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SPECIAL ISSUE ARTICLE **OPEN ACCESS**

Go Green or Go Digital? A Set-Theoretic Perspective of Incumbents' Paths to Success

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ABSTRACT

In response to growing pressures for environmental sustainability and technological advancement, this study examines how firms can effectively integrate green and digital innovations within ambidextrous strategies to enhance performance. Using fuzzy-set Qualitative Comparative Analysis (fsQCA) on a sample of 175 German manufacturing and service firms, the study identifies configurations that balance exploration and exploitation with digital and green innovation initiatives in different operational contexts. The findings emphasize that success hinges not on isolated elements but on their strategic integration into a coherent innovation framework. High-performing firms in dynamic environments emphasize digital innovation, while those in stable settings prioritize green innovation, and both require alignment with the firm's underlying innovation strategy. However, success depends on firm-specific factors: Smaller firms benefit from specialized innovation strategies, while large firms, particularly manufacturing firms, achieve resilience by combining green and digital innovation. Service firms gain competitive advantage by adapting their innovation focus to environmental shifts. The study demonstrates that innovation effectiveness results from context-specific, integrated approaches rather than one-size-fits-all strategies.

1 | Introduction

Innovation is crucial for the survival and competitiveness of firms, particularly as they navigate increasingly dynamic environments shaped by rapid technological advancements and growing pressures for environmental sustainability. Thereby, integrating green and digital innovations has emerged as a critical aspect of modern business strategies (Cegarra-Navarro et al. 2019; Ghobakhloo et al. 2021). While green innovations respond to societal and regulatory demands for more sustainable business practices (Chen 2008; Schaltegger et al. 2016), digital innovations enable firms to leverage cutting-edge technologies to enhance operational efficiency and adapt to changing market demands (Ferreira et al. 2019; Li et al. 2024; Nambisan et al. 2017). This dual imperative has pushed firms to reconsider their innovation strategies and how they balance exploratory,

risk-taking activities aimed at future growth and exploitative, efficiency-focused, incremental improvements to sustain the current business (Benner and Tushman 2003; Cancela et al. 2023; Hoessler and Carbon 2023; March 1991), as the adoption of such innovations requires reconfiguring organizational capacity and routines to realize their full potential (Madsen and Brix 2025; Schneider and Kokshagina 2021).

Research has often examined green and digital innovation as separate research streams, limiting our understanding of how firms can integrate both within their broader innovation framework (Holotiuik et al. 2024; Martínez-Falcó et al. 2024). This knowledge gap is especially pressing as firms operate in dynamic environments where rapid technological advancements and growing sustainability demands converge (Annosi et al. 2020; Bähr and Fliaster 2023) and balancing exploratory

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and exploitative innovation activities is crucial to succeed in competitive, fast-paced markets (Birkinshaw and Gibson 2004; O'Reilly and Tushman 2013). These innovation strategies can support the effective implementation of green and digital innovations, helping firms adapt to shifting market demands and environmental challenges (Abbate et al. 2023; Cancela et al. 2023; Holotiuk et al. 2024). In addition, firm characteristics like size and industry type further influence innovation effectiveness, as industry-specific dynamics affect the feasibility and impact of innovations and larger firms often have better access to critical resources (Chandy and Tellis 2000; Ettl and Rosenthal 2011; Lavie et al. 2010).

The integration of digital and green innovations with exploratory and exploitative strategies remains underexplored in terms of how these efforts can be streamlined effectively. This study addresses this gap by answering the following research question: *How can firms integrate green and digital innovations within their innovation strategies to maximize financial performance in different operational contexts?* by applying a fuzzy-set qualitative comparative analysis (fsQCA) to a dataset of 175 German service and manufacturing firms. The findings contribute to the intersection of ambidexterity research and literature on sustainability management and digital transformation by examining how firms can align exploratory and exploitative innovation activities with emerging technological and environmental trends to enhance performance. By uncovering how firms configure these elements, the study provides both theoretical insights into the alignment of innovation strategies and practical guidance for managers and policymakers to navigate the twin challenges of digitalization and sustainability management. The findings reveal that there is no one-size-fits-all approach to innovation: High-performing firms follow distinct innovation pathways depending on their size, industry and environmental dynamics where both ambidextrous and specialized innovation strategies can lead to success. Moreover, digital innovation proves most effective in dynamic environments, whereas green innovation is particularly valuable in stable settings. However, firms that fail to integrate these innovation efforts into a broader strategic framework consistently underperform. The results underscore that innovation success hinges not on the presence of individual elements but on their strategic alignment, that is, the coherent fit between innovation strategy, innovation type and operational context. Firms must tailor their innovation strategies to ensure that their approach is not only internally coherent, but also responsive to external pressures and industry dynamics, which introduces a more context-sensitive view of innovation activities.

The next section introduces the configurational framework of this study, characterizing green and digital innovations and outlining their relationship with ambidextrous innovation activities, followed by the research methodology, describing data collection and mapping the key steps of the fsQCA. Subsequently, the results, structured around the findings summarized in the solution chart (Table 3), are presented and discussed. This is followed by conclusion, including theoretical contribution, practical recommendation, limitations and directions for future research.

2 | Theoretical Background

2.1 | Green Innovation: The Push for Environmental Sustainability

Green innovation, or eco-innovation, refers to innovations that reduce the environmental impact of products and processes by addressing issues such as energy efficiency, pollution prevention and sustainable resource management (Chen 2008). Green innovation encompasses diverse approaches, including changes in product design, production processes and business models. For example, firms may adopt eco-design principles, use renewable or nontoxic materials, recycle waste and reduce energy and water consumption to minimize their environmental footprint (Aguilera-Caracuel and Ortiz-de-Mandojana 2013; Schaltegger et al. 2016; Xie et al. 2019). Furthermore, green innovation plays a crucial role in shifting from linear production models towards circular economy principles, where resource efficiency, waste reductions and close-loop systems are prioritized to create sustainable value chains (Gupta et al. 2021; Perotti et al. 2025). Thus, the importance of green innovations is growing as firms face increasing scrutiny of their environmental impact through regulatory requirements or customer demands, positioning it as both a compliance necessity and a competitive advantage (Bocken et al. 2014; Ghobakhloo et al. 2021; Huang and Li 2017; Provasnek et al. 2017; Zameer et al. 2020). While green innovation clearly offers environmental benefits, its financial impact is more complex. On one hand, studies indicate that green innovation can boost differentiation and brand image, attract environmentally conscious customers, strengthen stakeholder relationships and lower operational costs through energy efficiency and waste reduction, all while ensuring regulatory compliance (Amato and Amato 2012; Chen 2008; Provasnek et al. 2017; Wong 2013; Woo et al. 2014; Xie et al. 2019). On the other hand, some studies point to potential downsides of green innovation, particularly concerning financial performance, due to high implementation costs and challenges in capturing its full value, as benefits often accrue to society rather than the firm (Aguilera-Caracuel and Ortiz-de-Mandojana 2013; De Azevedo Rezende et al. 2019; Marcus and Fremeth 2009). Consequently, firms must carefully balance sustainability initiatives and other business objectives to avoid financial drawbacks (Amato and Amato 2012; Woo et al. 2014). Empirical evidence suggests that green innovation can enhance profitability, but its effectiveness relies on alignment with an appropriate strategy (Singh et al. 2020; Yin and Wang 2024). To maximize the benefits of green innovation, firms must develop approaches that balance exploratory and exploitative innovation (Cancela et al. 2023; Martínez-Falcó et al. 2024; Shafique et al. 2021; Zhang and Zhu 2019). This balance, referred to as green ambidexterity, is a nascent area of research that explores how firms can adapt to changing environments while improving their sustainability practices through green innovation (Cegarra-Navarro et al. 2019; Martínez-Falcó et al. 2024; Wang et al. 2020).

2.2 | Digital Innovation: Navigating Technological Evolution

Digital innovations are reshaping industries and customer demands by introducing advanced digital technologies, such as

artificial intelligence, big data, blockchain, digital platforms and smart technologies (Ardito et al. 2019; Dąbrowska et al. 2022; Ghobakhloo et al. 2021). These technologies improve existing offerings and processes while also driving significant shifts in strategies and business models (Hoessler and Carbon 2023; Nambisan et al. 2017; Ritter and Pedersen 2020; Teece and Linden 2017; Van Knippenberg et al. 2015). Initially, the value of digital technologies was emphasized within manufacturing firms, where 'Industry 4.0' became synonymous with digital transformation (Ardito et al. 2019; Gupta et al. 2021). Today, digital innovation extends across multiple industries and has become a catalyst for business model innovation, especially in service sectors (Frank et al. 2019; Gregori and Holzmann 2020; Ritter and Pedersen 2020; Teece and Linden 2017), often unfolding through diverse patterns of implementation rather than a single trajectory (Artusi et al. 2025). Despite the promise of digital technologies that include enhanced efficiency, operational performance and, ultimately, profitability, challenges remain as firms often struggle to implement the operational and strategic adjustments necessary to fully realize the benefits of digital innovations (Annosi et al. 2020; Bauwens and Pantazis 2018; Ferreira et al. 2019). Digital technologies are often characterized as radical or disruptive, as they enable large-scale improvements for firms (Benbya et al. 2020; Fitzgerald et al. 2013). However, digital technologies will only unlock 'game-changing opportunities' (Sebastian et al. 2017, S. 197) when enabled by an appropriate organizational framework (Imran et al. 2021; Vial 2019). Moreover, not all activities related to digital innovation require exploration. Literature often overlooks the need for a differentiated perspective on ambidextrous activities (Hoessler and Carbon 2023). Incumbent firms must remain open to integrating new technologies into their innovation frameworks to stay competitive and resilient in today's fast-paced environments by pushing both exploratory and exploitative digitalization efforts (Holotiuk et al. 2024; Li et al. 2024). The full potential of digital technologies is still not fully understood and requires further research (Annosi et al. 2020; Hoessler and Carbon 2023; Schneider and Kokshagina 2021).

2.3 | Bridging Ambidexterity, Green and Digital Innovation

Ambidexterity is an organization's ability to manage exploratory and exploitative innovations simultaneously (March 1991). Exploitation focuses on refining existing products and processes through incremental activities, extending the current knowledge base and improving efficiencies to enhance short-term performance and defend established domains. Exploratory innovation refers to activities aimed at future growth, embracing search and experimentation for new possibilities and entering new markets (Benner and Tushman 2003; March 1991). Research indicates that ambidextrous organizations generally achieve higher performance in growth, innovation, survival and financial outcomes but may also encounter inefficiencies, duplicate efforts and higher organizational complexity and costs arising from inherent tensions (Hansen et al. 2019; Levinthal and March 1993; Van Looy et al. 2005). Balancing exploration and exploitation, either simultaneously or through punctuated equilibrium, is essential, as overemphasizing one can lead to inefficiency or stagnation (Benner and Tushman 2003; Gupta

et al. 2006; March 1991). Firms overemphasizing exploitation may struggle to adapt to environmental changes, while those overfocusing exploration risk inefficiency and resource depletion (Birkinshaw and Gibson 2004; Hansen et al. 2019; O'Reilly and Tushman 2013; Uotila 2018). However, empirical evidence suggests that specializing in either exploration or exploitation can also enhance performance (Ciasullo et al. 2020; Solís-Molina et al. 2018; Wenke et al. 2021; Zhang and Zhu 2019). Some firms may benefit from focusing resources on exploitation to strengthen established advantages, while for others, an 'explorative push' (Cancela et al. 2023, 3081) may be essential to gain a foothold in new markets (Katou et al. 2021). Nonetheless, specialization strategies have potential downsides, such as increased R&D costs and higher risks associated with exploration, and danger of competency traps or organizational inertia from overreliance on exploitation (Levinthal and March 1993; Yin and Wang 2024).

While ambidexterity can be operationalized through various organizational design mechanisms, most notably as structural ambidexterity, where firms structurally separate exploratory and exploitative activities into distinct organizational units, and contextual ambidexterity, where individuals dynamically alternate between modes (O'Reilly and Tushman 2013), it can also be conceptualized as firm-level orientation towards innovation (Gupta et al. 2006; Raisch and Birkinshaw 2008). In this vein, exploration and exploitation represent distinct strategic approaches that help frame the organizational setting for innovation (Hansen et al. 2019; O'Reilly and Tushman 2013). Conceptualizing them as strategic orientation, rather than organizational design mechanisms, underscores their relevance for aligning innovation with contextual demands and the original understanding of ambidexterity as an organizational capability to managing competing demands (O'Reilly and Tushman 2013). This perspective is particularly relevant for firms integrating green and digital innovations in dynamic environments, where they face growing pressures to adapt to regulatory requirements, technological advancements and shifting customer expectations (Cegarra-Sánchez et al. 2020; Martínez-Falcó et al. 2024). Ambidextrous organizations are generally more agile and better equipped to navigate that twin challenge if they succeed in creating synergies across divergent innovation paths (Cegarra-Sánchez et al. 2020; Van Looy et al. 2005). Recent studies also show that firms managing both green and digital innovations perform better in dynamic environments, especially when aligned with ambidextrous strategies (Cancela et al. 2023; Yin and Wang 2024). Green innovation often necessitates exploratory actions, such as developing new technologies for pollution control and renewable energies. However, it also involves exploitative efforts, such as optimizing existing processes to improve energy efficiency (Lee and Raschke 2020; Woo et al. 2014). Similarly, digital innovation requires firms to explore new technological frontiers while simultaneously exploiting existing systems to enhance efficiency and decision-making (Ghobakhloo et al. 2021).

Organizational learning is vital for making internal adjustments and building the resources and capabilities required for digital and green innovation in exploratory and exploitative innovation processes (De Moura and Saroli 2021; Holotiuk et al. 2024; Levinthal and March 1993; Zhang and Zhu 2019). Firms must effectively apply knowledge across both exploration

and exploitation activities to fully leverage green and digital innovations (Hoessler and Carbon 2023; Kumar et al. 2021). The acquisition of new knowledge through learning is key for both exploratory and exploitative innovation, yet they represent two distinct learning modes that require different resources and capabilities (Gupta et al. 2006; Levinthal and March 1993). Moreover, different organizational setups are required for exploration and exploitation, adding complexity to the strategic alignment of innovation activities (Ciasullo et al. 2020). Thus, firms must develop differentiated innovation strategies that ensure their digital and green innovation efforts align with their organizational objectives and context to unlock their full potential (Birkinshaw and Gibson 2004; Hoessler and Carbon 2023). Digital or green innovation can act as catalysts, accelerating both exploratory and exploitative learning within firms (Holotiuk et al. 2024; Shafique et al. 2021). However, integrating green and digital innovations within an ambidextrous framework presents both challenges and opportunities. They often share common goals, such as improving sustainability and efficiency (Abbate et al. 2023; Ardito 2023; Bähr and Fliaster 2023). Paradoxically, they require different capabilities and resources (Annosi et al. 2020; Zhang and Zhu 2019), making it difficult for firms to pursue both simultaneously. For instance, green innovation often requires long-term investments, whereas digital innovation demands more immediate capital allocation for advanced technology infrastructure (Ghobakhloo et al. 2021). To successfully implement green and digital innovations, firms must either adapt their existing resources and capabilities to enhance current products and technologies along established pathways or develop new ones to explore entirely new trajectories (Chang et al. 2011; Gupta et al. 2006; Huang and Li 2017; Peters and Buijs 2022; Yin and Wang 2024). In conclusion, firms adapt to evolving environmental demands and technological advancements through exploration and exploitation. Ambidexterity, therefore, plays a crucial role in enabling firms to integrate green and digital innovations within their broader innovation strategies. Research on ambidexterity, sustainability management and digitalization has progressed, yet more work is needed to understand how green and digital innovation trends can be integrated into ambidextrous innovation strategies. While there is consensus on the need for strategic alignment, how to achieve this integration remains unclear (Ghobakhloo et al. 2021; Smith and Beretta 2021).

Lastly, innovation outcomes also depend on operational context, making it crucial to include contextual conditions (Shafique et al. 2021). Firstly, *firm size* affects ambidexterity and its impact on performance. Results, however, are inconsistent. On the one hand, large firms are better equipped with resources than smaller firms, which often face resource constraints limiting their ability to invest in innovation (Horváth and Szabó 2019; Wenke et al. 2021). On the other hand, large firms are less flexible and more prone to inertia which can hinder strategic adaptation (Chandy and Tellis 2000; Chang et al. 2011; De Massis et al. 2018; Jansen, Tempelaar, et al. 2009; Lavie et al. 2010). Moreover, large firms face different driving forces and barriers regarding digital innovation as SMEs and have generally received more attention in sustainability literature (Andersen et al. 2022; Bocken et al. 2014; Horváth and Szabó 2019; Passaro et al. 2023). Secondly, *industry type* influences innovation behaviour and its impact on financial performance (Andriopoulos

and Lewis 2009; Blindenbach-Driessen and Van Den Ende 2014). Manufacturing and service firms exhibit distinct approaches to innovation and ambidexterity (Ettlie and Rosenthal 2011; Geerts et al. 2010). Sustainable innovation has primarily been studied in manufacturing firms, with less attention on service firms (Dangelico 2016; Karimi Takalo et al. 2021), highlighting a gap in understanding how they approach green innovation. Lastly, *environmental dynamics* have been linked to ambidexterity. Dynamic environments shaped by rapid technological advancements and growing pressures for environmental sustainability demand more adaptive innovation strategies, influencing both financial performance and the balance between exploration and exploitation (Haefner et al. 2023; Jansen et al. 2006, 2009; Lakemond and Detterfelt 2013; Lavie et al. 2010).

3 | Method

3.1 | Research Approach

fsQCA, a set-theoretic method that examines cases as combinations of causal conditions and outcome (Meuer 2014), was chosen for this study because it is well-suited for analysing causal relationships where multiple factors interact to influence an outcome. Unlike regression-based methods, which assume linear effects, fsQCA allows for configurational analysis, making it ideal for understanding how firms combine exploration and exploitation strategies with green and digital innovation under varying contextual conditions to achieve high performance (Fiss 2011; Misangyi et al. 2017).

Three foundational assumptions underpin this configurational approach (Fiss et al. 2013; Misangyi et al. 2017; Ragin 2008): First, fsQCA emphasizes ‘causal recipes,’ meaning that the focus is on identifying combinations of conditions that produce the outcome in conjunction. Second, equifinality implies that different combinations of conditions can lead to the same outcome through multiple causal pathways. Third, asymmetric causation suggests that while a certain configuration can predict the presence of the outcome, the negation does not necessarily predict its absence. The approach, therefore, identifies multiple configurations of causal conditions that consistently result in the presence or absence of a specific outcome (Fiss 2011; Ragin 2008). To derive configurations of causal conditions that lead to the outcome of interest, fsQCA focuses on set memberships. Grounded in Boolean algebra, fsQCA analyses subset relationships between causal conditions and the desired outcome, using logical operators to describe these set relationships (Ragin 2008). Critical steps in any fsQCA include calibration, examination of necessary and sufficient conditions, truth table analysis and robustness checks (Greckhamer, Furnari, et al. 2018).

Assuming that firms follow distinct pathways to succeed with their innovation strategies, fsQCA’s equifinality principle is particularly relevant, as it enables the identification of multiple causal pathways leading to high (or low) performance. The asymmetric nature of fsQCA allows for examining both high and low performance, recognizing that the absence of a certain condition does not necessarily imply failure (Fiss 2011). In the context of innovation management, where success rarely depends on isolated variables, fsQCA has proven

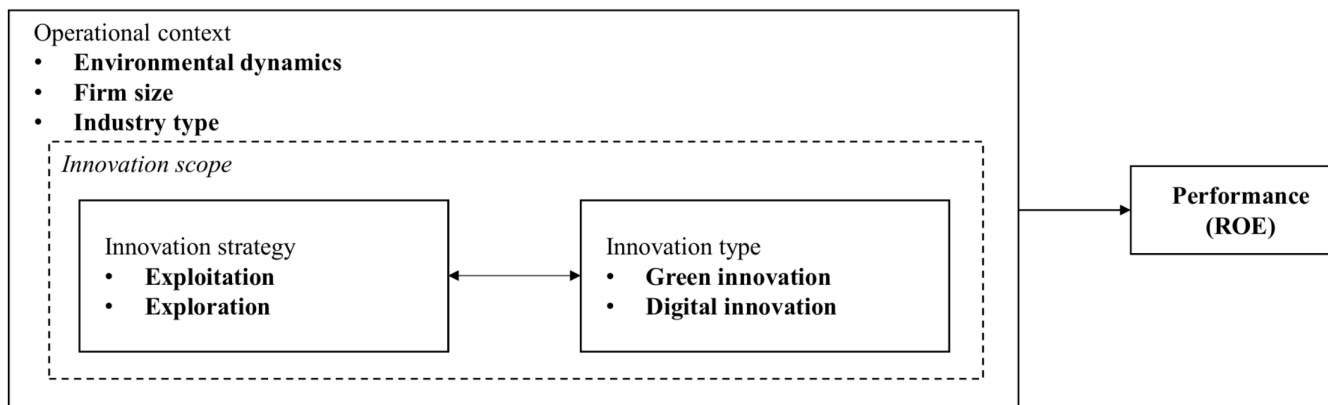


FIGURE 1 | Research framework.

particularly useful for capturing such complexity (Løbner and Goduscheit 2022) and is well suited for analyzing equifinal patterns of implementing certain innovation initiatives (Artusi et al. 2025). Instead of treating all variables as equal contributors, fsQCA allows for differentiation between core, peripheral and irrelevant conditions in configurations. This distinction is key for understanding the varying roles conditions play in producing the outcome (Fiss 2011; Misangyi et al. 2017). Therefore, fsQCA can provide a nuanced understanding of how firms configure their innovation approaches, making it an appropriate method for capturing the interplay between innovation strategy, innovation type and contextual conditions such as firm size, industry type and environmental dynamics in shaping financial outcomes. The configurational framework is presented in Figure 1.

3.2 | Sampling and Data Collection

Selecting relevant cases is crucial to ensure a comprehensive understanding of outcomes (Greckhamer, Furnari, et al. 2018). The sample includes small (10–49 employees), medium-sized (50–249 employees) and large (≥ 250 employees) manufacturing (SIC 2 and 3) and service firms (SIC 6 and 7), sourced from a German business database (Bisnode). Sampling from this database allows to combine survey data from a questionnaire with archival data from public sources (Bundesanzeiger). While fsQCA is often associated with small-N studies, larger sample sizes enhance the robustness and generalizability of findings and enable the inclusion of more causal conditions in the analysis, facilitating a more nuanced understanding of the phenomena under study (Greckhamer, Misangyi, et al. 2013). The initial sample consisted of 1688 firms, whose CEOs were contacted via personalized email invitations in spring 2024. Follow-up reminders were sent after 1 week and 1 month, yielding 180 responses, which corresponds to an 11% response rate and is consistent with surveys targeting top managers (e.g., Fiss 2011; Haefner et al. 2023; Kammerlander et al. 2015). Missing values were not imputed to avoid introducing bias, and the analysis proceeded with the 175 valid cases. The final sample contains 103 (59%) manufacturing firms and 72 (41%) service firms. Eleven (6%) of those are small, 79 (45%) are medium-sized and 85 (49%) are large firms. The questionnaire and measurement items have been discussed with peer researchers and practitioners in advance. First, information

on the respondents' position and role within the firm was collected to confirm their suitability for providing reliable information. Next, the standardized questionnaire addressed innovation activities (exploration and exploitation) and environmental dynamics. Finally, the questionnaire captured data on the extent of implementation of green and digital innovation within the firm.

3.3 | Measures and Calibration

To conduct the analysis, the empirical data are transformed into fuzzy sets using the direct method of calibration. This method involves setting a crossover point of maximum ambiguity, along with anchors that indicate full membership and nonmembership (Fiss 2011; Ragin 2008). The resulting Boolean membership scores range from 0 to 1, reflecting the degree to which each case belongs to the set of interest (Misangyi et al. 2017). The calibration thresholds applied in this transformation are detailed in the following subchapter and summarized in Table 1, alongside measurement, descriptive statistics and correlations of each condition.

3.3.1 | Outcome Condition: Return on Equity

Return on equity (ROE) was used as a measure to assess firm performance. ROE reflects a firm's ability to generate profits, serving as an indicator of both profitability and resource efficiency (Haefner et al. 2023). This is consistent with innovation literature, highlighting the significance of evaluating firm efficiency in assessing performance (Haefner et al. 2023; Raisch and Birkinshaw 2008). The data for calculating ROE were sourced from archival data obtained from public databases (Bundesanzeiger, Bisnode). While a positive ROE indicates profitability, it does not necessarily imply high overall performance (Haefner et al. 2023). Therefore, to establish meaningful calibration thresholds for ROE, calibration thresholds were benchmarked against firms listed in the German DAX (Fiss 2011; Misangyi and Acharya 2014; Ragin 2008; Rubinson et al. 2019). The 10-year average ROE for DAX-listed firms was approximately 10%. Consistent with the recommendation of Fiss (2011), the threshold for *fully out* the set of high-performing firms is set for firms that show average or below average performance (10%). The 75th percentile of the ROE distribution, corresponding

TABLE 1 | Measurements, calibration thresholds, descriptive statistics and correlations of conditions.

Condition	Calibration thresholds			Descriptive statistics							Correlations						
	Fully out	Crossover	Fully in	Min.	Max.	Mean	SD	1	2	3	4	5	6	7			
1. Performance	10	13	16	-66.30	84.29	14.69	23.67										
2. Exploitation	4	5.5	7	2	7	5.71	0.9	0.048									
3. Exploration	2	4.001	6.5	1	7	4.48	1.4	0.084	0.319***								
4. Green innovation	3	5.001	7	2	7	5.34	1.36	0.081	0.146	0.210**							
5. Digital innovation	3	5.001	8	1	8	5.88	1.97	0.161*	0.132	0.371***	0.349***						
6. Environmental dynamics	3	5.001	8	1	8	5.2	2.13	0.070	0.088	0.424***	0.135	0.348***					
7. Firm size	49	149.5	250	11	44,550	2045.85	5781.35	0.129	0.065	0.287***	0.53	0.187*	0.090				
8. Industry type	0	n/a	1	0	1	0.59	0.49	0.055	0.102	0.191*	0.172*	0.006	-0.110	0.039			

^a Assessed from standardized questionnaire.

^b Assessed from database records.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

to 16%, was used to define the threshold for *fully in* the set of high-performing firms. The midpoint of 13% was set as crossover point, marking the threshold where firms transition between being 'out' and 'in' the set of high-performing firms. The inverted thresholds used for high performance were applied to identify configurations that consistently drive firms into the set of low performers (Fiss 2011; Misangyi and Acharya 2014).

3.3.2 | Antecedent Conditions

Exploitation, exploration and dynamic environment were measured using three-item measures based on the original work of Jansen et al. (2006, 2009) and Haefner et al. (2023). Specifically, each construct—exploitation, exploration and environmental dynamics—was measured using three questionnaire items on a seven-point Likert scale (ranging from 1 = 'completely disagree' to 7 = 'completely agree') (Table 2). For each respondent, a single representative value for each construct was obtained by calculating the mean of the three corresponding items. This procedure is consistent with prior research, where composite constructs are formed by averaging multiple items and the resulting composite scores serve as the basis for the calibration process of each multi-item construct (Fiss 2011; Haefner et al. 2023). To ensure the robustness of this approach, reliability and validity of constructs is tested by calculating Cronbach's alpha, composite reliability (CR) and average variance extracted (AVE), all of which exceeded recommended thresholds and confirm high internal consistency (Bagozzi and Yi 1988) and are detailed in Table 2. Additionally, Heterotrait-monotrait (HTMT) values, ranging between 0.460 and 0.151, indicate good discriminant validity of constructs (Henseler et al. 2015).

Calibration anchors for exploitation, exploration and environmental dynamics were determined based on theoretical and empirical considerations (Fiss 2011; Ragin 2008; C. Q. Schneider and Wagemann 2012). These constructs differ in their level of tangibility and frequency in business operations, which influences how respondents perceive and assess them. Aligning the calibration thresholds with the conceptual nature of each construct, ensures meaningful differentiation between firms with varying strategic orientations and operating under different environmental dynamics (Fiss 2011). For instance, *exploitation* is associated with refinement and efficiency improvements in existing processes, making it more embedded in everyday business routines (Gupta et al. 2006; Lavie et al. 2010). These activities are often well-structured and routine, making them more concrete and easily identifiable for respondents. As a result, they tend to report higher values for exploitation, leading to a response distribution that is concentrated in the upper range of the scale. To reflect this, the crossover point is set at 5.5, capturing firms that engage in process refinement and efficiency improvements but do not fully rely on exploitation. *Exploration*, in contrast, is inherently future-oriented and risk-intensive, involving activities such as entering new markets or developing breakthrough innovations. Because these efforts are less frequent, respondents perceive them as more abstract, resulting in a tendency for lower reported values. The crossover point at 4.001 reflects firms that experiment with exploratory activities but have not fully committed to an exploration-driven strategy, representing the point of maximum ambiguity towards exploratory innovation.

TABLE 2 | Construct specifications and item loadings.

Construct	Paraphrased questionnaire items	Load	M	SD
Exploitation				
(AVE = 0.55 CR = 0.78 α = 0.63)	Ext_1: Implementation of small adaptations to existing products and services	0.84	5.57	1.28
	Ext_2: Introduction of improved, but existing products and services	0.651	5.65	1.29
	Ext_3: Improvement in efficiency of product and service provision	0.725	5.92	1.02
Exploration				
(AVE = 0.64 CR = 0.84 α = 0.80)	Exr_1: Experimentation with new products and services	0.772	4.85	1.6
	Exr_2: Commercialization of products and services that are completely new to firm	0.84	3.93	1.73
	Exr_3: Enter new technology fields	0.782	4.66	1.65
Environmental dynamics				
(AVE = 0.76 CR = 0.90 α = 0.87)	Env_1: Technology in industry is changing rapidly in the past couple of years	0.856	4.8	1.62
	Env_2: Technology is important change driver in industry	0.893	5.29	1.56
	Env_3: Firm needs to closely observe technological environment to remain competitive	0.863	5.83	1.24

Abbreviations: α = Cronbach's α ; AVE = average variance extracted; CR = composite reliability.

Environmental dynamics reflect the degree of market turbulence and environmental uncertainty firms face. While some firms operate in relatively stable conditions, others experience rapid changes in customer demand, technology and regulations (Jansen, Van Den Bosch, et al. 2006). Similar to exploitation, dynamic market conditions are often viewed as a constant in

strategic decision-making (Eisenhardt and Martin 2000), which explains the concentration of responses in the upper range of the scale. The crossover point at 5.001 reflects firms experiencing moderate environmental dynamics, marking the threshold of maximum ambiguity between firms operating in relatively stable market conditions and those navigating volatile, dynamic environments.

The extents of the implementation of *green* and *digital innovation* were assessed on an eight-point Likert scale ranging from 1 ('no experience') to 8 ('broad application') each. The crossover point was set at 5 ('pilot projects'), representing the point of maximum ambiguity where firms potentially decide on their transition from initial experimentation to full-scale implementation, depending on key learnings derived from the pilot phase (Cegarra-Sánchez et al. 2020; Kong et al. 2016).

Information on *firm size* and *industry type* was gathered from database records. *Firm size* was measured by number of fulltime employees (Chandy and Tellis 2000; Fiss 2011). Specifically, a threshold of 250 employees was set to mark full membership, representing large firms, while firms with fewer than 50 employees were classified as fully out of the set of large firms, representing small firms. The crossover point was established at 150 employees, reflecting the midpoint between large and small firms. *Industry type* was calibrated as a crisp set, where 0 represents service firms and 1 denotes manufacturing firms.

3.4 | Data Analysis

The data analysis was conducted using R Studio (Version 4.3.3) to identify configurations of causal conditions that consistently lead to the outcome of interest (Fiss 2011; Ragin 2008). The method distinguishes between two types of causal conditions: necessary and sufficient conditions (Fiss 2011; Ragin 2008). A condition is considered necessary if it is present in nearly all cases where the outcome occurs, but its presence does not guarantee the outcome. In contrast, a condition is deemed sufficient if its presence ensures the outcome, even though the outcome can occur without the condition being present (Greckhamer, Misangyi, et al. 2013). To evaluate necessity and sufficiency, QCA relies on the set-theoretic measures of consistency, which reflects how well a subset relationship holds across cases, and coverage, which indicates the empirical relevance of a configuration. For necessity, a consistency threshold above 0.9 is recommended, with a high coverage measure to validate its empirical significance. For sufficiency, the consistency threshold should exceed 0.8 (Greckhamer, Furnari, et al. 2018; Ragin 2008; C. Q. Schneider and Wagemann 2012). In this analysis, neither the presence nor absence of any individual condition exceeded the established thresholds for sufficiency, and no single condition or combination of conditions was found to be necessary.

To conduct the set-theoretic analysis, a truth table was constructed to display all possible combinations of causal conditions in the model. With seven causal conditions, this resulted in $2^7=128$ combinations. A consistency threshold of 0.8 and a PRI cutoff of 0.7 were applied to retain only causally relevant configurations (Fiss 2011; Greckhamer, Furnari, et al. 2018). Given the sample size of 175 cases, the frequency threshold was set to 3 to balance

excluding irrelevant configurations while maintaining sufficient diversity (Greckhamer, Misangyi, et al. 2013). Two solutions are generated from the refined truth table: intermediate and parsimonious. Comparing these helps identify core conditions, which are essential for explaining the outcome, and peripheral conditions, which support but have a weaker causal impact (Fiss 2011).

Lastly, literature emphasizes the importance of assessing the robustness of the calibration process and solution paths (Fiss 2011; Greckhamer, Furnari, et al. 2018). The analysis was rerun with different thresholds for refining the truth table, adjusting the consistency threshold from the standard 0.8 to 0.75 and 0.85, respectively. Then, the frequency threshold was lowered from 3 to 2. Lastly, the calibration anchors for the outcome variable were modified to test sensitivity to different thresholds. Specifically, ROE data were recalibrated using the 0.95, 0.5 and 0.05 quantiles, as recommended in case meaningful thresholds are lacking (Fiss 2011; Ragin 2008). These tests resulted in only minor variations in the identified configurations, confirming that the overall findings are robust across different calibration methods.

4 | Results

Table 3 visually depicts the solution paths that consistently lead to the outcome of interest and reports consistency and coverage values for each configuration and the overall solutions. All identified configurations exhibit acceptable consistency values above 0.8, confirming robust relationships between conditions and outcomes, supporting the reliability of the findings, as well as the assumption of equifinality inherent to QCA (Fiss 2011; Greckhamer, Furnari, et al. 2018). Unique coverage values highlight the relative contribution of each path to achieving high or low ROE. This helps understand each configuration's distinct impact on the outcome (Fiss 2011; Ragin 2008).

4.1 | Configurations Leading to High Performance

The analysis identifies five core configurations that are sufficient for achieving high ROE. Considering the specific firm context, these configurations capture how firms can successfully align exploitative and exploratory innovation with integrating green and digital innovations.

Configuration 1 (C1), labelled Dual trailblazer, refers to manufacturing firms operating in dynamic environments. These firms adopt an exploration strategy to navigate their fast-paced environments. C1 firms focus primarily on digital innovation, which enables them to stay ahead in rapidly evolving technological landscapes. At the same time, green innovations complement their innovation approach, helping them to address environmental concerns. Their ability to balance cutting-edge technology with sustainability positions them as trailblazers in the manufacturing sector. Given the resource intensity of this approach, C1 firms are typically large in size.

Configuration 2 (C2), labelled as Tech Adventurer, applies to small firms operating in dynamic environments, regardless of industry type. These firms pursue a specialization strategy with

TABLE 3 | Solution chart.

	High performance					Low performance			
	C1 Dual Trailblazer	C2 Tech Adventurer	C3a Digital Defender	C3b Green Guardian	C4 Dual Defender	C5 Dual Champion	C6 Lost Explorer	C7 Digital Straggler	C8 Green Misfit
Innovation strategy									
Exploitation	⊗	⊗	●	●	●	●	⊗	●	⊗
Exploration	●	●	⊗	⊗	⊗	●	●	●	⊗
Innovation type									
Green innovation	●	⊗	⊗	●	●	●	⊗	⊗	●
Digital innovation	●	●	●	⊗	●	●	⊗	●	⊗
Operational context									
Environmental dynamics	●	●	●	⊗	⊗	⊗	⊗	⊗	●
Firm size	●	⊗	⊗	⊗	⊗	●	⊗	⊗	●
Industry type	●	●	⊗	⊗	●	●	●	⊗	●
Consistency	0.87	0.85	0.97	0.92	0.94	0.92	0.8	0.83	0.83
Raw Coverage	0.14	0.16	0.08	0.05	0.09	0.13	0.34	0.16	0.01
Unique Coverage	0.06	0.11	0.03	0.01	0.02	0.03	0.18	0.1	0.01
Overall Solution Consistency						0.87		0.8	
Overall Solution Coverage						0.42		0.37	

Note: Black circles indicate the presence of a condition, and circles with 'x' indicate its absence. Large circles indicate core conditions; small ones peripheral conditions. Blank spaces indicate 'do not care' (based on Fiss 2011).

a strong focus on exploration. Unlike larger firms in C1 (Dual Trailblazer), Tech Adventurers concentrate their resources solely on digital innovation, allowing them to adapt quickly to changing market conditions and maintain their competitiveness in dynamic environments. This targeted approach to digital transformation enables Tech Adventurers to explore cutting-edge technologies and pursue new opportunities, allowing them to stay ahead of technological trends and continuously innovate in fast-paced markets.

Configuration 3 (C3) refers to service firms that follow a specialization strategy focused on exploitation. C3 has two subsolutions that differ in peripheral conditions regarding innovation type and environmental context. Configuration 3b (C3b), labelled as Green Guardians, includes service firms in stable environments prioritizing green innovation to refine and improve their business. This approach works for service firms regardless of size and is well-suited to stable environments. The incremental improvements work towards meeting customer demands and regulatory compliance by 'greening' the core business. Configuration 3a (C3a), Digital Defenders, on the other hand, are operating in dynamic environments. Under these circumstances, small firms shift their focus to digital innovation. These firms exploit digital technologies to optimize their operational efficiency and defend their market position by focusing on digital solutions that enhance efficiency. Though they do not invest in green innovation, Digital Defenders leverage their available resources effectively to enhance their technological readiness, enabling them to adapt to changing environments.

Configuration 4 (C4), labelled Dual Defender, involves small manufacturing firms in stable environments. These firms succeed by employing a specialization strategy focused on exploitative innovation, combining both digital and green innovation initiatives. Despite being smaller in size, Dual Defender firms

manage to invest into both digital and green innovation initiatives. Operating in rather stable markets allows them to adopt this calculated approach to improve both operational efficiency and environmental impact without the need for significant risk-taking. As these firms adapt to increasing sustainability awareness and digitalization trends within stable market conditions, their ability to enhance both digital and green innovations ensures steady and reliable performance.

Configuration 5 (C5), labelled the Dual Champion, applies to large manufacturing firms operating in stable environments that successfully balance exploration and exploitation through an ambidextrous strategy. They prioritize digital innovation as a key driver of operational efficiency and competitiveness, while simultaneously developing green innovation capabilities to meet sustainability goals and regulatory demands, investing significantly in building and sustaining both digital and sustainability capabilities. By continuously exploring new frontiers and exploiting existing resources, these firms maintain operational efficiency and ensure ongoing innovation, allowing them to thrive in stable environments. This seamless integration of exploratory and exploitative activities across both digital and green innovations enables C5 firms to achieve high performance and maintain a competitive edge, positioning them as leaders in their industry.

4.2 | Configurations Leading to Low Performance

The analysis of the inverted outcome identified three core configurations that consistently lead to low ROE. Configuration 6 (C6), labelled Lost Explorer, primarily applies to manufacturing firms operating in stable environments. The core conditions show a heavy reliance on exploration, but with no investments made in either green or digital innovations. Exploitative innovation is

absent, limiting their ability to capitalize on existing processes or resources. This lack of balance in innovation activities leaves C6 firms with limited potential for growth or performance improvement in otherwise stable market conditions.

Configuration 7 (C7), labelled Digital Straggler, primarily applies to small service firms operating in stable environments. The core conditions show that these firms focus on digital innovation but do not implement green innovation. While both exploration and exploitation strategies are present as peripheral conditions, the emphasis on digital innovation without integrating green initiatives limits their ability to adapt to increasing sustainability demands. In the context of stable environments, the absence of green innovation, combined with reliance on digital innovation, leads to low performance for these firms, despite efforts to balance innovation strategies.

Configuration 8 (C8), labelled Green Misfit, applies to large manufacturing firms operating in dynamic environments. The core conditions reveal the absence of both exploration and exploitation strategies, leaving these firms without strategic guidance to navigate their rapidly changing environments. Although they invest into green innovation, their effort is not anchored in a coherent strategy, making it difficult for the firms to leverage these green initiatives effectively. Additionally, these firms do not invest into digital innovation, further limiting their ability to adapt to technological advancements. As a result, C8 firms struggle as their innovation initiatives lack a strategic framework.

4.3 | Discussion of Results

The findings reveal that successful strategies require either exploration or exploitation, or a combination of both, and that an emphasis on either digital or green innovation, or both, must complete this focus. Firms that lack this alignment, such as those pursuing exploration without investments in digital or green innovation (C6—Lost Explorer), or those that invest in green innovation without a strategic framework (C8—Green Misfit), consistently show poor performance.

The findings further reveal a clear pattern in aligning innovation types with environmental conditions: in dynamic environments, digital innovation is essential in high-performing configurations, while in stable environments all high-performing configurations display an emphasis on green innovation. Interestingly, the configurations associated with low performance show an inverse pattern: firms in stable environments neglect green innovation (C6—Lost Explorer, C7—Digital Straggler), while those in dynamic environments emphasize green over digital innovations (C8—Green Misfit).

The findings also highlight differences in how manufacturing and service firms approach innovation. Service firms demonstrate a distinct trade-off between green and digital innovation based on dynamics in their environments: Even in dynamic environments, service firms succeed by focusing on exploitative strategies when prioritizing digital innovation to maintain competitive advantage (C3a—Digital Defender). However, in stable environments, service firms, particularly small ones, shift towards green innovation to differentiate their business from

competitors (C3b—Green Guardian). This adaptability of high-performing service firms emphasizes the crucial role of environmental dynamics in shaping their innovation strategies. In contrast, manufacturing firm's simultaneous pursuit of digital and green innovations proves essential for success across different environmental settings (C1—Dual Trailblazer, C4—Dual Defender, C5—Dual Champion), while failure to do so leads to low performance (C6—Lost Explorer, C8—Green Misfit).

Finally, the findings highlight the role of firm size in shaping innovation approaches. Small firms achieve better performance outcomes when they commit their resources to specialized innovation strategies and prioritize either digital or green innovation (C2—Tech Adventurer, C3a—Digital Defender, C3b—Green Guardian as opposed to C6—Lost Explorer, C7—Digital Straggler). An exception are small firms adopting an exploitative strategy in stable environments (C4—Dual Defender). This configuration suggests that in the absence of dynamic environments and uncertainty, small firms can leverage this predictability of familiar business settings to broaden their innovation scope and pursue both digital and green innovations to enhance existing business practices. However, in rather stable environments refining the core business through green innovation proves particularly advantageous (C3b—Green Guardian; C4—Dual Defender). In dynamic environments, however, small firms succeed by directing their limited resources towards digital innovation to stay agile and competitive (C2—Tech Adventurer, C3a—Digital Defender).

Notably, regardless of size, exploration strategies should be pursued primarily in dynamic settings, where environmental conditions demand rapid adaptation (C1—Dual Trailblaze, C2—Tech Adventurer as opposed to C6—Lost Explorer). When operating in stable environments, green innovation combined with an exploitative strategy proves effective, even without the presence of digital innovation (C3b—Green Guardian). While green innovation is a constant in all high-performing configurations for large firms (C1—Dual Trailblazer, C3b—Green Guardian, C5—Dual Champion), large firms also find that green innovation without strategic direction results in low performance (C8—Green Misfit). This suggests that green innovation, while valuable, requires integration into a broader strategic framework to be effective. Digital innovation, on the other hand, plays a critical role for large firms engaging in exploratory or ambidextrous strategies (C1—Dual Trailblazer, C5—Dual Champion), emphasizing the importance of digital readiness for large firms. However, large firms apparently benefit from dual innovation approaches that integrate both digital and green innovation to maintain high performance (C1—Dual Trailblazer, C5—Dual Champion), while failure to adopt this dual focus can lead to poor performance (C6—Lost Explorer, C8—Green Misfit).

5 | Conclusions

Innovation, long recognized as essential for competitive advantage and growth (Benner and Tushman 2003; Lavie et al. 2010; March 1991), has gained renewed focus as firms face the dual pressures of digitalization and sustainability. Drawing on a configurational approach, the study examines how firms align green and digital innovation efforts with exploration and exploitation

strategies to enhance financial performance across different organizational settings. The findings highlight that both ambidextrous and specialized innovation strategies can be effective for integrating green and digital innovation initiatives, depending on firm-specific characteristics such as size and industry type, as well as environmental dynamics. Rather than the presence or absence of individual innovation elements, it is their strategic alignment—the coherent fit between innovation strategy, innovation type and contextual factors—that determines success. Firms lacking such alignment consistently underperform, underlining the importance of a context-sensitive and strategically integrated approach to innovation.

5.1 | Theoretical Contribution

The theoretical contribution lies at the intersection of ambidexterity theory and research on sustainability management and digital transformation, providing novel insights into how firms can respond to the twin challenge of innovation by aligning exploration and exploitation strategies with green and digital innovation. Unlike prior studies, that often treat these elements separately, this research takes a configurational perspective to uncover multiple pathways that lead to either success or failure. Table 4 summarizes the contributions and explains their underlying mechanisms.

Firstly, this study advances literature on ambidexterity theory by demonstrating that the effectiveness of innovation strategies depends on the coherent alignment of exploration and exploitation with operational context. Prior research emphasizes the benefits of balancing exploration and exploitation (Birkinshaw and Gibson 2004; Gupta et al. 2021; Hansen et al. 2019), while also noting that ambidexterity may entail additional costs and that its positive effects are tied to specific conditions (Van Looy et al. 2005). This study refines these insights by showing that ambidexterity is neither always necessary nor beneficial. Instead, specialization strategies can be superior, particularly for small firms that lack the resources to pursue ambidextrous innovation approaches (Solís-Molina et al. 2018; Wenke et al. 2021). This implies that strategic misalignment, rather than the absence of innovation, is a key driver of poor performance and highlights the need for tailored innovation strategies, ensuring coherent alignment with internal and external contextual conditions.

Secondly, the study contributes to bridging ambidexterity theory with research on sustainability management and digital transformation by emphasizing their complementary nature (Cegarra-Sánchez et al. 2020; Martínez-Falcó et al. 2024). The findings indicate that pursuing digital or green innovation as isolated initiatives is unlikely to generate performance benefits, but that these efforts must rather be strategically integrated within the firm's overall innovation logic. This highlights the importance of exploratory and exploitative learning activities to build green and digital innovation capabilities. To ensure performance benefits, digital and green innovations require integration into a broader strategic framework, in which exploration and exploitation act as essential framing conditions (Hansen et al. 2019; O'Reilly and Tushman 2013). This corroborates prior research on the role of exploration and exploitation in driving innovation success (Cancela et al. 2023; Gupta et al. 2021;

Levinthal and March 1993), while also highlighting that technologies can themselves provide the framing that shape how these activities unfold (Xue and Swan 2020).

Moreover, the study refines literature on innovation contingencies regarding digital and green innovation by providing new insights into their interplay in different environmental settings. It reveals a systematic pattern in the alignment between digital and green innovation and environmental dynamics. Specifically, digital innovation is particularly effective in dynamic environments, underscoring its role in allowing firms to adapt swiftly to technological advances and market changes (Ferreira et al. 2019; Nambisan et al. 2017; Schneider and Kokshagina 2021). Conversely, green innovation is particularly beneficial in stable environments, where regulatory compliance and sustainability goals drive competitive advantage. This reinforces the role of sustainability-driven innovation to realize gains from resource efficiency, waste reduction and transforming production models (Bocken et al. 2014; Perotti et al. 2025; Schaltegger et al. 2016).

The study also introduces a more nuanced and context-sensitive understanding of industry-specific innovation strategies by refining how manufacturing and service firms adopt distinct innovation pathways. Prior research has emphasized the exploitative tendencies of service firms (Geerts et al. 2010), yet this study reveals that they exhibit a distinct trade-off between digital and green innovation based on environmental dynamics, opting for digital solution in dynamic environments and prioritizing green innovation to align with regulatory demands and customer expectations for sustainability. In contrast, manufacturing firms benefit from a dual innovation approach, leveraging both the potential for sustainability-related initiatives in manufacturing processes and economic benefits tied to production efficiency through digitalization. This aligns with research highlighting the operational benefits of combining digitalization and sustainability in production processes (Ghobakhloo et al. 2021; Horváth and Szabó 2019). Moreover, their organizational infrastructures and resource endowments enable manufacturing firms to effectively pursue ambidextrous strategies (Blindenbach-Driessen and Van Den Ende 2014; Holotiuk et al. 2024).

Lastly, the study extends research on the role of firm size in shaping firms' innovation approaches. While ambidexterity is often linked to superior performance, the findings show that this advantage is contingent on firm size. Small firms are not necessarily disadvantaged by their resource constraints, which reframes prior research on small firm innovation constraints (Horváth and Szabó 2019; Wenke et al. 2021). Instead, specialization in either exploration or exploitation can serve as competitive advantage if aligned with operational context and innovation efforts. In addition, their flexibility and responsiveness to external stimuli allows smaller firm to adapt their innovation focus more readily than large firms (Andersen et al. 2022; Chang et al. 2011; Passaro et al. 2023). In contrast, large firms are better positioned to pursue dual innovation, that is, simultaneously investing into green and digital innovation and ambidextrous strategies, as these approaches typically involve higher resource intensity (Lavie et al. 2010; Mueller et al. 2013). Digital readiness is crucial for growth, as failing to invest in digital innovation reduces flexibility and adaptability, leaving them vulnerable to technological shifts and market changes (Annosi et al. 2020; Li

TABLE 4 | Causal mechanism of innovation strategies and performance outcomes.

Constructs	Strategic relationships	Causal mechanisms	Theoretical explanation	Based on configuration(s)
Alignment of innovation and operational context	Firms can succeed with ambidextrous or specialization strategies depending on contextual conditions	Feasibility of innovation depends on coherent alignment with contextual conditions; misaligned strategies rather than lack of innovation leads to poor performance	Performance outcomes are not determined by the presence or absence of a single factor but by their coherent alignment (Fiss et al. 2013; Ragin 2008); benefits are contingent and tied to specific circumstances (Solís-Molina et al. 2018; Van Looy et al. 2005)	C1, C2, C3a, C3b, C4 for aligned specialization strategy; C5 for aligned ambidextrous strategy; C6 and C7 for misaligned strategies
Strategic integration of green and digital innovation	Firms must integrate green and digital innovation efforts into a broader strategic framework based on exploration and exploitation to leverage their complementary nature for enhanced performance	Innovation effectiveness depends on the integration with ambidextrous or specialisation strategies to form a coherent innovation framework	Treating green or digital innovation as isolated initiatives is unlikely to generate sustainable benefits; integration into a strategy framed by exploitation and exploration is key to building digital and green innovation capabilities and vice versa (Cancela et al. 2023; Gupta et al. 2021; Hansen et al. 2019; Xue and Swan 2020)	C1, C2, C3a, C3b, C4 and C5 as opposed to C6 and C8 for complementary integration
Environmental dynamics and innovation type	Digital innovation fosters adaptation in dynamic environments, while green innovation aligns with stable environments for improved sustainability performance; neglecting either one in those respective settings results in low performance	Environmental dynamics determine the effectiveness of digital and green innovations, reinforcing the need for context-dependent strategies	In dynamic environments, digital innovation strengthens technological readiness and agility (Ferreira et al. 2019; Nambisan et al. 2017); green innovation ensures advantages based on compliance with regulatory and customer expectations and transforming production processes in otherwise stable environments (Bocken et al. 2014; Schaltegger et al. 2016)	C1, C2 and C3a in contrast to C6 and C7 for digital innovation in dynamic environments; C3b, C4 and C5 in contrast to C8 for green innovation in nondynamic (stable) environments
Industry differences	Service firms prioritize either digital or green innovation based on environmental conditions; manufacturing firms benefit from dual innovation strategies regardless of environmental dynamics	Industry structures shape the effectiveness of digital and green innovations, with service firms adapting their innovation focus and manufacturing firms leveraging both innovation types	Service firms exhibit a context-specific trade-off, while manufacturing firms opt for dual innovation approaches to unlock sustainability- and automation-related potentials linked to production processes (Ghobakhloo et al. 2021; Horváth and Szabó 2019)	C2 and C3a in contrast to C3b for trade-off in service firms; C1, C4 and C5 in contrast to C6 and C8 highlighting dual innovation in manufacturing firms

(Continues)

TABLE 4 | (Continued)

Constructs	Strategic relationships	Causal mechanisms	Theoretical explanation	Based on configuration(s)
Firm size and innovation scope	Small firms succeed with specialization strategies and adjust innovation type based on environmental dynamics; large firms benefit from dual innovation approaches, particularly in ambidextrous settings	Firm size influences the feasibility of innovation strategies; small firms must focus, while large firms integrate innovation more broadly	Small firms are more responsive to external stimuli in adopting focused innovation approaches (Andersen et al. 2022; Chang et al. 2011; Passaro et al. 2023; Wenke et al. 2021); large firms' resource advantages enable broader innovation scope, fostering foundational sustainability capabilities and technological readiness (Ghobakhloo et al. 2021; Lavie et al. 2010; Li et al. 2024; Mueller et al. 2013; Teece & Linden, 2018)	C2, C3a and C3b in contrast to C7 for small firms; C1 and C5 in contrast to C8 for large firms

et al. 2024; Teece and Linden 2017). Green innovation proves viable across different settings. This indicates that green innovation constitutes a foundational capability in the innovation portfolio, enabling firms, particularly large firms, to comply with environmental regulations, meet customer expectations and adapt business logics (Bocken et al. 2014; Ghobakhloo et al. 2021; Schaltegger et al. 2016).

Ultimately, the findings reveal that both ambidextrous and specialized innovation strategies can lead to success or failure depending on firm-specific factors and contextual conditions. For smaller firms with limited resources, a specialized strategy focused on digital innovation is often advantageous in dynamic environments, while an exploitative strategy makes green innovation feasible in stable contexts. Large firms, particularly in manufacturing, are well-positioned to pair green and digital innovations, enhancing resilience and adaptability. Service firms, by contrast, benefit from their flexibility to prioritize digital or green innovations in response to market shifts, which appears imperative for maintaining competitiveness. However, the effectiveness of green and digital innovations requires strategic integration to ensure that innovation efforts are aligned with broader innovation goals to deliver long-term performance benefits rather than remaining isolated initiatives with only little impact. In conclusion, the study contributes a configurational perspective on ambidexterity, digital and green innovations, where success results from aligning innovation activities with a strategic framework tailored to operational context, rather than one-size-fits-all innovation approaches.

5.2 | Practical Recommendations

The findings provide valuable guidance for manager and policymakers on how to effectively align innovation strategies with firm size, industry type and environmental conditions to enhance performance, which is essential for firms to keep pace with the development of sustainable and digital technologies. For managers, it is crucial to recognize that both ambidextrous and specialized strategies can lead to success or failure depending on firm-specific and contextual factors. Strategic misalignment, on the other hand, will most likely lead to poor performance. For smaller firms, bundling their limited resources in specialized innovation strategies can be advantageous, focusing on digital innovation in dynamic environments, while an exploitative strategy is beneficial for fostering green innovation in stable contexts. Given that small and medium-sized firms are often considered the backbone of economy, policymakers should implement targeted initiatives such as subsidies to ensure they are equipped to navigate the dual pressures of sustainability and digitalization. In contrast, large firms, particularly in manufacturing, are well-positioned to integrate both digital and green innovations to enhance resilience and adaptability. Service firms, on the other hand, benefit from their flexibility to prioritize either digital or green innovations in response to market shifts to maintain their competitiveness. Thus, when framing innovations, managers should bear in mind that industrial differences shape innovation success and should, therefore, consider firm-specific strategic priorities. At the same time, policymakers should tailor incentives to industrial needs to ensure that industries facing high regulatory pressures receive the necessary support to implement

required innovations. Lastly, green and digital innovations should not be treated as isolated innovation initiatives but rather be integrated into broader strategic frameworks such as circular economy business models and resource or process optimization strategies. Policymakers should encourage this linkage through financial incentives and regulatory frameworks to sustainability-driven and digital transformation efforts.

5.3 | Limitations and Further Research Directions

While fsQCA offers a robust approach for examining complex interactions, it has limitations, especially in its inability to include control variables. Future research could incorporate alternative empirical methods to control for these factors and enrich insights into digital and green innovation strategies. Methodologically, another limitation of fsQCA is the restricted number of conditions that can be feasibly included, as model complexity and interpretative challenges rise exponentially and limit the model's applicability (Greckhamer, Furnari, et al. 2018). However, there are additional conditions that could provide valuable insights. Larger firms are often presumed to have more financial and human resources; however, research slack, an organization's buffer of untapped resources, may serve as a critical condition (Lavie et al. 2010). Additionally, diverse stakeholder pressures can significantly shape corporate environmental responsibility initiatives (Lee and Raschke 2020; Zhang and Zhu 2019). As this study is limited to manufacturing and service firms in Germany, future research could expand the research framework to different regions and industries. Including firms from diverse regions and industries could enhance the generalizability of the findings, revealing how differing geopolitical regulatory and sectoral pressures impact firms' approaches to digital and green innovation. The survey items for exploration and exploitation following Jansen et al. (2006, 2009) capture innovation behaviour rather than its implementation mechanisms within firms in organizational practice. Therefore, the study adopts a strategic lens, focusing on how firms balance or specialize in certain innovation behaviours. For instance, C5 firms (Dual Champion) simultaneously emphasize exploration and exploitation, which aligns with the conceptual definition of ambidexterity (March 1991; Tushman and O'Reilly 1996). However, the data do not allow conclusions about whether this balance is achieved via structural separation or contextual integration. Consequently, no claims can be made about the specific form of ambidexterity practiced. Future research could address this limitation by integrating dedicated survey items or qualitative data to investigate how different organizational forms of ambidexterity are operationalized in relation to green and digital innovation strategies. Moreover, future studies could benefit from examining strategy shifts over time. Since some strategic innovation initiatives yield measurable benefits only after a certain period, and some firms operate in a state of punctuated equilibrium (Gupta et al. 2006; Uotila 2018), longitudinal studies could provide a more granular perspective on the effects of sequential ambidextrous strategies over time. A further content-related limitation lies in the study's treatment of digital and green innovation as distinct innovation types, despite their frequent interdependencies. Digital innovations often influence a firm's environmental footprint, and many green innovations rely on digital technologies (Bähr and Fliaster 2023;

Ghobakhloo et al. 2021). Future studies could address this interdependence by examining how digital and green innovations interact to create a more holistic approach to innovation. Given the multifaceted nature of both digital, for example, artificial intelligence, digital platforms and big data and green innovation, for example, circular economy business models and eco-design principles (Ghobakhloo et al. 2021; Schaltegger et al. 2016), future research should explore in more detail whether those require tailored strategic approaches.

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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