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Entrepreneurial leadership and green product development for grand challenges: the roles of strategic sensitivity, collaborative innovation capability and political skill

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ABSTRACT

Green product development provides firms with a pathway to address grand challenges, including climate change, which threaten ecological balance, economic stability, and social well-being. Drawing on the dynamic capability view, this study examines how entrepreneurial leadership enables green product development in resource-constrained economies. We propose that strategic sensitivity and collaborative innovation capability mediate this relationship, while leaders' political skill moderates the effect of entrepreneurial leadership on strategic sensitivity. Using survey data from 252 SME leaders in Pakistan and analysing the model using structural equation modelling, the findings support the proposed hypotheses. Specifically, entrepreneurial leadership positively contributes to green product development. Also, strategic sensitivity and collaborative innovation capability significantly mediate the relationship between entrepreneurial leadership and green product development, while political skill strengthens the positive effect of entrepreneurial leadership on strategic sensitivity. This study contributes to the literature on entrepreneurial leadership, dynamic capabilities, and green product development, offering insights into how firms in resource-constrained settings can leverage leadership capabilities to create sustainable solutions and address grand societal challenges.

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Grand societal challenges; entrepreneurial leadership; green product development; strategic sensitivity; political skills; dynamic capability

Introduction

The world is facing multiple interconnected grand challenges, including extreme poverty, climate change, pollution, health issues, and inequality (George et al. 2016; Nambisan and George 2024). These challenges are closely interconnected, disrupting ecosystems and threatening global welfare (Brammer et al. 2019; George et al. 2024). Among these challenges, climate change is particularly critical due to its effects on resource depletion, environmental degradation, and disruptions to ecosystems and global markets (Falcke, Zobel, and Comello 2024). However, despite growing global urgency around climate change, a key puzzle remains: while many firms recognize the need for sustainability, few, particularly in resource-constrained economies such as Pakistan and Bangladesh, translate this awareness into market-oriented solutions. Firms in these contexts face resource scarcity, weak institutions, limited technological access, and inconsistent policies that constrain

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sustainability-oriented innovation (Khalid et al. 2025). This challenge reflects a broader pattern observed in emerging and institutionally constrained contexts, where the presence of resources does not necessarily translate into their effective activation, but instead depends on firms' ability to configure and mobilize capabilities under contextual pressures (Yasin and Nabi forthcoming; Zahoor et al. 2025).

For instance, SMEs in South Asia often operate with outdated technologies and limited access to financing, limiting their capacity to adopt green practices despite growing environmental pressures. This tension between widespread recognition of environmental imperatives and limited strategic responses raises an important question: how can firms operating with limited resources develop the capabilities needed to address complex challenges effectively?

Firms can create value and address the grand societal challenges arising from climate change through developing and designing green products (Bogers, Chesbrough, and Strand 2020; Liu et al. 2024). Given the complexity of climate change, green product development offers scalable solutions that address environmental challenges while contributing to a more sustainable economy (Falcke, Zobel, and Comello 2024; Ritala 2024). In resource-constrained contexts, green product development is both an environmental necessity and a strategic opportunity. It allows firms to reduce production costs through resource optimization, meet emerging global sustainability standards, and access environmentally conscious markets. For example, textile exporters in Pakistan and Vietnam increasingly adopt eco-friendly dyes and recyclable packaging to meet EU green standards, thereby enhancing competitiveness while contributing to sustainability.

In resource-constrained contexts, such initiatives are even more beneficial because they allow firms to leverage local materials, optimize limited resources, and build adaptive innovation systems that reduce dependency on imported technologies and volatile supply chains. Green product development, therefore, supports both sustainability and resilience, helping firms remain competitive while contributing to societal welfare. However, another theoretical puzzle lies: if green product development provides both ecological and economic benefits, why do many SMEs, particularly in emerging economies, struggle to engage in or sustain such an initiative? This tension suggests that, beyond financial or structural barriers, deeper organizational and leadership-related mechanisms may shape firms' ability to pursue sustainability through innovation.

Developing green products is important for creating value, supporting sustainability strategies, and improving community well-being (Albino, Balice, and Dangelico 2009; Y. S. Chen and Chang 2013; Khalid et al. 2025). Firms can greatly benefit from producing green products, as they can help reduce carbon emissions, protect natural resources, mitigate environmental impact, and manage organizational resources more effectively (Borah, Dogbe, and Marwa 2025; Li et al. 2021; A. P. Sharma 2021). However, it remains unclear how firms in resource-constrained environments develop the leadership and capabilities needed to translate sustainability intentions into outcomes. Despite the argued importance of green product development in achieving competitiveness and sustainability, studies focusing on the microfoundations, such as leadership traits and dynamic capabilities, behind green innovation in constrained and institutionally precarious contexts remain scarce (Aftab et al. 2023; Jugend et al. 2017; A. Sharma and Iyer 2012). This gap calls for a deeper understanding of how entrepreneurial leadership and capability development jointly enable firms to navigate grand challenges and pursue sustainable innovation. Recent work further suggests that such capability development is uneven and contingent on institutional and structural conditions, particularly in emerging economies where firms must continuously adapt resource configurations to sustain innovation trajectories (Yasin et al. 2026).

Based on the aforementioned knowledge gaps and in response to recent calls (Adomako et al. 2023; Bouguerra et al. 2023; Zahoor et al. 2024), we drew from the dynamic capability view (Teece, Pisano, and Shuen 1997) to propose a positive relationship between entrepreneurial leadership and green product development. Entrepreneurial leadership is defined as a leadership style characterized by vision, innovation, risk-taking, adaptability, and entrepreneurial skills (Fernald, Solomon, and Tarabishy 2005; Hoang, Luu, and Babalola 2025; Renko et al. 2015). We consider entrepreneurial leadership, because it can assist businesses to develop proactive initiatives and plans to deal with grand challenges (Bani-Melhem et al.

2025) and achieve sustainable goals, thus improving resource efficiency and organizational procedures for a sustainable world Moreover, entrepreneurial leadership can enable firms to capitalize on new opportunities and reduce the environmental impact by promoting environment friendly technologies, market offerings, and circular business models (Ameer and Khan 2023; Asad et al. 2024).

Seen through the lens of the dynamic capabilities view (Teece, Pisano, and Shuen 1997), we posit that strategic sensitivity and collaborative innovation capability serve as mechanisms through which entrepreneurial leadership contributes to green product development. While dynamic capabilities are generally understood as higher-order capabilities that enable firms to sense, seize, and reconfigure resources to respond to environmental changes (Teece 2007), strategic sensitivity and collaborative innovation capability serve as the microfoundations that enable these higher-order processes.

Strategic sensitivity refers to a firm's ability to detect environmental changes, identify risks, and recognize emerging opportunities (Clauss et al. 2019; Khorshid 2024). Entrepreneurial leaders, with their proactive and risk-taking orientation, foster this sensitivity among organizational members by promoting future-oriented thinking, continuous learning, and scenario planning (Bani-Melhem et al. 2025). This enhanced awareness transforms leadership vision and alertness into actionable insights that support green innovation, thereby strengthening the sensing dimension of dynamic capabilities.

Similarly, collaborative innovation capability is the firm's capacity to include or work with key collaborative innovation partners in the innovation process and assess how this enhances overall performance (Mishra and Shah 2009; Zahoor et al. 2025). It represents a lower-order, integrative routine that enables firms to seize opportunities by fostering cooperation and resource sharing among stakeholders (Swink 2006; C. Wang and Hu 2020). It involves processes such as cross-functional coordination, partner engagement, and knowledge co-creation (Mishra and Shah 2009), which collectively enhance a firm's ability to co-develop and implement sustainable innovations. By facilitating information exchange and joint problem-solving with external partners, collaborative innovation capability helps firms reconfigure their resource base and co-create value in response to evolving market and environmental demands. Together, these capabilities act as routines through which entrepreneurial leadership enables firms to sense opportunities and reconfigure resources for green product development.

We propose that a leader's political skill moderates the impact of entrepreneurial leadership on strategic sensitivity. Politically skilled leaders can build networks, secure resources, and influence stakeholders to enhance organizational learning and innovation (Ahearn et al. 2004; Usman et al. 2024). Prior studies highlight that political skills are more adaptable, proactive, creative, and quick to respond to evolving business dynamics and addressing the contemporary challenges (Rony et al. 2020; Usman et al. 2024). These abilities enable SMEs to gain market insights and identify trends, allowing them to introduce innovative offerings and improve existing ones to gain a competitive advantage while addressing environmental challenges that threaten people's welfare in contexts characterized by resource and institutional deficiencies. The proposed model is shown in Figure 1.

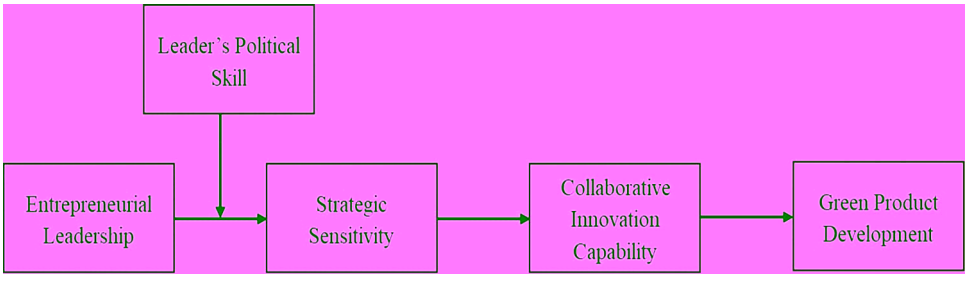

Figure 1. The conceptual model.

Theory and hypotheses development

Dynamic capability theory

To explain the proposed hypotheses, this study builds on the dynamic capability view, as it provides a more robust, strategic, and flexible framework than the resource-based view (Wu 2010). The dynamic capability view is particularly suitable for dynamic environments because it emphasizes adaptability, continuous improvement, and responsiveness to change (Teece, Pisano, and Shuen 1997). In contrast, the resource-based view is more appropriate in relatively stable contexts, where firms primarily focus on leveraging their existing resources and capabilities rather than continuously transforming them (Wu 2010).

The dynamic capability view provides a comprehensive, advanced, and flexible approach to achieving competitive advantage and sustaining long-term growth in dynamic markets, accounting for the complexities and uncertainties of the modern business environment (Khalid et al. 2025). It emphasizes the importance of unique knowledge, capabilities, and perspectives that enable firms to transform their operations, practices, and resources in response to changing conditions (Teece 2007). It focuses on a firm's ability to innovate and adapt to a constantly changing business environment (Cavusgil, Seggie, and Talay 2007). Dynamic capabilities arise from organizational activities that integrate, refine, and reconfigure both internal and external expertise to respond to evolving business demands (Wu 2010). This aligns with evidence that entrepreneurial behaviour and strategic adaptation are shaped by embedded socio-economic contexts, particularly in settings characterized by structural constraints and uneven resource access (Yasin and Hafeez 2023). This is particularly evident in resource-constrained environments, where firms must rely on adaptive capability configurations to compensate for institutional voids and limited resource endowments (Yasin et al. 2026; Zahoor et al. 2025). Through these capabilities, firms can address challenges by identifying opportunities, adapting to market changes, and continuously strengthening their resource base (Arend and Bromiley 2009).

Entrepreneurial leadership and green product development

According to Teece (2007), businesses recognize opportunities and market trends both internally and externally, develop proactive strategies, and adapt their structure and processes to capitalize on market opportunities for sustained growth and address contemporary challenges. Business leaders help firms stay ahead of market trends, enhance organizational expertise and capabilities, and drive innovation, fostering growth and long-term success (Bani-Melhem et al. 2025).

This study focuses on entrepreneurial leadership for its ability to identify opportunities, nurture innovation, encourage learning, and market-oriented solutions to capture opportunities and address challenges (Gupta, MacMillan, and Surie 2004; Leitch and Volery 2017). Through sensing, entrepreneurial leaders continuously scan the environment for emerging trends and sustainability challenges; through seizing, they design innovative business models and mobilize teams towards green innovation; and through reconfiguring, they restructure operations, processes, and resource allocations to sustain green product development efforts.

The literature highlights the importance of recognizing opportunities, formulating strategies to leverage them, and adapting business practices to evolving market conditions for long-term success (Teece, Pisano, and Shuen 1997). As such, we argue that improving organizational structure, optimizing resources, fostering innovation, and promoting encouraging creativity and learning are fundamental aspects of entrepreneurial leadership. Moreover, they are more willing to take risks and excel at making innovative decisions to address societal challenges, particularly in resource- and institution-constrained environments.

Entrepreneurial leaders demonstrate key traits such as innovation, risk-taking, creativity, entrepreneurial expertise, and a market-focused mindset, all driven by a long-term vision

(Fernald, Solomon, and Tarabishy 2005; Renko et al. 2015). Entrepreneurial leaders actively inspire and guide individuals, fostering collaboration to capture market opportunities and address emerging challenges through entrepreneurial choices. Entrepreneurial leaders actively inspire and guide individuals, fostering collaboration to capture market opportunities and address emerging challenges through strategic decision-making (Harrison, Burnard, and Paul 2018; Malibari and Bajaba 2022). They empower individuals to think creatively and identify new opportunities by cultivating a culture of innovation and experimentation (Bani-Melhem et al. 2025). Entrepreneurial leaders, leveraging skills such as creativity, a market-focused approach, resource optimization, and long-term vision (Hoang et al. 2022; Renko et al. 2015), prioritize addressing grand environmental challenges, thereby motivating them to develop green products. Entrepreneurial leaders possess an innovative mindset and constantly explore innovative solutions to emerging challenges (Bani-Melhem et al. 2025), enabling the development of green initiatives that play a key role in addressing critical environmental issues. They are more inclined to take risks and are highly skilled at making market-driven decisions (Hensellek, Kleine-Stegemann, and Kollmann 2023) that can lead to the development of sustainable products. Therefore, entrepreneurial leaders excel in innovation, streamline organizational processes, and tackle emerging challenges, even with limited resources. They are highly flexible and motivated to adapt to new settings (Fernald, Solomon, and Tarabishy 2005; Hoang et al. 2022). This adaptability allows leaders to adjust their strategies according to changing market dynamics, ensuring the firm is positioned to take advantage of contemporary opportunities and address the emerging challenges (Usman et al. 2024) that may ultimately drive the development of green market offerings. Together, we develop the following hypothesis.

H1: Entrepreneurial leadership is positively related to green product development.

Entrepreneurial leadership and strategic sensitivity

Strategic sensitivity enables firms to continuously monitor market shifts (Clauss et al. 2021), thereby identifying emerging opportunities and challenges that may affect their operations and business activities. Firms with strategic sensitivity are highly adaptable and responsive to change (Clauss et al. 2019; Hock, Clauss, and Schulz 2016), enabling them to navigate environmental challenges effectively and drive innovation.

The dynamic capability view underscores the importance of identifying opportunities, seizing them, and reallocating resources to enable effective adaptation (Teece, 1997). Entrepreneurial leadership plays a significant role in promoting proactive decision-making, innovation, and market awareness (Bani-Melhem et al. 2025; Hoang et al. 2022). Entrepreneurial leadership integrates creativity, risk-taking, innovation, and a market-driven approach (Renko et al. 2015), emphasizing continuous environmental scanning, proactive change anticipation, and organizational adaptability. Entrepreneurial leadership provides firms with essential support, resources, and frameworks (Surie and Ashley 2008) to recognize emerging opportunities and risks and effectively address major environmental challenges. Their visionary approach fosters a culture of continuous improvement and learning (Bani-Melhem et al. 2025), enabling firms to remain agile and responsive to environmental changes. Entrepreneurial leadership efficiently allocates resources to support organizational activities (Fernald, Solomon, and Tarabishy 2005; Malibari and Bajaba 2022), enabling the continuous monitoring of the external environment and the timely adjustment of strategies in response to emerging changes.

Additionally, entrepreneurial leadership facilitates experimentation, departmental collaboration, and flexibility that contribute to strategic sensitivity. Entrepreneurial leadership fosters a culture that encourages employees to contribute market insights, information, and creative ideas on market shifts and potential opportunities, ultimately enhancing strategic sensitivity.

Grounded in the dynamic capability view, we argue that entrepreneurial leadership enhances a firm's sensing ability (i.e. a core dynamic capability) by embedding environmental awareness, experimentation, and adaptive learning into daily operations (Teece 2007). Through these actions, leaders cultivate strategic sensitivity as a dynamic mechanism that links leadership-driven vision with continuous environmental adaptation. Therefore, entrepreneurial leadership provides the support, resources, and platforms necessary to strengthen strategic sensitivity. We argue that entrepreneurial leadership recognizes the value of strategic sensitivity by fostering a proactive approach to market awareness and by continuously monitoring both existing and emerging trends, which are essential for green product development. Thus, we propose the following hypothesis.

H2: Entrepreneurial leadership is positively related to strategic sensitivity.

Strategic sensitivity and collaborative innovation capability

Through the lens of dynamic capability, firms must identify emerging opportunities and potential risks, leverage existing ones, and adjust their strategies to adapt to a changing business landscape (Teece, Pisano, and Shuen 1997). From the perspective of the dynamic capability view, strategic sensitivity embodies the 'sensing' function, while collaborative innovation capability reflects the 'seizing' and 'reconfiguring' dimensions (Teece 2007). Firms first identify emerging opportunities and threats through strategic sensitivity and then operationalize these insights by collaborating, co-creating, and reconfiguring resources with partners to innovate effectively. This alignment of sensing and seizing capabilities is central to achieving sustainable competitive advantage in turbulent environments. Strategic sensitivity is crucial for enhancing organizational processes and practices, allowing firms to stay agile and competitive in dynamic business environments (Atkinson et al. 2022; Zahoor et al. 2024). Strategic sensitivity involves a firm's ability to identify, uncover, interpret, and respond to emerging market needs, changing business needs, and requirements (Hock, Clauss, and Schulz 2016), thereby helping firms make more informed, market-oriented decisions. Thus, strategic sensitivity contributes to organizational success by identifying valuable opportunities and generating insights through continuous scanning, thereby driving innovative solutions, collaboration, and operational efficiency.

Previous research suggests that strategic sensitivity assists firms in identifying gaps in the market and effectively navigating the complex regulatory landscape and support business model innovation (Clauss et al. 2019, 2021) that ultimately enhance the firm collaborative innovation capability and make them more agile to address the grand environmental challenges in various settings that are characterized by resource and institutional deficiencies. Strategic sensitivity enables firms to gather insights about various business functions and market needs (Hock, Clauss, and Schulz 2016), enabling firms to develop innovative solutions that align with changing market needs and address the contemporary grand societal challenges. Furthermore, strategic sensitivity enhances collaborative innovation capability by promoting awareness, adaptability, and proactive engagement with internal and external stakeholders (Zahoor et al. 2024). As such, it serves as a mechanism for antecedent knowledge and awareness that guides when, how, and with whom firms collaborate. Firms with high strategic sensitivity can proactively anticipate and understand market risks and opportunities (Clauss et al. 2021), thereby enhancing the effectiveness of collaborative innovation initiatives. By continuously scanning and interpreting environmental changes, these firms generate market intelligence that informs the design and direction of collaborative initiatives. In this way, strategic sensitivity transforms environmental awareness into actionable opportunities for joint problem-solving and innovation.

Strategic sensitivity enables firms to make quick and timely decisions about collaboration, engagement, research and development, and co-developing innovative solutions to address the grand environmental challenges. Moreover, it fosters a shared understanding of market trends and sustainability goals among internal and external stakeholders, making collaboration more targeted and effective (Zahoor et al. 2024). Thus, strategic sensitivity ensures more effective partnerships and sustained innovation outcomes in a rapidly changing business landscape. Through strategic sensitivity, firms can acquire insights about market needs, partner with stakeholders to develop innovative solutions, and achieve sustained growth and competitive advantage. As such, we argue that strategic sensitivity strengthens collaborative innovation capability by enhancing awareness, flexibility, agility, stakeholder engagement, and business evaluation, enabling firms to co-create innovative solutions in a dynamic business environment. Thus, we propose the following hypothesis.

H3: Strategic sensitivity is positively related to collaborative innovation capability.

Collaborative innovation capability and green product development

Businesses must develop expertise and skills to effectively integrate, manage, and utilize resources for success in a rapidly evolving business environment (Teece 2007). From the perspective of dynamic capability theory, sustainable competitiveness depends not only on owning valuable resources but on the ability to reconfigure, renew, and integrate them in response to environmental changes. Grounded in this view, we theorize that collaborative innovation capability represents a dynamic capability that enables firms to sense emerging sustainability challenges, seize innovation opportunities through joint actions, and reconfigure resources and partnerships to deliver environmentally responsible products and solutions.

Collaborative innovation capability enables firms to leverage diverse expertise, skills, and technologies (Swink 2006), which, in turn, contribute to more effective and environmentally friendly market offerings that mitigate environmental challenges. Indeed, collaborative innovation capability ensures innovation and optimizes the business processes (Najafi-Tavani et al. 2018). Collaborative innovation capability enables firms by fostering a culture of learning and experimentation across organizational processes (Swink 2006), ultimately enhancing their ability to develop environmentally friendly products and improve the quality of existing products to address contemporary environmental challenges. Collaborative innovation capability enhances collaboration and involves key stakeholders (Ozdemir et al. 2023) through knowledge, information, and resource integration, which are necessary for green product development.

Prior research highlights that collaborative innovation capability assists firms in improving their processes and design processes (Najafi-Tavani et al. 2018; C. Wang and Hu 2020), which, in turn, enables them to produce sustainable products to address environmental challenges. Notably, collaborative innovation capability leverages resources and capabilities across the value chain (Zhao et al. 2013), enabling firms to develop innovative market offerings and solutions that meet environmental needs and benefit the community. Moreover, collaborative innovation capability ensures firms stay ahead of competition by better understanding and responding to the emerging business landscape and changes (Swink 2006). Indeed, collaborative innovation capability enables firms to design and develop sustainable, competitive, and environmentally responsible products by engaging key stakeholders to sustain growth and societal welfare. It enables organizations to develop sustainable, competitive, and environmentally responsible offerings by continuously learning, adapting, and co-evolving with their partners. By leveraging collaborative innovation capabilities, firms can better sense market opportunities and risks and develop sustainable products to mitigate grand societal challenges. Therefore, we contend that collaborative innovation capability can contribute to green product development by facilitating knowledge and information sharing

and by integrating organizational resources and skills, particularly in resource- and institution-constrained settings. Thus, we propose the following hypothesis.

H4: Collaborative innovation capability is positively related to green product development.

Strategic sensitivity and collaborative innovation capability as serial mediators

Seen through the lens of dynamic capability view, we know that strategic sensitivity and collaborative innovation capability are essential for acquiring market insights and trends, facilitating collaboration through sharing knowledge and resources, and engaging stakeholders (Clauss et al. 2019, 2021; Najafi-Tavani et al. 2018; C. Wang and Hu 2020) to address the grand environmental challenges and contribute to the welfare of the society. From a dynamic capability view perspective, strategic sensitivity represents the sensing dimension, enabling firms to detect shifts in markets and technologies. In contrast, collaborative innovation capability reflects the seizing and reconfiguring dimensions, through which firms mobilize resources and partnerships to act upon those sensed opportunities (Teece 2007). This theoretical linkage suggests that firms not only identify external changes but also transform those insights into innovative and sustainable solutions through coordinated action and capability reconfiguration.

Strategic sensitivity and collaborative innovation capability enable firms to be proactive and responsive to market changes, leverage resources and capabilities across the value chain (Hock, Clauss, and Schulz 2016; Ozdemir et al. 2023; Zahoor et al. 2024), thereby enabling them to develop green products for a sustainable world. Importantly, strategic sensitivity contributes to the long-term success and sustained growth by continuously monitoring the market environment and offering deeper insights into emerging business needs that may impact their operations and business activities (Hock, Clauss, and Schulz 2016; Zahoor et al. 2024), while collaborative innovation capability streamlines the firm processes and operations by engaging stakeholders and sharing resources with them that is necessary for the green product development (Swink 2006). Indeed, both strategic sensitivity and collaborative innovation capability are key to acquiring a competitive advantage and addressing the grand societal challenges in contexts characterized by resource and institutional deficiencies. As such, the underlying premise of our arguments thus far has been that entrepreneurial leadership enables firms to improve their ability to identify, interpret, and respond to opportunities, emerging market trends, and perceived risk (i.e. strategic sensitivity) that are essential to developing proactive strategies to address grand societal challenges. Consequently, strategic sensitivity contributes to collaborative innovation capability, which, in turn, facilitates the development of environmentally friendly products. As such, we argue that strategic sensitivity and collaborative innovation capability act as serial mediators through which entrepreneurial leadership influences green product development in the context of emerging economies. Thus, the following hypothesis is proposed.

H5: Strategic sensitivity and collaborative innovation capability act as serial mediators of the associations of entrepreneurial leadership with green product development.

The moderating role of the leader's political skill

The dynamic capability view asserts that businesses must recognize opportunities, adopt proactive market-driven strategies, and continually update their resources to adapt to changing business environments (Teece, Pisano, and Shuen 1997; Wu 2010). In this view, the ability to sense environmental signals, seize opportunities, and reconfigure organizational resources is embedded not only in processes and systems but also in leaders' social and interpersonal

competencies. Individuals with political skills tend to inspire, motivate, and persuade others while building strong networks (Usman et al. 2024), helping companies secure key resources vital for green product development innovation. We argue that the relationship between entrepreneurial leadership, strategic sensitivity, collaborative innovation capability, and green product development is complex and may be influenced by a leader's political skill. In this work, we argue that entrepreneurial leadership is contingent on the leader's political skill. Individuals with strong political skills can enhance organizational capabilities in environmental scanning, increasing agility, strengthening communication, and managing risks (Lu et al. 2024). Through political skill, individuals can enhance the firm's ability to sense external opportunities, seize them through effective influence and coordination, and reconfigure internal processes to align with changing sustainability priorities, thereby allowing firms to respond more effectively to market dynamics by leveraging connections with key stakeholders (Rony et al. 2020).

Leaders high in political skill are adept at sensing market shifts and reconfiguring internal processes to align with external opportunities. They assist firms in making informed, market-oriented decisions, thereby improving organizational efficiency (Usman et al. 2024). They navigate environmental challenges by building networks with key stakeholders (Lu et al. 2024). Through the lens of dynamic capability theory, political skill operates as a micro-foundation that spans across sensing, seizing, and reconfiguring capabilities, enabling leaders to detect opportunities, mobilize support, and adapt resources for innovation. Focusing on developing, improving, and optimizing organizational activities and actions can contribute to strategic sensitivity. Moreover, they are better able to understand the emerging opportunities and challenges due to their commitment to add value to the organizational value chain. Seen through the lens of dynamic capability theory, leaders high in political skill identify opportunities, manage risks, build strong networks, and strengthen environmental scanning, ultimately contributing to green, environmentally friendly products for a sustainable economy and the welfare of the community. They must ensure that market intelligence, competitor insights, and industry trends can be effectively identified and integrated to develop strategies and market offerings that mitigate environmental challenges. Thus, we contend that, compared to their counterparts, leaders high in political skill are likely to engage in activities that contribute to strategic sensitivity.

H6: Leader's political skill moderates the positive relationship between entrepreneurial leadership and strategic sensitivity, such that this relationship is stronger when leader's political skill is high (vs low).

Prior studies highlight that political skill has been associated with several positive outcomes, such as innovation, creativity, and overall performance of the organization (Lu et al. 2024; Usman et al. 2024). Seen through the dynamic capability perspective, politically skilled leaders not only facilitate environmental sensing but also enhance firms' ability to seize opportunities and reconfigure capabilities through collaboration, communication, and influence (Teece 2007). Political skill thus acts as a cross-cutting capability that enables leaders to sense sustainability-oriented opportunities, seize them by mobilizing resources and stakeholder support, and reconfigure structures to foster innovation. A leader with high political skill can help navigate complex settings and foster a culture of awareness and adaptability (Ahearn et al. 2004; Rony et al. 2020). Therefore, they are likely to facilitate the development of skills and expertise that lead to green product development. Leaders can gather, manage, and interpret market insights (i.e. strategic sensitivity) from all sources, which, in turn, enable businesses to develop green products. In the existing study, we conceptualize that a leader's political skill influences green product development through strategic sensitivity and collaborative innovation capability.

Furthermore, as proposed above in H6, the impact of entrepreneurial leadership is strong for high (vs low) leader political skill. Thus, we argue that the indirect effect of entrepreneurial leadership via

strategic sensitivity and collaborative innovation capability is also strong. The current research, thus, proposes the following hypothesis.

H7: Leader's political skill moderates the indirect (via strategic sensitivity and collaborative innovation capability) relationship between entrepreneurial leadership and green product development, such that the relationship is stronger when leader's political skill is high (vs low).

Methods

Sample and procedure

Data were collected from 252 leaders using a time-lagged approach (three phases) with two-week intervals between phases. Temporal separation between measurements helps reduce common-method bias by limiting respondents' reliance on earlier responses (Podsakoff et al. 2003). We employed a two-week interval between survey waves, as it provides sufficient temporal separation to reduce common method bias by limiting respondents' ability to recall and directly relate their responses across survey rounds. At the same time, the interval is not excessively long, which helps minimize potential attrition across the data collection waves. Previous research (e.g. Zahoor et al. 2025) has used a two-week lag between different data collection waves.

Respondents belonged to various manufacturing and service SMEs in Pakistan. Pakistan is an appropriate case for empirical validation of these relationships, as organizations in this country are known to face considerable resource and institutional constraints, limiting their ability to engage in innovation and sustainability. Therefore, it is of interest to explore how entrepreneurial leadership and capability development help organizations to effectively mobilize their limited resources to look for opportunities for green product development in such contexts, which is likely to provide us with valuable insights into how entrepreneurial leadership and capability development help organizations to address environmental issues despite their limited resources effectively (Aftab et al. 2023; Jugend et al. 2017; A. Sharma and Iyer 2012).

Initially, 500 alumni from a public university in Pakistan working in top leadership positions across sectors such as telecommunications, textiles, information technology, leather, and ceramics were contacted. Of those, 332 agreed to participate after being informed of the study's purpose, confidentiality, and the assurance of anonymity. In the first phase, 388 questionnaires were returned, gathering information on firm age, size, entrepreneurial leadership, and leader political skill. Two weeks later, 288 managers provided data on the mediators – strategic sensitivity and collaborative innovation capability. In the final phase, 266 managers submitted data on green product development.

To match responses across the three survey waves while preserving anonymity, participants were asked to generate an eight-digit identification code based on simple personal cues. Specifically, respondents created the code by writing the last letters of their first name, the last two digits of their phone number, the last two letters of their organization, and the last two letters of their hometown. Participants used the same code in each survey phase, which enabled accurate matching of responses across waves without collecting personally identifiable information.

After matching responses using unique codes and checking for missing values, the final sample comprised responses from 252 managers. The data were analysed using structural equation modelling (SEM) in Mplus (8.8). We used Mplus because it provides robust estimation procedures, effectively handles missing data, and is widely used for SEM involving complex models. Firms' average age was 5.96 years. Further, 59.1% of the firms were small, 40.9% were medium-sized, 52.8% were manufacturing firms, and 47.2% were service sector firms.

Common method bias

A time-lagged design was employed to address common method bias (Podsakoff et al. 2003). We also tested the data for sampling bias. We also employed Harman's single-factor method. To do so, all the items were constrained to load on a single factor. This single factor explained 29.1% of the variance, which is well below the 50% cut-off.

Measures and variables

All the constructs were assessed on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). All the scale items are provided in Appendix A. The details of the measurement instruments used in the current research are as follows. We assessed entrepreneurial leadership using an eight-item scale (α = .93) adapted from Renko et al. (2015). Sample item: '*I often come up with radical improvement ideas for the products/services we are selling'*. Strategic sensitivity was assessed by adapting a three-item scale (α = .74) from Hock, Clauss, and Schulz (2016). Sample item: '*Our firm is very sensitive to external changes and integrates these into the strategic planning of our business'*. Collaborative innovation capability was assessed by adapting a seven-item scale (α = .92) from F. Wang et al. (2017). Sample item: *'Relative to competitors, our firm has a better ability to introduce new products in conjunction with our partner firms'*. Green product development was assessed by adapting a four-item scale (α = .88) from Schilke (2014). Sample item: *In the last three years, 'Our firm introduced a new generation of environmentally friendly products'*. Leader political skill was measured by using a six-item scale *(α = .92)* from Ahearn et al. (2004). Sample item: '*I am good at getting others to respond positively to me*'.

Control variables

Extant studies show that firm age and size may confound results (Al-Khatib 2022), and these variables were consequently included as control variables. Age was measured as the number of years a firm had been in business. The number of employees assessed is size. Small firms were categorized as 1, and medium firms as 2. Further, firms' ability to develop green products may vary across industries. Therefore, we controlled for industry type (1 = manufacturing organizations and 2 = service organizations).

Results

Means and correlations

Means and correlations are presented in Table 1. All the correlations among the main variables were significant and largely in the expected direction.

Table 1. Means and correlations.

	Mean	SD	1	2	3	4	5	6	7
1. Entrepreneurial leadership	3.92	.92							
2. Strategic sensitivity	3.90	.90	.24**						
3. CIC	3.78	.92	.31**	.30**					
4. GPD	3.75	.97	.24**	.31**	.51**				
5. LPS	3.91	.85	.18**	.04	.08	.07			
6. Firm age	5.96	1.82	.06	.13*	−.06	.07	.06		
7. Firm size	1.41	.49	−.07	−.04	−.05	.00	−.08	−.09	
8. Industry type	1.47	.50	.02	.00	.19**	.02	.00	−.06	−.11

Notes. *$p < .05$. **$p < .01$. Sample size (N) = 252. CIC = Collaborative innovation capability. GPD = Green product development. LPS = Leader political skill. Firm size = 1(small) and 2(medium). Industry type = 1(manufacturing organization) and 2 (service organization).

Measurement model

Confirmatory factor analysis was employed to assess the measurement model, which was comprised of entrepreneurial leadership, strategic sensitivity, collaborative innovation capability, green product development, and leader political skill. All items loaded significantly ($p < .01$). The fit indices, $\chi 2$ (340) = 785.12, $\chi 2/df = 2.31$, IFI = .91, TLI = .90, and RMSEA = .07, indicated that the measurement model provided a good fit to the data. The average variance extracted (AVE) for all variables exceeded the recommended level of .50 (Table 2). Further, for all variables, the square root of the AVE was greater than their inter-construct correlations, and both average shared variance (ASV) and maximum shared variance (MSV) were lower than the AVE values (Table 2). Thus, the measurement model was valid and satisfactory in both convergent and discriminant validity.

Hypotheses testing

The results are presented in Table 3. Overall, the results supported our hypotheses. The results (Table 3) confirmed a significant positive association between entrepreneurial leadership and green product development *(B = .25, SE = .06, p < .01)*. The results also confirmed a significant positive association between entrepreneurial leadership and strategic sensitivity *(B = .23, SE = .06, p < .01)*. Further, we found significant positive associations between strategic

Table 2. Discriminant validity and convergent validity.

	1	2	3	4	5	AVE	MSV	ASV	α
1. Entrepreneurial leadership	**.80**					.64	.12	.08	.93
2. Strategic sensitivity	.30	**.71**				.50	.14	.09	.74
3. CIC	.34	.36	**.79**			.62	.32	.14	.92
4. GPD	.27	.37	.57	**.81**		.65	.32	.14	.88
5. LPS	.18	.06	.08	.07	**.82**	.67	.03	.01	.92

Sample size (N) = 252. CIC = Collaborative innovation capability. GPD = Green product development. LPS = Leader political skill. AVE = Average variance extracted. MSV = Maximum shared variance. ASV = Average shared variance. Bolded values on the diagonals of columns 2 to 6 are the square root values of AVE.

Table 3. Hypotheses results.

	B	SE	95%CI	
			LL	*UL*
Total Effect				
Entrepreneurial leadership → GPD	.25**	.06	.13	.38
Direct Paths				
Entrepreneurial leadership → GPD	.07	.06	−.05	.19
Entrepreneurial leadership → Strategic sensitivity	.23**	.06	.12	.35
Strategic sensitivity → CIC	.25**	.06	.13	.37
CIC → GPD	.46**	.06	.34	.58
Indirect Path				
Entrepreneurial leadership → Strategic sensitivity → CIC → GPD	.03*	.01	.01	.05
Moderated Paths				
Entrepreneurial leadership * LPS → Strategic sensitivity	.20**	.06	.08	.32
Entrepreneurial leadership → Strategic sensitivity (on high LPS)	.41**	.08	.25	.57
Entrepreneurial leadership → Strategic sensitivity (on low LPS)	.07	.08	−.09	.22
Entrepreneurial leadership → GPD (via strategic sensitivity and CIC on high LPS)	.04**	.02	.02	.08
Entrepreneurial leadership → GPD (via strategic sensitivity and CIC on low LPS)	.01	.01	−.01	.03
Index of moderated mediation	.02*	.01	.01	.04

Notes. *N=252. B = Unstandardised coefficient, SE = Standard error, Bootstrapping specified at 5000 with 95% confidence interval. CI = Confidence* interval. LL = lower limit. UL = Upper limit. CIC = Collaborative innovation capability. GPD = Green product development. LPS = Leader political skill.

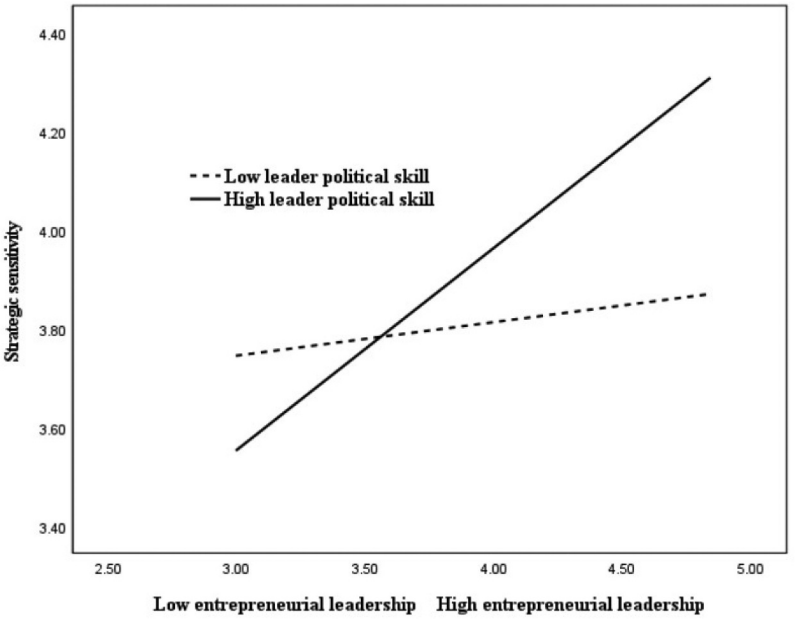

Figure 2. Leader political skill as a moderator of the relationship between entrepreneurial leadership and strategic sensitivity.

sensitivity and collaborative innovation capability *(B = .25, SE = .06, p < .01)* and collaborative innovation capability and green product development *(B = .46, SE = .06, p < .01)*. Thus, hypotheses 1, 2, 3, and 4 were supported. We also found a significant indirect positive relationship between entrepreneurial leadership and green product development via strategic sensitivity and collaborative innovation capability *(B = .03, SE = .01, p < .05)*. Thus, hypothesis 5 was supported, showing that strategic sensitivity and collaborative innovation capability as serial mediators to significantly mediate the association between entrepreneurial leadership and green product development.

To test the moderation effect of leader political skill on the association between entrepreneurial leadership and strategic sensitivity, the interaction of entrepreneurial leadership and leader political skill was included in the mediation model. The moderation analysis showed that the interaction between entrepreneurial leadership and leader political skill was positively related to strategic sensitivity *(B = .20, SE = .06, p < .01)*. The interactions plotted at +1/-1 SD (Figure 2) from the mean of leader political skill revealed that the influence of entrepreneurial leadership on strategic sensitivity was significant when leader political skill was high *(B = .41, SE = .08, p < .01)*. On the contrary, the influence of entrepreneurial leadership on strategic sensitivity was insignificant when leader political skill was low *(B = .07, SE = .08, ns)*. Thus, hypothesis 6 was supported.

Finally, the moderated-moderation analysis showed that the indirect influence of entrepreneurial leadership on green product development was significant *(B = .04, SE = .02, p < .01)* when leader political skill was high. However, the indirect influence of entrepreneurial leadership on green product development was insignificant when the leader's political skill was low *(B = .01, SE = .01, ns)*. Further, the index of moderated mediation was significant *(B = .02, SE = .01, p < .01)*. Conditional indirect effect is depicted in Figure 3. Thus, hypothesis 7 was supported.

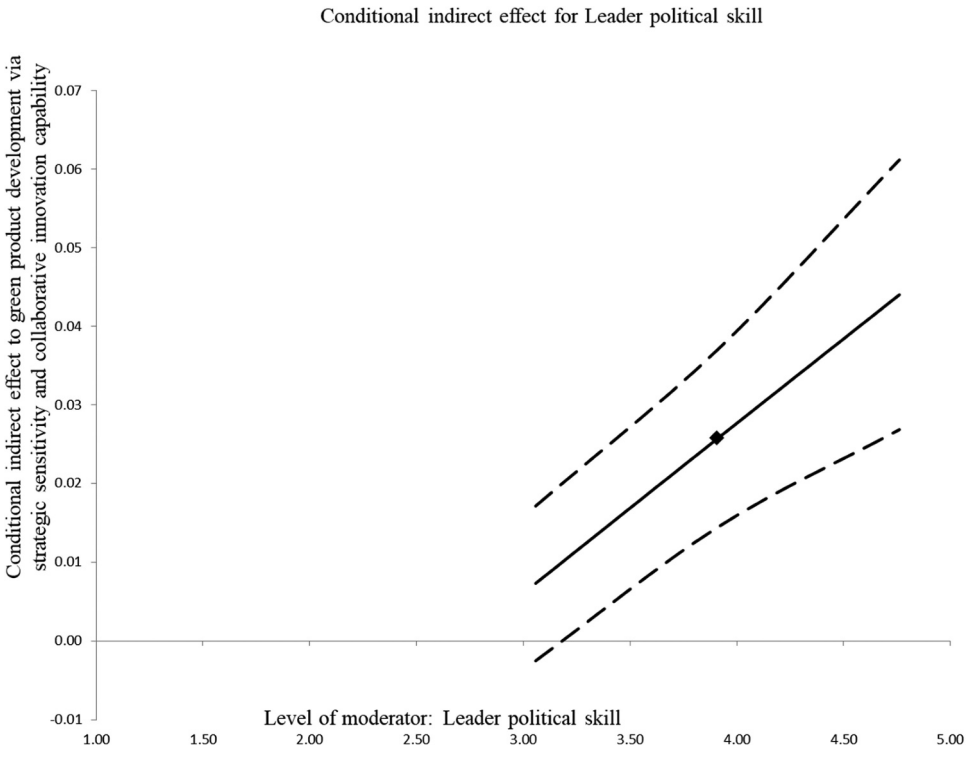

Figure 3. Conditional indirect effect on green product development via strategic sensitivity and collaborative innovation capability.

Discussion

Drawing on the dynamic capability view, this study examined how and when entrepreneurial leadership fosters green product development through strategic sensitivity and collaborative innovation capability. The findings show that entrepreneurial leadership, both directly and indirectly, contributes to green product development, and that a leader's political skill strengthens this relationship. These results suggest that entrepreneurial leaders play an important role in enabling firms to respond to sustainability challenges by identifying opportunities, mobilizing limited resources, and facilitating innovation processes. This reinforces prior evidence that the effectiveness of leadership-driven innovation is contingent not merely on resource availability, but on how those resources are activated and reconfigured within specific institutional contexts (Yasin and Nabi forthcoming).

Unlike green transformational or responsible leadership, which primarily focuses on motivating individuals towards environmental goals, entrepreneurial leadership emphasizes opportunity recognition, calculated risk-taking, and resource mobilization to transform sustainability challenges into market-oriented innovations. The findings further indicate that entrepreneurial leadership enhances firms' ability to recognize environmental opportunities through strategic sensitivity and to implement sustainable innovations through collaborative innovation capability. In addition, the moderating role of leader political skill suggests that leaders who effectively build networks and influence stakeholders can strengthen firms' ability to mobilize resources and sustain innovation, particularly in contexts characterized by institutional constraints and resource limitations. Prior work also highlights how embedded relational and institutional pressures can constrain strategic autonomy and shape organizational behaviour in subtle but consequential ways (Yasin et al. 2025).

The Pakistani context highlights how these mechanisms work under institutional and resource constraints. In such settings, weak infrastructure, limited financing, and policy inconsistencies drive leaders to rely on networks and adaptive learning to develop green innovations. Political skill becomes more important for navigating institutional voids and securing external support. While these insights enrich understanding of dynamic capabilities in constrained contexts, their generalizability to more stable, resource-rich economies may be limited, as formal systems substitute for relational and adaptive mechanisms.

Theoretical contributions

First, this study advances the literature on the antecedents of green product development (Albino, Balice, and Dangelico 2009; Y. S. Chen and Chang 2013; Guo, Choi, and Shen 2020), particularly in contexts characterized by resource and institutional deficiencies. Prior research has identified several enablers of green product development, including environmental strategies, stakeholder pressures, technological advancements, and government incentives (Albino, Balice, and Dangelico 2009; C. Chen 2001; Zolfagharinia, Zangiabadi, and Hafezi 2023). While these studies provide valuable macro-level insights, they tend to overlook the micro-foundations of green innovation, particularly the leadership capabilities that drive firms to reconfigure limited resources towards sustainability goals. Drawing on the dynamic capability view, which emphasizes firms' ability to sense opportunities, seize them, and reconfigure resources in response to environmental changes, our study identifies entrepreneurial leadership as a critical yet underexplored antecedent of green product development. In doing so, the study highlights entrepreneurial leadership as a leadership-based micro-foundation that enables firms to build capabilities for sustainability-oriented innovation.

Secondly, this study contributes to the growing literature on entrepreneurial leadership by exploring its role in addressing grand societal challenges. The literature on entrepreneurial leadership has highlighted several outcomes, including growth hacking, creativity, organizational performance, and flexibility (Bani-Melhem et al. 2025; Hensellek, Kleine-Stegemann, and Kollmann 2023; Razzaque, Lee, and Mangalaraj 2024). While existing studies offer key insights, our research expands the literature by emphasizing the role of entrepreneurial leadership in driving sustainability-oriented innovation (i.e. green product development), particularly in resource-constrained contexts. Grounded in the dynamic capability perspective, our findings demonstrate how entrepreneurial leaders facilitate firms' ability to sense emerging environmental opportunities, mobilize scarce resources, and reconfigure organizational processes to support green innovation.

Third, this study identifies strategic sensitivity and collaborative innovation capability as key mediating mechanisms linking entrepreneurial leadership to green product development. Prior research has recognized that strategic sensitivity enables firms to identify market shifts, assess environmental risks, and drive business model innovation (Clauss et al. 2019; Hock, Clauss, and Schulz 2016), while collaborative innovation capability facilitates stakeholder engagement, knowledge integration, and joint value creation (Khalid et al. 2025; Najafi-Tavani et al. 2018; C. Wang and Hu 2020). From a dynamic capability perspective, these mechanisms represent key processes through which firms sense opportunities and reconfigure resources to respond to environmental challenges. By highlighting strategic sensitivity and collaborative innovation capability as key serial mediators, this research advances theoretical understanding of how leadership-driven capabilities enable green product development in resource-constrained economies.

Lastly, the current research study integrates a key individual difference, leader political skill, into our framework and exhibits that it considerably moderates the direct influence of entrepreneurial leadership on strategic sensitivity and the indirect impact on green product development. Owing to individual differences, firms may better scan and monitor the market environment, identifying emerging opportunities and potential risks, which helps them respond to grand environmental challenges more effectively. Previous research highlights that a leader's political skill enhances

organizational performance, access to resources, network building, innovation, and creativity (Ahearn et al. 2004; Rony et al. 2020; Usman et al. 2024). Extending the dynamic capability view, the current study is the first to integrate the construct of leaders' political skill in the context of entrepreneurial leadership, strategic sensitivity, collaborative innovation capability, and green product development in the resource- and institutionally constrained settings. Leaders with high political skill are better able to interpret stakeholder expectations, secure cooperation, and create supportive conditions for strategic sensitivity and collaborative innovation, ultimately facilitating green product development.

Practical implications

Our study has several practical implications. First, our research findings offer insights into how firms can facilitate green product development through entrepreneurial leadership in developing economies. The findings demonstrate that entrepreneurial leadership is essential to advancing the green product development process and achieving sustained growth while enabling firms to respond proactively to grand environmental challenges such as climate change, resource depletion, and escalating environmental degradation. In emerging and resource-constrained economies, firms often face increasing pressure from governments, communities, and global markets to adopt sustainable practices and help address large-scale societal challenges. Therefore, managers of firms seeking to develop and facilitate innovative market solutions must acquire, integrate, and manage the key resources required for green product development. Importantly, firms that emphasize entrepreneurial leadership are more likely to achieve success by addressing pressing societal challenges that reduce environmental harm, improve resource efficiency, and support more sustainable consumption and production systems. To do so, entrepreneurial leaders must proactively identify sustainability-related opportunities, assess potential environmental risks, and empower employees to drive the development of environmentally friendly products through initiatives. These efforts, in turn, enable organizations to actively participate in addressing systemic environmental problems such as pollution, excessive waste generation, and inefficient resource utilization – issues that are particularly acute in many developing economies.

Entrepreneurial leadership is also important for embedding sustainable actions and activities into the core business strategy. By promoting a long-term vision, entrepreneurial leaders inspire organizations to invest in green product development initiatives, which, in turn, help them address emerging grand challenges effectively. Entrepreneurial leaders foster a culture of learning and experimentation, enabling employees to develop innovative solutions and adopt emerging technologies that, in turn, contribute to the green product development process. They can set clear goals, guide organizational sustainable policies, and train employees from various departments who work collectively to design and introduce green products. Such leadership practices are particularly important for tackling complex environmental challenges, as they encourage cross-functional collaboration and continuous experimentation with sustainable technologies and processes. Through effective resource reallocation, waste reduction, and process optimization, entrepreneurial leaders enable firms to develop innovative solutions at relatively low cost – an especially critical capability in resource-constrained economies seeking to address environmental challenges while maintaining economic growth.

Moreover, entrepreneurial leaders can facilitate the creation of a supportive ecosystem for green market innovation by influencing key stakeholders. Because grand environmental challenges are inherently systemic and cannot be solved by individual organizations alone, entrepreneurial leaders play an important role in mobilizing partners, institutions, and stakeholders around shared sustainability objectives. By building relationships with external actors and encouraging collaborative engagement, they help organizations develop market-oriented solutions that contribute to environmental sustainability while enhancing organizational agility and adaptability. Importantly, our findings highlight that businesses aiming to facilitate green product development must prioritize

strategic sensitivity. Strategic sensitivity enables firms to continuously monitor the external environment, enhance market awareness, and develop proactive strategies that support both competitiveness and sustainability. In the context of grand challenges, strategic sensitivity is particularly valuable because it enables firms to detect emerging environmental risks and societal expectations early. Managers must therefore support organizations in developing and strengthening their strategic sensitivity so that they can effectively navigate environmental challenges and drive innovation aligned with evolving market and societal needs.

Moreover, firms with strategic sensitivity are better equipped to integrate sustainable initiatives into their organizational decision-making processes. By identifying sustainability-driven market opportunities early, organizations can allocate resources more effectively towards green product innovation that addresses environmental challenges while meeting growing consumer demand for environmentally responsible products. This alignment enables firms to strengthen their competitive position while simultaneously contributing to broader societal sustainability goals.

Similarly, collaborative innovation capability plays a critical role in enabling firms to address environmental challenges through green product development. Collaborative innovation capability allows firms to engage stakeholders across the value chain – including suppliers, customers, government agencies, research institutions, and non-profit organizations – in their innovation processes. Because many grand challenges are characterized by high complexity and interdependence, collaborative innovation enables firms to access diverse knowledge sources and complementary capabilities that are essential for developing effective sustainability solutions. Through collaborative innovation capabilities, firms can integrate external knowledge and complementary assets that may be unavailable internally, thereby overcoming resource limitations and accelerating the commercialization of sustainable solutions. Collaborative innovation capability enables businesses to leverage knowledge, skills, technologies, and resources, enhancing green product development and the adoption of sustainable technologies.

At the organizational level, managers need to develop and enhance collaborative innovation capability to drive sustainable product innovation, reduce the carbon footprint, and enhance market positioning. At the broader economic level, collaborative innovation capability contributes to ecosystem-level development by diffusing green technologies, stimulating new industries, and creating employment opportunities within local supply chains. By promoting open innovation and multi-sector partnerships, collaborative innovation capability helps build innovation clusters that foster sustainable industrial development, especially in resource-constrained economies. Moreover, partnering with business partners enables firms to optimize raw material sourcing, processes, research and development, and logistics, ultimately contributing to the development of environmentally friendly products.

From a societal perspective, collaborative innovation capability also promotes inclusivity and shared prosperity by involving diverse stakeholders such as local communities and small enterprises in co-innovation activities. This inclusive innovation approach ensures that sustainability initiatives generate not only environmental benefits but also broader societal value, such as improved livelihoods and community resilience in the face of environmental change. Collaborative innovation capability thus facilitates knowledge sharing and capability development across industries, government agencies, and non-profit organizations, enabling collective action to address environmental challenges and achieve sustainable growth.

Finally, our findings regarding the moderating role of leaders' political skill offer important managerial implications. The results highlight the importance of considering individual leadership capabilities when promoting green product development in emerging economies. Leaders with high political skill are better able to build strong relationships with business partners, mobilize resources, and coordinate stakeholder interests. Such capabilities are particularly important when organizations attempt to address grand environmental challenges, which typically require collaboration across multiple actors with diverse interests. Consequently, firms operating in emerging economies should prioritize developing and recruiting leaders with strong political skills. The politically skilled

leaders are better equipped to align organizational capabilities, stakeholder relationships, and innovation strategies to support green product development and address pressing environmental challenges.

Limitations and future research directions

This study employed a time-lagged research design to analyse the proposed model, accounting for favourability bias and potential common method variance. Despite this design's strengths, several limitations remain. First, although our data collection approach mitigates common method bias, establishing causal inferences remains challenging. Therefore, future researchers are encouraged to adopt longitudinal designs to strengthen causal conclusions. Second, as our data were collected from firms operating in an emerging economy, the findings may not be generalizable to developed economies, presenting an important avenue for future investigation. Finally, future studies could examine the role of AI and big data capabilities, generative AI, managerial latitude, and digital leadership in enhancing the green product development process. Additionally, exploring the influence of cultural values, government support, and institutional frameworks in facilitating green product development would provide further valuable insights.

Author contributions

CRediT: **Nadia Zahoor:** Conceptualization, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing; **Adeel Khalid:** Conceptualization, Investigation, Writing – original draft, Writing – review & editing; **Muhammad Usman:** Data curation, Formal analysis, Investigation, Methodology, Software, Validation; **Naveed Yasin:** Project administration, Supervision, Writing – original draft, Writing – review & editing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

AI use statement

The authors used AI-assisted tools (ChatGPT and OpenAI) solely for language editing and clarity improvement. The authors retain full responsibility for the content.

Data availability statement

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

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Appendix

Appendix A. Scale items

Entrepreneurial leadership

(1) I often come up with radical improvement ideas for the products/services we are selling.
(2) I often come up with ideas for completely new products/services that we could sell.
(3) I take risks.
(4) I have creative solutions to problems.
(5) I demonstrate passion for his/her work.
(6) I have a vision of the future of our business.
(7) I challenge and push my subordinates to be more innovative.
(8) I want my subordinates to challenge the current ways we do business.

Collaborative innovation capability

(1) Compared with competitors, our firm has a stronger ability to introduce new products in conjunction with our partner firms.
(2) Compared with competitors, our firm has a stronger ability to generate new ideas when solving problems in conjunction with our partner firms.
(3) Compared with competitors, our firm has a better ability to provide additional services in conjunction with our partner firms.
(4) Compared with competitors, our firm has a stronger ability to launch new functionalities for existing products in collaboration with our partner firms.
(5) Compared with competitors, our firm has a stronger ability to implement new marketing strategies (e.g. social network marketing) in conjunction with our partner firms.
(6) Compared with competitors, our firm has a stronger ability to develop new collaborative skills.
(7) Compared with competitors, our firm has a stronger ability to design new collaborative business processes.

Strategic sensitivity

(1) Our firm is very sensitive to external changes and integrates them into the strategic planning of our business.
(2) Our firm utilizes different mechanisms to become aware of strategic developments early.
(3) In our firm, requirements for strategic adaptations are communicated quickly and comprehensively through the organization.

Leader's political skill

(1) I find it easy to imagine myself in others' positions.
(2) I can make most people feel comfortable and at ease around me.
(3) It is easy for me to build rapport with most people.
(4) I understand people well.
(5) I am good at getting others to respond positively to me.
(6) I usually try to find common ground with others.

Green product development

In the last three years:

(1) Our firm introduced a new generation of environmentally friendly products.
(2) Our firm extended the range of environmentally friendly products.
(3) Our firm opened up new markets for environmentally sustainable products.
(4) Our firm entered new fields of environmentally sustainable technology.