

# Digital Transformation and Sustainable Performance in Chinese Manufacturing Firms: Evidence from the Yangtze River Delta

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**Abstract:** Digital transformation (DT) has become an important pathway for manufacturing firms seeking sustainable development, yet empirical evidence on how it translates into sustainable performance (SP) remains limited, especially in emerging economies. Drawing on the Natural Resource-Based View (NRBV) and the Dynamic Capability View (DCV), this study examines the relationship between digital transformation and sustainable performance, focusing on the mediating role of green innovation in Chinese manufacturing firms. Using survey data from 310 firms in the Yangtze River Delta and applying partial least squares structural equation modeling (PLS-SEM), digital transformation is conceptualized as a multidimensional construct including digital capability, strategy, technology application, product value creation, and information sharing and analysis. Sustainable performance is assessed across economic, environmental, and social dimensions, while green innovation covers process, product, technology, and management innovation. The results show that digital transformation positively affects sustainable performance and enhances green innovation. Green innovation partially mediates this relationship, indicating that digital transformation improves sustainability outcomes by enabling the development and implementation of green innovations. The study contributes by clarifying the digital transformation–green innovation–sustainable performance mechanism and providing evidence from a major manufacturing region in an emerging economy, while also emphasizing the importance of aligning digital transformation initiatives with green innovation strategies.

**Keywords:** digital transformation; green innovation; sustainable performance; manufacturing firms; Yangtze river delta

**JEL Classification:** O33; L60; M15

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## 1. Introduction

Digital transformation (DT) has become a critical strategic response for manufacturing firms facing intensifying sustainability pressures in an increasingly volatile global environment. Manufacturing activities contribute substantially to global greenhouse gas

emissions, resource depletion, and environmental degradation, thereby exacerbating climate change risks and threatening long-term industrial resilience (Xu et al., 2023; Luthra et al., 2022). Since 2019, global carbon dioxide emissions have continued to rise and have reached unprecedented levels, further highlighting the urgency of aligning industrial development with environmental and social responsibility (BP, 2024). These challenges are particularly pronounced in emerging economies, where rapid industrialization has historically emphasized output expansion at the expense of sustainable development (Wang & Wang, 2020).

Against this backdrop, digital technologies, such as artificial intelligence (AI), the Internet of Things (IoT), blockchain, and big data analytics, are increasingly regarded as key enablers of sustainability-oriented transformation in manufacturing. By enhancing real-time monitoring, optimizing resource allocation, and improving information transparency across supply chains, DT allows firms to reduce waste, enhance energy efficiency, and mitigate environmental risks (Patwa et al., 2021; Ghobakhloo et al., 2021). Accordingly, DT is no longer viewed merely as a technological upgrade; rather, it represents a strategic process that reshapes organizational capabilities, operational models, and mechanisms of value creation (Cai et al., 2023).

At the global level, sustainability has emerged as a central policy and strategic priority. International frameworks, including the Paris Agreement and the United Nations Sustainable Development Goals (SDGs), underscore the imperative of integrating environmental protection with economic development (Guan et al., 2023). Governments, investors, and consumers increasingly expect firms to demonstrate measurable sustainability outcomes, while sustainability-oriented investment criteria and regulatory regimes continue to reshape corporate decision-making. Within this context, sustainable performance (SP), encompassing economic, environmental, and social dimensions, has become a critical indicator of long-term organizational success.

China occupies a pivotal position in the global sustainability transition. As the world's largest manufacturing economy, China contributes substantially to global industrial output and carbon emissions, with manufacturing and industrial activities accounting for a significant share of national emissions (Wang & Wang, 2020). In response, the Chinese government has introduced a series of initiatives, including Made in China 2025 and the national Emissions Trading System, to promote digitalization, green innovation (GI), and high-quality industrial development (Liao et al., 2024). Meanwhile, structural pressures, such as slowing economic growth, rising labor costs, intensifying international competition, and weakening demand, have further underscored the urgency for Chinese manufacturing firms to pursue sustainable transformation rather than growth driven solely by scale expansion.

Despite strong policy support and rapid technological progress, the adoption and effectiveness of DT remain uneven across firms and regions in China. Advanced manufacturing clusters, such as the Yangtze River Delta (YRD), exhibit relatively high levels of digital adoption and innovation capability, whereas many firms, particularly small and medium-sized enterprises, continue to face constraints related to legacy systems, limited resources, and insufficient digital expertise (Kraus et al., 2021). These disparities raise critical questions

regarding how and through what mechanisms DT translates into sustainability outcomes, as well as the organizational conditions under which such transformation is most effective.

Despite the growing recognition of DT as a driver of sustainability, existing studies have examined DT, GI, and SP largely as independent or weakly connected research streams. Studies on DT frequently rely on Technology-Organization-Environment or diffusion-based frameworks, thereby conceptualizing digitalization primarily as a response to external pressures rather than as an internal capability that actively reshapes innovation processes (Sun et al., 2024; Feng et al., 2022). In contrast, research on GI, frequently grounded in the Resource-Based View, emphasizes green products or processes as strategic assets but offers limited insight into how digital capabilities facilitate the development and diffusion of such innovations across organizational domains (Hart, 1995; He et al., 2024). Similarly, studies on SP, particularly within ESG-oriented research, tend to focus on outcome measurement, leaving the internal mechanisms linking DT and sustainability insufficiently theorized.

To address these limitations, this study adopts an integrated theoretical perspective that combines the Natural Resource-Based View (NRBV) and the Dynamic Capability View (DCV). From the NRBV perspective, GI constitutes a critical sustainability-oriented resource that enables firms to achieve competitive advantage while reducing environmental impact (Hart, 1995). The DCV complements this perspective by emphasizing firms' ability to reconfigure resources and capabilities in response to dynamic environmental conditions (Teece et al., 1997). Within this integrated framework, DT is conceptualized as a digital dynamic capability that enables firms to sense opportunities, reconfigure resources, and facilitate GI across product, process, technology, and management domains.

Building on this perspective, the present study investigates how DT influences SP through the mediating role of GI in the Chinese manufacturing sector, with a particular focus on firms located in the YRD region. DT is operationalized as a multidimensional construct encompassing digital capability, digital strategy, digital technology application, product value creation, and information sharing and analysis. Using survey data collected from manufacturing firms of varying sizes, this study further examines whether firm size conditions the effectiveness of DT in promoting sustainable outcomes.

This study makes three primary contributions. First, it advances the DT-sustainability literature by elucidating the mechanism through which DT enhances SP via GI, thereby addressing a key gap in existing empirical research. Second, by integrating the NRBV and DCV, it provides a coherent theoretical framework that conceptualizes DT as a dynamic capability and GI as a strategic sustainability resource. Third, it offers empirical evidence from a leading manufacturing cluster in an emerging economy, thereby extending understanding of sustainability-oriented DT beyond developed-country contexts.

## 2. Methodology

Data for this study were collected through a structured survey administered to managerial personnel working in manufacturing firms in China's Yangtze River Delta (YRD). In total, 502 questionnaires were disseminated, and 310 usable responses were retained for empirical analysis, corresponding to a valid response rate of 72.5%. The survey instrument

was organized into two main components. The first component captured basic demographic characteristics of the respondents, whereas the second component assessed the key study variables, namely digital transformation (DT), sustainable performance (SP), green innovation (GI), and firm size. All participants were informed of the research objectives prior to participation and voluntarily consented to take part in the survey.

Table 1 presents the demographic characteristics of the 310 respondents. With respect to gender, 60% of the respondents were male and 40% were female. In terms of work experience, respondents were classified into four categories: less than one year (11.61%), 1-3 years (19.86%), 4-6 years (24.19%), and more than six years (44.52%). Regarding organizational position, the sample included directors (4.19%), chief executive officers (14.52%), senior managers (52.58%), senior engineers (26.13%), and administrative directors (2.58%).

Table 1 also reports firm-level characteristics. The surveyed firms operated across a range of manufacturing industries, including automotive manufacturing and electronics and electrical equipment. Firm types included state-owned enterprises, private enterprises, joint ventures, foreign-invested enterprises, and other ownership forms. Firm age ranged from less than five years to more than twenty years, and firm locations covered major manufacturing provinces and municipalities in the YRD region, including Shanghai, Zhejiang, and Jiangsu. In addition, firms served different primary markets, such as original equipment manufacturing (OEM), original design manufacturing (ODM), and contract manufacturing. Firm size was measured based on registered capital, ranging from less than one million to more than five million. Firms reporting a zero level of digitalization were excluded from the sample to reduce potential bias associated with non-digital operations.

Table 1. Demographic characteristics of respondents

Items	Variables	Frequency	Percentage (%)
Gender	Male	165	60
	Female	124	40
Year of Experience of Respondents	Less than 1 year	36	11.61
	1 to 3 years	61	19.86
	4 to 6 years	75	24.19
	More than 6 years	138	44.52
Position	Director	13	4.19
	CEO	45	14.52
	Senior Manager	163	52.58
	Senior Engineer	81	26.13
	Administrative Director	8	2.58
Firms' basic information			
Main Type	Automotive Manufacturing	81	26.13
	Electronics and Electrical Equipment	60	19.35
	Textiles and Apparel	113	36.45
	Machinery and Equipment	23	7.42
	Chemicals and Materials	33	10.65
	Others	0	0
Ownership	State-owned Enterprise	68	21.94
	Private Enterprise	181	58.39
	Joint Venture	33	10.65
	Foreign-owned Enterprise	25	9.03

Years	Less than 5 years	5	1.61
	5–10 years	113	34.45
	10–20 years	167	53.87
	More than 20 years	25	8.06
Location	Shanghai	33	10.65
	Zhejiang	180	58.06
	Jiangsu	97	31.29
Primary Market	Domestic Market (China)	198	63.87
	International Market	76	24.52
	Domestic and International	36	11.61
Manufacturing Activities	Original Equipment Manufacturer (OEM)	174	56.13
	Original Design Manufacturer (ODM)	64	20.65
	Contract Manufacturer	68	21.94
	Other	4	1.29
Registered Capital	Large or List Firm (5 million yuan ≤ Registered capital)	102	32.9
	Medium Firm (1 million yuan ≤ Registered capital < 5 million)	104	33.55
	Micro and Small Firm (Registered capital < 1 million)	104	33.55

### 2.1. Common Method Bias

Potential common method bias was examined using Harman's single-factor procedure. The analysis shows that a single factor accounts for 20.896% of the total variance, which is substantially below the conventional threshold of 50%, indicating that common method bias is not a critical issue in the present study. In line with established PLS-SEM research practices, DT, GI, and SP were specified as second-order constructs following a reflective-reflective measurement structure, with all lower-order dimensions modeled reflectively. Specifically, the repeated indicators approach was employed to estimate the higher-order constructs.

### 3. Results

The measurement model results presented in Table 2 indicate that all indicators exhibit adequate reliability, with standardized outer loadings exceeding the recommended cutoff value of 0.70. In addition, all constructs demonstrate satisfactory internal consistency, as their composite reliability (CR) values surpass the minimum threshold of 0.70. Convergent validity is further supported, given that the Average Variance Extracted (AVE) values for all constructs are above 0.50, ranging from 0.615 for product value creation to 0.960 for digital transformation (DT) and 0.888 for green innovation (GI). These findings suggest that each latent construct captures a substantial proportion of variance in its corresponding indicators. Taken together, the results confirm that the measurement model meets established criteria for indicator reliability, internal consistency, and convergent validity. The relatively high AVE values associated with the higher-order constructs can be attributed to the strong conceptual alignment among their underlying dimensions rather than to redundancy among measurement items, which is consistent with the hierarchical nature of the higher-order constructs.

Table 2. Reliability and validity analysis

Constructs		Items	Loading	Composite reliability	AVE
LOC	HOC				
Digital Capacity (DC)		DC1	0.873	0.941	0.761
		DC2	0.858		
		DC3	0.873		
		DC4	0.887		
		DC5	0.871		
Digital Strategy (DS)		DS1	0.874	0.943	0.768
		DS2	0.892		
		DS3	0.883		
		DS4	0.868		
		DS5	0.867		
Product Value Adding (PVA)		PVA1	0.886	0.905	0.615
		PVA2	0.859		
		PVA3	0.886		
		PVA4	0.859		
		PVA5	0.855		
Digital Technology Application (DTA)		DTA1	0.884	0.941	0.760
		DTA2	0.872		
		DTA3	0.861		
		DTA4	0.882		
		DTA5	0.859		
Information Sharing Analysis (ISA)		ISA1	0.835	0.926	0.715
		ISA2	0.826		
		ISA3	0.836		
		ISA4	0.864		
		ISA5	0.866		
	DT	DC	0.842	0.827	0.960
		DS	0.944		
		PVA	0.992		
		DTA	0.942		
		ISA	0.815		
Green Process Innovation (GPI)		GPI1	0.845	0.922	0.703
		GPI2	0.844		
		GPI3	0.818		
		GPI4	0.846		
		GPI5	0.841		
Green Product Innovation (GPI_A)		GPI_A1	0.880	0.922	0.704
		GPI_A2	0.879		
		GPI_A3	0.903		
		GPI_A4	0.884		
		GPI_A5	0.878		
Green Technology Innovation (GTI)		GTI1	0.889	0.939	0.756
		GTI2	0.883		
		GTI3	0.859		
		GTI4	0.859		
		GTI5	0.859		
Green Management Innovation (GMI)		GMI1	0.842	0.929	0.724
		GMI2	0.831		
		GMI3	0.867		
		GMI4	0.862		
		GMI5	0.852		

	GI	GPI	0.915	0.969	0.888
		GPI_A	0.980		
		GTI	0.987		
		GMI	0.884		
Sustainable Social Performance (SSP)		SSP1	0.872	0.937	0.747
		SSP2	0.873		
		SSP3	0.868		
		SSP4	0.849		
		SSP5	0.861		
Sustainable Economic Performance (SEP)		SEP1	0.851	0.919	0.697
		SEP2	0.835		
		SEP3	0.820		
		SEP4	0.816		
		SEP5	0.851		
Sustainable Environmental Performance (SEP_A)		SEP_A1	0.870	0.944	0.770
		SEP_A2	0.894		
		SEP_A3	0.856		
		SEP_A4	0.886		
		SEP_A5	0.881		
	SP	SSP	0.976	0.987	0.961
		SEP	0.988		
		SEP_A	0.977		

Discriminant validity was evaluated using the heterotrait–monotrait (HTMT) criterion, which assesses the extent to which latent constructs are empirically distinguishable by contrasting correlations across different traits and measurement methods. Smaller HTMT values indicate a higher degree of discriminant validity. Consistent with the guidelines proposed by Henseler et al. (2015), HTMT values below 0.85, or below 0.90 in the case of conceptually less related constructs, are regarded as acceptable.

Table 3. HTMT ratio result for lower order constructs

	DC	DS	DT	DTA	GI	GMI	GPI	GPI_A	GTI	ISA	PVA	SEP	SEP_A	SP
DC														
DS	0.191													
DT	0.681	0.633												
DTA	0.311	0.219	0.698											
GI	0.402	0.386	0.631	0.405										
GMI	0.274	0.342	0.472	0.275	0.714									
GPI	0.246	0.214	0.398	0.290	0.707	0.229								
GPI_A	0.301	0.249	0.403	0.275	0.758	0.280	0.269							
GTI	0.214	0.192	0.356	0.206	0.728	0.239	0.236	0.302						
ISA	0.226	0.222	0.691	0.265	0.374	0.266	0.312	0.189	0.203					
PVA	0.206	0.158	0.641	0.191	0.310	0.245	0.126	0.182	0.244	0.262				
SEP	0.275	0.181	0.368	0.171	0.314	0.307	0.189	0.098	0.220	0.201	0.267			
SEP_A	0.285	0.235	0.375	0.271	0.397	0.339	0.286	0.206	0.199	0.164	0.156	0.121		
SP	0.433	0.320	0.581	0.329	0.548	0.444	0.398	0.262	0.318	0.315	0.330	0.762	0.721	
SSP	0.286	0.208	0.393	0.198	0.358	0.220	0.300	0.204	0.203	0.251	0.226	0.284	0.179	0.798

The combined use of the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio provides a robust assessment of discriminant validity in the measurement model. Figure 1 presents a graphical representation of the measurement model evaluation.

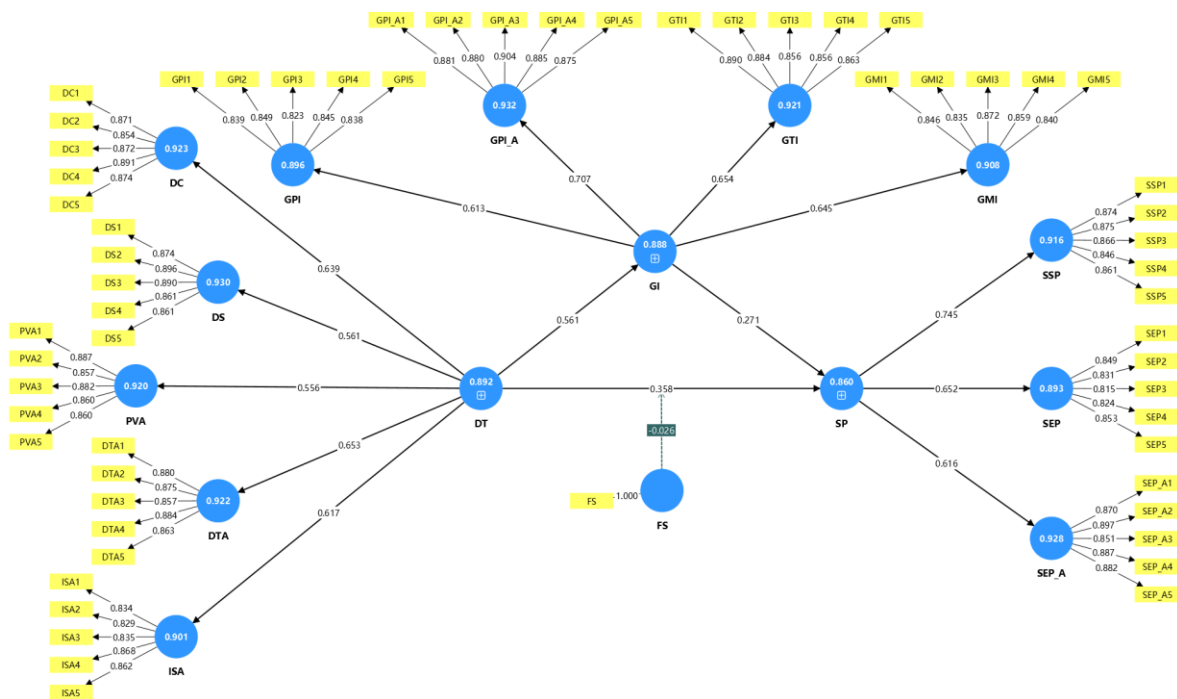


Figure 1. Measurement model results

Table 4 presents the results of the structural model and the hypothesis testing. Hypothesis H1 examines the direct effect of DT on sustainable performance (SP). The results indicate a positive and statistically significant relationship ( $\beta = 0.347$ ,  $t = 6.368$ ,  $p < 0.001$ ), providing strong support for H1. This finding suggests that higher levels of DT are associated with superior SP outcomes.

Table 4. Hypothesis testing- direct effect

Relationship	$\beta$	STDEV	T-value	P-value	Decision
H1	0.347	0.054	6.368	0.000	Supported
H2	0.572	0.037	15.416	0.000	Supported
H3	0.294	0.054	5.435	0.000	Supported
H4	0.168	0.033	5.106	0.000	Supported
H5	-0.024	0.049	0.498	0.309	Not Supported

The influence of DT on GI is examined in Hypothesis H2. The analysis identifies a strong and statistically significant association between the two constructs ( $\beta = 0.572$ ,  $t = 15.416$ ,  $p < 0.001$ ), indicating that higher levels of DT are closely linked to increased engagement in GI activities among manufacturing firms.

Hypothesis H3 evaluates the relationship between GI and SP. The results demonstrate a positive and significant effect of GI on SP ( $\beta = 0.294$ ,  $t = 5.435$ ,  $p < 0.001$ ), underscoring the importance of GI as a key contributor to sustainability outcomes. This evidence supports the view that environmentally oriented innovation practices can be effectively translated into improved SP.

To further explore the causal mechanism, the mediating effect of GI in the DT–SP relationship is analyzed. The indirect effect of DT on SP through GI is positive and statistically significant ( $\beta = 0.168, t = 5.106, p < 0.001$ ). At the same time, the direct effect of DT on SP remains significant ( $t = 5.368, p < 0.001$ ), providing evidence of a partial mediation effect. These findings indicate that DT contributes to SP both directly and through its capacity to stimulate GI.

Finally, the moderating role of firm size in the relationship between DT and SP is assessed. The results show that firm size does not exert a statistically significant moderating effect on this relationship ( $p = 0.309, t = 0.498$ ), and thus Hypothesis H5 is not supported. The estimated structural model is presented in Figure 2.

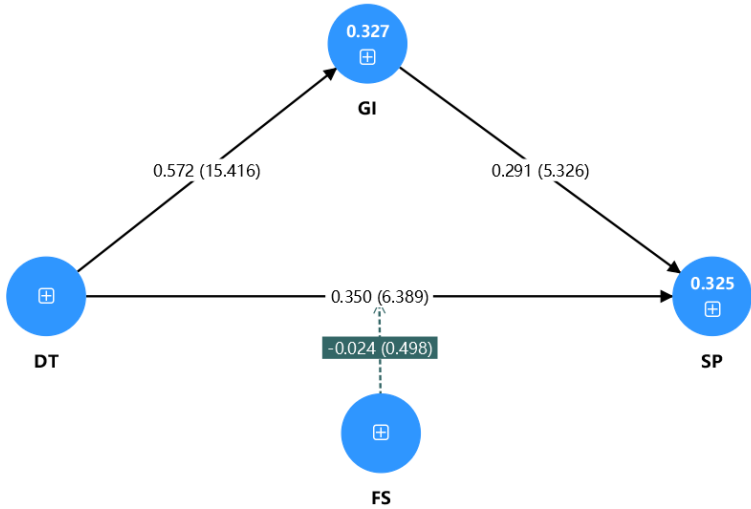


Figure 2. Structural model

Table 5 reports the explanatory power and effect sizes of the structural model. DT explains a substantial proportion of variance in SP ( $R^2 = 0.325$ ) and GI ( $R^2 = 0.327$ ). Regarding effect sizes, DT exerts a small effect on SP ( $f^2 = 0.122$ ) and a large effect on GI ( $f^2 = 0.487$ ), highlighting its critical role in driving GI. GI shows a small effect on SP ( $f^2 = 0.084$ ). Overall, the  $f^2$  values indicate varying strengths of influence among the latent variables, with the DT–GI relationship representing the strongest effect in the model.

Table 5. Coefficient of determination results

Latent Variables	Explanatory Power ( $R^2$ )	Effect Size	
		( $f^2$ )	Magnitude
DT->SP	0.325 (substantial)	0.122	Small
GI->SP		0.084	Small
DT->GI	0.327 (substantial)	0.487	Large

#### 4. Discussion

The empirical evidence indicates that digital transformation (DT) is positively associated with sustainable performance (SP), supporting the expectations outlined in the research hypotheses. This result is consistent with earlier studies showing that digital technologies contribute to sustainability by improving operational efficiency, optimizing resource allocation, and strengthening environmental governance mechanisms (Ghobakhloo et al.,

2021; Guan et al., 2023). Within the Chinese manufacturing context, DT facilitates the incorporation of advanced digital tools, such as artificial intelligence, big data analytics, and the Internet of Things, into core production and managerial activities. As a result, firms are better able to rely on data-driven decision processes and to achieve more coordinated economic, environmental, and social performance outcomes (Xu et al., 2023). From the perspective of the Dynamic Capability View (DCV), DT enhances firms' capacities to recognize sustainability-related challenges, capitalize on emerging green opportunities, and reconfigure internal resources to adapt to evolving environmental and technological pressures.

The results further confirm that DT significantly promotes green innovation (GI). This finding supports existing studies that identify DT as a key enabler of green process, product, technology, and management innovation by improving information sharing, technological integration, and organizational coordination (Zhou et al., 2020; Guo et al., 2023). Through enhanced digital capabilities and greater information transparency, manufacturing firms are better positioned to redesign production processes, develop environmentally friendly products, and adopt cleaner technologies. These outcomes are consistent with the Natural Resource-Based View (NRBV), which posits that environmentally oriented innovations constitute strategic resources capable of generating sustained competitive advantages (Hart, 1995).

More importantly, the mediation analysis further clarifies the mechanism through which DT contributes to SP. Specifically, GI serves as a key pathway that translates DT into sustainability outcomes, rather than DT exerting its influence solely through immediate operational efficiency gains. By enabling firms to develop and implement environmentally oriented innovations across products, processes, technologies, and management practices, DT facilitates deeper and more enduring sustainability improvements. This finding underscores the role of GI as a critical conduit through which digital capabilities are converted into tangible economic, environmental, and social benefits, reinforcing the view that sustainability-oriented DT depends on the effective integration of innovation activities rather than on digitalization alone.

Contrary to expectations, firm size does not significantly moderate the relationship between DT and SP. This result suggests that, once a certain level of digital adoption is achieved, the sustainability benefits of DT can be realized across firms of different sizes. While large firms typically possess greater financial and technological resources, small and medium-sized enterprises may benefit from greater organizational flexibility and agility when implementing digital initiatives (Song et al., 2024). In the Chinese manufacturing context, supportive industrial policies and the continuous development of digital infrastructure may have reduced size-related disparities, enabling firms of varying scales to leverage DT for sustainability objectives.

Overall, the findings indicate that DT, when strategically aligned with GI initiatives, constitutes a powerful pathway toward SP in the manufacturing sector. By integrating digital technologies with environmentally oriented innovation practices, firms can simultaneously respond to regulatory pressures, meet market demands, and pursue long-term sustainability goals.

#### *4.1. Study Limitations and Future Directions*

While this study offers meaningful insights, several limitations warrant consideration. First, the use of a cross-sectional research design constrains the ability to observe how DT and GI evolve over time and limits strong causal inference. Future research may address this issue by adopting longitudinal or panel data designs to capture temporal dynamics more effectively. Second, the empirical investigation is confined to manufacturing firms located in China's Yangtze River Delta. Although this region represents a highly developed manufacturing cluster, the results may not be readily generalizable to firms operating in other regional or national settings. Extending the analysis to different regions or other emerging economies would help improve the external validity of the findings. Third, this study focuses on GI as the primary mediating mechanism between DT and SP. Future studies could incorporate additional mediators, such as organizational learning capabilities, digital culture, supply chain collaboration, or environmental management systems, to develop a more comprehensive understanding of the transformation pathway. Furthermore, while firm size is examined as a moderating variable, other contextual factors, including the intensity of environmental regulation, competitive pressures, and technological turbulence, may also condition the DT–SP relationship and thus deserve further empirical attention.

#### *4.2. Theoretical Contributions*

This study makes several important theoretical contributions. First, it advances DT research by conceptualizing DT as a digital dynamic capability rather than merely a technological investment. By integrating the NRBV and the DCV, the study elucidates how DT enables firms to develop GI as a strategic sustainability resource, thereby enhancing SP. In addition, the study empirically validates the mediating role of GI in the relationship between DT and SP, addressing a key gap in the literature where the underlying mechanisms linking digitalization and sustainability outcomes remain insufficiently explored. By disaggregating GI into process, product, technology, and management dimensions, the study offers a more nuanced explanation of how digital capabilities are converted into sustainability gains. Moreover, the findings contribute to the ongoing debate on firm heterogeneity by demonstrating that firm size does not significantly moderate the impact of DT on SP. This result challenges the assumption that the sustainability benefits of DT are confined to large firms and highlights the inclusive potential of DT in emerging manufacturing economies.

#### *4.3. Managerial Implications*

The findings of this study offer several practical implications for managers and policymakers. Firstly, managers should regard DT as a strategic enabler of sustainability rather than merely an operational upgrade. Investments in digital capabilities, strategic digital alignment, and information-sharing systems can substantially enhance GI outcomes and SP. Secondly, firms should explicitly integrate GI objectives into their DT initiatives. Digital technologies can be leveraged to redesign production processes, develop green products, and strengthen environmental management practices, thereby maximizing the

sustainability returns of digital investments. Thirdly, policymakers should continue to support the development of digital infrastructure and provide targeted incentives for green digital innovation, particularly for small and medium-sized manufacturing enterprises. Such policy interventions can help reduce adoption barriers and promote more balanced and sustainable industrial development.

In sum, this study demonstrates that SP in the Chinese manufacturing industry can be achieved through the strategic integration of DT and GI, regardless of firm size, underscoring the critical role of digitalization in advancing sustainable industrial development.

## 5. Conclusions

Digital transformation (DT) has fundamentally reshaped the competitive logic of the manufacturing industry, compelling firms to reconsider how value is created, resources are deployed, and sustainability objectives are pursued. As manufacturing environments become increasingly complex and environmentally constrained, sustaining long-term performance can no longer rely solely on incremental efficiency improvements. Instead, firms must cultivate scalable digital capabilities and innovation-oriented processes that support continuous adaptation.

Against this backdrop, this study investigates the impact of DT on sustainable performance (SP) in the Chinese manufacturing industry, with particular emphasis on the mediating role of green innovation (GI) and the moderating effect of firm size. Using firm-level survey data from manufacturing enterprises in the Yangtze River Delta region, the study empirically tests a DT–GI–SP mechanism.

The results indicate that DT contributes positively to SP while simultaneously fostering GI, which itself exerts a favorable influence on sustainability outcomes. Evidence further suggests that GI operates as a partial intermediary through which DT affects SP, implying that the sustainability benefits of digitalization arise not only from immediate operational efficiencies but also from the stimulation of environmentally oriented innovations across products, processes, technologies, and managerial practices. In addition, the analysis reveals no significant moderating effect of firm size on the DT–SP relationship, suggesting that firms can derive sustainability gains from DT regardless of organizational scale, provided that a sufficient level of digital adoption has been achieved.

Overall, this study provides robust empirical evidence that SP in manufacturing firms depends not on digitalization alone, but on the strategic alignment between DT and GI. By integrating digital technologies with sustainability-oriented innovation practices, firms can simultaneously enhance economic efficiency, reduce environmental impacts, and strengthen social responsibility. These findings offer clear and actionable insights for both scholars and practitioners seeking to understand how DT can be strategically leveraged to support sustainable development in emerging manufacturing economies.

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