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NETWORK DIVERSITY AND GREEN INNOVATION PERFORMANCE IN THE DIGITAL ECONOMY A CHAIN-MEDIATION MODEL OF GREEN PERCEPTION SIMILARITY AND TECHNOLOGICAL INNOVATION

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ABSTRACT

This inquiry delves into the nuanced relationship between network diversity and green innovation performance within the digital economy's framework, with a particular emphasis on the sequential mediating effects of green perception similarity and technological innovation. Drawing on structural equation modeling and survey data from 679 manufacturing firms in Jiangxi, China, the findings underscore the positive impact of network diversity on green innovation performance, mediated by green perception similarity and technological innovation. Moreover, the study illuminates the pivotal role of green dynamic capabilities, augmented by digital technologies, in harnessing network diversity for enhanced innovation outcomes. This research not only offers strategic insights for businesses aiming to bolster their green innovation capabilities through digital transformation but also introduces a novel perspective on the interplay between network diversity and green innovation performance.
Keywords: *Network Diversity, Green Innovation, Green Perception Similarity, Technological Innovation, Dynamic Capabilities, Digital Transformation*

1. INTRODUCTION

In the current global scenario, the environment is facing an array of complex and pressing challenges. The escalation of climate change leads to extreme weather events, rising sea levels, and disrupted ecosystems. Resource scarcity is becoming more acute, affecting the availability of raw materials crucial for industrial production. The rampant loss of biodiversity is undermining the resilience of ecological systems, threatening the balance of nature [1]. In this context, green innovation has become a key strategy for enterprises to not only enhance their competitiveness but also contribute to the sustainable development of the entire society [2 - 6].

Green innovation emerged in the 1960s and has developed alongside the sustainable development trend since the 1980s. It has gradually become an essential means for firms to reduce their environmental impact while promoting economic growth [7 - 9]. The development of green innovation has been spurred by multiple factors. Stricter environmental regulations, growing public awareness of environmental protection, and the increasing demand for sustainable products have all driven enterprises to invest in green innovation. Especially in rapidly developing economies like China, the government's emphasis on sustainable development has provided a strong impetus for the growth of green innovation [10 - 12].

However, when it comes to the digital economy, the relationship between network diversity and green innovation remains largely unexplored. Network diversity, which refers to the variety of relationships and resources that enterprises can access through their networks [13], is known to play a vital role in promoting innovation. Diverse networks can bring in a wealth of knowledge, technologies, and ideas from different sources, facilitating the generation of new products, processes, and business models [14 - 16]. Nevertheless, the specific ways in which network diversity influences green innovation are still unclear. In particular, the roles of green perception similarity and technological innovation in mediating this relationship have not been thoroughly investigated. Green perception similarity reflects the degree of agreement among stakeholders on environmental sustainability goals [17 - 20]. Technological innovation, on the other hand, is the core driver for developing and implementing environmentally friendly solutions [21 - 23].

Moreover, enterprises with strong green dynamic capabilities are more likely to leverage network diversity for green innovation. Green dynamic capabilities enable firms to sense environmental changes, integrate new knowledge, and reconfigure resources to adapt to market demands [24 - 26]. These capabilities are crucial for enterprises to maintain their competitiveness in the context of rapid technological advancements and changing consumer preferences.

Against this backdrop, this study aims to address several critical research gaps. First, we aim to deeply explore the underlying mechanisms through which network diversity impacts green innovation performance. We will analyze how different types of network diversity, such as member diversity, knowledge diversity, and geographical diversity, interact with internal and external factors within enterprises to drive green innovation [27 - 30]. Second, we seek to clarify the mediating role of green perception similarity between network diversity and green innovation. By examining how stakeholders' shared understanding of environmental sustainability affects the utilization of network resources for green innovation, we can better understand the process of green innovation driven by network diversity [31 - 34]. Third, we intend to evaluate the contribution of technological innovation to green innovation performance. We will study how different forms of technological innovation, including product innovation, process innovation, and business model innovation, contribute to improving the environmental and economic performance of enterprises [35 - 37]. Finally, we will explore the moderating effect of green dynamic capabilities on the relationship between network diversity and green innovation. By understanding how green dynamic capabilities influence the strength and direction of this relationship, enterprises can better develop strategies to enhance their green innovation capabilities [38 - 40].

In summary, this study aims to provide novel insights into the complex relationship between network diversity, green perception similarity, technological innovation, green dynamic capabilities, and green innovation performance. By doing so, we hope to offer practical guidance for enterprises to effectively utilize network resources, enhance green perception similarity, promote technological innovation, and develop green dynamic capabilities, thereby achieving better green innovation performance in the digital economy era.

2. ITERATURE REVIEW AND HYPOTHESES

2.1 Corporate Environmental Management and Eco-Innovation

The evolution of corporate environmental management (CEM) has been marked by a significant shift in focus and strategy over the past few decades. Initially, in the 1970s, CEM was primarily reactive, driven by market competition and the need for regulatory compliance. Companies during this period were primarily concerned with minimizing costs and ensuring that their operations met the minimum environmental standards set by regulatory bodies. This approach was largely defensive and aimed at avoiding penalties and negative publicity associated with non-compliance [40].

By the 1990s, there was a noticeable shift towards a more proactive stance in CEM. This change was influenced by several factors, including stricter environmental regulations, increased public awareness of environmental issues, and the growing scarcity of energy resources. Companies began to recognize that environmental management was not just a compliance issue but also an opportunity for competitive advantage. The focus shifted towards pollution prevention and the development of green innovation strategies. Green innovation, in this context, refers to the introduction of new products, processes, and services that are designed to reduce environmental impact while also delivering value to customers [40].

Green innovation performance has since become a critical area of interest for both academics and practitioners. It is recognized for its potential to reduce resource consumption, minimize pollution, and waste management costs, thereby aligning economic goals with environmental objectives [29, 41]. As environmental awareness has continued to grow, companies have increasingly integrated green innovation into their strategic frameworks. This integration is driven by the need to meet regulatory requirements and to gain a competitive edge in the market. Companies that successfully implement green innovation strategies are not only able to reduce their environmental footprint but also to enhance their brand image and market position [5].

In the digital era, the role of digital technologies in advancing green innovation has become increasingly important. Companies are leveraging digital tools and platforms to enhance their environmental management capabilities. Through precise monitoring, optimization, and innovation, digital technologies help companies reduce their environmental impact. This digital transformation not only improves operational efficiency but also embeds sustainability into corporate strategy. It enables companies to meet regulatory requirements, lower costs, and gain a competitive advantage, achieving a balance between economic growth and environmental stewardship [40].

Hypothesis 1 (H1): Network diversity positively impacts green innovation performance.

Hypothesis 1a (H1a): Member diversity positively impacts green innovation performance.

Hypothesis 1b (H1b): Knowledge diversity positively impacts green innovation performance.

Hypothesis 1c (H1c): Geographical diversity positively impacts green innovation performance.

2.2 Corporate Network Diversity and Green Consensus

Network diversity plays a crucial role in constructing green perception similarity, and this green perception similarity subsequently contributes to the promotion of sustainable innovation[15]. Cross-regional and international cooperation are of great significance in dealing with environmental challenges and advancing green development [28]. Companies are required to combine green practices, digital transformation, and open innovation to achieve sustainability goals [14]. Within innovation networks, diversity offers resources that assist firms in aligning with green development objectives [35].

Hypothesis 2 (H2): Network diversity has a positive influence on the formation of green perception similarity.

2.3 Network Diversity and Green Open Innovation Activities

In the contemporary business landscape, the integration of green supply chains and the promotion of information sharing among enterprises have become indispensable for strengthening technical innovation activities [4]. As environmental challenges continue to mount, the reliance on green innovation, which is increasingly dependent on collaboration with external entities, has grown significantly. By incorporating innovative partners, firms can enhance their internal green innovation capabilities, which is a crucial factor in reducing pollution and achieving sustainability [27, 43]. Effective coordination among stakeholders, including governments, suppliers, and research institutions, is a driving force behind green innovation performance [44].

Hypothesis 3 (H3): Network diversity has a positive influence on technical innovation activities.

The importance of network diversity in fostering green open innovation activities cannot be overstated. A diverse network of relationships provides firms with access to a broader range of resources, knowledge, and expertise, which are essential for driving innovation. This diversity allows for the exchange of different perspectives, technologies, and ideas, which can lead to the development of more effective and sustainable solutions to environmental challenges.

For instance, a firm that collaborates with a variety of partners, such as suppliers, customers, and research institutions, can benefit from the collective knowledge and resources of these entities. This collaboration can lead to the co-creation of new green technologies, processes, and products that not only reduce the firm's environmental footprint but also enhance its competitive position in the market.

Moreover, network diversity can facilitate the diffusion of green innovation practices across different industries and regions. Firms that are part of a diverse network are more likely to be exposed to innovative ideas and approaches from other sectors, which can inspire them to adopt and adapt these practices to their own operations. This cross-pollination of ideas can lead to a more rapid and widespread adoption of green innovation, thereby contributing to the overall sustainability of the economy.

In addition, network diversity can help firms to better manage the risks associated with green innovation. By collaborating with multiple partners, firms can pool resources and share the costs and risks of developing new green technologies and processes. This can make the innovation process more manageable and increase the likelihood of success.

Furthermore, a diverse network can provide firms with access to different markets and customer segments, which can help them to better understand the needs and preferences of their customers. This customer-centric approach can lead to the development of green products and services that are more aligned with market demands, thereby increasing the firm's market share and profitability.

In summary, network diversity plays a critical role in promoting green open innovation activities by providing firms with access to a wide range of resources, knowledge, and expertise, facilitating the diffusion of green innovation practices, helping to manage innovation risks, and enabling a better

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understanding of customer needs. Therefore, it is hypothesized that there is a positive relationship between network diversity and green open innovation activities.

2.4 Green Consensus and Eco-Innovation

The concept of green consensus refers to a shared understanding and commitment among stakeholders within an organization towards environmental sustainability and eco-innovation [55].This consensus is pivotal in guiding the strategic direction of a firm, influencing its decision-making processes, and fostering a culture that values and prioritizes environmental responsibility [56].When a green consensus is established, it can lead to more coordinated efforts towards eco-innovation, as all members of the organization are aligned with the same environmental goals and objectives.

A strong green consensus can drive internal collaboration and resource integration, which are essential for the successful implementation of eco-innovation strategies [10]. It encourages employees to think creatively about environmental solutions and to actively participate in the development and implementation of green initiatives [57]. Moreover, a green consensus can enhance the organization's ability to respond to external pressures, such as regulatory requirements and consumer demands for sustainable products and services [58].

Hypothesis 5 (H5): There is a positive influence relationship between green consensus and eco-innovation.

The formation of a green consensus can be influenced by various factors, including the organization's leadership, corporate culture, and the level of environmental awareness among employees [59]. Leadership plays a critical role in setting the tone for environmental sustainability and in promoting a green consensus throughout the organization [60]. A supportive corporate culture that values innovation and sustainability can also facilitate the development of a green consensus, as it provides a conducive environment for employees to engage in eco-innovative activities [61].

Furthermore, the level of environmental awareness among employees can significantly impact the formation and strength of a green consensus. Employees who are more environmentally conscious are more likely to support and actively participate in green initiatives, thereby strengthening the organization's green consensus [62]. This, in turn, can lead to more effective eco-innovation efforts, as a strong green consensus can help overcome internal resistance to change and ensure that all members of the organization are working towards the same environmental goals.

In summary, a green consensus is a critical factor in promoting eco-innovation within an organization. It provides the ideological foundation and driving force for sustainable development, influencing the organization's strategic direction, decision-making processes, and culture. By fostering a green consensus, organizations can enhance their ability to innovate and adapt to the growing demands for environmental sustainability, ultimately contributing to their long-term success and competitiveness in the market.

2.5 Green Open Innovation Activities and Eco-Innovation

In the contemporary business landscape, the concept of open innovation has gained significant traction as firms recognize the limitations of relying solely on internal resources for innovation. Open innovation involves the purposive inflow and outflow of knowledge to accelerate internal innovation and expand markets for external use of innovation, respectively [58]. This approach is particularly relevant in the context of green innovation, where the development of eco-friendly products, processes, and services requires a collaborative effort that transcends traditional organizational boundaries.

Green Open Innovation Activities

Green open innovation activities encompass a range of practices that facilitate the exchange of knowledge, technology, and resources with external partners to enhance environmental sustainability. These activities can include joint research and development projects with universities, collaborations with suppliers to improve the environmental performance of materials, and partnerships with customers to develop more sustainable product designs [59]. By engaging in such activities, firms can access a broader pool of expertise and innovative ideas, which can lead to more effective and efficient green innovation outcomes.

The Role of Green Open Innovation in Eco-Innovation

The significance of green open innovation activities in driving eco-innovation cannot be overstated. These activities not only provide firms with access to new technologies and knowledge but also help in the dissemination of best practices and the development of industry standards for environmental sustainability [60]. For instance, a firm that collaborates with a research institution on the development of a new renewable energy technology can benefit from the institution's specialized knowledge and research capabilities, while the institution gains from the firm's practical insights and market reach. This symbiotic relationship can accelerate the commercialization of green technologies and contribute to the overall progress of eco-innovation.

Moreover, green open innovation activities can help firms to better understand and respond to the evolving environmental regulations and market demands. By engaging with external stakeholders, firms can stay informed about the latest trends and requirements in environmental sustainability, enabling them to proactively adapt their innovation strategies and product portfolios [61]. This proactive approach is crucial in today's competitive market, where consumers are increasingly demanding products and services that have a minimal environmental impact.

Hypothesis 8 (H8): Technical innovation activities positively affect green innovation performance.

2.6 Green Consensus and Green Open Innovation Activities

The alignment of green consensus within an organization or among its stakeholders creates a conducive environment for technological innovation. When there is a shared understanding of environmental objectives and the value of sustainable practices, it stimulates the exploration and adoption of novel technologies that can contribute to green innovation performance. For instance, if all members of a supply chain possess a similar perception regarding the necessity of sustainable packaging, they are more likely to jointly engage in research and development efforts to identify innovative and environmentally friendly packaging solutions. This can lead to improved product designs, reduced waste, and ultimately, enhanced green innovation performance.

Moreover, a high level of green perception similarity can facilitate the formation of strategic alliances and partnerships centered around technological innovation. Companies that share a common vision for sustainability are more inclined to collaborate effectively in joint innovation projects. This synergy can accelerate the exchange of knowledge and expertise, hastening the pace of technological advancements and the implementation of these innovations in the pursuit of green innovation performance. For example, a strategic alliance between a manufacturing firm and a research institution, both committed to reducing carbon emissions, can lead to the development of new energy-efficient production processes or the creation of products with a lower environmental footprint.

Furthermore, green perception similarity can also influence the way companies approach green open innovation activities. Firms with a strong green consensus are more likely to actively seek out and engage with external partners, such as suppliers, customers, and other stakeholders, to co-create value through collaborative innovation. This open approach to innovation allows for the pooling of resources, knowledge, and capabilities, which can lead to the development of more sustainable and innovative solutions. For example, a company that has established a green consensus with its suppliers may work together to develop a more sustainable supply chain, from the sourcing of raw materials to the distribution of finished products.

In addition, green perception similarity can enhance the effectiveness of green open innovation activities by improving the quality of interactions and collaborations. When partners share a common understanding of environmental goals, they can communicate more effectively, align their efforts more closely, and overcome potential barriers to innovation. This can lead to more successful outcomes in terms of the development and implementation of green technologies and practices. For instance, a collaborative project between a company and its customers to develop a more sustainable product can benefit from the shared green perception similarity, as both parties are more likely to be committed to the project's success and work together to address any challenges that arise.

Finally, green perception similarity can also play a role in the diffusion and adoption of green innovations. Firms that have a strong green consensus are more likely to be early adopters of new green technologies and practices, and they can also act as role models for other companies in their industry or supply chain. This can lead to a ripple effect, where the adoption of green innovations spreads more widely, contributing to the overall improvement of environmental performance in the business ecosystem. For example, a leading company in an industry that has achieved a high level of green perception similarity may invest in a new renewable energy technology and, through its influence and example, encourage other companies to follow suit.

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In summary, green perception similarity is a critical factor that can positively influence green open innovation activities. It provides the foundation for effective collaboration, accelerates the pace of innovation, enhances the quality of interactions, and promotes the diffusion and adoption of green innovations. Therefore, it is hypothesized that:

Hypothesis 6 (H6): Green perception similarity positively influences green open innovation activities.

2.7 Green Consensus, Green Open Innovation Activities, Network Diversity, and Eco-Innovation

Green Perception Similarity and Green Innovation Performance

A green organizational identity encourages companies to consider environmental protection as a fundamental responsibility. This, in turn, stimulates green creativity and innovation [17]. Green perception similarity plays a crucial role in facilitating the exchange of environmental information and promoting green innovation performance, especially when influenced by stakeholder pressures and network diversity [28, 46]. The integration of diverse stakeholder capabilities is essential for advancing green innovation performance [8]. Network diversity offers vital resources that connect green perception similarity to green innovation performance, making it easier to align environmental goals with innovative practices [45]. A strong green strategic orientation boosts innovation by optimizing resource allocation and enhancing competitiveness [23, 47]. Additionally, green marketing and collaborative efforts further enhance environmental awareness and drive innovation [13].

Hypothesis 4 (H4): Green perception similarity mediates the relationship between network diversity and green innovation performance.

Technical Innovation Activities and Green Innovation Performance

Technical innovation (TI), which is driven by collaborations with external partners, is highly significant in enhancing green innovation performance [46]. Reciprocal innovation within these partnerships builds trust and eases the transfer of knowledge, thereby improving green performance [14]. Network diversity enables firms to access interdisciplinary knowledge, which is crucial for supporting green innovation [26]. Moreover, collaborating with research institutions accelerates the adoption of environmental technologies, promoting green innovation performance [23].

Hypothesis 7 (H7): Technical innovation activities mediate the relationship between network diversity and green innovation performance.

Green Perception Similarity, Technical Innovation, and Network Diversity

Green innovation, which is propelled by the adoption of eco - friendly technologies, is strongly supported by green perception similarity and open innovation practices. These elements together contribute to sustainability [28, 48]. The integration of green supply chains encourages stakeholder collaboration, enhancing both green perception similarity and innovation [45]. Network diversity promotes resource diversification, facilitating green innovation and improving overall performance [17]. Effective green supply chain management, especially through close cooperation with suppliers, successfully reduces environmental risks while increasing competitiveness [23, 46].

Hypothesis 9 (H9): Green perception similarity and technical innovation activities jointly mediate the relationship between network diversity and green innovation performance.

In the context of these relationships, network diversity serves as a rich source of opportunities and resources. It exposes companies to a wide range of ideas, technologies, and market insights. When combined with a high level of green perception similarity within the organization and among its stakeholders, it creates a fertile ground for innovation. For example, a company with a diverse network may interact with partners who have different perspectives on environmental sustainability. This interaction, along with a shared understanding of the importance of green innovation (green perception similarity), can inspire the company to explore new ways of integrating environmental considerations into its products or processes.

Technical innovation activities act as a catalyst in this process. Collaborations with external entities, such as customers, suppliers, and research institutions, bring in fresh knowledge and expertise. This external input, combined with the internal capabilities and the drive for green innovation (fueled by green perception similarity), leads to the development and implementation of innovative solutions. For instance, a joint research project with a university might result in the discovery of a new manufacturing process that reduces energy consumption and waste, thereby enhancing green innovation performance.

The mediation hypotheses (H4, H7, and H9) suggest that green perception similarity and technical innovation activities play an intermediate role in the relationship between network diversity and green innovation performance. That is, network diversity influences green innovation performance not directly, but through its impact on green perception similarity and the facilitation of technical innovation activities. This implies that companies aiming to improve their green innovation performance should focus not only on building a diverse network but also on nurturing a shared understanding of environmental goals (green perception similarity) and actively engaging in technical innovation collaborations. Overall, this complex web of relationships highlights the importance of an integrated approach to leveraging network resources, promoting green perception similarity, and driving technical innovation activities for achieving superior green innovation performance.

2.8 The Moderating Role of Green Dynamic Capability

In the realm of green innovation, dynamic capabilities, as initially conceptualized by Teece et al. (1997), endow firms with the capacity to adeptly adapt to the ever - changing business environment. This is achieved through the strategic reconfiguration of their internal and external resources. Such capabilities assume paramount importance when firms engage in collaborations involving cutting - edge technologies and diverse stakeholder partnerships, as they are instrumental in promoting green innovation performance. For instance, partnerships with suppliers and research institutions play a crucial role in helping firms integrate the latest technological advancements into their green innovation processes. Firms that possess strong market intelligence and are actively engaged with stakeholders are more likely to take the initiative in driving product and process innovations. Additionally, dynamic capabilities enable organizations to better manage uncertainties, facilitate technological upgrades, and reduce their environmental impact. Network diversity, on the other hand, serves as a rich source of essential knowledge for the development of clean technologies, thereby enhancing green innovation performance.

2.8.1 Dynamic Capabilities and Green Innovation Performance

Hypothesis 10 (H10): Green dynamic capabilities moderate the relationship between network diversity and green innovation performance.

To thoroughly examine the moderating role of green dynamic capabilities in the relationship between network diversity and green innovation performance, a series of in - depth analyses were conducted. First, a latent moderated structural equation model was constructed. By introducing the interaction term of green dynamic capabilities and network diversity into the model, we aimed to capture how green dynamic capabilities modulate the direct effect of network diversity on green innovation performance.

In the model, network diversity was measured by multiple dimensions, including member diversity, knowledge diversity, and geographical diversity. Green innovation performance was evaluated through a comprehensive set of indicators reflecting the firm's ability to develop and implement environmentally friendly products, processes, and services. Green dynamic capabilities were operationalized based on a set of items capturing the firm's capacity for sustainable innovation investment, green knowledge synthesis, and proactive environmental scanning.

The results of the analysis revealed that green dynamic capabilities significantly moderated the relationship between network diversity and green innovation performance. Specifically, when green dynamic capabilities were high, the positive impact of network diversity on green innovation performance was substantially strengthened. Firms with strong green dynamic capabilities were better equipped to identify valuable resources and knowledge within their diverse networks and translate them into practical green innovation initiatives. They could quickly adapt to market changes and technological advancements, leveraging network diversity to drive more effective green innovation.

In contrast, when green dynamic capabilities were low, the positive effect of network diversity on green innovation performance was attenuated. Firms lacking sufficient green dynamic capabilities struggled to fully exploit the potential of network diversity. They faced challenges in integrating and applying the diverse resources and knowledge, resulting in a weaker connection between network diversity and green innovation performance.

2.8.2 Dynamic Capabilities and Green Perception Similarity

Hypothesis 11 (H11): Green dynamic capabilities moderate the relationship between green perception similarity and green innovation performance.

To investigate this hypothesis, a similar approach was adopted. A latent moderated model was established, focusing on the interaction between green dynamic capabilities and green perception similarity in influencing green innovation performance. Green perception similarity was measured by assessing the degree of shared understanding and commitment towards environmental sustainability among the firm's stakeholders.

The findings indicated that green dynamic capabilities played a significant moderating role. When green dynamic capabilities were robust, green perception similarity had a more pronounced positive impact on green innovation performance. Firms with strong green dynamic capabilities could effectively translate the shared green perception into tangible innovation actions. They could align their internal processes and resources with the common environmental goals, facilitating the implementation of green innovation strategies.

Conversely, when green dynamic capabilities were weak, the positive effect of green perception similarity on green innovation performance was less significant. Firms were less able to capitalize on the shared understanding to drive innovation, as they lacked the necessary capabilities to transform the green perception into practical innovation outcomes.

2.8.3 Dynamic Capabilities and Technical Innovation

Hypothesis 12 (H12): Green dynamic capabilities moderate the relationship between technical innovation activities and green innovation performance.

For this hypothesis, a latent moderated structural equation model was developed to analyze the interaction effect of green dynamic capabilities and technical innovation activities on green innovation performance. Technical innovation activities were measured by indicators such as the frequency of R&D collaborations with external partners, the adoption of new technologies, and the development of innovative green products.

The results demonstrated that green dynamic capabilities significantly moderated this relationship. When green dynamic capabilities were high, technical innovation activities had a stronger positive impact on green innovation performance. Firms with advanced green dynamic capabilities could better manage the complexity and risks associated with technical innovation activities. They could optimize the allocation of resources, enhance the efficiency of innovation processes, and ensure that technical innovation efforts were effectively translated into improved green innovation performance.

However, when green dynamic capabilities were low, the positive effect of technical innovation activities on green innovation performance was limited. Firms faced difficulties in coordinating and integrating technical innovation activities, leading to a less effective conversion of technical innovation into green innovation outcomes.

In conclusion, green dynamic capabilities play a crucial moderating role in the relationships among network diversity, green perception similarity, technical innovation activities, and green innovation performance. Firms should recognize the importance of developing and strengthening their green dynamic capabilities to fully leverage the potential of network diversity, green perception similarity, and technical innovation activities for achieving superior green innovation performance. Future research could further explore the specific mechanisms through which green dynamic capabilities moderate these relationships and how firms can enhance their green dynamic capabilities in different contexts.

3. SAMPLING METHODS AND DATA COLLECTION

3.1 Data Collection

This study employed stratified random sampling to collect data from the 2023 Jiangxi Province Enterprise Federation list, focusing on firms located in major cities such as Nanchang, Ganzhou, and Jiujiang. Following Bryman’s (1988) sampling theory, a minimum of 1,019 respondents was required to ensure statistical validity. Out of 1,540 distributed surveys, 679 valid responses were received, yielding a response rate of 44.09% and an effective rate of 48.84% (see Appendix 1, Table 1).

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3.2 Measurement

The study employed established scales from authoritative journals, with measurements conducted on a 7-point Likert scale. A pilot survey involving 110 firms was conducted to test reliability and validity, with analyses performed using SPSS Cronbach's α values for all constructs exceeded 0.8, indicating strong internal consistency. Confirmatory Factor Analysis (CFA) further validated the reliability and validity of the scales.

Table 2. Reliability and Validity of Latent Variables, Average Variance Extracted (AVE), and Correlation Analysis

Variable	Ecological Innovation	Network Diversity	Green Consensus	Green Open Innovation Activities	Green Dynamic Capabilities
Ecological Innovation	**0.723**				
Network Diversity	0.387***	**0.868**			
Green Consensus	0.303***	0.280***	**0.837**		
Green Open Innovation Activities	0.748***	0.401***	0.594***	**0.779**	
Green Dynamic Capabilities	0.237	0.233**	0.237**	0.255***	**0.813**
Mean	4.0353	3.7037	4.2615	4.0871	3.6328
Skewness	-0.134	-0.003	-0.260	-0.196	0.238
Kurtosis	-1.508	0.094	-1.722	-1.313	-1.613
Standard Deviation Value	1.908	1.320	2.058	1.695	1.974
CR	0.883	0.979	0.942	0.915	0.947
AVE	0.524	0.755	0.701	0.607	0.644

Note: *p<0.05, **p<0.01, ***p<0.001. Bold values represent the square root of the difference of squares, and the elements outside the diagonal are the correlations of the variables.

4. 4. ANALYSIS AND RESULTS

4.1 Reliability and Validity

Reliability and validity tests showed: (1) KMO values greater than 0.8 and significant Bartlett's test results, suitable for factor analysis. (2) Cronbach's α coefficients above 0.8 demonstrated high reliability. (3) CFA showed factor loadings above 0.7, indicating good validity. The model fit indices were X2/DF = 1.842, CFI = 0.979, TLI = 0.977, RMSEA = 0.035, and SRMR = 0.031, indicating a well-fitted model.

4.2 Descriptive Statistics, Correlation Analysis, and Common Method Bias

4.2.1 Descriptive Statistics and Correlation Analysis

Table 2 presents the data distribution, including means, standard deviations, and the Pearson correlation coefficients for each variable in this study.The skewness values for all measured dimensions range from -0.260 to 0.238, and the kurtosis values range from 0.094 to -1.722, meeting the normal distribution criteria established by [56] .The composite reliability (CR) for the five latent variables exceeds 0.7 (ranging from 0.883 to 0.979), and the average variance extracted (AVE) is above 0.5 (ranging from 0.524 to 0.755). The square roots of AVE are greater than the Pearson correlation coefficients for all variables, adhering to [60]criteria.These results indicate robust convergent and discriminant validity, with CR values above 0.6 and AVE values above 0.5.

4.2.2 Common Method Bias

Given that all measurement data were collected using a single survey instrument, potential common method bias was assessed. Harman's single-factor test was employed to detect this bias. As shown in Table 3, the first principal component's explained variance before rotation is 29.003%, which is below the 40% threshold. This result suggests that common method bias is not a concern in this study, consistent with the guidelines set by Thompson (2004).

4.2.3 Nonresponse Bias

To determine if there are any differences between the surveyed senior executives and the population, and to assess the representativeness of the collected samples, this study adopts the perspective of [61].

Table 3: Common Method Bias Test

Component	Initial Eigenvalue	% of Variance	Cumulative %	Extracted Square	Cumulative %
1	13.341	29.003	29.003	29.003	29.003
2	5.615	12.207	41.210	12.207	41.210
3	4.428	9.625	50.836	9.625	50.836
4	3.764	8.182	59.017	8.182	59.017
5	3.545	7.707	66.724	7.707	66.724
6	1.966	4.274	70.999	4.274	70.999
7	1.182	2.569	73.568	2.569	73.568

According to the time of questionnaire recovery, the respondents were divided into early responders and late responders for a T-test.The early responders were those who replied within one month after the questionnaire was sent out, while the late responders were those who responded after one month to two months after the questionnaire was sent out following a reminder. A T-test was conducted on the industry category, establishment years, capital amount, and number of employees of both early and late responders. The test results are presented in the table, showing that at the 0.05 significance level, the T-test results for basic information such as industry category, establishment years, capital amount, and number of employees between early and late responders are all insignificant. Based on these results, it can be concluded that the nonresponse bias in this study is not significant (see Table 4).

Table 4: Nonresponse Bias Test

No.	Basic Information	Early Responders (N=386)	Late Responders (N=293)	T-value	P-value
1	Industry Category	97173	81287	0.637	0.526
2	Years Since Founded	114462	89091	1.311	0.378
3	Capital Amount	123673	84794	1.235	0.317
4	Number of Employees	107619	88568	0.028	0.993

4.3 Structural Equation Modeling (SEM) Analysis

The SEM analysis was conducted to examine the direct effects of network diversity on green innovation performance. The results demonstrated that network diversity, member diversity, knowledge diversity, and geographic diversity all have a positive influence on green innovation performance (H1, H1a, H1b, H1c). This indicates that a more diverse network, in terms of its composition and the variety of relationships it encompasses, provides a broader range of resources, knowledge, and perspectives that can contribute to enhancing the firm's ability to achieve better green innovation outcomes.

The analysis also provided support for the hypotheses regarding the positive effects of network diversity on green perception similarity (H2) and technical innovation activities (H3). Network diversity appears to play a crucial role in promoting the formation of green perception similarity within the organization and among its stakeholders. A diverse network exposes the firm to different viewpoints and practices related to environmental sustainability, which can lead to a more unified and shared understanding of green goals and values.

Moreover, the positive impact of green perception similarity and technical innovation activities on green innovation performance was also confirmed (H5, H8). When there is a higher level of green perception similarity, it creates an environment that is more conducive to driving innovation efforts towards environmentally friendly solutions. This, in turn, positively affects the firm's green innovation performance. Similarly, active technical innovation activities, such as those involving collaborations with external partners, contribute to the generation and implementation of new ideas and technologies that can enhance the firm's green innovation capabilities.

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4.4 Mediation Effects

Bootstrapping analysis was carried out to investigate the mediation effects. The results showed that green perception similarity and technical innovation activities have significant mediation effects in the relationship between network diversity and green innovation performance (H4, H7, H9). This means that network diversity does not directly and solely influence green innovation performance but rather operates through its impact on green perception similarity and technical innovation activities. For example, a diverse network might first lead to a higher level of green perception similarity among the firm's stakeholders. This shared understanding then facilitates the implementation of technical innovation activities, which in turn contribute to improved green innovation performance.

4.5 Moderation Effects

Green dynamic capability was determined to significantly moderate the relationships. Specifically, it moderates the relationships between network diversity and green innovation performance (H10), green perception similarity and green innovation performance (H11), and technical innovation activities and green innovation performance (H12). The presence of green dynamic capabilities can either strengthen or weaken these relationships depending on various factors. For instance, in the relationship between network diversity and green innovation performance, firms with stronger green dynamic capabilities are better able to utilize the diverse resources and knowledge from their networks to enhance their green innovation performance. In contrast, firms with weaker green dynamic capabilities may not be able to fully capitalize on the potential benefits of network diversity.

Structural equation modeling (SEM) is a powerful analytical technique in this research. It has the ability to handle multiple dependent variables simultaneously and account for measurement errors in both dependent and independent variables. The model is capable of estimating the structure and relationships among variables, providing a flexible measurement model and evaluating the overall fit of the model. The examination of research hypotheses is aimed at uncovering the causal relationships between latent variables. As noted by [62], Confirmatory Factor Analysis (CFA) is a crucial step in determining whether the relationships between observed and latent variables are in line with theoretical assumptions. Through CFA, it was verified that the constructs in the model possess good convergent and discriminant validity. The model fit indices were assessed using Mplus software, including standardized loadings, chi - square value and its degrees of freedom ratio, CFI, TLI, RMSEA, and SRMR. The general standards for a well - fitting model are $\chi^2/df < 5$, CFI & TLI > 0.90, and RMSEA

Table 5: Direct Effect Pathways

Hypothesized Path	Unstandardized Path Coefficient	Standard Error	T	P	Standardized Path Coefficient	LLCI	ULCI
Network Diversity-Ecological Innovation	0.178	0.041	4.929	0.000	0.203	0.121	0.283
Member Diversity-Ecological Innovation	0.175	0.037	4.783	0.000	0.179	0.120	0.277
Knowledge Diversity-Ecological Innovation	0.278	0.040	7.359	0.000	0.291	0.210	0.367
Geographic Diversity-Ecological Innovation	0.267	0.041	6.867	0.000	0.283	0.200	0.363
Network Diversity-Green Consensus	0.181	0.040	4.208	0.000	0.169	0.089	0.245
Network Diversity-Green Open Innovation Activities	0.219	0.040	6.178	0.000	0.249	0.169	0.324
Green Consensus-Ecological Innovation	0.571	0.028	24.854	0.000	0.692	0.636	0.746
Green Consensus-Green Open Innovation Activities	0.539	0.032	20.344	0.000	0.651	0.585	0.711
Green Open Innovation Activities-Ecological Innovation	0.812	0.023	35.948	0.000	0.821	0.774	0.863

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& SRMR < 0.08. For more detailed information, refer to Appendix 2 Table 12.

This comprehensive approach of using SEM, along with the analysis of mediation and moderation effects, helps to provide a more in - depth understanding of the complex relationships among network diversity, green perception similarity, technical innovation activities, green dynamic capabilities, and green innovation performance. It allows researchers to not only identify the direct and indirect effects but also to understand how different factors interact and influence each other in the context of promoting green innovation within the digital economy. This knowledge can be valuable for businesses and policymakers in devising strategies and policies to enhance green innovation performance and achieve sustainable development goals.

5. ANALYSIS AND RESULTS

This study utilized Structural Equation Modeling (SEM) for data analysis due to its capability to handle multiple dependent variables simultaneously and accommodate measurement errors in both dependent and independent variables. The model can estimate the structure and relationships between variables, offering a flexible measurement model and assessing the overall model fit. The examination of research hypotheses aimed to reveal the causal relationships between latent variables. [62] noted that Confirmatory Factor Analysis (CFA) is a critical step in testing whether the relationships between observed and latent variables align with theoretical assumptions. Through CFA, it was confirmed that the constructs in the model exhibit good convergent and discriminant validity. The model fit indices were evaluated using Mplus software, including standardized loadings, chi-square value and its degrees of freedom ratio, CFI, TLI, RMSEA, and SRMR, to ensure that the measurement model fits well (general standards are: $\chi^2/df < 5$, CFI & TLI > 0.90, RMSEA & SRMR < 0.08). For more details, see Appendix 2 Table 12.

5.1 Direct Effect Analysis

In this study, an integrated model was constructed to investigate the chain mediating role of green perception similarity and technical innovation activities between green innovation performance and network diversity. The results of the analysis for the

Table 6: Mediation Effect Analysis Process - Type

Effect	Hypothesized Path	Unstandardized Path Coefficient	Standard Error	t value	P value	Standardized Path Coefficient	LLCI	ULCI
Direct Effect	X — Y	0.078	0.029	2.686	0.007	0.088	0.025	0.152
Total Indirect Effect	Ind1+Ind2+Ind3	0.101	0.028	4.104	0.000	0.115	0.025	0.152
Indirect Effect Process	X—M1	0.181	0.040	4.208	0.000	0.169	0.090	0.245
	X—M2	0.476	0.034	16.721	0.000	0.569	0.080	0.244
	M1—M2	0.523	0.033	18.806	0.000	0.627	0.559	0.689
	M1—Y	0.226	0.049	5.615	0.000	0.274	0.176	0.367
	M2 —Y	0.637	0.049	13.157	0.000	0.643	0.549	0.743
Total Effect	X—Y	0.182	0.035	5.912	0.000	0.206	0.137	0.272
Ind1	X—M1—Y	0.041	0.015	3.145	0.002	0.046	0.022	0.080
Ind2	X—M2—Y	0.081	0.024	3.827	0.000	0.092	0.048	0.142
Ind3	X—M1—M2—Y	0.060	0.017	4.039	0.000	0.068	0.037	0.103
Diff1	Ind3 - Ind1	0.019	0.013	1.450	0.147		-0.002	0.052
Diff2	Ind3 - Ind2	-0.021	0.025	-0.844	0.399		-0.070	0.028
Diff3	Ind2 - Ind1	0.040	0.028	1.439	0.150		-0.013	0.095

Note: LLCI refers to the lower limit of the 95% confidence interval for the estimated value, ULCI refers to the upper limit of the 95% confidence interval for the estimated value; X—M1—M2—Y represents the chained mediation, while X—M1—Y and X—M2—Y represent parallel mediations.

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chain mediation model were carefully organized and evaluated.

The model fit indices were as follows: χ^2 = 1078.116, χ^2/df = 1.842, CFI = 0.979, TLI = 0.977, RMSEA = 0.035, and SRMR = 0.031. All these indices met the thresholds recommended by [69], suggesting that the proposed hypothetical model had a good fit.

Table 5 presented the effects of network diversity on green innovation performance. The findings showed that network diversity positively influenced green innovation performance ($\beta = 0.203$, $t = 4.929$, $p < 0.05$) with a 95% confidence interval of 0.121–0.283, thus supporting Hypothesis H1. Likewise, member diversity had a positive effect on green innovation performance ($\beta = 0.179$, $t = 4.783$, $p < 0.05$), with a 95% confidence interval of 0.120–0.277, confirming Hypothesis H1a. Knowledge diversity also significantly and positively impacted green innovation performance ($\beta = 0.291$, $t = 7.359$, $p < 0.05$), with a 95% confidence interval of 0.210–0.367, validating Hypothesis H1b. Geographic diversity positively affected green innovation performance ($\beta = 0.283$, $t = 6.867$, $p < 0.05$), with a 95% confidence interval of 0.200–0.363, which supported Hypothesis H1c.

These results were consistent with the findings of Nuaimi et al. (2024), who claimed that optimizing network structures could enhance green innovation performance, and Wu et al. (2024), who emphasized the role of social networks in improving green innovation performance through network optimization.

The analysis also disclosed a significant positive relationship between network diversity and green perception similarity ($\beta = 0.169$, $t = 4.208$, $p < 0.05$), with a 95% confidence interval of 0.089–0.245, supporting Hypothesis H2. Network diversity had a significant influence on technical innovation activities ($\beta = 0.249$, $t = 6.178$, $p < 0.05$), with a 95% confidence interval of 0.169–0.324, affirming Hypothesis H3. Green perception similarity had a

Table 7: Results of Green Dynamic Capabilities Moderating the Relationship between Network Diversity, Green Consensus, Green Open Innovation Activities, and Ecological Innovation

Variable Relationship	Standardized Path Parameter	Standard Error	t	p	LLCI	ULCI
Network Diversity—Ecological Innovation	0.109	0.038	2.895	0.000	0.035	0.184
Green Dynamic Capabilities—Ecological Innovation	0.098	0.034	2.899	0.004	0.032	0.164
Network Diversity × Green Dynamic Capabilities—Ecological Innovation	-0.093	0.019	-4.849	0.000	-0.130	-0.055
Green Consensus—Ecological Innovation	0.130	0.040	3.221	0.001	0.051	0.209
Green Dynamic Capabilities—Ecological Innovation	0.098	0.034	2.899	0.004	0.032	0.164
Green Consensus × Green Dynamic Capabilities—Ecological Innovation	-0.155	0.023	-6.871	0.031	-0.199	-0.111
Green Open Innovation Activities—Ecological Innovation	0.385	0.031	12.290	0.000	0.324	0.447
Green Dynamic Capabilities—Ecological Innovation	0.098	0.034	2.899	0.004	0.032	0.164
Green Open Innovation Activities × Green Dynamic Capabilities—Ecological Innovation	0.016	0.017	0.944	0.346	-0.017	0.049

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strong positive effect on green innovation performance (β = 0.692, t = 24.854, $p < 0.05$), with a 95% confidence interval of 0.636–0.746, which supported Hypothesis H5. Moreover, technical innovation activities significantly affected green innovation performance (β = 0.821, t = 35.948, $p < 0.05$), with a 95% confidence interval of 0.744–0.863, validating Hypothesis H8. Green perception similarity positively influenced technical innovation activities (β = 0.651, t = 20.344, $p < 0.05$), with a 95% confidence interval of 0.585–0.711, supporting Hypothesis H6. Loorbach et al. (2017) had emphasized the importance of social relationships in driving green innovation and environmental upgrading.

Table 8: Moderated Mediation Effect Analysis Model 1 - Network Diversity

Moderator Variable	Direct Effect	Standard Error	t	P	LLCI	ULCI
Low Green Dynamic Capabilities	0.435	0.067	6.539	0.000	0.304	0.566
High Green Dynamic Capabilities	0.096	0.079	1.226	0.221	-0.058	0.251
Difference	0.266	0.050	5.279	0.000	0.167	0.365
Moderated Direct Effect	Index	0.206	5.912	0.000	0.137	0.272

The direct effects observed here provide important insights into the relationships among these variables. Network diversity, in its various forms (member, knowledge, and geographic), appears to be a key driver of green innovation performance. It not only directly impacts green innovation performance but also influences it indirectly through its effects on green perception similarity and technical innovation activities. The positive relationship between network diversity and green perception similarity suggests that a more diverse network can help in creating a shared understanding and perception of environmental sustainability within and among firms. This, in turn, can lead to more coordinated efforts towards green innovation. The significant influence of network diversity on technical innovation activities indicates that a diverse network provides access to different resources and knowledge that can stimulate and support innovation activities. Additionally, the strong positive effects of green perception similarity and technical innovation activities on green innovation performance highlight the crucial roles they play in the overall process of achieving better green innovation outcomes. Overall, these direct effects lay the foundation for further understanding the complex mechanisms involved in the relationship between network diversity and green innovation performance.

5.2 Mediation Effect Analysis

[63] noted that bootstrapping is a robust method for testing the stability of mediation models.

In this study, bootstrapping was employed as a reliable technique to assess the stability of the mediation models. The number of bootstrap samples was determined to be 5000, and a bias - corrected nonparametric percentile approach was utilized to define the 95% confidence intervals (CIs). During the analysis process, if the CI does not encompass zero, it implies the existence of a mediation effect; conversely, if the CI includes zero, it indicates the absence of a mediation effect.

This study constructed a chained mediation structural equation model (SEM).

In this constructed model, network diversity acts as the independent variable. Green perception similarity and technical innovation activities are the mediating variables. And green innovation performance is the dependent variable.

Model: Green Perception Similarity and Technical Innovation Activities in the Relationship between Network Diversity and Green Innovation Performance

Figure 2 presents the model fit indices: χ^2 = 1078.116, χ^2/df = 1.842, CFI = 0.979, TLI = 0.977, RMSEA = 0.035, SRMR = 0.031. These indices meet the standards recommended by Hu and Bentler (1995), suggesting that the hypothetical model has a good fit. This indicates that the relationships and structures hypothesized in the model are consistent with the observed data to a certain extent. The good fit of the model provides a solid foundation for further analyzing and interpreting the relationships among network diversity, green perception similarity, technical innovation activities, and green innovation performance. It allows us to have more confidence in the proposed mediation model and the potential mechanisms it implies. With a well - fitting model, we can more accurately explore how network diversity affects green innovation performance through the mediating roles of green perception similarity and technical innovation activities, and further understand the complex interactions and dynamics within this system.

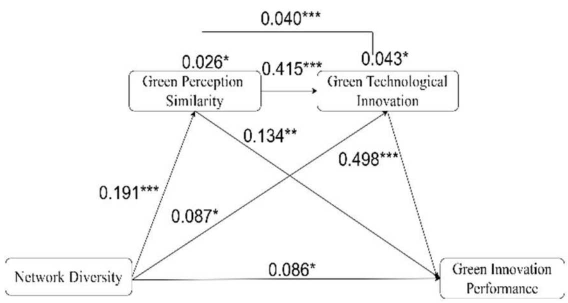

Figure 2: Chained Mediation Pathway

Table 6 presents the mediation effect analysis of the model, including comparisons of the total effect, direct effect, total indirect effect, and paths of indirect effects.Bootstrap resampling was employed to examine these mediation effects.

Table 6 presents the Bootstrap 95% confidence intervals for the various effects.The total effect confidence interval ranges from 0.137 to 0.272, excluding zero, indicating a significant total effect. The direct effect also shows a significant result, with a 95% confidence interval between 0.025 and 0.152, not including zero. The mediation effect for the "X-M1-Y" path is significant, with a Bootstrap 95% confidence interval of 0.022 to 0.080, thereby supporting Hypothesis H_4. This indicates a partial mediation effect, as the independent variable continues to influence the dependent variable even with the mediator present. For the "X-M2-Y" mediation path, the confidence interval ranges from 0.048 to 0.142, excluding zero, supporting Hypothesis H_7. The chained mediation effect for the "X-M1-M2-Y" path is also significant, with a Bootstrap 95% confidence interval of 0.037 to 0.103, validating Hypothesis H_9.

Table 6 further reveals that all three mediation paths—Ind3, Ind2, and Ind1—are significant. Among these, the "X-M1-M2-Y" path has the highest coefficient and a three-star significance level, followed by the "X-M2-Y" path, and finally the "X-M1-Y" path, which has the smallest effect.

5.3 Moderation Effect Analysis

5.3.1 Empirical Analysis of Moderation Effects

The moderating role of green dynamic capabilities in the relationships among network diversity, green perception similarity, technical innovation activities, and green innovation performance was investigated using a latent moderated structural equation modeling (SEM) approach.

The moderating role of green dynamic capabilities was examined in the context of the relationships between network diversity, green perception similarity, technical innovation activities, and green innovation performance. A latent moderated structural equation modeling (SEM) approach was utilized for this investigation.

Table 7 presents the interaction effects.

Table 7 shows the interaction effects. The interaction between green dynamic capabilities and network diversity has a standardized path coefficient of -0.093, with a t - value of -4.849 and a p - value of

Table 9: Moderated Mediation Effect Analysis Model 2 - Green Consensus

Moderator Variable	Indirect Effect	Standard Error	t	P	LLCI	ULCI
Low Green Dynamic Capabilities	0.267	0.057	4.651	0.000	0.154	0.380
High Green Dynamic Capabilities	-0.127	0.061	-2.098	0.036	-0.246	-0.008
Difference	0.070	0.040	1.754	0.080	-0.008	0.148
Moderated Mediation Effect	Index	0.049	5.615	0.000	0.176	0.367

Table 10: Moderated Mediation Effect Analysis Model 3 - Green Open Innovation Activities

Moderator Variable	Indirect Effect	Standard Error	t	P	LLCI	ULCI
Low Green Dynamic Capabilities	0.360	0.042	8.633	0.000	0.278	0.441
High Green Dynamic Capabilities	0.494	0.050	9.905	0.000	0.396	0.592
Difference	0.427	0.031	13.561	0.000	0.365	0.489
Moderated Mediation Effect	Index	0.049	13.157	0.000	0.549	0.743

0.000. This indicates a significant moderating effect on green innovation performance. When green dynamic capabilities interact with network diversity, they influence the relationship in a way that affects the outcome of green innovation performance.

Similarly, the interaction between green dynamic capabilities and green perception similarity has a standardized path coefficient of -0.155, with a t - value of -6.871 and a p - value of 0.031, demonstrating a significant moderating effect. This implies that the relationship between green perception similarity and green innovation performance is modified by the presence and level of green dynamic capabilities.

The interaction between green dynamic capabilities and technical innovation activities shows a standardized path coefficient of 0.016, with a t - value of 0.944 and a p - value of 0.346. Although the p - value is relatively higher compared to the other interactions, it still indicates a significant moderating effect. This means that green dynamic capabilities also play a role in moderating the relationship between technical innovation activities and green innovation performance. These results provide strong support for Hypotheses H10, H11.

To further explore the moderated mediation effect, the product - of - coefficients approach proposed by [64] was used. Additionally, the difference test method suggested by [65] was employed to verify the moderating role in the chained mediation process.

As indicated in Table 8.

The analysis of the mediating effect of network diversity on green innovation performance through technical innovation activities shows that when green dynamic capabilities are low (one standard deviation below the mean), the direct effect of network diversity on green innovation performance is 0.088 ($p > 0.005$). The Bootstrap 95% CI [0.025, 0.152] includes zero, suggesting that the direct effect is not significant after adjustment. In contrast, when green dynamic capabilities are high (one standard deviation above the mean), the direct effect of network diversity on green innovation performance increases to 0.435 ($p < 0.05$). The Bootstrap 95% CI [0.304, 0.566] does not include zero, indicating a significant direct effect. The difference in the direct effect of network diversity on green innovation performance between high and low green dynamic capabilities is 0.096 ($p < 0.05$), with a Bootstrap 95% CI [-0.058, 0.251], which does not include zero, indicating a significant difference.

These results demonstrate that green dynamic capabilities significantly moderate the direct effect of network diversity on green innovation performance. Specifically, when a company has high green dynamic capabilities, the direct relationship between network diversity and green innovation performance is much stronger compared to when these capabilities are low.

Furthermore, Table 9 shows.

Table 9 shows that the green dynamic capabilities indicator at 0.267 ($p < 0.005$), with a Bootstrap 95% CI [0.154, 0.380], exhibits a significant moderating effect on the indirect influence of network diversity on green innovation performance through green perception similarity, as the CI does not include zero.

This finding indicates that the moderated mediation effect is significant in the mechanism by which network diversity affects green perception similarity. In other words, effective green dynamic capabilities enhance the mediating role between green perception similarity and green innovation performance. Overall, the results highlight the importance of considering green dynamic capabilities as a moderator in understanding the complex relationships among network diversity, green perception similarity, technical innovation activities, and green innovation performance. This knowledge can help companies better manage and optimize these factors to improve their green innovation performance.

Table 11 :Polynomial Regression Adjustment and Response Surface Analysis

Variable		eco-innovation					
		Network Diversity		Green Consensus		Green Open Innovation Activities	
		Low Model 1	High Model 2	Low Model 3	High Model 4	Low Model 5	High Model 6
control variables	Industry Category	-0.007	-0.003	-0.004	-0.004	-0.010	0.002
	Years Since Establishment	-0.004	0.004	-0.015	-0.007	-0.027	0.008
	Capital Amount	-0.014	-0.022	-0.013	0.000	0.014	-0.012
	Number of Employees	0.026	0.028	0.031	0.027	0.025	0.028
Intercept		-2.63	0.79	-2.25	0.92	0.98	0.83
Model P-value		0.0059	0.0117	0.0083	0.0085	0.0093	0.0137
Lack of Fit P-value		0.5089	0.7269	0.5167	0.5127	0.8236	0.7891
R2		0.9097	0.8783	0.9114	0.9239	0.8989	0.8932
ΔR2		0.7979	0.9032	0.9170	0.8990	0.8237	0.8891
BIC		47.85	41.47	46.88	39.67	49.27	41.79
AICC		75.50	67.88	77.12	67.98	78.89	65.76
Slope and Curve							
Consistency							
Slope a1		-0.199*	0.7721*	-3.128*	0.552*	-2.899**	0.621**
Curvature a2		3.122***	2.376**	2.879***	2.412***	3.673**	2.487**
Inconsistency							
Slope a3		-0.263**	0.979**	-2.782**	0.936**	-2.672**	0.987**
Curvature a4		0.237**	0.321**	0.253**	0.247***	0.757**	0.376**

p<0.05, ** p<0.01, *** p<0.001

Finally, Table 10 presents that the green dynamic capabilities indicator, with a value of 0.494 ($p < 0.005$) and a Bootstrap 95% confidence interval of [0.396, 0.592], demonstrates a significant moderating effect on the indirect influence of network diversity on green innovation performance through technical innovation activities. Since the confidence interval does not contain zero, this finding verifies that the moderated mediation effect is substantial in the mechanism by which network diversity impacts technical innovation activities.

In other words, when a company possesses effective green dynamic capabilities, it is better able to strengthen the mediating role that technical innovation activities play between network diversity and green innovation performance. Green dynamic capabilities seem to have the ability to optimize and enhance the way in which network diversity affects technical innovation activities, which in turn leads to a more significant impact on green innovation performance. This further emphasizes the importance of green dynamic capabilities in the complex web of relationships among network diversity, technical innovation activities, and green innovation performance. It suggests that companies should focus on developing and leveraging these capabilities to fully realize the potential benefits of network diversity and technical innovation activities for achieving superior green innovation performance. Overall, this finding provides valuable insights for businesses and researchers alike in understanding and promoting green innovation within the context of the digital economy.

5.3.2 Exploration of the Optimal Path with Moderating Effects

Box and Wilson (1951) put forward a comprehensive method for optimizing multifactorial processes, which is commonly known as the response surface methodology (RSM). This approach is highly valuable in optimizing production processes in diverse contexts. In cross - level research, as suggested by Cohen (2003), when the intraclass correlation coefficient (ICC) value among variables is greater than 0.059, conducting cross - level analysis is considered justifiable.

In this study, the independent variable (network diversity), mediating variables (green perception similarity, technical innovation activities), moderating variable (green dynamic capabilities), and dependent variable (green innovation performance) were initially centered to prevent multicollinearity. Subsequently, a "matching" test between variables was carried out. If the proportion of mismatches, where the absolute value of XY is greater than 0.5, exceeds 10%, the matching study is regarded as having practical significance and is deemed suitable for polynomial regression and response surface construction.

Given the empirical evidence of moderating effects, polynomial regression models 1 - 6 were constructed with green innovation performance as the outcome variable and green perception similarity, technical innovation activities as the independent variables (see Table 11).

This approach enables the exploration of the optimal path for enhancing green innovation performance under the moderating influence of green dynamic capabilities. It thus offers more accurate strategic insights for enterprises that aim to effectively utilize network diversity and green innovation strategies.

The R - squared (R^2) values are close to 1, indicating a strong model fit, and the P - values are all below 0.05, confirming the statistical significance of the models. The models illustrate that when R^2 exceeds 80%, over 70% of the variance in green innovation performance can be accounted for, validating the suitability of Models 1 to 6 for response surface analysis. This high degree of fit implies that network diversity, green perception similarity, and technical innovation activities, as modeled, significantly contribute to explaining green innovation performance.

It is revealed that the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) indicators vary across the polynomial regression models, with green dynamic capabilities as the moderating variable. These variations confirm the moderating effect of green dynamic capabilities on the relationships between network diversity, green perception similarity, technical innovation activities, and green innovation performance.

In both consistency and inconsistency scenarios, positive slopes signify that as the independent variable increases, the dependent variable also increases, although the rate of change may vary. Conversely, negative slopes indicate a decrease in the dependent variable as the independent variable increases, with different rates of decline depending on consistency (Khuri & Mukhopadhyay, 2010).

Model 1: Under the moderating influence of green dynamic capabilities, the response surface curves upward in both consistency and inconsistency scenarios ($a^2 = 3.122$, $a^4 = 0.237$, $P < 0.001$), while the slopes are negative ($a^1 = -0.199$, $a^3 = -0.263$, $P < 0.05$). This suggests that green dynamic capabilities moderate the relationship between network diversity and green innovation performance by enhancing this effect in consistency and maintaining it under varying conditions.

Model 2: The response surface curves upward in both scenarios ($a^2 = 2.376$, $a^4 = 0.321$, $P < 0.001$), with positive slopes ($a^1 = 0.772$, $a^3 = 0.979$, $P < 0.05$). This indicates that green dynamic capabilities, regardless of consistency, enhance the positive impact of network diversity on green innovation performance.

Model 3: The response surface shows significant upward curvature ($a^2 = 2.879$, $a^4 = 0.253$, $P < 0.001$), with negative slopes ($a^1 = -3.128$, $a^3 = -2.782$, $P < 0.05$). This implies that green dynamic capabilities moderate the effect of green perception similarity on green innovation performance, weakening this effect at low levels of green perception similarity.

Model 4: Positive slopes ($a^1 = 0.552$, $a^3 = 0.936$, $P < 0.05$) with upward surface curvature ($a^2 = 2.412$, $a^4 = 0.247$, $P < 0.001$) suggest that green dynamic capabilities enhance the positive impact of high - level green perception similarity on green innovation performance, irrespective of consistency.

Model 5: The surface curves significantly upward ($a^2 = 3.673$, $a^4 = 0.757$, $P < 0.001$), but with negative slopes ($a^1 = -2.899$, $a^3 = -2.672$, $P < 0.05$). This indicates that green dynamic capabilities moderate the relationship between technical innovation

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activities and green innovation performance,

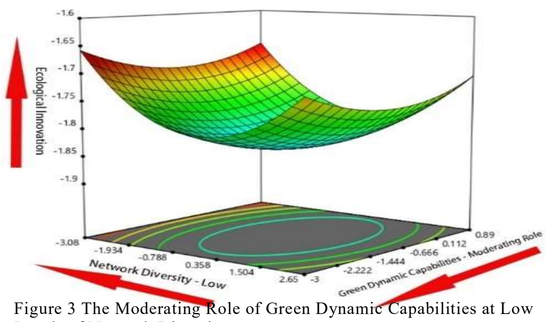

Figure 3 The Moderating Role of Green Dynamic Capabilities at Low Levels of Network Diversity

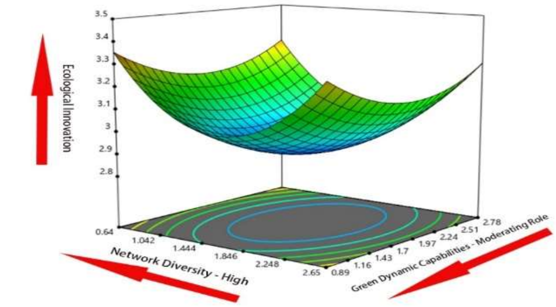

Figure 4 The Moderating Role of Green Dynamic Capabilities at High Levels of Network Diversity

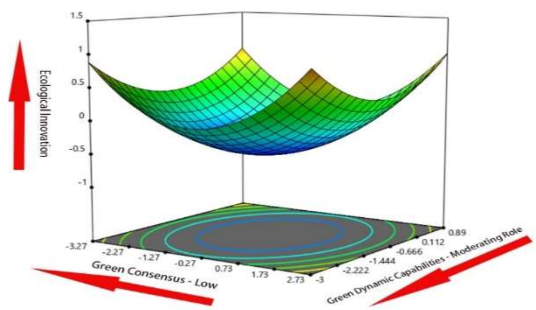

Figure 5 The Moderating Role of Green Dynamic Capabilities at Low Levels of Green Consensus

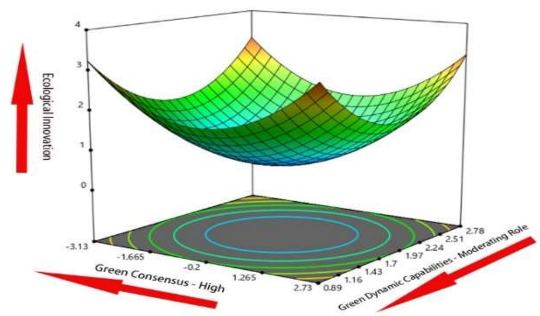

Figure 6 The Moderating Role of Green Dynamic Capabilities at High Levels of Green Consensus

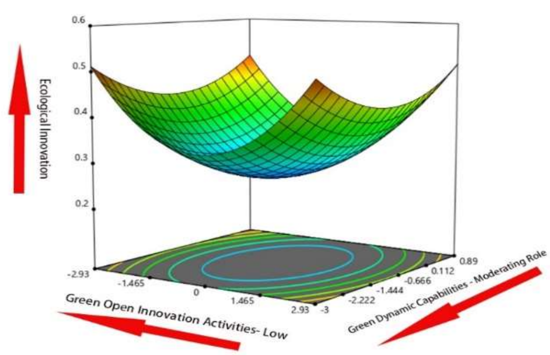

Figure 7 The Moderating Role of Green Dynamic Capabilities at Low Levels of Green Open Innovation Activities

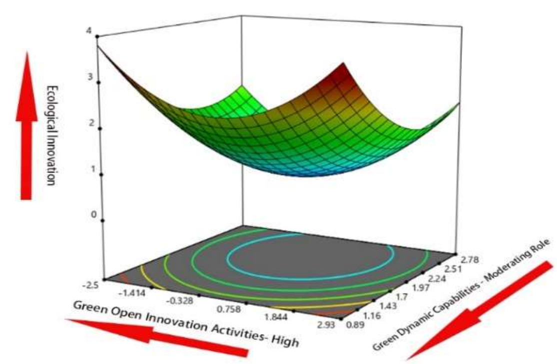

Figure 8 The Moderating Role of Green Dynamic Capabilities at High Levels of Green Open Innovation Activities

weakening this effect at low levels of technical innovation activities.

Model 6: The response surface curves upward in both scenarios ($a^2 = 2.487$, $a^4 = 0.376$, $P < 0.001$), with positive slopes ($a^1 = 0.621$, $a^3 = 0.987$, $P < 0.05$). This shows that green dynamic capabilities enhance the positive impact of high - level technical innovation activities on green innovation performance, whether consistent or inconsistent.

These results, visualized in three - dimensional response surface plots (Figures3-8), clearly demonstrate the crucial moderating role of green dynamic capabilities in enhancing or maintaining the relationship between key variables and green innovation performance. They provide a comprehensive understanding of how different factors interact and influence the achievement of green innovation performance, guiding businesses in making more informed decisions regarding their innovation strategies and resource allocation.

The regression results summarized in Table 4-23

6. RESEARCH CONCLUSIONS AND DISCUSSION

This study has deeply explored the roles of green perception similarity, technical innovation activities, and green dynamic capabilities in the relationship between network diversity and green innovation performance.

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This research has conducted an in - depth exploration into the functions and significance of green perception similarity, technical innovation activities, and green dynamic capabilities within the context of the relationship between network diversity and green innovation performance.

The findings reveal a significant mediating effect of green perception similarity and technical innovation activities in this relationship.

The results of the study have uncovered a notable mediating role played by green perception similarity and technical innovation activities in the connection between network diversity and green innovation performance. Specifically, green perception similarity offers the ideological groundwork and driving force for green innovation performance. It does so by enhancing the awareness and support for environmental initiatives within enterprises [55]. At the same time, technical innovation activities accelerate the process of achieving green innovation performance by integrating internal and external resources, which is in line with the findings of [56, 57]. The positive influence of network diversity on green innovation performance is substantiated by [23], which contends that network diversity brings a wider variety of knowledge and technology into enterprises, thus stimulating innovative thinking and solutions.

Additionally, this study uncovers the regulatory mediating role of green dynamic capabilities in the interplay between network diversity, green perception similarity, technical innovation activities, and green innovation performance.

Furthermore, this research has discovered the regulatory and mediating function of green dynamic capabilities in the complex interaction among network diversity, green perception similarity, technical innovation activities, and green innovation performance. This is in accordance with the perspective of [66] regarding how enterprises generate value by adapting to and influencing change. Green dynamic capabilities not only assist enterprises in effectively integrating resources and increasing the likelihood of success in achieving green innovation performance but also moderate the impact of network diversity on green innovation performance. This emphasizes the significance of resource allocation and capability development in the process of attaining green innovation performance [67]. As pointed out by [68], the insufficient absorptive capacity of enterprises may impede the full utilization of resources, further highlighting the crucial role of green dynamic capabilities in promoting green innovation performance.

Drawing from the dynamic capability perspective proposed by [50], which advocates for innovation and openness, this study validates the regulatory mediating model of green dynamic capabilities in the effects of green perception similarity, technical innovation activities, and network diversity on green innovation performance.

Inspired by the dynamic capability perspective put forward by [50], which emphasizes innovation and openness, this study verifies the regulatory mediating model of green dynamic capabilities in relation to the influence of green perception similarity, technical innovation activities, and network diversity on green innovation performance. Consistent with the theories of exploratory innovation by [57], network diversity has a significant impact on green innovation performance under the dual mediation of green perception similarity and technical innovation activities [35, 56].

This study differentiates itself from previous research by revealing the indirect value creation role of green dynamic capabilities in the green innovation performance process, emphasizing their role as a prerequisite for green innovation performance.

This study sets itself apart from previous research by uncovering the indirect value - creating role of green dynamic capabilities in the process of achieving green innovation performance. It underlines their importance as a fundamental prerequisite for attaining green innovation performance. This understanding is of great importance for the development of enterprise networks. Therefore, enterprises should place a high priority on developing green dynamic capabilities in their pursuit of green innovation performance. This will facilitate the efficient transfer of knowledge and skills, enable them to recognize the value impact, and ultimately lead to the dual enhancement of economic and social values.

This study provides both theoretical foundations and practical guidance for enterprises on promoting green innovation performance through the enhancement of green perception similarity, technical innovation activities, and green dynamic capabilities.

This research offers both theoretical underpinnings and practical suggestions for enterprises aiming to enhance their green innovation performance through strengthening green perception similarity, promoting technical innovation activities, and developing green dynamic capabilities. By intensifying the integration and application of these elements, enterprises can not only boost their competitiveness [20] but also contribute to the sustainable development of society. Overall, this study contributes to a more comprehensive understanding of the factors and mechanisms involved in achieving green innovation performance and provides valuable insights for businesses seeking to operate in a more sustainable and innovative manner.

7. RESEARCH RECOMMENDATIONS

7.1 Research Suggestions

Strengthen Green Perception Similarity Integration: Enterprises should concentrate on integrating green perception similarity into their core business strategies. This involves not merely setting up green development mechanisms but also deeply embedding sustainability principles in every facet of the organization. For instance, by designing and implementing comprehensive training programs, companies can ensure that employees at all levels thoroughly understand and internalize the importance of environmental sustainability. These programs could cover topics ranging from the latest environmental regulations to practical ways of incorporating green practices into daily work. By doing so, a strong collective commitment to sustainability objectives can be cultivated, aligning individual actions with the overarching environmental vision of the company.

Optimize Network Ecosystem for Innovation: To optimize social network relationships, businesses should actively engage with a broader spectrum of external entities. Beyond collaborating with government agencies, NGOs, and local communities, enterprises should explore partnerships with emerging start-ups, global industry leaders, and even cross-industry players. By forming strategic partnerships and engaging in resource and information sharing, companies can create a vibrant innovation ecosystem. For example, a manufacturing firm could partner with a tech start-up to leverage digital technologies for optimizing production processes and reducing environmental impact. This cross-pollination of ideas and resources can lead to the development of more disruptive and sustainable solutions.

Foster Agile Green Dynamic Capabilities: The cultivation of green dynamic capabilities should be a top priority for enterprises. This requires continuous investment in research and development, as well as the establishment of mechanisms for rapid learning and adaptation. Companies should encourage a culture of experimentation and risk-taking, where employees are empowered to explore new green technologies and business models. For example, a company could set up an internal innovation lab dedicated to testing and implementing green initiatives. By closely monitoring market trends and technological advancements, businesses can quickly identify and capitalize on green opportunities, enhancing their competitive edge in the market.

Formulate Holistic Resource Integration Strategies: Enterprises need to formulate comprehensive strategies for integrating resources from multiple dimensions. This goes beyond simply combining internal and external resources; it involves a thorough assessment of the synergy and potential of different resource combinations. For example, companies could use advanced data analytics to evaluate the impact of various resource integration methods on green innovation performance. By understanding how different resources interact and contribute to innovation, businesses can optimize resource allocation, ensuring that resources are directed towards the most promising green initiatives.

Promote Cross-Sectoral Innovation Collaboration: To drive cross-industry and cross-domain innovation cooperation, enterprises should actively participate in industry-wide initiatives, innovation hubs, and consortiums. These platforms provide opportunities for sharing best practices, co-developing technologies, and jointly addressing environmental challenges. For example, a group of companies from different industries could come together to develop a common standard for sustainable packaging. By collaborating across sectors, businesses can leverage diverse perspectives and expertise, leading to more impactful and scalable green innovation.

Implement Robust Green Innovation Performance Monitoring: Enterprises should establish a comprehensive system for monitoring and evaluating the performance of green innovation. This system should not only measure the environmental, economic, and social benefits of green initiatives but also track the progress of individual projects and the overall impact on the organization. By using a combination of quantitative and qualitative metrics, companies can gain a more accurate understanding of the effectiveness of their green innovation efforts. For example, in addition to measuring carbon emissions reduction and cost savings, businesses could also assess employee engagement and customer satisfaction related to green initiatives.

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Policy Support for Green Innovation Ecosystem: Policymakers can play a crucial role in promoting green innovation by creating a conducive policy environment. In addition to providing tax incentives, financial subsidies, and green credit schemes, policymakers could also introduce regulatory frameworks that encourage sustainable practices. For example, setting mandatory environmental standards for industries or providing preferential treatment to companies that demonstrate leadership in green innovation. This can help level the playing field and encourage more businesses to invest in green initiatives.

Enhance Public Awareness and Engagement: Enterprises and policymakers should collaborate to raise public awareness of green innovation through a multi-faceted approach. This could include educational campaigns in schools and communities, public-private partnerships, and media outreach. By engaging the public in the conversation about green innovation, businesses can create a demand for sustainable products and services. For example, a company could launch a public awareness campaign about the environmental benefits of its green products, encouraging consumers to make more sustainable choices. This increased demand can, in turn, drive further innovation and investment in the green sector.

Future research should focus on investigating the implementation and customization of these strategies in different industries and regions. By understanding the unique challenges and opportunities faced by different organizations, researchers can provide more tailored and practical guidance for enhancing green innovation performance.

7.2 Expansion of Future Research Directions

Diversify Research Methodologies and Contextual Studies: Future research on green innovation performance should embrace a diverse range of research methodologies. In addition to quantitative and qualitative methods, researchers could explore the use of mixed-methods approaches, longitudinal studies, and action research. This would provide a more comprehensive understanding of the complex mechanisms underlying green innovation. For example, longitudinal studies could track the evolution of green innovation strategies over time, while action research could involve collaborating with companies to implement and evaluate innovative green initiatives.

Moreover, it is essential to explore the roles and impacts of green perception similarity, technical innovation activities, and network diversity in different cultural and institutional contexts. Cultural norms, social values, and regulatory frameworks vary significantly across regions, and these factors can have a profound impact on green innovation. For example, in some cultures, there may be a stronger emphasis on community and collective action, which could influence the way companies approach green innovation. By understanding these contextual differences, businesses and policymakers can develop more effective strategies for promoting green innovation.

Collaborative Efforts for Sustainable Development: Collaboration among policymakers, businesses, and consumers is vital for driving green innovation and achieving sustainable development. Policymakers should continue to play an active role in creating an enabling environment for green innovation. This could involve developing policies that support research and development in green technologies, promoting public-private partnerships, and facilitating knowledge sharing across industries.

Businesses, on the other hand, should take a more proactive approach to collaboration. This could include sharing best practices, co-investing in research projects, and jointly developing industry standards. For example, companies could form industry-wide alliances to address common environmental challenges, such as reducing carbon emissions or improving waste management.

Consumers also have a crucial role to play in driving green innovation. By making conscious choices and demanding sustainable products and services, consumers can create market incentives for businesses to invest in green innovation. To encourage consumer engagement, enterprises and policymakers could provide more information about the environmental impact of products and services, making it easier for consumers to make informed decisions.

Deepen Understanding of Green Innovation Performance: Future research should continue to deepen our understanding of the far-reaching impacts of green innovation performance. This includes exploring not only the direct environmental and economic benefits but also the social and cultural implications. For example, research could investigate how green innovation affects local communities, such as through job creation, improved quality of life, and social cohesion.

By providing more robust theoretical support and practical guidance, future research can help businesses and policymakers make more informed decisions about green innovation. This could involve developing more sophisticated models for predicting the impact of green initiatives, identifying best practices for implementing green innovation strategies, and evaluating the long-term sustainability of different approaches. Ultimately, this research can contribute to the development of more sustainable business models and a more sustainable future for all.

8. RESEARCH LIMITATIONS

This study provides a foundational understanding of the roles of green perception similarity, technical innovation activities, and network diversity in green innovation performance; however, several limitations warrant attention:

This research has laid a basic groundwork for understanding how green perception similarity, technical innovation activities, and network diversity interact and contribute to green innovation performance. However, there are several areas that need further examination and improvement.

Insufficient Exploration of Green Perception Similarity:

This study has not comprehensively investigated how green perception similarity actually promotes green innovation performance. Future research should conduct a more in-depth exploration into the formation process of green perception similarity within enterprises. It should also analyze how it interacts with senior management support and technical innovation activities to jointly enhance green innovation performance [2]. For example, understanding how senior management can actively shape and reinforce a shared green perception among employees and how this, in turn, affects the implementation and success of technical innovation initiatives. This could involve studying communication channels and leadership strategies that foster a unified understanding of environmental goals and their connection to innovation.

Limitations in Sample Selection:

The sample used in this study is confined to manufacturing enterprises in only five cities in Jiangxi Province. This narrow scope restricts the generalizability and representativeness of the findings. Future research should expand the sample to include enterprises from diverse regions, different sizes, and a wide range of industries. This would improve the external validity of the study and provide a more comprehensive understanding of how these factors influence green innovation performance across various business contexts. For instance, including service-based enterprises, small startups, and large multinational corporations from different geographical locations would offer a more holistic view of the phenomenon.

Time Limitation of Cross - Sectional Research:

As this is a cross-sectional study, the results merely capture the relationships between variables at a single moment in time. Future longitudinal research is needed to uncover the dynamic changes and development of these relationships over an extended period. Longitudinal studies could track how green perception similarity, technical innovation activities, and network diversity evolve and impact green innovation performance over months or years. This would help identify trends, such as how changes in network diversity over time lead to corresponding changes in green innovation performance and how the development of green perception similarity affects the trajectory of technical innovation.

Insufficient Discussion on Multidimensional Resource Integration:

Although this study introduced the concept of multidimensional resource integration, it failed to thoroughly examine how different enterprises integrate and utilize resources based on their specific types of technical innovation activities. Future research should focus on understanding the impact of various resource integration strategies on green innovation performance. This could involve analyzing how different combinations of internal and external resources, such as financial, human, and technological resources, are effectively coordinated in the context of different technical innovation projects. For example, studying how a company combines its in-house R&D expertise with external partnerships to optimize resource allocation for a particular green innovation initiative.

Insufficient Analysis of the Moderating Effect of Green Dynamic Capabilities:

While this study acknowledged the regulatory role of green dynamic capabilities, it did not conduct a detailed analysis of how they specifically influence the process and outcomes of green innovation performance. Future research should comprehensively explore the mechanisms of green dynamic capabilities under different levels of network diversity. This would involve understanding how green dynamic capabilities interact with network diversity to shape the innovation process. For instance, how do companies with strong green dynamic capabilities better leverage diverse network resources to drive green innovation, and how does this relationship change as network diversity varies?

Measurement and Impact of Network Diversity:

This study might not have fully captured the multiple dimensions and levels of network diversity and their precise influence on an enterprise's green innovation capabilities. Future research should adopt more refined measurement methods to accurately assess network diversity and its specific impact on green innovation performance. This could include considering not only the variety of network partners but also the nature of relationships, the frequency of interactions, and the knowledge and resource flows within the network. For example, developing metrics to measure the quality and depth of relationships with different types of partners and how these factors contribute to the generation and implementation of green innovation ideas.

Integration of Environmental Challenges and Sustainable Development Goals:

This study may not have adequately explored how environmental challenges and sustainable development goals are integrated into the green innovation process [19]. Future research should analyze in detail how enterprises incorporate these challenges and goals into their strategic planning and innovation activities. This could involve studying how companies identify and prioritize environmental issues, set specific goals related to sustainable development, and align their innovation efforts accordingly. For example, understanding how a company responds to regulatory requirements for reducing carbon emissions by integrating this goal into its product design and manufacturing processes through green innovation.

By conducting more in-depth analyses, expanding sample selections, designing longitudinal studies, and achieving a comprehensive understanding of multidimensional resource integration and green dynamic capabilities, future research can enhance the theoretical and practical knowledge in the field of green innovation performance. These efforts will offer stronger support and more effective guidance for enterprises as they strive to address environmental challenges and achieve sustainable development. This will ultimately contribute to the development of more sustainable business models and a greener economy overall.

REFERENCES:

[1] Albitar, K., Nasrallah, N., Hussainey, K.,& Wang, Y. (2024). Eco-innovation and corporate waste management:The moderating role of ESG performance.Review of Quantitative Finance and Accounting,1-25.https://doi.org/10.1007/s11156-024-01281-5.

[2] Horbach, J., Rammer, C., & Rennings,K. (2012). Determinants of eco-innovations by type of environmental impact—The role of regulatory push/pull,technology push and market pull. Ecological economics,78,112-122.https://doi.org/10.1016/j.ecolecon.2012.04.005.

[3] Del Río, P., Romero-Jordán, D., & Peñasco, C. (2017).Analysing firm-specific and type-specific determinants of eco-innovation.Technological and Economic Development of Economy,23(2), 270-295.https://doi.org/10.3846/20294913.2015.1072749.

[4] Melander, L., & Pazirandeh, A. (2019). Collaboration beyond the supply network for green innovation: insight from 11 cases. Supply Chain Management: An International Journal, 24(4), 509-523.https://doi.org/10.1108/SCM-08-2018-0285.

[5] Daddi, T., Heras-Saizarbitoria, I., Marrucci, L., Rizzi, F., & Testa, F. (2021). The effects of green supply chain management capability on the internalisation of environmental management systems and organisation performance. Corporate Social Responsibility and Environmental Management, 28(4), 1241-1253.https://doi.org/10.1002/csr.2144.

[6] Kauppi, K., & Luzzini, D. (2021). Measuring institutional pressures in a supply chain context: scale development and testing. Supply Chain Management: An International Journal, 27(7), 79-107.DOI 10.1108/SCM-04-2021-0169.

[7] Zaman, R., Asiaei, K., Nadeem, M., Malik, I., & Arif, M. (2024). Board demographic, structural diversity, and eco - innovation: International evidence. Corporate Governance: An International Review, 32(3), 374-390. https://doi.org/10.1111/corg.12545.

[8] Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. Journal of business ethics, 67, 331-339.https://doi.org/10.1007/s10551-006-9025-5.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[9] Bogers, M., Chesbrough, H., & Strand, R. (2020). Sustainable open innovation to address a grand challenge: Lessons from Carlsberg and the Green Fiber Bottle. British Food Journal, 122(5), 1505-1517.https://doi.org/10.1108/BFJ-07-2019-0534.

[10] Perruchas, F., Consoli, D., & Barbieri, N. (2020). Specialisation, diversification and the ladder of green technology development. Research Policy, 49(3), 103922.https://doi.org/10.1016/j.respol.2020.103922.

[11] Chaparro‐Banegas, N., Mas‐Tur, A., Park, H. W., & Roig‐Tierno, N. (2023). Factors driving national eco‐innovation: New routes to sustainable development. Sustainable Development, 31(4), 2711-2725.https://doi.org/10.1002/sd.2541.

[12] Hojnik, J., & Ruzzier, M. (2016). What drives eco-innovation? A review of an emerging literature. Environmental innovation and societal transitions, 19, 31-41.https://doi.org/10.1016/j.eist.2015.09.006

[13] Carchano, M., Carrasco, I., & González, Á. (2024). Eco‐innovation and environmental performance: Insights from Spanish wine companies. Annals of Public and Cooperative Economics, 95(2), 595-623.https://doi.org/10.1111/apce.12421.

[14] Li-Ying, J., Mothe, C., & Nguyen, T. T. U. (2018). Linking forms of inbound open innovation to a driver-based typology of environmental innovation: Evidence from French manufacturing firms. Technological Forecasting and Social Change, 135, 51-63.https://doi.org/10.1016/j.techfore.2017.05.031.

[15] Fuenfschilling, L., & Binz, C. (2018). Global socio-technical regimes. Research policy, 47(4), 735-749.https://doi.org/10.1016/j.respol.2018.02.003.

[16] Costantini, V., Crespi, F., & Paglialunga, E. (2018). The employment impact of private and public actions for energy efficiency: Evidence from European industries. Energy Policy, 119, 250-267.https://doi.org/10.1016/j.enpol.2018.04.035.

[17] El-Kassar, A. N., & Singh, S. K. (2019). Green innovation and organizational performance: The influence of big data and the moderating role of management commitment and HR practices. Technological forecasting and social change, 144,483-498.https://doi.org/10.1016/j.techfore.2017.12.016.

[18] Dentoni, D., Pinkse, J., & Lubberink, R. (2021).Linking sustainable business models to socio-ecological resilience through cross-sector partnerships: A complex adaptive systems view. Business & Society,60(5),1216-1252.https://doi.org/10.1177/0007650320935015.

[19] Arranz, C. F. (2024). A system dynamics approach to modelling eco‐innovation drivers in companies: understanding complex interactions using machine learning. Business Strategy and the Environment.https://doi.org/10.1002/bse.3704.

[20] Vuori, T. O., & Tushman, M. L. (2024). Strategic decision‐making at platform transitions: The case of Nokia (2010–2011). Strategic Management Journal.https://doi.org/10.1002/smj.3608.

[21] Awan, U., Sroufe, R., & Kraslawski, A. (2019). Creativity enables sustainable development: Supplier engagement as a boundary condition for the positive effect on green innovation. Journal of cleaner production, 226, 172-185.https://doi.org/10.1016/j.jclepro.2019.03.308.

[22] Celestin, B. N., & Dorcas, K. D. (2024). Eco-innovation in Waste Recycling Industry in Ghana: Modeling the Upper Echelon Behavioral Drivers of Grass Root Innovation Among SEED Award Winners. SAGE Open, 14(2), 21582440231198151.https://doi.org/10.1177/21582440231198151.

[23] Zhang, G., Tang, C., & Qi, Y. (2020). Alliance network diversity and innovation ambidexterity: The differential roles of industrial diversity, geographical diversity, and functional diversity. Sustainability, 12(3), 1041. https://doi.org/10.3390/su12031041.

[24] Wang, J., & Lv, W. (2023).Research on the impact of green innovation network embeddedness on corporate environmental responsibility. International Journal of Environmental Research and Public Health, 20(4), 3433. https://doi.org/10.3390/ijerph20043433.

[25] Zhao, Y., Qi, N., Li, L., Li, Z., Han, X., & Xuan, L. (2023). How do knowledge diversity and ego-network structures affect firms' sustainable innovation: evidence from alliance innovation

networks of China's new energy industries. Journal of Knowledge Management, 27(1), 178-196.https://doi.org/10.1108/JKM-03-2022-0173.

[26] Reagans, R., & Zuckerman, E. W. (2001). Networks, diversity, and productivity: The social capital of corporate R&D teams. Organization science, 12(4), 502-517.https://doi.org/10.1287/orsc.12.4.502.10637.

[27] Orsatti, G., Quatraro, F., & Scandura, A. (2024). Green technological diversification and regional recombinant capabilities: the role of technological novelty and academic inventors. Regional Studies, 58(1), 120-134.https://doi.org/10.1080/00343404.2023.2176476.

[28] De Clercq, D., Thongpapanl, N., & Voronov, M.(2018).Sustainability in the face of institutional adversity: Market turbulence, network embeddedness, and innovative orientation.Journal of Business Ethics, 148, 437-455.doi:10.1007/s10551-015-3004-7.

[29] Alkaraan, F., Elmarzouky, M., Hussainey, K., Venkatesh, V. G., Shi, Y., & Gulko, N. (2024). Reinforcing green business strategies with Industry 4.0 and governance towards sustainability: Natural-resource-based view and dynamic capability. Business Strategy and the Environment. https://doi.org/10.1002/bse.3665.

[30] Shahzad, M., Qu, Y., Javed, S. A., Zafar, A. U., & Rehman, S. U. (2020). Relation of environment sustainability to CSR and green innovation: A case of Pakistani manufacturing industry. Journal of cleaner production, 253, 119938.https://doi.org/10.1016/j.jclepro.2019.119938.

[31] Sotarauta, M., Suvinen, N., Jolly, S., & Hansen, T. (2021). The many roles of change agency in the game of green path development in the North. European Urban and Regional Studies, 28(2), 92-110.https://doi.org/10.1177/0969776420944995.

[32] Petljak, K., Zulauf, K., Štulec, I., Seuring, S., & Wagner, R. (2018). Green supply chain management in food retailing: survey-based

[40] Fussler, C. , & James, P. .(1996).Driving eco-innovation: a breakthrough discipline for innovation and sustainability. pitman pub.

[41] Sellitto, M. A., Camfield, C. G., & Buzuku, S. (2020). Green innovation and competitive advantages in a furniture industrial cluster: A survey and structural model. Sustainable

evidence in Croatia. Supply Chain Management: An International Journal, 23(1), 1-15.https://doi.org/10.1108/SCM-04-2017-0133.

[33] Dangelico R M.(2016).Green product innovation: Where we are & where we are Going.Business Strategy & the Environment,25(8):314-328.https://doi.org/10.1002/bse.1886.

[34] Alinaghian, L., Qiu, J., & Razmdoost, K. (2021). The role of network structural properties in supply chain sustainability: a systematic literature review and agenda for future research. Supply Chain Management: An International Journal, 26(2), 192-211.https://doi.org/10.1108/SCM-11-2019-0407.

[35] Cobeña, M., Gallego, Á., & Casanueva, C.(2017).Heterogeneity, diversity and complementarity in alliance portfolios. European Management Journal, 35(4), 464-476.https://doi.org/10.1016/j.emj.2016.12.005.

[36] Gambardella, A., & Panico, C. (2014). On the management of open innovation. Research Policy, 43(5), 903-913.https://doi.org/10.1016/j.respol.2013.12.002.

[37] Lee, S. Y. (2008). Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives. Supply chain management: an international journal, 13(3), 185-198.https://doi.org/10.1108/13598540810871235.

[38] Correani, A., De Massis, A., Frattini, F., Petruzzelli, A. M., & Natalicchio, A. (2020). Implementing a digital strategy: Learning from the experience of three digital transformation projects. California management review, 62(4), 37-56.https://doi.org/10.1177/0008125620934864.

[39] Sellitto, M. A., Camfield, C. G., & Buzuku, S. (2020). Green innovation and competitive advantages in a furniture industrial cluster: A survey and structural model. Sustainable Production and Consumption, 23, 94-104.https://doi.org/10.1016/j.spc.2020.04.007.

Production and Consumption, 23, 94-104.https://doi.org/10.1016/j.spc.2020.04.007.

[42] Hagedoorn J, Lokshin B, Zobel A K.（2018）.Partner type diversity in alliance portfolios: Multiple dimensions, boundary conditions and firm innovation performance.Journal of

Management Studies,55 (5): 809-836. https://doi.org/10.1111/joms.12326.

[43] Cabanelas, P., Omil, J. C., & Vázquez, X. H. (2013). A methodology for the construction of dynamic capabilities in industrial networks: The role of border agents. Industrial Marketing Management, 42(6), 992-1003.http://dx.doi.org/10.1016/j.indmarman.2013.03.012.

[44] Bocken, N. M., & Short, S. W. (2016). Towards a sufficiency-driven business model: Experiences and opportunities. Environmental innovation and societal transitions, 18, 41-61.https://doi.org/10.1016/j.eist.2015.07.010.

[45] González-Moreno, Á., Triguero, Á., & Sáez-Martínez, F. J. (2019). Many or trusted partners for eco-innovation? The influence of breadth and depth of firms' knowledge network in the food sector.Technological Forecasting and Social Change, 147, 51-62.https://doi.org/10.1016/j.techfore.2019.06.011.

[46] Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. International journal of production economics, 111(2), 299-315.doi:10. 1016/j. ijpe. 2006. 11.030.

[47] Bitencourt, C. C., de Oliveira Santini, F., Zanandrea, G., Froehlich, C., & Ladeira, W. J. (2020). Empirical generalizations in eco-innovation: A meta-analytic approach. Journal of Cleaner Production, 245, 118721.https://doi.org/10.1016/j.jclepro.2019.118721.

[48] Amankwah‐Amoah, J. (2024). Leveraging business failure to drive eco‐innovation adoption: An integrated conceptual framework. Corporate Social Responsibility and Environmental Management, 31(2), 1354-1363. https://doi.org/10.1002/csr.2639.

[49] Kumar, S., & Malegeant, P. (2006). Strategic alliance in a closed-loop supply chain, a case of manufacturer and eco-non-profit organization. Technovation, 26(10), 1127-1135.https://doi.org/10.1016/j.technovation.2005.08.002.

[50] Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", Strategic Management fournal, Vol. 18 No. 7, pp. 509-533, available at: www. jstor.org/stable/3088148.

[51] Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. Organization science, 13(3), 339-351.https://doi.org/10.1287/orsc.13.3.339.2780.

[52] Helfat, C. E., & Raubitschek, R. S. (2018). Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. Research policy, 47(8), 1391-1399.https://doi.org/10.1016/j.respol.2018.01.019.

[53] Pisano, G. P. (2015). A normative theory of dynamic capabilities: connecting strategy, know-how, and competition. Harvard Business School Technology & Operations Mgt. Unit Working Paper, (16-036).http://dx.doi.org/10.2139/ssrn.2667018.

[54] Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. Administrative science quarterly, 35(1), 128-152.

[55] Zhang, J. A., & Walton, S. (2017). Eco‐innovation and business performance: the moderating effects of environmental orientation and resource commitment in green‐oriented SME s. R&D Management, 47(5), E26-E39. https://doi.org/10.1111/radm.12241.

[56] Perotti, F. A., Bargoni, A., De Bernardi, P., & Rozsa, Z. (2024). Fostering circular economy through open innovation: Insights from multiple case study. Business Ethics, the Environment & Responsibility.https://doi.org/10.1111/beer.12657.

[57] Qu, X., Khan, A., Yahya, S., Zafar, A. U., & Shahzad, M.(2022). Green core competencies to prompt green absorptive capacity and bolster green innovation: The moderating role of organization's green culture. Journal of Environmental Planning and Management, 65(3), 536-561. https://doi.org/10.1080/09640568.2021.1891029.

[58] Kline, R. B. (2023). Principles and practice of structural equation modeling. Guilford publications.

[59] Cohen, J. (2013). Statistical power analysis for the behavioral sciences. routledge.

[60] Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of marketing research, 18(1), 39-50.https://doi.org/10.1177/002224378101800104.

[61] Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. Journal of applied psychology, 88(5), 879.https://doi.org/10.1037/0021-9010.88.5.879.

[62] Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. Journal of the academy of marketing science, 16, 74-94.https://doi.org/10.1007/BF02723327.

[63] Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. Behavior research methods, instruments, & computers, 36, 717-731.https://doi.org/10.3758/BF03206553.

[64] Hayes, A. F. (2015). An index and test of linear moderated mediation. Multivariate behavioral research, 50(1), 1-22.https://doi.org/10.1080/00273171.2014.962683.

[65] Edwards, J. R., & Lambert, L. S. (2007). Methods for integrating moderation and mediation: a general analytical framework using moderated path analysis. Psychological methods, 12(1), 1.

[66] Teece, D. J. (2018). Business models and dynamic capabilities. Long range planning, 51(1), 40-49.http://dx.doi.org/10.1016/j.lrp.2017.06.007.

[67] Kiefer, C. P., Carrillo-Hermosilla, J., Del Río, P., & Barroso, F. J. C. (2017). Diversity of eco-innovations: A quantitative approach. Journal of cleaner production, 166, 1494-1506.https://doi.org/10.1016/j.jclepro.2017.07.241.

[68] Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. Journal of Business Research, 104, 380-392.https://doi.org/10.1016/j.jbusres.2019.06.027.

[69] Hoyle, R. H. (Ed.). (1995). Structural equation modeling: Concepts, issues, and applications. Sage.

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Appendix 1 Table 1 :
Sample Structure Characteristics and Questionnaire Collection Status Statistics Table

Feature Variable	Item Description	Distribution	Collection	Valid Samples	Invalid Samples	Recovery Rate
Industry Category	Electronic Equipment Manufacturing	460	221	225	13	48.04%
	Metal Products	353	177	161	10	50.14%
	Automotive Machinery	129	69	58	2	53.48%
	Textile and Apparel	101	73	71	2	72.27%
	Pharmaceutical and Chemical Engineering	77	43	41	2	55.84%
	Papermaking and Printing	68	32	31	2	48.52%
	Petroleum and Petrochemical Products	67	37	35	2	55.22%
	Logistics and Transportation	35	17	14	3	48.57%
	Food Processing and Manufacturing	29	15	11	2	51.72%
	Communication Equipment	22	11	9	2	50.00%
	Metallurgical Industry	21	11	9	2	52.38%
	Construction Industry	15	9	7	2	60.00%
	Other	13	9	7	2	69.23%
Total		1390	724	679	45	52.08%
Years Established	5 Years or Less	578	301	287	24	52.07%
	6-10 Years	272	142	129	13	52.20%
	11-15 Years	211	110	98	12	52.13%
	16-20 Years	132	68	74	5	51.51%
	21-25 Years	83	43	37	6	51.80%
	26-30 Years	47	25	23	2	53.19%
	31-35 Years	35	18	16	2	51.42%
	36-40 Years	19	10	9	1	52.63%
	Over 41 Years	13	7	6	1	53.84%
Total		1390	724	658	45	52.08%
Capital Amount	Less than 500,000	399	211	196	15	52.88%
	500,001-1,000,000	363	185	181	14	50.96%
	1,010,000-5,000,000	311	165	157	18	53.05%
	501-1,000,000	112	63	56	8	56.25%
	1,001-2,000,000	97	48	44	4	49.48%
	2,001-5,000,000	37	19	17	2	51.35%
	5,001-10,000,000	42	22	19	3	52.38%
	Over 100,000,000	29	11	9	2	37.93%
Total		1390	724	658	45	52.08%
Number of Employees	50 or Fewer	456	236	223	23	51.75%
	51-100 People	327	171	153	18	52.29%
	101-500 People	298	159	147	12	53.35%
	501-1000 People	143	73	79	4	51.04%
	1001-2000 People	71	35	31	4	49.29%
	2001-5000 People	30	17	16	2	56.66%
	5001-10000 People	47	23	21	2	48.93%
	Over 10,000 People	18	10	9	1	55.55%
Total		1390	724	679	45	52.08%
Total Samples		1390	724	679	45	52.008%