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Impacts of Social Network Characteristics on Digital Seizing Capabilities and Sustainable Performance: Evidence from Advanced Manufacturing Clusters in China

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Abstract: This study investigates how social network relational characteristics (SNRC) and structural characteristics (SNSC) influence sustainable performance (SP) in China's advanced manufacturing clusters, with particular attention to the mediating role of digital seizing capability (DSZC). Drawing on Social Network Theory and Dynamic Capabilities Theory, SP is conceptualized as a second-order construct that integrates economic, environmental, and social performance. Using survey data from 236 firms across eight national-level clusters, the analysis was conducted through Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings demonstrate that SNRC significantly improves SP both directly and indirectly through DSZC. At the same time, SNSC affects SP only indirectly, underscoring the central role of DSZC in transforming network advantages into sustainability outcomes. These results extend theoretical insights by linking social networks and dynamic capabilities to sustainable competitiveness, though the reliance on data from a limited number of Chinese clusters may restrict broader generalization. The study contributes by offering new evidence on the mechanisms through which inter-firm networks foster digital-enabled sustainability, providing practical guidance for managers and policymakers in the Industry 4.0 era.

Keywords: *Social network characteristics; digital seizing capability; sustainable performance; advanced manufacturing clusters*

1. Introduction

China's advanced manufacturing clusters (AMCs), despite their industrial scale and technological sophistication, face persistent challenges in achieving sustainable performance. High-profile examples, such as Suzhou's high-end scientific instruments cluster, reveal a disconnection between industrial growth and ecological sustainability, with energy-intensive processes driving significant carbon emissions and resource depletion (Elaouzy & El Fadar, 2024; Mendrela et al., 2024). Many firms, particularly small and medium-sized enterprises (SMEs), struggle to meet stringent green certification requirements due to fragmented knowledge sharing and limited access to sustainable technologies. These challenges are compounded by global supply chain disruptions and rising environmental, social, and governance (ESG) demands, placing additional operational pressures on cluster members.

Institutional and structural factors exacerbate these issues. High pollution control costs disproportionately burden SMEs, while rigid administrative mandates often discourage market-driven collaborations and underutilize self-organized networks for resource sharing and green technology diffusion (Zheng & Zhang, 2023). Moreover, a core–periphery paradox persists, with core firms monopolizing green resources and externalizing environmental costs to peripheral actors, as seen in new energy vehicle clusters, 2023. Homogeneous competition and price wars further hinder sustainability, leading to redundant investments, weakened corporate social responsibility, and energy consumption per GDP unit above global benchmarks.

While prior research has examined network structures and innovation within clusters, little is known about how relational dimensions of inter-firm networks—rather than structural ones—drive capability development that supports sustainability outcomes (Henao et al., 2019; Napoli, 2023). In the context of digital transformation, digital seizing capability is increasingly recognized as a critical dynamic capability for translating network-derived knowledge into sustainable performance gains (Heredia et al., 2022; Kump et al., 2018). By integrating Social Network Theory and Dynamic Capabilities Theory, this study addresses this gap by investigating how SNRC influences SP through DSZC in China's AMCs, providing both theoretical insights and practical guidance for advancing sustainability in highly interconnected industrial ecosystems.

2. Literature Review and Hypothesis Development

Theoretical Background: Theoretical Framework Integration

This study develops an integrated framework combining social network theory and dynamic capability theory to elucidate how firms utilize network advantages to attain sustainable performance. Social network theory emphasizes the ability of enterprises to access critical resources embedded in external networks (Granovetter, 1983; Granovetter, 1973), whereas dynamic capability theory explains how firms internally reconfigure such resources—through processes of sensing, seizing, and transforming—to adapt to environmental shifts and generate value (Teece, 2007; Teece et al., 1997). In the proposed model, network characteristics act as "inputs", sustainable performance represents the "outputs", and digital capture capability—the pivotal manifestation of dynamic capability in the digital era—constitutes the central "black box" mechanism that translates inputs into outputs.

Social Network Characteristics

Literature commonly categorizes social network characteristics into two dimensions: structural and relational. The structural dimension refers to the overall architecture of the network and the position of a firm within it, including attributes such as centrality, structural holes, and network size (Borgatti et al., 2009). These features determine the diversity and novelty of information and resources accessible to the firm. For instance, centrally positioned enterprises tend to acquire information more rapidly, while those with extensive and diverse partnerships are more likely to obtain heterogeneous knowledge. The relational dimension, in contrast, pertains to the quality of ties developed through ongoing interactions, exemplified by trust, reciprocity, and tie strength (Granovetter, 1973). These characteristics influence the actual acquisition and utilization of resources, particularly in terms of depth and reliability. Strong trust-based relationships, for example, facilitate the sharing of tacit knowledge and enhance joint problem-solving capacity, while also reducing transaction costs (Uzzi, 1997).

Despite extensive evidence supporting the positive influence of network characteristics on innovation and general firm performance (Chen et al., 2024; Landherr et al., 2010; Yin & Shi, 2019)Their specific mechanisms for driving sustainable performance—particularly across the economic, environmental, and social dimensions of the triple bottom line—remain inadequately understood. Many studies focus exclusively on either structural or relational aspects, lacking an integrative view. More importantly, in the evolving context shaped by digitalization and sustainability imperatives, the critical capability processes that connect network attributes to sustainable outcomes remain underexplored.

Sustainable Performance

Sustainable performance has emerged as a central paradigm in modern corporate strategic management. It transcends traditional financial metrics by emphasizing the simultaneous pursuit of economic prosperity, the minimization of environmental impact, and proactive social responsibility—conceptualized as the triple bottom line.(Elkington, 1998). Within the context of manufacturing clusters, this translates into specific outcomes: economic performance, environmental performance and social performance. Achieving this integrated objective necessitates fundamental process and product innovation, which is highly dependent on both the acquisition of external knowledge and the reconfiguration of internal capabilities (Paulraj, 2011). Existing research on the antecedents of sustainable performance has primarily focused on three key dimensions: technological, organizational, and governmental regulatory factors.

Regarding technological factors, the correlation between technological innovation and sustainable performance has become a prominent research stream. Studies indicate that artificial intelligence techniques can enhance the enduring quality of financial reports (Gshayish & Faik, 2023), while big data analytics (BDA) is considered a main pillar of sustainable manufacturing. The effectiveness of BDA is heavily dependent on data accessibility and directly impacts a firm's sustainable competitive advantage (Baig et al., 2023; Ikumapayi et al., 2023). Furthermore, green innovation has been demonstrated to significantly correlate with overall business sustainability (Anaya & Qutaishat, 2022). Concerning organizational factors, internal practices such as corporate governance, human resource management, and supply chain management are crucial. Organizational and production knowledge management are regarded among the most powerful instruments for enhancing sustainable organizational performance (Sun et al., 2023). Resource management capabilities have been found

to partially mediate the relationship between dynamic sustainability capabilities and corporate environmental and social performance (Shang et al., 2020). Concurrently, continuous learning, both within and between organizations, is a critical strategic factor for successfully implementing sustainable management and maintaining future competitiveness (Oelze et al., 2016). Collaboration and coordination within supply chains have also been shown to significantly affect sustainable supply chain performance (Nayal et al., 2022). In terms of government regulation, public policies and schemes are widely recognized as accelerators for corporate economic growth and sustainable transformation. Research highlights that regulatory instruments, such as industrial land policies, exert differential effects on regional industrial land green use efficiency (Xie et al., 2016) and are identified as key drivers for the financial, social, and environmental performance of manufacturing SMEs (Lopes De Sousa Jabbour et al., 2020). However, academic consensus on this is not uniform. Some studies found that cost implications were the most significant factor influencing the implementation of sustainable manufacturing, with government regulations perceived as having the least impact (Xu et al., 2024), indicating the context-dependent nature of policy effectiveness.

Despite these valuable insights, a critical perspective remains relatively underexplored: the mechanism linking social network characteristics to corporate sustainable performance. Although the benefits of social networks are widely acknowledged, research explicitly connecting them to sustainable development remains nascent. A few pioneering studies have begun to explore this intersection. For instance, Abbas et al. (2019) were among the first to empirically investigate the relationship between entrepreneurial business networks and the sustainable performance of small firms, identifying dynamic capabilities as a mediating factor. Similarly, Li et al. (2013) assessed the impacts of network structural and relational characteristics on performance, including their moderating effects on spatial relationships. These studies suggest that mechanisms such as collaboration, information sharing, mutual trust, communication, and commitment within networks are vital for performance enhancement. Nevertheless, significant limitations persist in the extant literature. Most studies focus exclusively on either the structural or the relational dimension of networks, lacking an integrated theoretical perspective. More importantly, within the dual context of digitalization and sustainability, the key capability processes (i.e., the mediating 'black box') that connect network attributes to sustainable outcomes remain inadequately theorized and investigated. Therefore, a deeper inquiry into how the structural and relational characteristics of social networks influence a firm's economic, environmental, and social performance through specific dynamic capabilities (such as digital capture capability) is essential to address this theoretical gap.

Digital Seizing Capabilities

Rooted in dynamic capability theory, “seizing” refers to the organizational processes through which a firm mobilizes, invests, and reconfigures resources in response to perceived opportunities (Teece, 2007). In the context of Industry 4.0, this notion evolves into what we define as digital seizing capability—the ability of an enterprise to evaluate, integrate, and deploy digital technologies and data resources to seize value-creating opportunities (Kump et al., 2018; Warner, 2018). This capability encompasses activities such as collecting data from external partners, translating digital solutions into concrete projects or operational processes, and coordinating cross-departmental resources to enable rapid implementation.

The theoretical connection proposed here addresses a significant gap in the current literature. While numerous studies have directly examined the relationship between "social network characteristics" and "digital capabilities," few have considered digital seizing capability as the essential mediating pathway. Social networks supply the critical "raw materials"—such as novel information and knowledge—necessary for innovation. Digital seizing capability, in turn, acts as the "production line" that processes and transforms these inputs into tangible value. Without such an internal capacity, even the highest-quality external resources cannot be effectively converted into sustainable outcomes. It is precisely this theoretical and mechanistic gap that the present study seeks to fill.

Review of Key Concepts and Hypothesis Development

Social Network Characteristics and Sustainable Performance: Social network relational characteristics encompass the trust, frequency of interaction, and stability of relationships between firms and their network partners. In high-quality relational contexts, firms benefit from stronger commitments, more open communication, and the willingness to share critical knowledge, which together foster mutual growth and innovation (Grant, 1996; Tallman et al., 2004). These relational conditions reduce transaction costs, enhance

problem-solving efficiency, and create fertile ground for adopting sustainable practices such as green technology implementation, cleaner production processes, and resource optimization.

Within the triple bottom line framework—covering economic, environmental, and social performance—robust relational ties have been linked to cost savings, improved return on investment, reduced emissions, greater resource efficiency, enhanced workplace safety, and stronger community engagement (Liu et al., 2018; Paulraj, 2011). In advanced manufacturing clusters, these benefits are amplified through collaborative projects and shared technological platforms that align industrial competitiveness with sustainability goals.
H1: Social network relational characteristics (SNRC) have a positive effect on sustainable performance (SP).
H2: Social network structural characteristics (SNSC) have a positive effect on sustainable performance (SP).

Social Network Characteristics and Digital Seizing Capability
Digital seizing capability refers to the ability to mobilize resources and implement solutions after identifying promising opportunities (Kump et al., 2018). Firms embedded in strong relational networks are better positioned to engage in deep, (Bhatti et al., 2024; Vo Thai et al., 2024). Trust-based exchanges that yield valuable tacit knowledge and technical insight. Such relational contexts promote secure data sharing, foster collaborative innovation, and accelerate the adoption of advanced digital tools such as IoT platforms and big data analytics.
By providing timely access to external expertise and collaborative partners, a strong SNRC can enhance a firm's agility in seizing emerging digital opportunities. This, in turn, allows for faster integration of new technologies into operations, improving competitiveness and enabling more responsive sustainability strategies.
H3: Social network relational characteristics (SNRC) have a positive effect on digital seizing capability (DSZC).
H4: Social network structural characteristics (SNSC) have a positive effect on digital seizing capability (DSZC).

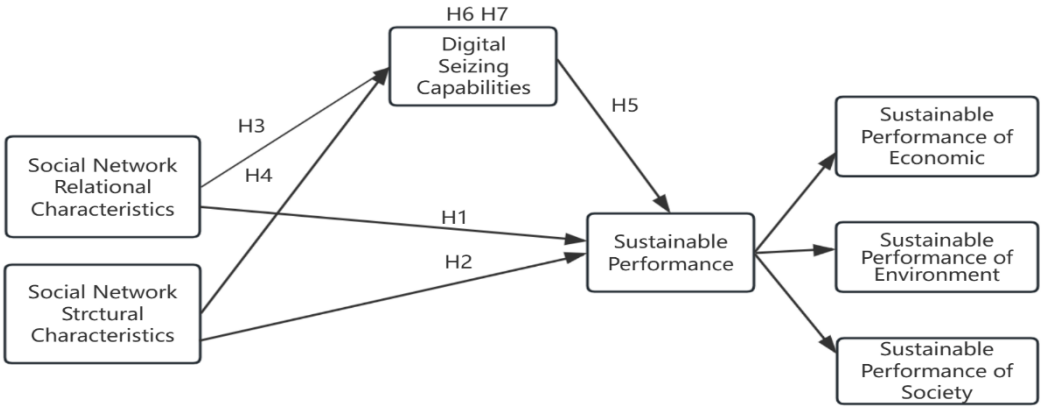
Digital Seizing Capability and Sustainable Performance
Digital seizing capability empowers firms to transform identified opportunities into tangible outcomes such as process innovations, product advancements, and improved service delivery (Frishammar et al., 2018). In the sustainability domain, this capability facilitates the adoption of low-carbon technologies, the optimization of energy consumption, and enhanced supply chain transparency (Lopes De Sousa Jabbour et al., 2020). By efficiently integrating external resources and aligning them with sustainability objectives, firms can realize significant improvements in economic, environmental, and social performance.

In advanced manufacturing clusters, DSZC plays a crucial role in bridging the gap between technological potential and practical application, ensuring that digital investments directly contribute to sustainability goals.
H5: Digital seizing capability (DSZC) has a positive effect on sustainable performance (SP).

The Mediating Role of Digital Seizing Capability
While social network relational characteristics (SNRC)may exert a direct influence on SP, a substantial portion of this relationship is mediated through capability development (Pinho & Prange, 2016). Relational characteristics provide the foundational access to high-quality external knowledge, trusted partnerships, and collaborative opportunities. DSZC serves as the conversion mechanism that transforms these relational resources into measurable sustainability achievements.

When firms excel in evaluating, integrating, and acting upon knowledge from their networks, they are better equipped to implement sustainability-focused innovations, enhance resource efficiency, and strengthen social responsibility initiatives. This positions DSZC as a key mediator linking relational networks to sustainable performance outcomes.
H6: Digital seizing capability (DSZC) positively mediates the relationship between social network relational characteristics (SNRC) and sustainable performance (SP).
H7: Digital seizing capability (DSZC) positively mediates the relationship between social network structural characteristics (SNSC) and sustainable performance (SP).

Figure 1: Proposed Model With All the Hypotheses



Source： Authors' own elaboration

3. Research method

Sample Characteristics

The target population for this study comprised all enterprises operating within the 80 national-level advanced manufacturing clusters in China, as designated by the Ministry of Industry and Information Technology (MIIT) in 2022 and 2024. These clusters represent strategic emerging industries, including new-generation information technology, high-end equipment, biomedicine, and new energy. Due to the diversity and scale of the population, a combination of stratified and purposive sampling techniques was employed to ensure representation of different cluster characteristics relevant to the research objectives. Eight clusters were selected from the 80 national-level clusters based on industry representativeness, geographical distribution, and accessibility for data collection, as shown in Table 1.

Table 1: Sampling Clusters List

Type of Industry Clusters	Total Number	Selected Number	Sampling Clusters List
New Generation IT and High-end Equipment	16	2	Beijing-Tianjin-Hebei Integrated Circuit Cluster; Beijing-Tianjin-Hebei New-Generation Information Technology Application and Innovation Cluster
High-end Equipment	29	2	Beijing-Tianjin-Hebei Safety and Emergency Equipment Cluster; Harbin Aviation Cluster
Biomedicine and High-end Medical Devices	7	1	Beijing-Tianjin-Hebei Life and Health Cluster
Consumer Goods	6	1	Foshan Dongguan Pan-Home Furnishings Cluster
New Energy and Intelligent Connected Vehicles	5	1	Beijing-Tianjin-Hebei Intelligent Connected New Energy Vehicle Cluster
Photovoltaics	2	1	Yancheng Suhuai Photovoltaics Cluster

Source: Authors' own elaboration based on MIIT (2024).

Within each selected cluster, a designated key contact person facilitated data collection by distributing 30 questionnaires to firms meeting the inclusion criteria: active engagement in manufacturing activities within the cluster and respondents possessing relevant managerial or operational experience. This approach was chosen

for three main reasons. First, purposive sampling is well-suited for specialized research contexts where access to qualified respondents is restricted (Etikan, 2016). Second, stratification ensured that a variety of industrial sectors and regional contexts were represented, thereby enhancing the diversity and contextual relevance of the collected data. Third, the involvement of key contacts improved the response rate and data quality.

Out of 240 distributed questionnaires, 236 valid responses were obtained, yielding a response rate of 98%. While purposive sampling may limit the statistical generalizability of the findings, it is considered appropriate for theory-testing research in specialized industrial settings. Ensuring that all respondents were knowledgeable and directly involved in cluster-related activities increased the accuracy and contextual validity of the collected data.

The demographic profile of respondents is presented in Table 2. The respondent pool was nearly balanced by gender (49.6% male, 50.4% female) and largely composed of young to middle-aged professionals, with 48.3% aged between 25 and 35. Educational attainment was high, with 61% holding a Bachelor's degree, and 75.8% holding a Bachelor's degree or higher. Most respondents occupied middle management positions (77.5%), followed by top management (14.8%) and CEOs/MDs (7.6%).

The sample was dominated by small and medium-sized enterprises (SMEs), with 74.6% of firms employing between 21 and 299 people, and over 60% having been established for between 1 and 10 years. The industry representation included new-generation information technology, high-end equipment, and new energy, ensuring the generalizability of the study's findings within the advanced manufacturing cluster context. Notably, 95.8% of leaders reported prior experience with digital projects, and 97.9% indicated a high level of attention to digitalization and sustainability, providing a robust foundation for analyzing the relationships proposed in this research.

Measures

The questionnaire was designed based on existing literature (Appendix A). Social Network Relational Characteristics (SNRC) and Social Network Structural Characteristics (SNSC) were measured using adapted scales from established instruments in prior studies (Chen et al., 2024; Shi et al., 2019). SNRC was conceptualized through three key dimensions: tie strength, tie quality, and tie stability (including network breadth). To enhance contextual relevance to Chinese advanced manufacturing clusters and reduce redundancy, conceptually overlapping items from the original scales were consolidated, and wording was simplified for clarity. For example, two separate items assessing tie stability and network breadth were merged into a single statement, and reverse-coded items were rephrased positively to minimize potential response bias. The final adapted SNRC scale consisted of four items, each rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Reliability and validity analyses confirmed that the adapted instrument maintained satisfactory measurement quality.

Digital Seizing Capability (DSZC) was measured using an adapted scale based on prior works (Kump et al., 2018; Warner, 2018). The construct reflects a firm's ability to mobilize resources and implement solutions to capture identified opportunities in a digital context. In the setting of advanced manufacturing clusters, the adapted items emphasize concrete actions such as collecting and integrating data from external partners, extracting valuable information for internal analysis, and establishing cross-departmental data sharing mechanisms to ensure timely access to operational information. The final scale consisted of four items, each rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Reliability and validity tests confirmed that the adapted scale achieved satisfactory measurement quality.

Sustainable Performance (SP) was operationalized as a second-order reflective construct comprising three first-order dimensions: economic performance, environmental performance, and social performance, following the triple bottom line framework(Carter & Rogers, n.d.; Paulraj, 2011). Economic performance items capture improvements in financial efficiency and competitiveness, such as reductions in material and energy costs and increased returns on investment. Environmental performance items assess reductions in emissions, resource usage, and environmental incidents, as well as improvements in energy efficiency. Social performance items measure enhancements in stakeholder welfare, occupational health and safety, community engagement, and environmental awareness among partners. The adapted scale consisted of 15 items—five for each dimension—measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). All three dimensions

demonstrated satisfactory reliability and validity, and the second-order model structure was supported by confirmatory analysis.

Data Analysis

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0. PLS-SEM was selected to analyze data (Peng and Lai, 2012).

Measurement model

The reliability and validity of the measurement model were assessed following established criteria (Fornell & Larcker, 1981)As shown in Table 4, all constructs exhibited strong internal consistency reliability, with Cronbach's alpha (α) values ranging from 0.882 (SNRC) to 0.973 (SP), all exceeding the recommended threshold of 0.70. Composite reliability (CR) values ranged from 0.918 to 0.975, well above the 0.80 benchmark, indicating high internal consistency.

Convergent validity was evaluated using outer loadings, composite reliability, and average variance extracted (AVE). The average outer loading values for each construct were 0.859 (SNRC), 0.876 (SNSC), 0.877 (DSZC), 0.9168 (SPEC), 0.9002 (SPEN), and 0.8976 (SPSO), all well above the minimum threshold of 0.50 and significant at $p < 0.001$. AVE values ranged from 0.724 to 0.841, surpassing the 0.50 criterion, thereby confirming satisfactory convergent validity.

4. Results and Discussion

Table 4: Results of Reflective Measurement Model

First Order Construct	Type	No of Items	Item Description	Outer Loadings	AVE	CR	Cronbach's alpha (α)
SNRC	Reflective	4	SNRC1	0.857	0.738	0.918	0.882
			SNRC2	0.852			
			SNRC3	0.856			
			SNRC4	0.871			
SNSC	Reflective	5	SNSC1	0.906	0.768	0.943	0.925
			SNSC2	0.892			
			SNSC3	0.857			
			SNSC4	0.853			
			SNSC5	0.874			
DSZC	Reflective	4	DSZC1	0.887	0.77	0.93	0.9
			DSZC2	0.878			
			DSZC3	0.847			
			DSZC4	0.897			
SPEN	Reflective	5	SPEN1	0.9	0.81	0.955	0.941
			SPEN2	0.901			
			SPEN3	0.892			
			SPEN4	0.895			
			SPEN5	0.913			
SPSO	Reflective	5	SPSO1	0.922	0.806	0.954	0.94
			SPSO2	0.888			
			SPSO3	0.879			
			SPSO4	0.879			
			SPSO5	0.918			
SPEC	Reflective	5	SPEC1	0.932	0.841	0.964	0.953
			SPEC2	0.915			
			SPEC3	0.892			

SPEC4	0.911
SPEC5	0.934

Discriminant validity was evaluated using the Fornell–Larcker criterion, cross-loadings, and the heterotrait–monotrait ratio (HTMT). As shown in Table 5, the square root of AVE for each construct (diagonal values) was greater than the corresponding inter-construct correlations, satisfying the Fornell–Larcker criterion. Cross-loading results indicated that all indicators loaded highest on their associated constructs compared to other constructs, with no severe cross-loadings, further supporting discriminant validity.

Table 5: Fornell-Larcker criterion

	DSZC	SNRC	SNSC	SP	SPEC	SPEN	SPSO
DSZC	0.877						
SNRC	0.468	0.859					
SNSC	0.402	0.403	0.877				
SP	0.565	0.581	0.356	0.851			
SPEC	0.499	0.521	0.363	0.938	0.917		
SPEN	0.518	0.525	0.306	0.939	0.818	0.9	
SPSO	0.577	0.592	0.333	0.943	0.825	0.834	0.898

The HTMT values (Table 6) between first-order constructs were below the conservative threshold of 0.85 and the more lenient threshold of 0.90, indicating adequate discriminant validity. For the second-order construct Sustainable Performance (SP), the HTMT values with its three first-order reflective dimensions—economic performance (SPEC), environmental performance (SPEN), and social performance (SPSO)—were 0.974, 0.982, and 0.986, respectively. These elevated values are theoretically expected, as the three dimensions are reflective indicators of the same higher-order construct and thus share substantial variance. Such high interrelations do not indicate a lack of discriminant validity but rather confirm the conceptual and empirical coherence of the SP construct in a reflective–reflective higher-order model (Hair & Sarstedt, 2019).

Table 6 : Results of Discriminant Validity-HTMT

	DSZC	SNRC	SNSC	SP	SPEC	SPEN	SPSO
DSZC	1						
SNRC	0.523	1					
SNSC	0.437	0.447	1				
SP	0.603	0.626	0.372	1			
SPEC	0.539	0.568	0.384	0.974	1		
SPEN	0.562	0.575	0.326	0.982	0.863	1	
SPSO	0.627	0.65	0.354	0.986	0.871	0.887	1

Overall, the combined evidence from Fornell–Larcker, cross-loadings, and HTMT assessments confirmed that the measurement model demonstrated satisfactory reliability, convergent validity, and discriminant validity.

Structural model

The structural model was evaluated by examining multicollinearity, coefficient of determination (R^2), effect sizes (f^2), and predictive relevance (Q^2). First, collinearity was assessed using the variance inflation factor (VIF). As shown in Table X, all VIF values ranged from 1.000 to 1.378, far below the threshold of 5.0, indicating no multicollinearity concerns(Khan et al., 2021; Peng & Lai, 2012).

Table 7: Collinearity Statistics (VIF) – Inner Model

Path	VIF
DSZC → SP	1.376
SNRC → DSZC	1.194
SNRC → SP	1.378
SNSC → DSZC	1.194
SNSC → SP	1.283
SP → SPEC	1
SP → SPEN	1
SP → SPSO	1

The explanatory power of the model was evaluated using R^2 values. The R^2 for DSZC was 0.273, indicating that 27.3% of the variance in DSZC is explained by SNRC and SNSC. The R^2 for SP was 0.450, showing that 45.0% of the variance in SP is explained by DSZC, SNRC, and SNSC. The three first-order dimensions of SP (SPEC, SPEN, and SPSO) exhibited high R^2 values of 0.880, 0.882, and 0.889, respectively, indicating strong explanatory power for these dimensions. Third, the f^2 statistic was used to assess the effect size of each exogenous construct on endogenous constructs (Cohen, 1998). The results show that SNRC (f^2 = 0.201) and DSZC (f^2 = 0.173) have medium effects on SP, while SNSC has a negligible effect on SP (f^2 = 0.004). The effects of SP on its three first-order dimensions (SPEC, SPEN, SPSO) are extremely large (f^2 > 7.0), which is expected for a reflective–reflective higher-order construct. Finally, predictive relevance was assessed using the Stone–Geisser Q^2 test via the blindfolding procedure(Hair, 2020). All Q^2 values for endogenous constructs were greater than zero, indicating good predictive relevance. Specifically, Q^2 was 0.207 for DSZC, 0.321 for SP, and above 0.70 for SPEC, SPEN, and SPSO, suggesting that the model has strong predictive accuracy for both the higher-order and first-order constructs (Khan et al., 2021; Peng & Lai, 2012).

Table 8: Predictive relevance

Construct	R^2	Q^2
DSZC	0.273	0.207
SP	0.45	0.321
SPEC	0.88	0.735
SPEN	0.882	0.71
SPSO	0.889	0.712

Table 9: The f-square values

Path	f^2	Effect Size Interpretation
DSZC → SP	0.173	Medium
SNRC → DSZC	0.154	Medium
SNRC → SP	0.201	Medium
SNSC → DSZC	0.075	Small
SNSC → SP	0.004	Negligible
SP → SPEC	7.321	Very Large (expected)
SP → SPEN	7.507	Very Large (expected)
SP → SPSO	7.987	Very Large (expected)

Hypothesis Testing

We used the bootstrapping procedure (n = 5000) in Smart PLS to examine both the direct and mediating effects in the proposed model (Table 10). The results indicate that Digital Seizing Capability (DSZC) exerts a significant positive effect on Sustainable Performance (SP) (β = 0.361, $p < 0.001$), supporting H5. Social Network Relational Characteristics (SNRC) significantly influence DSZC (β = 0.365, $p < 0.001$) and SP (β = 0.390, $p < 0.001$), confirming H1 and H3. Social Network Structural Characteristics (SNSC) significantly affect DSZC (β = 0.255, p

< 0.001), supporting H4; however, its direct effect on SP is not significant (β = 0.053, p = 0.382), thus H2 is not supported. For the second-order construct SP, the three reflective dimensions—Economic Performance (SPEC), Environmental Performance (SPEN), and Social Performance (SPSO)—are all strongly predicted by SP (β = 0.938, 0.939, and 0.943, respectively; all p < 0.001).

Regarding mediation effects, DSZC significantly mediates the relationship between SNRC and SP (β = 0.490–0.492, all p < 0.001) as well as between SNSC and SP (β = 0.136–0.137, p < 0.05), supporting H6 and H7. Specifically, DSZC indirectly influences SPEC (β = 0.339, p < 0.001), SPEN (β = 0.340, p < 0.001), and SPSO (β = 0.341, p < 0.001) through SP. The indirect effects from SNSC to the three sustainability dimensions via DSZC and SP are smaller but still significant (β ≈ 0.136–0.137, p < 0.05).

The total effects analysis shows that SNRC has the strongest influence on SP (β = 0.522, p < 0.001), followed by DSZC (β = 0.361, p < 0.001) and SNSC (β = 0.145, p < 0.05). These results emphasize that relational network characteristics play a more substantial role than structural ones in enhancing DSZC, which in turn promotes sustainable performance in advanced manufacturing clusters.

Table 10: Path Coefficients and Hypotheses Testing of the Mediating Relationship

Path	β (Original Sample)	t-value	p-value	Significance
SNRC → DSZC	0.365	4.983	0	***
SNSC → DSZC	0.255	3.665	0	***
DSZC → SP	0.361	4.549	0	***
SNRC → SP	0.39	5.56	0	***
SNSC → SP	0.053	0.875	0.382	n.s.
SNSC -> DSZC -> SP	0.092	2.731	0.006	***
SNRC -> DSZC -> SP	0.132	3.188	0.001	***

Discussion

This study set out to examine the mechanisms through which Social Network Relational Characteristics (SNRC) and Social Network Structural Characteristics (SNSC) influence Sustainable Performance (SP) in the context of Chinese advanced manufacturing clusters, with a particular focus on the mediating role of Digital Seizing Capability (DSZC). Drawing upon Social Network Theory and Dynamic Capabilities Theory, the findings provide several noteworthy theoretical and practical implications.

First, the results confirm that SNRC exerts a significant positive effect on both DSZC and SP, supporting the notion that strong, trust-based, and stable relationships in enterprise networks facilitate the transfer of high-quality information, knowledge sharing, and collaborative innovation (Borgatti et al., 2009; Nahapiet & Ghoshal, 1998). These findings are consistent with prior studies showing that relational embeddedness can directly enhance organizational performance by fostering mutual trust and reducing transaction costs (Granovetter, 1973). Moreover, the significant indirect effect of SNRC on SP via DSZC highlights that such relational advantages are further amplified when firms are able to effectively capture and exploit digital opportunities, in line with the seizing dimension of dynamic capabilities (Teece, 2007).

Second, contrary to initial expectations, SNSC does not have a direct significant effect on SP. This suggests that simply occupying a central position in the network or maintaining a large number of diverse partners may not directly translate into improved sustainability outcomes. One possible explanation is that structural advantages, such as network centrality and network size, represent potential rather than realized resources. Without the capability to process, interpret, and utilize information from multiple network ties, these structural positions may not automatically lead to performance gains. This aligns with the argument in dynamic capabilities literature that sensing opportunities alone is insufficient—firms must possess the capabilities to seize them (Kump et al., 2018).

However, SNSC significantly influences SP through DSZC, indicating that DSZC acts as a strong mediator in this relationship. This finding underscores the transformational role of digital capabilities: firms with greater

structural network advantages can leverage DSZC to integrate and exploit information from diverse sources, transforming structural potential into tangible sustainability outcomes. The strength of this mediating pathway suggests that DSZC is not merely a complementary capability but a critical mechanism that unlocks the value embedded in network structures.

Third, the magnitude of effects indicates that SNRC exerts the strongest total influence on SP, followed by DSZC and SNSC. This pattern implies that relational quality still forms the foundation of effective collaboration and knowledge flow, while structural positions play a more enabling role contingent on the firm's ability to seize opportunities digitally. This nuanced insight extends previous social network research by highlighting that in the digital transformation era, the benefits of network structures are conditional upon the development of advanced digital capabilities.

From a managerial perspective, these results suggest that firms should not only focus on expanding their network size or improving their centrality but should also invest in developing DSZC to transform these structural advantages into sustainable performance gains. For firms already possessing strong relational networks, strengthening digital seizing processes—such as data integration, cross-departmental sharing, and real-time analytics—can magnify the direct positive effects on sustainability outcomes.

5. Conclusion

This study investigated how Social Network Relational Characteristics (SNRC) and Social Network Structural Characteristics (SNSC) influence Sustainable Performance (SP) in Chinese advanced manufacturing clusters, emphasizing the mediating role of Digital Seizing Capability (DSZC). Drawing on Social Network Theory and Dynamic Capabilities Theory, we developed and tested a research model using survey data collected from eight advanced manufacturing clusters across China. The findings provide several important insights.

First, the results show that SNRC positively and directly affects SP and also enhances DSZC, which in turn further contributes to SP. This confirms that trust-based, high-quality, and stable inter-firm relationships play a critical role in facilitating the transfer of valuable knowledge and resources that improve economic, environmental, and social performance outcomes.

Second, SNSC does not directly affect SP, but it significantly influences SP through DSZC. This highlights the contingent nature of structural network advantages: occupying a central network position and maintaining a broad partner base provide access to diverse information, but without the ability to seize and apply this information digitally, such structural advantages may remain unrealized.

Third, the mediating analysis underscores the pivotal role of DSZC in transforming both relational and structural network advantages into tangible sustainability outcomes. The strength of the mediation effect for SNSC indicates that digital capability is a necessary condition for converting structural potential into performance gains.

From a theoretical perspective, this research integrates network theory and dynamic capabilities by demonstrating how different dimensions of social network characteristics interact with digital capability to shape sustainability performance. From a managerial standpoint, the findings emphasize that firms should not only cultivate strong relational ties but also invest in digital capabilities to fully leverage both relational and structural network advantages.

Overall, this study provides a nuanced understanding of the pathways linking social network characteristics and sustainable performance in digitally intensive industrial ecosystems. Future research could extend this work by adopting longitudinal designs, exploring additional digital or organizational capabilities, and testing the model in diverse industrial and cultural contexts. By doing so, scholars and practitioners can better understand and leverage the interplay between network relationships, structural positions, and digital capabilities to achieve sustainability goals.

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Appendix A.

Measures

In assessing the dimension of sustainable performance, fifteen items were adapted from (Paulraj, 2011), who in turn adapted them from (Carter & Rogers, n.d.).

Economic performance

	Original Items	Adapted Items
		Our company….
1	Decrease in the cost of materials purchased	has decreased the cost of materials purchased
2	Decrease in the cost of energy consumption	has decreased the cost of energy consumption
3	Decrease in the fee for waste discharge	has decreased the fee for waste discharge
4	Improvement in return on investment	has improved its return on investment(ROI)
5	Improvement in earnings per share	has improved earnings per share (EPS)

Economic performance

	Original Items	Adapted Items
		Our company….
1	Reduction in air emissions	has reduced greenhouse gas emissions (e.g., CO_2/SO_x/NO_x)
2	Reduction in waste (water and/or solid)	has reduced resource usage (e.g., water, raw materials).
3	Decrease in the consumption of hazardous/harmful/toxic materials	has decreased the use of hazardous/harmful materials

4	Decrease in frequency of environmental accidents	has decreased the frequency of environmental incidents.
5	Increase in energy saved due to conservation and efficiency improvements	has increased energy savings

Economic performance

		Our company….
1	Improvement in overall stakeholder welfare or betterment	has improved welfare for employees, suppliers, and partners.
2	Improvement in community health and safety	has reduced workplace accident rates.
3	Improvement in the occupational health and safety of employees	has improved health and safety standards for employees.
4	Reduction in environmental impacts and risks to the general public	has reduced environmental impact on surrounding communities.
5	Improved awareness and protection of the claims and rights of people in the community served	has enhanced environmental awareness among partner enterprises in the cluster network.

Digital Seizing Capabilities

	Original Items	Adapted Items
		Our company…
1	Our company can quickly relate to new knowledge from the outside	can efficiently collect data from external partners (e.g., orders, production logs).
2	We recognize what new information can be utilized in our company	can effectively extract valuable data for internal analysis.
3	Our company is capable of turning new technological knowledge into process and product innovation	is capable of systematically collecting data from external channels such as customers and suppliers
4	Current information leads to the development of new products or services	established a cross-departmental data sharing mechanism, enabling timely access to internal operational data

Social Network Relational Characteristics

	Original Items	Adapted Items
		Our company…
1	The frequency with which our company exchanges technical/business knowledge with local suppliers	maintains frequent communication with partners.
2	The frequency with which our company exchanges technical/business knowledge with local customers Tie stability	
3	How long has our company been established technical/business knowledge exchanges with local customers	has established long-term win-win relationships with partners.
4	How long has our company been established	

	technical/business knowledge exchanges with local suppliers	
	Tie Quality	
5	When our company has technical exchanges with suppliers (or customers), both parties avoid serious harm to the other party.	and its partners have a high level of mutual trust.
6	When our company has technical exchanges with suppliers (or customers), both parties do not take advantage of the other even if opportunities to do so arise.	
7	When our company has technical/business knowledge exchanges and collaboration with other companies, we sometimes suspect the accuracy of the information these companies provide (reverse coded).	
8	our company tends to build stable relationships with more network members.	maintain stable cooperation with a broad set of partners.

Social Network Structural Characteristics

	Original Items	**Adapted Items**
1	The enterprises are dominant in the cooperation network	Our company has significant influence on the cooperation network.
2	In the innovation network, the cooperative R&D process between enterprises can only be accomplished through the participation of the enterprise.	Cooperation projects can only be completed with our company's deep involvement.
3	In the innovation network, enterprises can transfer information to other network entities without relying on additional enterprises.	We can directly transfer information to our partners without third-party assistance.
	Network Size	
4	Number of enterprises in the innovation network.	We have a large number of partner enterprises in our cooperation network.
5	Number of universities and scientific institutions in the innovation network.	Our partners are diverse in type, such as universities, financial institutions, and other organizations.
6	Number of NGOs in the innovation network.	
7	Number of financial institutions in the innovation network.	
8	Number of intermediaries, such as consulting enterprises, in the innovation network.	