	0.835	0.876	0.542
	ESG_E_2	0.746			
	ESG_E_3	**-**			
	ESG_E_4	0.69			
	ESG_E_5	0.767			
	ESG_E_6	**-**			
	ESG_E_7	0.717			
	ESG_E_8	0.754			
	ESG_S_1	**-**	0.939	0.945	0.518
	ESG_S_2	0.706			

Note: (-) *indicates that the measures fail the validity and reliability tests*

Constructs	Code	Loadings	rho_a	rho_c	AVE
LOC measurement model					
	ESG_S_3	0.694			
	ESG_S_4	0.733			
	ESG_S_5	0.708			
	ESG_S_6	-			
	ESG_S_7	0.726			
	ESG_S_8	**-**			
	ESG_S_9	**-**			
	ESG_S_10	**-**			
	ESG_S_11	**-**			
	ESG_S_12	0.74			
	ESG_S_13	**-**			
	ESG_S_14	0.721			
	ESG_S_15	**-**			
	ESG_S_16	0.707			
	ESG_S_17	0.719			
	ESG_S_18	0.714			
	ESG_S_19	0.735			
	ESG_S_20	0.716			
	ESG_S_21	0.732			
	ESG_S_22	**-**			
	ESG_S_23	0.719			
	ESG_S_24	**-**			
	ESG_S_25	**-**			
	ESG_S_26	0.726			
	ESG_S_27	**-**			

Note: (-) *indicates that the measures fail the validity and reliability tests*

Constructs	Code	Loadings	rho_a	rho_c	AVE
LOC measurement model					
	ESG_S_28	0.716			
	ESG_G_1	0.766	0.905	0.921	0.537
	ESG_G_2	0.76			
	ESG_G_3	0.725			
	ESG_G_4	0.722			
	ESG_G_5	0.74			
	ESG_G_6	0.728			
	ESG_G_7	-			
	ESG_G_8	0.727			
	ESG_G_9	0.709			
	ESG_G_10	0.736			
	ESG_G_11	0.716			
Organizational resilience (ORS)	**ORB_1**	0.769	0.839	0.881	0.553
	ORB_2	0.751			
	ORB_3	0.724			
	ORB_4	0.734			
	ORB_5	0.754			
	ORB_6	0.731			
	REC_1	0.736	0.856	0.889	0.535
	REC_2	0.726			
	REC_3	0.712			
	REC_4	0.71			
	REC_5	0.755			
	REC_6	0.761			
	REC_7	0.719			

Note: (-) *indicates that the measures fail the validity and reliability tests*

Constructs	Code	Loadings	rho_a	rho_c	AVE
LOC measurement model					
	ANTI_1	0.727	0.836	0.877	0.544
	ANTI_2	0.723			
	ANTI_3	0.778			
	ANTI_4	0.72			
	ANTI_5	0.709			
	ANTI_6	0.766			
HOC measurement model					
ORS	**ORB**	0.895	0.873	0.92	0.794
	REC	0.88			
	ANTI	0.897			
Note: (-) *indicates that the measures fail the validity and reliability tests*					

Next, discriminant validity was assessed using the heterotrait-monotrait (HTMT) criterion and remained satisfactory (Table 2 and Table 3), with all values in LOC and HOC measurement models remaining below the 0.85 threshold (Henseler et al., 2015).

Table 2
HTMT ratio in LOC measurement model

ANTI	ANTI	DT	ESG_E	ESG_G	ESG_S	IC	ORB	REC
DT	0.309							
ESG_E	0.475	0.101						
ESG_G	0.364	0.062	0.06					
ESG_S	0.378	0.061	0.061	0.064				
IC	0.358	0.408	0.062	0.072	0.07			
ORB	0.838	0.335	0.47	0.439	0.378	0.377		
REC	0.824	0.369	0.42	0.357	0.331	0.345	0.794	

Table 3
HTMT ratio in HOC measurement model

DT	DT	IC	ORS
IC	0.408		
ORS	0.374	0.398	

In addition, ESG practices are built on three dimensions, namely environmental, social, and governance practices. Thus, ESG practices are assessed using outer VIF and outer weight criteria. VIF values in Table 4 ranged between 1.001 and 1.002, which are well below the threshold of 5 (Hair et al., 2019). Moreover, the outer weight of LOCs of ESG practices shows that the values range between 0.544 and 0.634, with p-values below 0.05. This means that three dimensions of ESG practices have a meaningful role in the formation of its HOC.

Table 4
Outer VIF of ESG practices

ESG_E	VIF
	1.001
ESG_G	1.002
ESG_S	1.001

Table 5
Outer weights of ESG practices

ESG_E → ESG	β	t-statistics	SD	95% CI	p_value
	0.634	**17.862**	**0.035**	**[0.564;0.703]**	**< 0.001**
ESG_G → ESG	0.583	15.285	0.038	[0.508;0.657]	< 0.001
ESG_S → ESG	0.544	14.403	0.038	[0.467;0.614]	< 0.001

4.2. Structural model

Prior to evaluating the structural paths, inner variance inflation factor (VIF) values were examined to check for potential lateral collinearity. As reported in Table 6, all inner VIF values ranged from 1.000 to 1.131, remaining well below the conservative threshold of 5.0 (Hair et al., 2019) as well as the stricter 3.3 threshold for full collinearity tests (Kock, 2015), confirming that multicollinearity and common method bias do not distort the structural estimates.

Table 6
Inner VIF of the structural model

DT → IC	VIF
	1.000
DT → ORS	1.131
ESG → ORS	1.005
ESG x DT → ORS	1.004
IC → ORS	1.129

Next, the model's in-sample explanatory power was assessed via the coefficient of determination (R^2), and effect size (f^2). Table 7 shows the R-square values of IC and ORS in the research model. It indicates that DT, IC, and ESG explained 65.2% of the variance in ORS (R^2 = 0.652), demonstrating substantial explanatory power generated jointly by DT, IC, and ESG practices. Meanwhile, DT explained only 11.2% of the variance in IC (R^2 = 0.112). Given that organizational culture is a deeply embedded, multifaceted construct shaped by numerous leadership and historical factors, accounting for 11.2% of its variance through a single technological antecedent (DT) represents a meaningful theoretical and empirical contribution.

Table 7
R^2 value in the research model

IC	R-square	R-square adjusted
	0.112	**0.11**
ORS	0.652	0.65

In addition, effect size (f^2) is analyzed based on the criteria of Cohen (1988). Table 8 shows that DT had a small effect on IC (f^2 = 0.126) and ORS (f^2 = 0.089), whereas IC exerts a small-to-moderate effect on ORS (f^2 = 0.14). Notably, ESG practices demonstrate a substantial direct effect size on ORS (f^2 = 1.273), underscoring the foundational role of corporate sustainability in building enterprise resilience. Furthermore, the interaction term (ESGxDT) yields an f^2 of 0.129. While the criteria of Cohen (1988) indicate that 0.129 is small, methodological literature on moderation analysis emphasizes that interaction effect sizes above 0.025 are considered large (Hair et al., 2021), confirming the substantial potency of ESG as a boundary condition.

Finally, the research evaluated hypothesis testing as well as both mediating and moderating mechanisms in the structural model. Table 8 shows that the bootstrapping results support hypothesis testing. First, these results show that all direct hypotheses are supported. DT is positively associated with ORS (β = 0.187, t = 6.203, p_value < 0.001) and IC (β = 0.334, t = 9.023, p_value < 0.001) and,

supporting H1 and H2. In turn, IC also has a positive relationship with ORS (β = 0.235, t = 8.511, p_value < 0.001), supporting H3. Regarding the mediating mechanism, the specific indirect effect of DT on ORS via IC is positive and statistically significant (β = 0.078, t = 6.502, p_value < 0.001), supporting H4. Because the relationship between DT and ORS remains significant, IC serves as a complementary partial mediator.

Table 8
Bootstrapping results

Hypothesis	β	t-statistics	SD	f^2	CI 95%	p-value	Result
Direct effect							
DT → IC	0.334	9.023	0.037	0.126	[0.263;0.408]	< 0.001	Supported
DT → ORS	0.187	6.203	0.03	0.089	[0.129;0.247]	< 0.001	Supported
ESG → ORS	0.667	32.357	0.021	1.273	[0.627;0.707]	< 0.001	Supported
ESG x DT → ORS	0.234	8.025	0.029	0.129	[0.174;0.288]	< 0.001	Supported
IC → ORS	0.235	8.511	0.028	0.14	[0.179;0.287]	< 0.001	Supported
Indirect effect							
DT → IC → ORS	0.078	6.502	0.012	-	[0.056;0.103]	< 0.001	Supported

Finally, Table 8 confirms a significant positive interaction effect between DT and ESG practices on ORS (β = 0.234, t = 8.025, p_value < 0.001), supporting H5. To further unpack this moderating mechanism, a simple slope analysis was conducted to examine the conditional direct effect of DT on ORS across three levels of ESG practices: Low (-1SD), average (Mean), and high (+ 1SD) (Table 9 and Fig. 2).

Table 9
The conditional direct effect of DT on ORS

ESG at + 1 SD	DT → ORS	CI 95%	p-value
	0.421	**[0.350;0.489]**	**< 0.001**
ESG at -1 SD	-0.046	[-0.135;0.048]	0.329
ESG at Mean	0.187	[0.129;0.247]	< 0.001

As reported in Table 9, the positive impact of DT on ORS strengthens substantially when firms exhibit high ESG practices (+ 1SD: β = 0.421, 95% CI [0.350; 0.489], p < 0.001) compared to the average ESG level (Mean: β = 0.187, 95% CI [0.129; 0.247], p < 0.001). Conversely, when ESG practices are low (-1SD), the conditional direct effect of DT on ORS becomes statistically non-significant (β = -0.046, 95% CI [-0.135; 0.048], p = 0.329). These findings confirm that ESG practices act as a vital boundary condition governing the DT–ORS nexus: digital transformation only generates significant resilience returns when supported

by moderate-to-high ESG commitment, whereas deficient ESG practices completely neutralize the resilience-enhancing potential of digitalization.

5. Discussion

5.1. Discussion of findings

This study yields several important insights into how digital transformation shapes organizational resilience in manufacturing enterprises.

First, while our findings confirm that DT is positively associated with ORS, the standalone direct effect size is modest. This implies that digital technologies do not automatically influence the resilience capability of an organization. With these results, we challenge previous studies that conclude that DT has a positive influence on ORS by building stability, mitigating systemic risks (Guan et al., 2023), detecting operational threats (Modgil et al., 2022), and converting change-related risks into developmental opportunities (Z. Wang & Jia, 2025). Rather than refuting the positive role of DT, our results demonstrate that digital infrastructure alone provides only a limited direct boost to ORS, requiring complementary organizational mechanisms and boundary conditions to unlock its full potential.

Second, our findings establish IC as a complementary partial mediator linking DT and ORS. These results indicate that IC plays a role in transforming DT's influence on ORS. This indicates that digital technologies create collaborative platforms that reshape organizational workflows (Liu et al., 2025) and enable low-cost trial-and-error experimentation, thereby fostering an innovative mindset across the enterprise (Bindel Sibassaha et al., 2025; Guo et al., 2025). Thus, DT facilitates an innovative culture in which innovation and change are viewed as natural and ongoing within the enterprise (Malewska et al., 2024).

In turn, IC serves as an intangible capability that strengthens ORS (S. Su et al., 2022; Velyako & Musa, 2024) through ongoing experimentation (Zhen et al., 2021). Specifically, IC cultivates psychological safety and proactivity, encouraging employees to explore novel solutions without fear of failure (T. Liu et al., 2025), and maintain operational stability during crises (Rodríguez-González et al., 2023). Thus, IC creates a mindset that encourages members to explore alternatives, share knowledge, and adapt their behavior when existing practices become ineffective.

Through a DCT lens, our research indicates that digital capability provides only a foundation and does not automatically generate adaptive responses. To strengthen resilience capability, the firm needs a process to build dynamic capability to improve ORS. Specifically, digital technologies provide the facilities, data, and digital tools needed to develop an innovation-supportive environment. When a firm prioritizes innovation, it is more likely to adapt through innovation initiatives and experimentation, further reconfiguring necessary resources to create resilience capability when facing disruptions (Guo et al., 2025).

Third, our findings confirm that ESG practices positively moderate the relationship between DT and ORS, offering a compelling empirical resolution to the ongoing "digital paradox" debate. Specifically, simple slope results reveal that while DT strongly promotes ORS under high ESG conditions, its impact is rendered statistically non-significant when ESG practices are low. Through the DCT lens, DT serves as a mechanism to acquire real-time information and coordinate cross-functional activities (Warner & Wäger, 2019). However, to translate DT-derived insights into organizational resilience during crises, firms require reputational capital and external legitimacy to mobilize stakeholder support (Luo et al., 2025). While digital technologies generate strategic options, ESG practices align firm objectives toward sustainable operations and green innovation (X. Su et al., 2023). Consequently, combining DT with strong ESG commitment fosters a sustainable strategic orientation (X. Su et al., 2023). The technology-responsibility synergy will amplify DT's positive influence on ORS.

Specifically, in firms with high ESG practices, reputational capital functions as a risk-absorption buffer that secures stakeholder trust and external resources to overcome disruptions (H. Wang et al., 2024). Conversely, under low ESG conditions, firms face stricter stakeholder scrutiny regarding how digital data and operations are managed. This deficit in social legitimacy restricts access to vital external resources during turbulent periods, effectively neutralizing the benefits of digital investments on organizational resilience.

5.2. Theoretical contribution

This study offers three primary theoretical contributions to the DCT and digitalization literature. First, we extend the understanding of the link between DT and ORS. Whereas prior studies have debated whether the influence of DT on ORS is positive or negative, our empirical evidence demonstrates that DT alone has a modest direct effect on resilience capability. By showing that technological deployment requires sequential internal and external alignment to generate substantial resilience outcomes, we reconcile conflicting findings in the digital paradox literature.

Second, we unpack the internal organizational "black box" translating digital technologies into organizational resilience by identifying innovation culture as a pivotal mediating mechanism. Our research indicates that innovation culture is seen as a mediator that influences this relationship. By drawing on the DCT framework of Teece (2007), we explain the mediating mechanism through serial processing of sensing, seizing, and reconfiguring to transform digital technologies into an innovation-supportive environment that develops innovation capability and changes organizational behavior to enhance resilience capability. From these results, we extend understanding of DCT by conceptualizing DT as a strategic transformation stimulus and IC as a reconfiguring cultural condition that translates digital information into adaptive employee behaviors.

Third, we extend DCT by establishing ESG practices as a critical boundary condition governing the DT–ORS relationship. Through the DCT lens, we find that social responsibility strengthens this relationship. By differentiating ESG practices, we explain how DT amplifies its influence on resilience capability. This demonstrates that internal digital capabilities cannot operate in a vacuum; rather, firms must pair

internal digitalization with external ESG legitimacy to build stakeholder trust and access external resources during crises. By integrating technological capabilities with corporate sustainability, we enrich the literature on how technology–responsibility synergies drive organizational resilience.

5.3. Management implication

Our findings provide actionable guidance for manufacturing executives and policymakers.

First, managers must shift their mindset regarding digital transformation. Because investing in digital technology alone only weakly drives resilience, executives should not treat DT merely as an IT infrastructure upgrade, but as a catalyst to reshape organizational culture and employee behavior. To maximize the return on digital investments, managers should deploy integrated digital platforms and shared knowledge repositories that break down departmental silos, while actively cultivating psychological safety and rewarding trial-and-error experimentation.

Second, executives should strategically integrate ESG practices into their core digital and operational strategies. Our results warn that neglecting ESG responsibilities completely neutralizes the resilience benefits of digital transformation. Therefore, manufacturing leaders must allocate resources toward environmental stewardship, social welfare, and transparent governance to build reputational capital. Strong ESG commitment ensures that when crises strike, firms possess the stakeholder trust and external resource networks needed to turn real-time digital insights into rapid recovery.

Third, for policymakers aiming to promote industrial resilience, digital transformation policies should be designed alongside sustainability and cultural capacity-building programs. Rather than pressuring manufacturing enterprises to adopt digital technologies abruptly, governments should provide phased roadmaps, training subsidies, and incentives that encourage firms to simultaneously upgrade their digital infrastructure and ESG standards.

6. Conclusion

This study demonstrates that digital transformation enhances the organizational resilience of Vietnamese manufacturing firms both directly and indirectly through the mediating mechanism of innovation culture. Crucially, our findings highlight that ESG practices serve as a vital boundary condition: strong ESG commitment amplifies the positive impact of digitalization on resilience, whereas weak ESG performance neutralizes it.

Besides, like any research, our study has faced several inherent limitations that are a foundation for developing other research in the future. First, we focused on manufacturing firms in the Vietnamese context. This should be acknowledged as a limitation on generalization. Thus, future research can be carried out in other countries to explore whether different backgrounds can provide different outcomes on the relationship between DT and ORS. Second, we have a methodological limitation concern potential endogeneity. Our model assumes that DT is associated with IC and ORS. However, based on cross-sectional data, we cannot entirely exclude reverse causality or omitted variable bias. We expect future

research to use other methodologies to address this problem. Finally, given the modest variance explained in IC (R^2 = 0.112), future inquiries should integrate external and other internal capabilities to build a more comprehensive predictive model of innovation culture.

Declarations

Ethical Approval and accordance

The research protocol was approved by the Scientific Committee of Ho Chi Minh City Open University in accordance with all relevant guidelines and regulations ***for social science and business research.***

Consent to participate

Informed consent to participate in the study was freely given and obtained from all individual participants included in the study.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Author Contribution

Ha Minh Nguyen: Conceptualization, Writing - Review & Editing, SupervisionDat Thang Phan: Methodology, Software, Formal analysis, Investigation, Writing - Original Draft

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

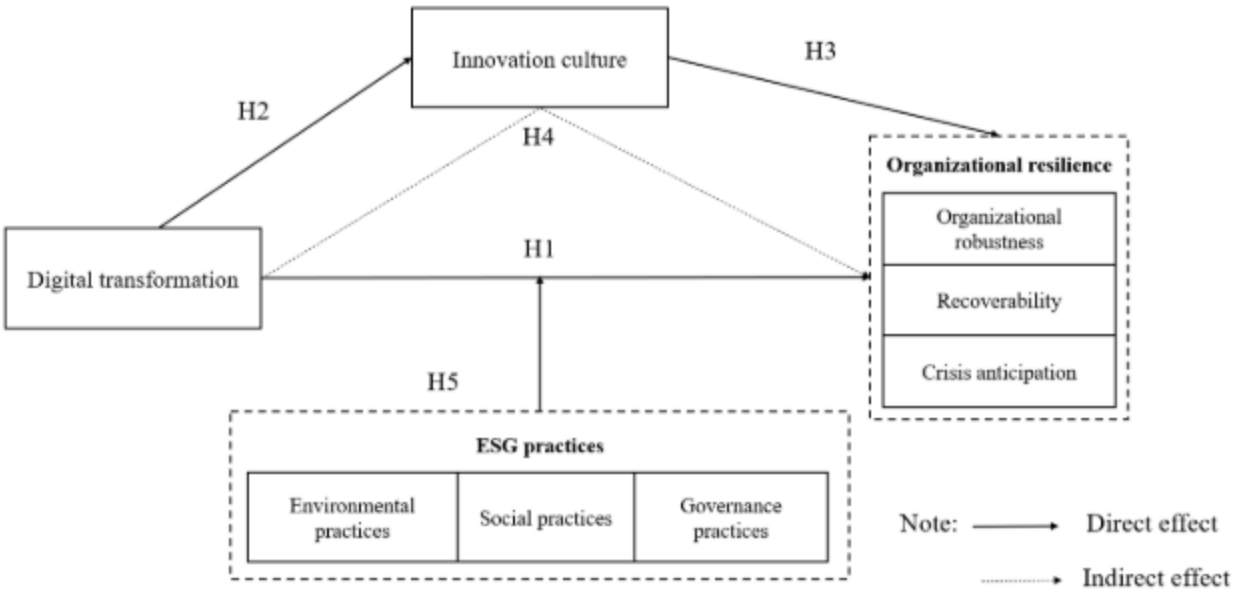


Figure 1

Research model

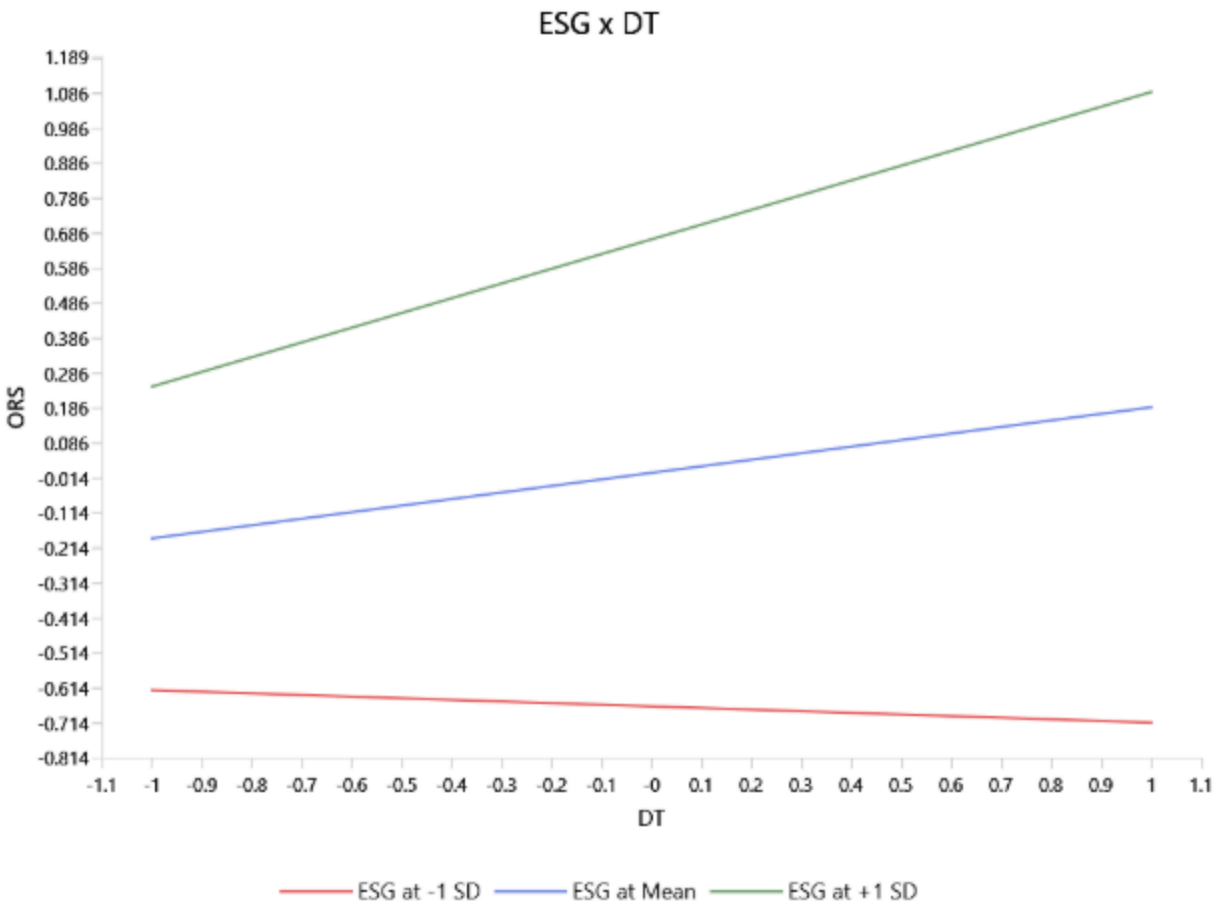


Figure 2

The simple slope analysis