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Exploitative and exploratory search: Dynamic capabilities enhancing SME adaptation, new product development, and environmental performance

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ABSTRACT

This study delves into how small and medium-sized enterprises (SMEs) adapt to market changes and enhance environmental performance through exploitative and exploratory search strategies within emerging economies. Operationalizing these strategies as dynamic capabilities, we investigate their impact on new product development amid environmental dynamism. Utilizing a two-wave survey of 437 manufacturing SMEs, with lagged primary environmental performance data, we applied partial least squares—structural equational modeling (PLS-SEM) to test our hypotheses. Our findings contribute invaluable insights to entrepreneurship literature, emphasizing the crucial role of intentional search in SMEs' continuous adaptation and innovation. We shed light on the distinctive contributions of exploitative and exploratory search in shaping SMEs' resource base and specific outputs, such as environmental performance. By discerning between possessing a capability and achieving successful outcomes, our study offers a resilient framework for SMEs, boosting both new product development and environmental performance in emerging economies.

KEYWORDS

Dynamic capabilities; exploitative search; exploratory search; new product development; environmental performance

Introduction

In emerging economies, the imperative for industrialization and economic growth necessitates the development of new products within manufacturing sectors (Kruse et al., 2023). However, within small and medium-sized enterprises (SMEs), introducing new products effectively while considering environmental responsibility poses a nuanced challenge caused by operational dynamism (Rosca et al., 2017). Due to their inherent "liability of smallness," SMEs may encounter limitations in knowledge management capabilities, potentially hindering their ability to independently address the environmental impacts of new product innovation (Morgan & Anokhin, 2023). While prior research has explored how knowledge

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acquisition influences SMEs' new product development, the specific mechanisms for acquiring this vital knowledge and its influence on environmental performance warrant further investigation (Smith et al., 2005; Tyler et al., 2023). Prioritizing firm-level environmental performance, our study aims to understand how SMEs enhance ecological sustainability through their operational decisions and strategies. This approach is crucial for examining the role of SME knowledge acquisition strategies in product development activities and their impact on environmental footprint within their immediate sphere of influence, rather than on broader industry or national trends (Bakos et al., 2020).

We draw on the idea of organizational search to examine this issue. Organizational search delineates the process through which businesses seek solutions to address firm constraints and opportunities for firm growth (Laursen & Salter, 2014). SMEs engage in search activities driven by the acknowledgment that they do not have all the necessary resources and expertise to attain or maintain their competitiveness (Cheah et al., 2021). Our study is focused on examining two search types: exploitative and exploratory. Exploitative search aims to uncover existing solutions to overcome firm constraints, while exploratory search seeks novel ideas to address internal innovation gaps (Billinger et al., 2021). Both types enable SMEs to adapt to evolving markets, fostering continuous processes of change and improvement.

Yet, understanding the optimal conditions for maximizing the benefits of exploitative and exploratory search in SMEs' new product development in emerging economies remains unclear. While existing research has studied factors such as firm-level dynamics (Shao & Hart, 2017) and industry-specific variables (Zhou et al., 2022), a noticeable gap exists in grasping the influence of environmental-level factors, particularly environmental dynamism, on SMEs in such a context. Within the manufacturing sector, environmental dynamism involves the pace and scale of changes and uncertainties, covering regulatory demands, consumer preferences, technological advancements, and natural resource availability (Ahmed et al., 2022). Environmental dynamism acts as a boundary condition shaping the context in which a firm's search strategy is implemented and evaluated (García-Granero et al., 2014).

To address these issues, we operationalized exploitative and exploratory search as dynamic capabilities (Hilliard & Goldstein, 2019), examining their impact on new product development and the resulting environmental performance amid environmental dynamism. Exploitative and exploratory searches are conceived of as dynamic capabilities since they involve complex bundles of skills, knowledge, and processes that enable firms to coordinate activities and reconfigure resources in response to environmental changes (Yalcinkaya et al., 2007). By gaining insight into these capabilities as essential components of a firm's strategic toolkit, we can more effectively assess how they contribute to product development and sustainability in an increasingly dynamic market landscape.

Our findings contribute to the entrepreneurship literature, offering insightful perspectives on the SME search process (Billinger et al., 2021). We elucidate the specific roles of exploitative and exploratory search, empowering SMEs to discern, integrate, and (re)combine pertinent resources in their product development while remaining attuned to their environmental context. The results firmly establish that when exploitative and exploratory search align with firm goals and needs, they synergistically contribute to a resilient framework for continuous adaptation and innovation (Ricci et al., 2021).

Following invaluable insights from Hilliard and Goldstein (2019), this study contributes to dynamic capabilities theory, demonstrating the integral role of exploitative and exploratory search in SMEs' intentional sensing, seizing, and reconfiguration (Eriksson et al., 2016). This study underscores the contribution of exploitative and exploratory search to knowledge discovery and integration, directly benefiting new product development, as well as environmental performance amid environmental dynamism. It emphasizes how dynamic capabilities enable a clear distinction between possessing a capability and achieving successful outcomes, mitigating presumptions about effectiveness in specific outputs (Hilliard & Goldstein, 2019). This intentional approach of search empowers SMEs to adapt their resource base, thereby enhancing specific performance outputs, such as environmental performance.

The subsequent sections of the paper delve into the theoretical framework and formulate hypotheses. Subsequently, the employed research methods are outlined. The paper then proceeds to present the results of hypothesis testing. Following this, the implications of the quantitative findings are thoroughly examined and discussed. The study concludes by summarizing its limitations and providing recommendations for future research.

Theoretical background and hypothesis development

Persistent and disruptive shifts in the business landscape necessitate developing "search" as a dynamic capability to address rapidly changing market conditions (Pandza & Thorpe, 2009). Dynamic capabilities involve the deliberate adaptation of resources to address rapidly changing environments (Giudici & Reinmoeller, 2012; Peteraf et al., 2013; Teece, 2007). Search, as a dynamic capability, enables organizations to efficiently adapt to evolving market and environmental conditions by acquiring new knowledge, skills, and resources to enhance their resource base and the capabilities needed for new product innovation (Giudici & Reinmoeller, 2012; Pandza & Thorpe, 2009). This perspective aligns with the premise of dynamic capabilities, emphasizing that businesses should efficiently adapt to changing market conditions by modifying their resource base, rather than solely relying on existing resources (Helfat, 2022; Helfat et al., 2007).

Recent research indicates that SMEs with strong dynamic capabilities in sensing and seizing opportunities can transform their resource base to perform better before and during turbulent periods (Dejardin et al., 2023). This highlights the importance of developing search as a dynamic capability, as it enables organizations to adapt their resource base and innovate effectively in response to persistent market disruptions, fostering both agility and a proactive approach to maintaining competitive advantage (Hilliard & Goldstein, 2019).

By characterizing search as a dynamic capability, it is possible to distinguish it from other elements that may contribute to specific outputs, such as luck or spontaneous reactions (Ambrosini & Bowman, 2009). In an emerging economy context, resource search holds particular significance for resource-constrained firms (An et al., 2020), enabling them to efficiently identify "the best sources of resources" (Desa & Basu, 2013, p. 28) and effectively enhance their resource base (Ricci et al., 2021).

This study fosters search as a foundation for operationalizing dynamic capabilities using a modest conceptual adaptation of its description by Helfat et al. (2007, p. 4), "the capacity of an organization to purposefully create, extend, or modify its resource base." Moreover, exploitation and exploration have been demonstrated as dynamic capabilities that transcend being mere sources of competitive advantage (Zhan & Chen, 2013). Instead, they represent a purposeful approach to sense, seize, and reconfigure resources and capabilities, addressing both constraints and opportunities within the firm (Yuan et al., 2018). This adaptation opens the door for researchers to not only recognize dynamic capabilities but also establish empirical indicators of their strength, considering factors such as environmental dynamism and new product development. In theory, this idea has been acknowledged (DiStefano et al., 2014; Peteraf et al., 2013), but its implementation has been slow. Figure 1 illustrates the proposed conceptual framework.

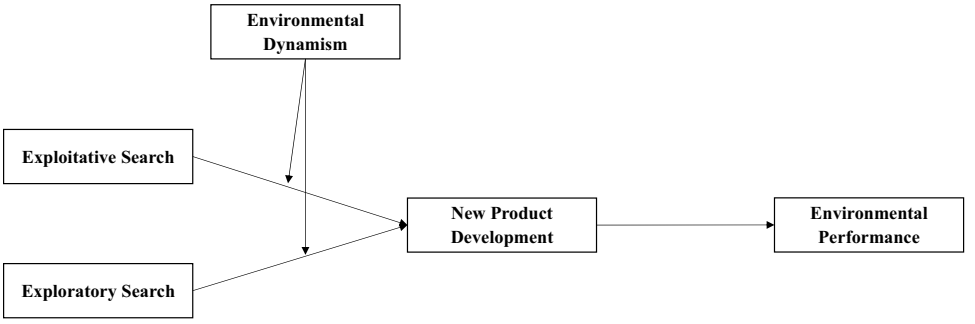

Figure 1. The conceptual framework.

Hypothesis development

Exploitative search, new product development and environmental performance

Exploitative search, focused on leveraging existing solutions to overcome organizational constraints (Shao & Hart, 2017), significantly influences the environmental performance of manufacturing SMEs (Shafique et al., 2021). Exploitative search enables SMEs to leverage their existing knowledge and capabilities to identify and implement incremental improvements in environmental sustainability (Tyler et al., 2023). SMEs engaged in exploitative search typically possess prior knowledge about eco-friendly technologies relevant to their industry, allowing them to effectively adopt existing innovations that align with their current operations. For example, a small manufacturing firm experienced in energy-efficient production processes would be well-positioned to adopt newer, advanced energy-saving technologies. This existing knowledge foundation equips the firm to implement incremental improvements and enhance environmental performance without requiring radical changes to its core competencies (Tempelaar & van de Vrande, 2021). Embracing this approach enables organizations to seamlessly integrate environmental considerations into their existing knowledge base, identifying opportunities for sustainable practices and enhancements (Uotila, 2018; Wu et al., 2023).

Exploitative search is particularly effective in time-sensitive scenarios, offering significant advantages to SMEs aiming for rapid product launches (Tempelaar & van de Vrande, 2021). This approach leverages existing skills efficiently, ensuring the seamless integration of relevant insights into ongoing innovation projects. By focusing on current capabilities, it identifies gaps where expertise can be most effectively applied, facilitating targeted improvements (Laureiro-Martínez et al., 2015). This synergy enables the development of products that meet emerging market demands while incorporating sustainable features, enhancing competitive advantage, and aligning with customer preferences for environmentally responsible offerings, thereby increasing market appeal (García-Granero et al., 2014).

Exploitative search builds trust, fosters valuable connections, and provides critical information on product development, establishing strong reciprocal relationships and facilitating systematic learning (Greve, 2018). By uncovering relevant information, it translates abstract knowledge into actionable strategies for new product development (Guan & Liu, 2016). This allows businesses to address environmental challenges by breaking them down into manageable subproblems related to their products (Tempelaar & van de Vrande, 2021). For instance, it enables businesses to make environmentally conscious decisions regarding materials, production processes, supply chains, and end-of-life management (Uotila, 2018). Consequently, businesses can develop

competitive products that meet market demands while aligning with increasing customer expectations for sustainability (Shafique et al., 2021).

Hypothesis 1: New product development mediates the relationship between exploitative search and environmental performance.

Exploratory search, new product development, and environmental performance

The relationship between exploratory search and environmental performance hinges on the deliberate departure from established organizational routines and knowledge bases (Shafique et al., 2021; Shao & Hart, 2017). Exploratory search serves as a mechanism for businesses to maintain agility in response to changing environmental challenges and regulations (Ko et al., 2021). When SMEs engage in explorative search to uncover novel ideas, they face a complex and demanding process. This involves discovering new information and integrating it into their existing frameworks (Ryu et al., 2022). To innovate, SMEs must first identify and value new insights related to their goals (Dejardin et al., 2023). Once recognized, they must assimilate this knowledge by connecting it with their existing understanding, enhancing their current capabilities (Teece, 2007). Next, they need to transform their practices and processes, which may involve new production methods, updating designs, or changing distribution strategies (Hilliard & Goldstein, 2019). Finally, SMEs must apply this integrated knowledge to develop new innovative solutions that meet market demands and sustainability goals (Yuan et al., 2018).

Exploratory search enables businesses to extend beyond their existing boundaries and identify emerging market opportunities, accessing the latest advancements in knowledge (Radicic & Pugh, 2017). By actively seeking fresh ideas, companies foster the creativity and flexibility needed to develop innovative products that address evolving consumer sustainability concerns (Shafique et al., 2021). This proactive approach generates diverse and forward-thinking concepts during the ideation phase, crucial for new product development (Billinger et al., 2021). Additionally, exploratory search plays a key role in incorporating advanced technologies, such as cutting-edge manufacturing techniques, smart technologies, and data analytics (Uotila, 2018). This integration is vital for maintaining competitiveness and adapting to a rapidly evolving business environment, ensuring businesses create standout products that meet increasing environmental demands (Tang et al., 2019).

New product development is crucial for advancing waste reduction and promoting circular economy practices (Morgan & Anokhin, 2023). It fosters the creation of sustainable products, including eco-friendly packaging, energy-efficient technologies, and waste-minimizing innovations (Wang et al., 2021).

During development, firms can incorporate carbon-neutral practices and offset initiatives to enhance their environmental impact (Katsikeas et al., 2016). Exploratory search supports this by helping firms identify and integrate effective sustainable practices, optimizing resource allocation toward the most beneficial initiatives (García-Granero et al., 2014). Consequently, SMEs can achieve outstanding environmental performance and significantly lower their ecological footprints.

Hypothesis 2: New product development mediates the relationship between exploratory search and environmental performance.

Exploitative search, new product development and environmental dynamism

Environmental dynamism introduces a higher degree of uncertainty and volatility within new product development (McKelvie et al., 2018). Adaptability to current dynamism within an environment can be facilitated by insights from exploitative search (Tempelaar & van de Vrande, 2021). In the face of environmental dynamism, SMEs in manufacturing need to proactively exploit opportunities, requiring continuous search for innovative solutions, novel technologies, and market gaps to inform and enhance new product development strategies (Ahmed et al., 2022; Tempelaar & van de Vrande, 2021). The insights acquired through exploitative search play a pivotal role in adapting to market changes in the course of new product development (Guan & Liu, 2016; Shafique et al., 2021). This involves considerations such as incorporating sustainable practices, adopting cutting-edge technologies, and responding to evolving consumer expectations (D.-Y. Li & Liu, 2014).

Rapid environmental changes demand timely market entry with pertinent products (Girod & Whittington, 2017). Exploitative search expedites development by offering current insights, enabling businesses to introduce innovations that address their operational dynamism (Uotila, 2018). By staying proactive, SMEs can consistently scan the environment for shifts, aligning strategies with the evolving landscape of new product development (Zhou et al., 2022). Proactively identifying emerging trends and leveraging market gaps strategically positions manufacturing SMEs to innovate and introduce offerings that directly address dynamic market demands (Dykes et al., 2019). This empowers them to effectively navigate environmental shifts and sustain or improve their development efforts, aiming for incremental improvements in new product development (Ko et al., 2021).

Hypothesis 3: The impact of exploitative search on new product development is contingent on environmental dynamism.

Exploratory search, new product development, and environmental dynamism

In dynamic environments, exploratory search boosts SMEs' adaptability and innovation through several key processes (Zhang et al., 2020). It expands the firm's knowledge base by introducing diverse ideas and practices, helping to recognize and interpret weak signals of change (Ko et al., 2021). Exploratory search also fosters combinatorial innovation by integrating disparate knowledge elements, which is essential for recognizing, assimilating, and applying new information for commercial purposes (M. Yang et al., 2021). For manufacturing SMEs, it can involve combining technologies from different fields to create novel products or processes. Additionally, exploratory search enhances a SME's ability to swiftly learn and integrate new knowledge, crucial in rapidly evolving markets (Kammerlander et al., 2015). This broad search process promotes creativity and adaptability, especially in emerging economies (Torres de Oliveira et al., 2022). By exploring diverse information sources, SMEs can identify niche opportunities and unmet needs, better preparing them to handle market turbulence and anticipate future demands (dos Santos et al., 2020; Ricci et al., 2021).

Exploratory search enables SMEs to strategically allocate limited resources for potential environmental dynamism in their product development, prioritizing the most relevant constraints (De Massis et al., 2018). These insights facilitate informed decision-making, streamlining development processes and reinforcing competitive positioning. Additionally, exploratory search aids SMEs in identifying potential pitfalls in radical innovation, ensuring risk-aware decision-making, and directing resources toward products with a higher likelihood of success, especially in fluctuating environmental conditions (Radicic & Pugh, 2017). This enables SMEs to navigate less promising ventures, conserving resources for efforts that significantly contribute to their development objectives in dynamic markets (M. Yang et al., 2021).

In a stable environment, the absence of disruptive forces may create a sense of routine, masking underlying risks and growth opportunities (Soto-Acosta et al., 2018). To counteract potential stagnation, exploring new product development strategies becomes crucial as a proactive measure (Cillo & Verona, 2022; Tempelaar & van de Vrande, 2021). Even in periods of stability, customer expectations and market demands subtly evolve over time (Ahmed et al., 2022). Continuous exploration keeps firms attuned to these shifts, enabling adaptation and innovation to stay ahead (Billinger et al., 2021). This empowers SME to venture beyond established boundaries, discover emerging opportunities, and access cutting-edge knowledge for innovative products (Aliasghar et al., 2023).

Hypothesis 4: The impact of exploratory search on new product development is contingent on environmental dynamism.

Methods

Research setting

Empirical studies are beginning to investigate organizational search in the manufacturing sector of emerging economies (Torres de Oliveira et al., 2022). Research reveals how firms use exploitative search to optimize processes, incorporating technologies like Industry 4.0 for enhanced efficiency and competitiveness (Ricci et al., 2021). Prior studies have also delved into the dynamics of exploratory search, scrutinizing how organizations navigate uncertainty to discover innovative solutions (Guo et al., 2015). The expanding empirical insights into the applications of search in manufacturing emphasizes the need for increased attention to comprehend their impact on product development and the resulting environmental performance, particularly in dynamic environments.

Our research delves into the manufacturing sector in Ghana, offering an opportune setting to explore the relationship between new product development and the synergies environmental performance within a dynamically changing environment Despite its status as a low-income country, Ghana stands as an enticing hub for foreign investors, boasting an estimated growth rate of approximately 8 percent (World Bank, 2019). The entrepreneurial landscape in Ghana's manufacturing sector is dynamic, marked by technological advancements, market fluctuations, institutional gaps, regulatory shifts, and competitive pressures (Opoku et al., 2019). This sector assumes a pivotal role in the country's developmental agenda, aligning with initiatives such as the "One District One Factory" program. This alignment holds promising prospects for steering toward a low-carbon and sustainable economy, that fosters economic industrialization (Mensah et al., 2021).

Approximately 90 percent of registered businesses in Ghana are classified as SMEs, contributing around 70 percent to the nation's GDP and generating nearly 85 percent of employment opportunities within the manufacturing sector (Ghana Statistical Services, 2023; Multisoft Solutions, 2021). This aligns with patterns observed in other emerging economies such as Brazil, India, and Nigeria (Odunukan et al., 2022; Pereira et al., 2022; Schaefer et al., 2021). Ghana's recognition as one of Africa's fastest-growing innovative economies (Global Data, 2023) creates an environment where both exploitative and exploratory search strategies are not only advantageous but also practically achievable.

Data collection

We employed the tailored design approach (Dillman, 2011) to administer a questionnaire to SMEs. The questionnaire, crafted after an extensive literature review, underwent a pretest involving three academics and eleven SMEs.

Post-pretest, refinements were made to enhance question clarity. In line with established sustainability research recommendations for product development (Katsikeas et al., 2016), we utilized a time-lagged data collection method. Initially, data for independent, mediator, and moderator variables were collected, with data for the dependent variable gathered six months later. This method, designed to address common method bias (CMB) (Podsakoff et al., 2012), bolsters the robustness of our hypothesized linkages.

We focused on manufacturing SMEs registered with the Association of Ghana Industries (AGI). AGI offers regular training in optimal managerial practices, capacity building, and knowledge-sharing initiatives (Agyapong & Attram, 2019; Coffie et al., 2021). The sampling frame was derived from the AGI database, encompassing business names, locations, types, and contact details (phone/email) for registered SMEs. Only businesses that met the Ghana Statistical Services (2023) criterion—defined as firms employing 100 or fewer people—were considered in this research.

We distributed questionnaires to 800 randomly selected SME CEOs or managers, seeking permission for physical survey submissions to enhance participation. Unreachable SMEs were replaced through random selection from the remaining database in the initial phase. After two weeks, nonresponsive businesses were contacted at each data collection phase. In the first phase, we obtained 642 responses. Subsequently, in the second phase, we distributed questionnaires to the 642 respondents from the first phase and received 497 responses. Fifty-four responses were excluded due to significant missing data, leaving us with a usable sample of 437. Among respondents, 67.11 percent were male, and 32.89 percent were female, with an average business age of 8.92 years.

With 642 respondents in the first wave and 437 in the second, we assessed nonresponse bias by comparing early (within two weeks) and late respondents (after two weeks) in each wave. T-tests showed no significant differences in average firm size: in the first wave, early respondents had 51 employees and late respondents had 48 ($p = .76$); in the second wave, early respondents had 42 employees and late respondents had 49 ($p = .68$). These results indicate that nonresponse bias is unlikely to impact our findings.

Measures

Multiple-item scales were employed with a seven-point scale and are reported in Table 1.

To measure environmental performance, we adopted a dual perspective (Y. Li et al., 2020; Singh et al., 2019), focusing on (i) the firm's explicit initiatives to integrate environmental issues into products using life-cycle-based management approaches and (ii) the implementation of environmental management systems to monitor and enhance environmental performance, with $\alpha = 0.741$.

Table 1. Measurement of constructs including validity and reliability.

Construct and items	Factor loading
Environmental performance (Cronbach's α = 0.741, CR = 0.739, AVE = 0.562) (e.g.,	
During the past three years, our firm has experienced …	
… reduced waste across our processes	0.752
… resource efficiency across our processes	0.788
… improved compliance with environmental standards	0.726
… chosen raw materials that can be recycled or that are less harmful to the environment	0.732
Exploitative search (Cronbach's α = 0.886, CR = 0.902, AVE = 0.597)	
Over the last three years …	
… we searched for solutions to customer problems that were close to existing solutions rather than completely new solutions	0.705
… we upgraded our skills in operational processes in which our firm already had significant experience	0.739
… we focused on reducing inefficiencies in our existing work processes	0.772
… we fine-tuned what we offer to keep our current customers satisfied	0.802
… we focused on developing our existing technologies and competences	0.898
… we found new ways to improve quality of the firm's product and processes	0.676
… we penetrate more deeply into existing customer base	0.797
Exploratory search (Cronbach's α = 0.921, CR = 0.929, AVE = 0.679)	
Over the last three years …	
… we proactively searched for new technical solutions	0.711
… we sought new managerial and organizational knowledge that are important for innovation	0.850
… we searched for product and process development that is entirely new to the firm	0.793
… we sought novel and advanced knowledge for our work processes	0.850
… we looked for creative ways to satisfy our customers' needs	0.830
… we continually searched for new possibilities to improve our work processes	0.837
… we actively targeted new customer groups	0.885
Environmental dynamism (Cronbach's α = 0.901, CR = 0.929, AVE = 0.768)	
Customer demands are changing rapidly in our industry	0.829
New markets are emerging for products in our industry	0.861
In our local market, changes are taking place continuously	0.895
Competitors are constantly trying out new competitive strategies	0.918

These measures involve exploring new and existing ideas, technologies, and practices to innovate and adapt to emerging trends. Despite potential criticisms of self-reported environmental performance measures, Liu et al. (2016) argue that they are valuable for providing industry-specific, time-sensitive, and contextually relevant data, allowing for meaningful comparisons across firms.

Moreover, we focused on environmental performance in this study because it can serve as a proxy for broader organizational capabilities, particularly in sectors with critical environmental concerns. For instance, Russo and Fouts (1997) suggest that strong environmental performance reflects capabilities like innovation and adaptability, which are vital for overall firm success. Hart et al. (2011) argue that integrating environmental concerns into organizational strategies demonstrates dynamic capabilities that can enhance competitive advantage. M. G. M. Yang et al. (2011) show that lean manufacturing and environmental management practices positively impact business performance. Additionally, Aragón-Correa et al. (2008) and (Agan et al., 2013) find that proactive green strategies and environmental processes are positively associated with financial and economic performance in SMEs. Thus, strong

environmental performance often correlates with broader capabilities such as financial success and innovation.

To evaluate the extent of SMEs' exploitative and exploratory search efforts, survey responses concentrated on their search activities over the preceding three years. In developing economies, shorter business cycles require frequent strategic adjustments to remain competitive (Oura et al., 2016). A three-year period offers a timely assessment of exploitative and explorative activities, capturing how firms adapt to rapid market changes, technological advancements, and regulatory shifts. This timeframe reflects recent improvements and innovations, aligning with the shorter cycles of these economies (Vo-Thai et al., 2021). Additionally, many firms in developing economies are relatively young, and a three-year span includes these newer firms and their recent adaptation efforts, providing a comprehensive view of their innovation strategies (Oura et al., 2016).

Items for both searches were formulated based on literature delineating firms' exploitative and exploratory search activities (Kammerlander et al., 2015; Kristal et al., 2010; Mom et al., 2007). Recognizing the entrepreneurial nature and single business unit structure of SMEs (Miocevic & Morgan, 2018), this study acknowledges the absence of "facilitating resources" and "slack resources" that larger firms possess to balance ambidexterity—pursuing both exploitation and exploration in a balanced and trade-off manner (Lubatkin et al., 2006, p. 647). Moreover, given the lower ambidexterity levels observed in this study's population (Amankwah-Amoah & Adomako, 2021; Ansah et al., 2022), exploitative and exploratory searches were measured separately. This approach allows for a precise evaluation of the effectiveness of each strategy.

To capture exploitative search, survey questions focused on identifying ways to refine the existing status quo through incremental changes (Billinger et al., 2021). The variable "exploitative search" was constructed using seven items adapted from Kristal et al. (2010); Mom et al. (2007), with $\alpha = 0.886$. Survey questions for "exploratory search" were framed around the concept that businesses actively seek new opportunities by extending beyond their current capabilities or competitive positions to alter the status quo (Billinger et al., 2021). The variable "exploratory search" was created using seven items adapted from Kristal et al. (2010); Mom et al. (2007), with $\alpha = 0.921$.

Consistent with previous research (Smith et al., 2005), our assessment of new products involved quantifying the number introduced by a SME within the last three years. This approach is consistent with Katila and Ahuja (2002) suggestions, which emphasized the count of new products as a robust measure for assessing new product development. While this approach may not fully capture the detailed timelines of product development, especially for explorative searches that require longer to establish new structures, it remains practical and relevant. Similar metrics have been used in previous SME innovation studies, allowing for comparability

with existing research (Ridge et al., 2017; Yli-Renko & Janakiraman, 2008). The count of new products introduced is a straightforward, objective measure that enables consistent comparison across firms and industries. It provides a tangible outcome of firms' search activities while avoiding the complexities of more qualitative measures (Ridge et al., 2017). Additionally, SMEs in developing economies often have shorter innovation cycles due to rapid adaptation needs, making frequent new product introductions a good reflection of their innovative capacity and agility (Arunachalam et al., 2020). To capture this accurately, we applied a logarithmic transformation to the count of newly introduced products in the market.

Environmental dynamism, referring to the unpredictability and uncertainty in the business environment, impacting business operations (Y. Li et al., 2020), was measured using a four-item scale ($\alpha = 0.901$), adapted from Jansen et al. (2006) and Mammassis and Kostopoulos (2019). This scale assessed the perceived speed and magnitude of change, uncertainty, and the variety of new product development in the industry.

Control variables in our study included firm age and gender. Firm age was quantified by taking the logarithm of the firm's operational years. Younger firms often experience more substantial performance growth, while older firms tend to focus on process enhancement and resource accumulation to sustain performance (Pollok et al., 2019). Gender was coded as 0 for male and 1 for female. Existing research presents varied perspectives: some suggest that female organizational leaders may benefit from additional training, while others argue that female managerial representation can enhance overall performance (Ali et al., 2020; Salloum et al., 2019).

Analysis and results

We utilized PLS-SEM to construct a moderated-mediation framework, examining how environmental dynamism predicts the relationship between exploitative and exploratory search and new product development. We also explored the mediating role of new product development between exploitative and exploratory search and environmental performance. PLS-SEM was selected for its suitability as a variance-based approach for modeling intricate relationships, effectively addressing issues such as "inadmissible solutions and factor indeterminacy" within a moderated-mediation framework (Liang et al., 2007, p. 70). Additionally, PLS-SEM prioritizes optimizing the predictive capabilities of endogenous constructs (Hair et al., 2014). By enhancing endogenous constructs at the local level, PLS-SEM provides more precise predictions with heightened statistical power, ultimately enriching the explanatory depth achievable when testing our framework.

Measurement model

Table 1 shows that all items, except one, exhibit loadings greater than 0.702. This specific item has an outer loading of 0.676, falling within the range of 0.40–0.72; hence, an outer loading relevance test, as recommended by Hair et al. (2022), was conducted. Removal of the item did not impact the construct composite reliability (CR) or average variance extracted (AVE) for the exploitative search variable. Collectively, these results affirm satisfactory indicator reliability. Furthermore, the minimum Cronbach's alphas and minimum CR values in Table 1, standing at 0.741 and 0.739 respectively, indicate that the construct reliability of each reflective construct in this study is deemed acceptable.

All constructs exhibit AVE values exceeding 0.5 (with a minimum AVE of 0.562), signifying convergent validity (Hair et al., 2014). To confirm discriminant validity, both the Fornell-Larcker criterion and the heterotrait-monotrait (HTMT) test were employed. As per the Fornell-Larcker criterion (Table 2), the square root of the AVE for each construct surpasses the construct's highest correlation with any other construct. Additionally, Table 3 indicates that the maximum HTMT value is 0.862, which falls below the 0.9 threshold (Hair et al., 2014). Overall, these findings suggest discriminant validity.

Controlling for common method bias testing

In addition to employing the time-lagged procedure during data collection to mitigate CMB, a full collinearity test was conducted (Kock, 2017). A model is

Table 2. Fornell-Larcker criterion for discriminant validity.

	Variable	1	2	3	4	5	6	7
1	Environmental performance	**0.750**						
2	Exploitative search	0.635	**0.773**					
3	Exploratory search	0.586	0.743	**0.824**				
4	New product development	0.481	0.400	0.430	**1.000**			
5	Environmental dynamism	0.251	0.174	0.181	0.296	**0.876**		
6	Firm age	−0.038	0.068	0.077	0.221	−0.100	**1.000**	
7	Gender	0.011	0.056	−0.048	−0.046	−0.062	0.067	**1.000**

Bold diagonal elements are the square root of average variance extracted (AVE).

Table 3. Heterotrait-monotrait (HTMT) values for discriminant validity.

	Variable	1	2	3	4	5	6	7	8	9
1	Environmental performance									
2	Exploitative search	0.763								
3	Exploratory search	0.675	0.812							
4	New product development	0.555	0.416	0.437						
5	Environmental dynamism	0.303	0.232	0.199	0.297					
6	Firm age	0.097	0.121	0.096	0.221	0.111				
7	Gender	0.135	0.118	0.106	0.046	0.078	0.067			
8	Environmental dynamism x Exploratory search	0.410	0.175	0.175	0.266	0.133	0.116	0.154		
9	Environmental dynamism x Exploitative search	0.479	0.313	0.172	0.239	0.157	0.092	0.214	0.862	

Table 4. Inner variance inflation factor (VIF) values for full collinearity test.

	Variable	1	2	3	4	5	6	7
1	Environmental performance		1.756	1.946	1.785	1.990	1.188	1.128
2	Exploitative search	2.328		1.718	2.636	2.417	1.772	1.162
3	Exploratory search	2.380	1.576		2.391	2.454	1.776	1.343
4	New product development	1.394	1.518	1.497		1.444	1.268	1.373
5	Environmental dynamism	1.135	1.152	1.151	1.084		1.101	1.097
6	Firm age	1.091	1.123	1.124	1.032	1.085		1.104
7	Gender	1.035	1.017	1.021	1.029	1.020	1.026	

deemed free of CMB when the values of all inner variance inflation factors (VIFs) are below 3.3. Table 4 reveals a maximum inner VIF value of 2.391, indicating that CMB does not pose a concern in this study.

Analytical model

The significance of the path coefficients in the inner model of PLS-SEM was assessed using the bootstrapping method with 5,000 sub-samples (Hair et al., 2022). Table 5 indicates that R^2 for environmental performance ($R^2 = 0.497$, $p < .001$) and new product development ($R^2 = 0.280$, $p < .001$) surpass the recommended threshold of 0.10 (Falk & Miller, 1992).

The CVPAT method was used to evaluate the out-of-sample predictive relevance of the model (Sharma et al., 2023). As presented in Table 6, the average loss value was contrasted with the average loss value obtained from a prediction using indicator averages (IA) as a naive benchmark and the average loss value derived from a linear model (LM) forecast, serving as a more conservative benchmark. The average loss of PLS-SEM is expected to be lower than that of the benchmarks, indicated by a negative difference between the two values. CVPAT assesses whether the average loss of PLS-SEM is significantly superior to the benchmarks. Therefore, a significantly negative difference in average loss values demonstrates the model's enhanced predictive capabilities when compared to the prediction benchmarks (Hair et al., 2022). The results in Table 6 show that our analytical model satisfies the naive benchmark but not the conservative benchmark.

Hypothesis 1 posits that new product development serves as a mediator in the relationship between exploitative search and environmental performance. As shown in Table 5, there is a positive and significant coefficients for the relationship between exploitative search and new product development ($\beta = 0.193$, $p < .01$, $f^2 = 0.018$), as well as between new product development and environmental performance ($\beta = 0.273$, $p < .001$, $f^2 = 0.114$). Moreover, the indirect effect of exploitative search on environmental performance through new product development was also significant ($\beta = 0.052$, $p < .001$), with a 95 percent confidence interval (CI) of lower confidence interval (LCI) = 0.021 and upper confidence interval (UCI) = 0.082. When new product development is held

Table 5. Structural equation modeling results.

Endogenous construct	R^2				
Environmental performance	0.497***				
New product development	0.280***				
			CI 95%		
Structural path	Coefficients	SD	LCI	UCI	f^2
Exploitative search → Environmental performance	0.394***	0.036	0.323	0.464	0.133
Exploratory search → Environmental performance	0.188***	0.051	0.083	0.284	0.029
New product development → Environmental performance	0.273***	0.037	0.200	0.344	0.114
Exploitative search → New product development	0.193**	0.062	0.070	0.315	0.018
Exploratory search → New product development	0.220**	0.067	0.087	0.352	0.026
Environmental dynamism → New product development	0.210***	0.027	0.158	0.263	0.058
Firm age → Environmental performance	−0.141***	0.031	−0.203	−0.081	0.037
Gender → Environmental performance	0.040	0.060	−0.077	0.159	0.001
Environmental dynamism x Exploitative search → New product development	0.105†	0.054	−0.001	0.211	0.026
Environmental dynamism x Exploratory search → New product development	−0.231***	0.055	−0.340	−0.122	0.005
Indirect effects					
Exploitative search → New product development → Environmental performance	0.052***	0.015	0.021	0.082	
Exploratory search → New product development → Environmental performance	0.061*	0.024	0.021	0.114	
Environmental dynamism → New product development → Environmental performance	0.057***	0.010	0.038	0.078	
Environmental dynamism x Exploitative search → New product development → Environmental performance	0.028*	0.015	−0.001	0.057	
Environmental dynamism x Exploratory search → New product development → Environmental performance	−0.063***	0.017	−0.098	−0.031	

†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$; two-tailed test. SD: Standard deviation, CI: Confidence interval, LCI: Lower confidence interval, UCI: Upper confidence interval.

Table 6. Results of out-of-sample predictive relevance (CVPAT).

Variable	Average loss difference	t value	*p*-value
CVPAT PLS-SEM vs IA			
Environmental performance	−0.460	5.797	.000
New product development	−0.447	4.547	.000
Overall	−0.458	5.645	.000
CVPAT PLS-SEM vs LM			
Environmental performance	0.535	15.109	.000
New product development	0.336	5.376	.000
Overall	0.495	15.737	.000

constant, the direct relationship between exploitative search and environmental performance remains significant ($\beta = 0.394$, $p < .001$, $f^2 = 0.133$).

Hypothesis 2 predicts that new product development mediates the relationship between exploratory search and environmental performance. As shown in Table 5, we observe positive and significant coefficients for the relationship between exploratory search and new product development ($\beta = 0.220$, $p < .01$, $f^2 = 0.026$), as well as between new product development and environmental performance ($\beta = 0.273$, $p < .001$, $f^2 = 0.114$). Moreover,

the indirect effect of exploratory search on environmental performance through new product development remains significant ($\beta = 0.061$, $p < .05$), substantiated by a 95 percent CI ranging from LCI = 0.021to UCI = 0.114. When new product development is controlled, the direct relationship between exploratory search and environmental performance is significant ($\beta = 0.188$, $p < .001$, $f^2 = 0.029$).

Hypothesis 3 posits that the influence of exploitative search on new product development is contingent on environmental dynamism. The results in Table 5 demonstrate the positive and significant coefficients for the relationship between environmental dynamism and new product development ($\beta = 0.210$, $p < .001$, $f^2 = 0.058$), with a 95 percent CI spanning LCI = 0.158 to UCI = 0.263. Additionally, the interaction effect of environmental dynamism and exploitative search demonstrates a positive and significant relationship with new product development ($\beta = 0.105$, $p < .10$, $f^2 = 0.026$), with a 95 percent CI ranging from LCI = −0.001 to UCI = 0.211. Furthermore, as shown in Figure 2, heightened environmental dynamism accentuates the positive impact of exploitative search on new product development. Conversely, in environments with lower dynamism, the influence of exploitative search on new product development is comparatively subdued.

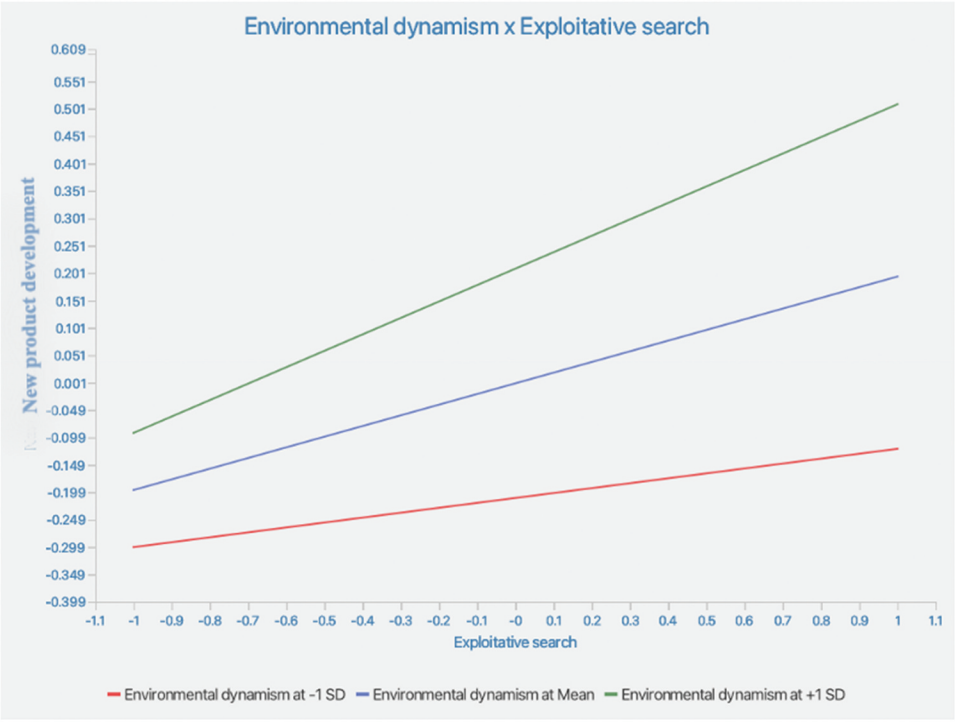

Figure 2. The moderating effect of environmental dynamism x exploitative search on new product development.

Hypothesis 4 anticipates that the influence of exploratory search on new product development is contingent on environmental dynamism. The results in Table 5 demonstrate the positive and significant coefficients for the relationship between environmental dynamism and new product development ($\beta = 0.210$, $p < .001$, $f^2 = 0.058$), with a 95 percent CI between LCI = 0.158 to UCI = 0.263. However, as shown in Table 5, the interaction of environmental dynamism and exploratory search, while significant, is negatively associated with new product development ($\beta = -0.231$, $p < .001$, $f^2 = 0.005$), with a 95 percent CI ranging from LCI = −0.340 to UCI = −0.122. Furthermore, as shown in Figure 3, higher environmental dynamism diminishes the positive impact of exploratory search on new product development. This indicates that as environmental dynamism increases, the relationship between exploratory search and new product development weakens.

Discussion and theoretical implications

Conceptualizing exploitative and exploratory search as dynamic capabilities, we investigated their impact on new product development amid environmental dynamism and the resultant impact on the firms' environmental

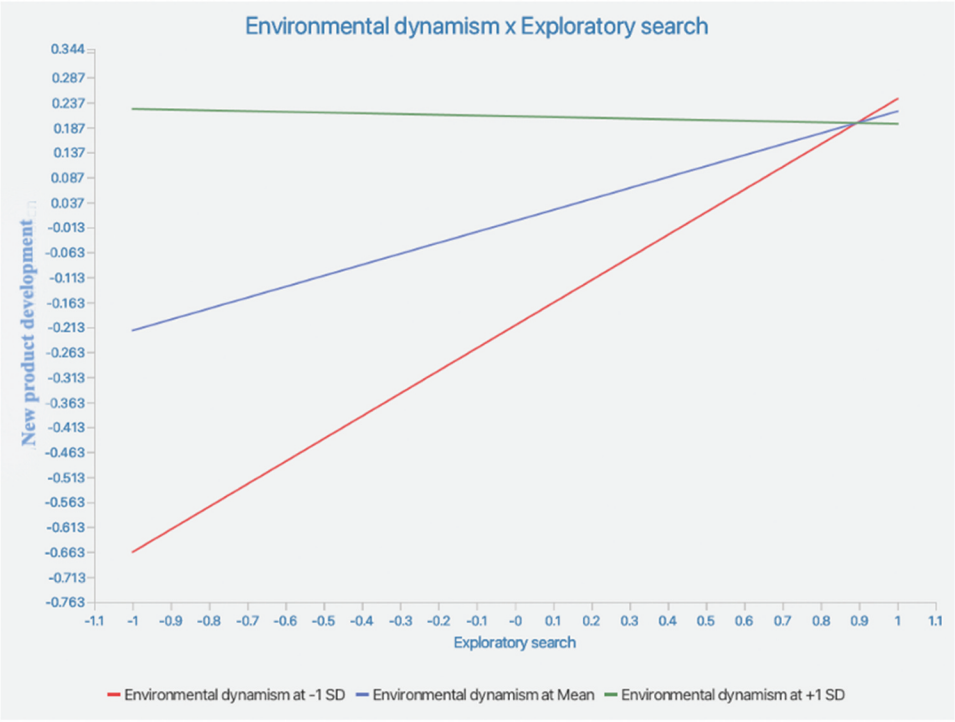

Figure 3. The moderating effect of environmental dynamism x exploratory search on new product development.

performance. Leveraging a real-world dataset, our findings validate the simulation results of Billinger et al. (2021) and contribute to dynamic capabilities theory, highlighting the crucial role of exploitative and exploratory search in the sensing-seizing-reconfiguration framework (Teece, 2007). Enabling SMEs to advance on the learning curve, search provides the insights necessary to adapt both tangible and intangible assets (Kammerlander et al., 2015). This strategic use of search aids SMEs in optimizing incremental and radical innovation for improved product development, and enhancing specific performance outputs like environmental performance (Shafique et al., 2021). Exploitative and exploratory search thus discerns between possessing a capability and achieving successful outcomes, avoiding assumptions of effectiveness in output enhancement (Hilliard & Goldstein, 2019).

First, our findings demonstrate that exploitative search, as an internal resource acquisition behavior, functions as a dynamic capability, facilitating the identification, integration, and (re)combination of existing resources for new product development (Cillo & Verona, 2022; Eriksson et al., 2016). Our results indicate that exploitative search aids SMEs in sensing existing opportunities and best practices within their industry (Tyler et al., 2023). Specifically, exploitative search facilitates the identification of incremental improvements and the optimization of current operations. For instance, it enables SMEs to discover and adopt proven eco-friendly technologies and practices, thereby improving their ability to sense immediate opportunities for enhancement (Lehner et al., 2015). Furthermore, our findings imply that exploitative search bolsters seizing capabilities by refining operations, which allows for the rapid implementation of incremental innovations. This process leverages existing knowledge and resources to boost efficiency and competitiveness (Yuan et al., 2018).

Exploitative search supports reconfiguration by refining existing processes, helping firms stay agile and responsive to incremental market changes (Teece, 2007). Our results show that in the context of new product development, exploitative search focuses on enhancing and optimizing current offerings through incremental improvements. This includes refining features, boosting performance, or increasing efficiency. By leveraging existing knowledge and capabilities, our findings imply that firms are able to gradually adjust their resource base, maintain competitiveness, and effectively respond to customer feedback (Greve, 2018). Additionally, this approach helps mitigate risks associated with more radical changes. The intensified and frequent interactions inherent in exploitative search foster the sharing of tacit knowledge, accelerating learning and enabling SMEs to swiftly capitalize on current market opportunities, by addressing customer preferences for environmentally responsible offerings (García-Granero et al., 2014; Partanen et al., 2020).

Second, we further expand on the work of Blattman et al. (2016), examining how exploratory search addresses the constraints of SMEs with limited in-

house research and development, enabling the discovery of predeveloped innovative ideas. Our study highlights how explorative search expands SMEs' sensing capabilities by encouraging them to move beyond their current knowledge base and explore new ideas, market trends, and innovations. This broader perspective helps SMEs identify and assess opportunities that may not be apparent through traditional methods (Dykes et al., 2019; Rashidirad & Salimian, 2020). Our results show that explorative search also enhances seizing capabilities by allowing SMEs to act swiftly on new insights and trends. It allows SMEs to realign strategies and resources to capture emerging opportunities, ensuring they can adapt swiftly to evolving market demands (Ko et al., 2021). For instance, if a SME identifies a shift toward digital solutions, explorative search helps it pivot its focus and capitalize on this trend, thus gaining a competitive edge (Girod & Whittington, 2017; Helfat, 2022).

Additionally, our study reveals that explorative search drives significant reconfiguration by introducing new paradigms, technologies, and business models (Behi et al., 2020). This transformative approach helps SMEs adapt to major environmental shifts, supporting long-term sustainability and growth (Teece, 2007). Our results suggest that in new product development, explorative search often involves creating radically different products or services, which necessitates a major reconfiguration of the firm's capabilities. This may include acquiring new skills, adopting innovative technologies, or entering new markets (Hilliard & Goldstein, 2019).

Our third contribution explores how environmental dynamism affects new product development through exploitative search. Based on our findings, while exploitative search promotes incremental innovation, excessive reliance on this approach can lead to the "no innovation trap" (Aghion & Howitt, 1992). This paradox occurs when increased R&D efforts result in diminished overall innovative output. Our results suggest a nonlinear relationship between exploitative search and new product development: initial intensification of exploitative search enhances innovation and adaptability, but beyond a certain point, it may lead to diminishing returns or even hinder innovation, particularly in highly dynamic environments. This observation is consistent with Laursen and SalterSalter's (2006) finding of an inverted U-shaped relationship between search breadth and innovation performance. For manufacturing SMEs operating in dynamic settings, our findings imply that a balance between exploitative and exploratory activities is crucial. Exploitative search remains essential for refining core products (Zhou et al., 2022), yet overinvestment in this strategy can suppress broader innovation. In volatile environments, SMEs should engage in frequent but moderate exploitative search activities to maintain agility, sustain innovation, and prevent over-reliance on any single approach (Wu et al., 2023).

Lastly, contrary to expectations (Torres de Oliveira et al., 2022), our research aligns with Uotila (2018), suggesting that increased exploratory

search during heightened environmental dynamism may not enhance new product development. Our findings reveal that in rapidly changing environments, SMEs often struggle to acquire complete and accurate information about new technologies, market trends, and competitive actions (Soto-Acosta et al., 2018). This information asymmetry, where SMEs lack comprehensive insights compared to competitors, can hinder informed decision-making and the effective integration of new knowledge into innovation processes. As Courtney et al. (2017) note, heightened dynamism exacerbates information asymmetry, increasing uncertainty and complexity in decision-making. Although exploratory search provides valuable external knowledge, the absence of tacit insights—context-specific and difficult to transfer—can limit its practical application. This supports Mammassis and Kostopoulos (2019) argument that tacit knowledge is essential for successful innovation. Without such insights, SMEs may find it challenging to translate acquired information into actionable strategies. Additionally, increased information asymmetry can lead to divergent understandings among stakeholders, further complicating the innovation process.

Practical implications

Given the inherent complexity of entrepreneurship faced by SMEs, the strategic implementation of search proves highly advantageous in guiding their efforts to enhance product development while concurrently addressing environmental impacts. This study aligns with the understanding that the success of a SMEs extends beyond tangible assets, encompassing dynamic capabilities such as exploitative and exploratory search (Hilliard & Goldstein, 2019; Zhan & Chen, 2013). Search serves as a practical function essential for business operations (Katila & Ahuja, 2002), facilitating opportunity identification, decision-making, network development, commercial dialogs, resource utilization, and stakeholder engagement, all contributing to SME success (Baumann et al., 2019; Minh & Hjortsø, 2015). SME managers are encouraged to leverage these search capabilities to identify and support optimal business strategies tailored to their environment. The unique search activities undertaken by a firm for information gathering and network building pose challenges for competitors attempting to replicate similar strategies (Partanen et al., 2020), especially in the dynamic context of environmental dynamism (Shafique et al., 2021).

Limitations and directions for future studies

This study's limitations highlight potential directions for future research. The findings' generalizability is constrained by the reliance on data from a single nation. Although crucial for achieving the research objectives, broadening data collection to encompass other developing countries could provide a more

nuanced understanding of the roles and current state of exploitative and exploratory search in developing economies. Further research could also compare SMEs in both developed and developing nations, examining potential variations in their use of exploitative and exploratory search strategies (Ryu et al., 2022).

Our measures of exploitative and exploratory search include factors related to the customer base and their needs, while our primary performance measure focuses on environmental performance. Although customer needs provide some insights into environmental performance, future research should broaden performance metrics for a more comprehensive evaluation. This expansion should include financial metrics like sales or revenue from new products to assess economic impact. Additionally, innovation performance should be evaluated through metrics related to new product development, market introduction, and process improvements. Customer satisfaction metrics should capture feedback to evaluate how well products and innovations meet expectations. Expanding these measures will offer a more holistic view of firm performance and innovation outcomes (Amankwah-Amoah & Adomako, 2021).

To comprehend the influence of diverse search strategies on SMEs' new product development, innovation, competitiveness, and sustainability, it's essential to explore the specific impact of emerging technologies (Wang et al., 2021). Technological advancements, such as search engines, social media, and artificial intelligence, play a crucial role in shaping SME search methodologies (Wei & Pardo, 2022). In this regard, context is also material, as the effectiveness of these technologies can vary based on industry specifics, organizational size, and the regulatory environment. While we recognize that the number of new products does not fully capture the depth of explorative search activities, it remains a practical measure within our study's constraints (Katsikeas et al., 2016). Future research could enhance understanding by integrating both qualitative and quantitative metrics to provide a more comprehensive view of new product development processes.

A key limitation of this study is its reliance on self-reported environmental performance measures, which are subjective and prone to biases like social desirability and recall issues. Future research should address this by incorporating objective measures such as third-party audits or environmental impact assessments. Triangulating self-reported data with other sources can also enhance the robustness and credibility of the findings.

While this study advances our understanding of dynamic capabilities at the organizational level, a notable gap persists regarding its functioning at the individual and team levels (Salvato & Vassolo, 2018). At the individual level, further research is crucial to uncover how employees' skills, knowledge, and abilities contribute to the development of dynamic capabilities. Questions arise, such as how organizations can identify and cultivate individuals with skills essential for sensing, seizing, and reconfiguring market opportunities.

Additionally, exploring how to motivate these individuals to leverage their capabilities for driving innovation and organizational change is warranted. At the team level, there is a need for research on how teams can collaborate effectively to develop dynamic capabilities. Organizing teams to promote collaboration and information sharing, crucial for effective sensing, seizing, and reconfiguration of opportunities, demands attention. Research should delve into how team members can be trained and motivated to collaborate in transforming the organization in response to evolving market conditions.

While this study highlights the distinctive impact of environmental dynamism, encompassing both negative and positive effects, on the types of search engaged by SMEs for new product development, the intricacies and nuances of this influence warrant deeper exploration and elucidation. Future research should delve into the examination and characterization of these complexities. Additionally, exploring specific contingencies, such as crises (e.g., COVID-19) or instability (Calabrese et al., 2022; Pertuze et al., 2019), is essential for understanding how these external factors could shape the exploitative and exploratory search behaviors of SMEs.

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