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Strategic foresight, knowledge management, and open innovation: Drivers of new product development success

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ABSTRACT

To remain competitive and make effective decisions in increasingly challenging markets, firms must integrate internal and external knowledge by embedding knowledge management strategies and technologies into their operations. This study aims to examine the roles of strategic foresight and knowledge management in promoting open innovation and driving new product development. Grounded in the knowledge-based view (KBV) of the firm, it investigates how strategic foresight influences open innovation processes and how knowledge management catalyzes innovation success. Using structural equation modelling (SEM) on data collected from 298 technology-based firms located in Lithuania (n = 142) and Slovakia (n = 156), the study demonstrates that strategic foresight directly impacts open innovation and significantly improves new product development through open innovation; in addition, knowledge exploration and exploitation are shown to play important roles in open innovation, with balanced effects on new product development outcomes. The study identifies open innovation as a critical mechanism that links strategic foresight and knowledge management to improve new product development, extending the KBV of the firm by highlighting the integration of external knowledge with internal processes, particularly in smaller, emerging economies. Practically, managers are recommended to prioritize foresight and balanced knowledge management practices while leveraging strategic alliances and networks to improve new product development outcomes. This integrated approach highlights the importance of collaborative innovation and external knowledge in achieving competitive advantage in dynamic business environments.

Introduction

Product innovation is fundamental to organizational growth and long-term success, allowing firms to respond effectively to changing market demands and technological advancements (Jang & von Zedtwitz, 2023). In today's competitive landscape, product innovation has become a necessity for firms striving to maintain or strengthen their market positions (Hervas-Oliver et al., 2021). The new product development process operationalizes product innovation by transforming innovative ideas into marketable products. It acts as a bridge between conceptual innovation and market reality, playing a critical role in improving a firm's competitiveness. If firms effectively manage their new product development processes, it will enable them to create market-ready products that not only address consumer needs and desires, but also open new markets and provide opportunities for firms to differentiate themselves from competitors (Abhari et al., 2020; Trott & Simms, 2017).

The significance of new product development in achieving competitive advantage cannot be understated. In increasingly saturated markets, firms must continuously innovate to survive. new product development enables firms to adapt to shifting consumer preferences, technological advancements, and competitive pressures, ensuring their

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ability to maintain and strengthen their market position (Abhari et al., 2020). Moreover, new product development is closely linked to a firm's ability to sustain competitive advantage. Firms that excel in new product development can more effectively meet consumer demands, reduce time to market, and achieve operational efficiencies, all of which contribute to enhanced market positions (Cooper, 2019; Knudsen et al., 2023). However, traditional approaches to new product development, which mainly rely on the internal resources and capabilities of a firm, are increasingly being challenged by the growing demand for more inclusive and collaborative innovation practices (Abhari et al., 2020).

The democratization of product innovation is becoming increasingly important in new product development processes. This approach highlights the critical need for firms to engage diverse stakeholders, such as customers, suppliers, and even competitors, in their innovation processes (Annosi et al., 2020). Democratizing new product development allows firms to tap into a wider pool of ideas and expertise, leading to more innovative and customer-centric products (Dabic et al., 2023). The involvement of external stakeholders not only improves the quality and relevance of new products, but also creates a sense of ownership and commitment among all parties (Bogers et al., 2017; Tidd & Bessant, 2018). This shift toward more open and collaborative innovation reflects the growing recognition that innovation does not occur in isolation, but rather through the interactions of diverse actors within an innovation ecosystem. Collaborative innovation has become a key measure of success within new product development. By integrating external knowledge and resources into the new product development process, firms can substantially improve their innovation capabilities (Idrees et al., 2023; Stock et al., 2021). Collaborative innovation enables firms to capture and utilize the expertise and capabilities of others, thereby reducing the risks and costs associated with new product development. Moreover, it creates a more inclusive and flexible approach to product innovation, allowing firms to respond more quickly to changes in the market (Enkel et al., 2009; Hald & Nordio, 2021). The open innovation paradigm, which advocates the integration of external knowledge into the internal innovation process, has become particularly relevant in this context.

Open innovation, as a strategic approach to new product development, provides firms with the opportunity to improve their product innovation outcomes by integrating external knowledge, ideas, and technologies (Obradovic et al., 2021). By breaking down the traditional boundaries between firms and their external environment, open innovation provides access a wide range of capabilities, thereby potentially accelerating new product development (Annosi et al., 2020; Chesbrough, 2003; Hald & Nordio, 2021). The role of open innovation in new product development is particularly significant in industries characterized by rapid technological change and high levels of competition (Dabic et al., 2023; Petraite et al., 2022). In such competitive environments, the ability of firms to integrate external knowledge and collaborate with external partners provides them with a critical edge in the development of new and innovative products (Laursen & Salter, 2006). However, the successful implementation of open innovation in new product development requires a strategic approach that considers both internal and external factors related to knowledge, as well as the overall (i.e., technological) orientation of firm (Mubarak & Petraite, 2020). In this context, strategic foresight, which involves the ability of firms to anticipate and prepare for future trends and uncertainties in the market, is crucial for successful new product development (Li et al., 2020). Foresight allows firms to identify emerging opportunities and threats, enabling them to align their new product development efforts with future market needs and technological advancements (Linares-Barbero & De La Vega, 2024). By integrating strategic foresight into new product development, firms can improve their ability to innovate in a way that is both proactive and adaptive (Mubarak et al., 2024b; Rohrbeck & Kum, 2018). Foresight-driven new product development is more likely to deliver products that align with future market demands while positioning firms to capitalize on emerging market opportunities. This proactive approach is especially critical in fast-paced industries, such as healthcare and start-up environments, where anticipating and adapting to change is a key factor for success (Ghobakhloo et al., 2023; Li et al., 2020).

Knowledge exploration and exploitation play critical roles in improving the NPD outcomes of firms. Knowledge exploration refers to the search for novel ideas, technologies, and insights, while knowledge exploitation emphasizes the application and refinement of existing knowledge to create new products (Dabic et al., 2023; Mubarik et al., 2021). Both are essential for successful new product development as they enable firms to balance the need for innovation with the efficient use of resources (Griffith et al., 2021; March, 1991). Firms that effectively balance knowledge exploration and exploitation are better positioned to develop innovative products that meet market demands while maximizing the value of their existing knowledge base (Clauss et al., 2021; Zahra & George, 2002). In addition, the integration of these knowledge processes into the new product development process is critical for achieving sustained innovation and competitive advantage.

Despite increasing recognition of the importance of integrating open innovation, strategic foresight, and knowledge management into new product development, substantial gaps persist in the existing literature. Previous research has explored the individual impacts of these factors on new product development in varying contexts. For example, Miroshnychenko et al. (2021) investigated the strategic flexibility of firms in the context of business model innovation, while Hutton et al. (2024) studied strategic agility in the context of open innovation. Moreover, Dabic et al. (2023) studied the impact of open innovation and digital transformation on new product development improvements, while Sakellariou and Vecchiato (2022) examined strategic flexibility and users' foresights for NPD. Although research exists, there is a critical need for a holistic investigation of how these factors jointly interact to influence NPD outcomes (Li et al., 2020; Sakellariou & Vecchiato, 2022). Specifically, the indirect role of open innovation in the relationship between strategic foresight, knowledge management, and new product development, has not been fully reported in current literature (Linares-Barbero & De La Vega, 2024; Pulsiri et al., 2018; Sakellariou & Vecchiato, 2022).

This study aims to address this critical research gap and, in doing so, it contributes to current innovation management literature by addressing the relatively underexplored intersection of strategic foresight, knowledge management, and open innovation in the context of new product development. While previous studies have examined these elements in isolation, few have investigated their interdependent relationships. This research, therefore, aims to empirically demonstrate how strategic foresight and knowledge management, supported by the critical role of open innovation, collectively improves firms' new product development success. The study's novelty lies in its integrated approach, moving beyond traditional new product development models that mainly emphasize the importance of firms' internal knowledge and capabilities. Instead, it positions open innovation as a strategic mechanism for improving new product development outcomes. Furthermore, while most existing research focuses on larger and more developed economies, this study addresses a critical gap by examining two rapidly developing countries in Central Eastern Europe (Lithuania and Slovakia), providing valuable insights specific to these contexts.

This research draws on the KBV of the firm, extending it by incorporating strategic foresight as a dynamic capability that enables firms to proactively align their innovation processes with future market trends (Eisenhardt & Martin, 2000). This approach improves current understanding of how foresight and knowledge management can be used to foster open innovation and drive new product development outcomes, particularly in technology-based industries that are characterized by rapid change. Moreover, this study contributes to industrial practice by offering insights into how firms can strategically deploy foresight activities and knowledge management processes to improve open innovation. For managers operating in fast-paced, technology-driven environments, the findings highlight the importance of both external

knowledge integration and internal capability development for driving innovation outcomes. By demonstrating that nearly 50 % of the variance in new product development success can be explained by these factors, this study provides a clear roadmap for firms aiming to improve their innovation performance based on new product development through collaborative innovation practices. In this context, the current research aims to address this issue by investigating how strategic foresight and knowledge management (dimensions) collectively contribute to new product development by leveraging open innovation. The study addresses the following three research questions:

RQ1: What is the impact of strategic foresight on open innovation practices within firms?

RQ2: What is the role of knowledge management dimensions for improving open innovation?

RQ3: How does open innovation contribute to the success of new product development outcomes?

The remainder of this paper is structured as follows. First, the theoretical background is discussed, followed by the development of the research hypotheses. Next, the research methodology is described, along with the presentation of the study's findings. Then, a discussion of the results is provided which outlines the theoretical and practical implications of the research. Finally, the paper concludes with an explanation of the study's limitations and suggestions for future research.

Theoretical background

This study is grounded in the KBV of the firm, which asserts that knowledge is the most strategically important resource for a firm. The KBV emphasizes that a firm's ability to create, integrate, and effectively utilize knowledge is critical for achieving competitive advantage and improved performance (Grant, 1996). In the context of new product development, the KBV of the firm highlights the importance of leveraging both internal and external knowledge sources to enable innovation and maintain competitive advantage (Zhang et al., 2022). This theoretical perspective provides a foundation for understanding how strategic foresight and knowledge management contribute to new product development through the mediating influence of open innovation.

Knowledge exploration and exploitation in new product development

Recent research on knowledge exploration and exploitation has advanced our understanding of how firms manage knowledge to achieve success in new product development. Knowledge exploration involves searching for new knowledge, ideas, and technologies, while knowledge exploitation focuses on refining and applying existing knowledge to create value for the firm (Idrees et al., 2023). Both processes are considered essential for enabling firms to develop innovative products that meet market demands while ensuring the efficient utilization of organizational resources. Several studies emphasize the importance of balancing knowledge exploration and exploitation in the context of new product development. For example, Fernandes Rodrigues Alves, Pacheco, & Galina, 2025 argue that firms must manage this balance across their boundaries to achieve new product development success. Similarly, Griffith et al. (2021) highlight the significance of using both knowledge exploration and exploitation to improve a firm's innovation capabilities and new product success, particularly in fast-paced and competitive market environments. Hald and Nordio (2021) extend this discourse by highlighting that ambidexterity (i.e., the ability to simultaneously explore and exploit knowledge) is critical in collaborative new product development processes, while more recent research by Zhang et al. (2022) has examined the knowledge-seeking intentions of new product development teams, demonstrating that firms that actively pursue knowledge exploration are better equipped to adapt to dynamic market conditions and develop innovative products. Botega and da Silva (2020) propose that Artificial Intelligence (AI) can support knowledge management by optimizing the selection of creativity and innovation techniques, enhancing firms' abilities to balance exploration and exploitation during new product development.

Stock et al. (2021) investigated the knowledge-sharing practices used by firms in new product development projects and demonstrated how effective knowledge management can help firms cope with uncertainties during product development. Their findings suggest that knowledge sharing, particularly the exchange of both exploratory and exploitative knowledge, is essential for managing the risks and challenges inherent in NPD. Idrees et al. (2023) provided a review of knowledge management practices in new product development projects and highlighted the important role of knowledge management in driving product innovation. They demonstrated that firms that create robust knowledge management practices are better positioned to manage new product development projects. In the context of open innovation, both knowledge exploration and exploitation are seen as critical for integrating external knowledge into internal innovation processes. Ferreira et al. (2021) identified that strategic alliances and knowledge-sharing activities between partners enhance both knowledge exploration and exploitation, leading to improved new product development outcomes. In addition, Nascimento et al. (2021) showed how firms dynamically interact with external partners and emerging technologies through knowledge management and strategic foresight, further enhancing their exploration and exploitation capabilities. In addition, recent studies by Li et al. (2020) and Sakellariou and Vecchiato (2022) provide insights into the role of foresight and sensemaking in new product development. Both emphasize the importance of aligning new product development with future market trends and uncertainties through foresight-driven strategies. In addition, the authors suggest that firms should capitalize on external collaboration to improving their foresight capabilities, thereby supporting both knowledge exploration and exploitation.

Strategic foresight and new product development

Strategic foresight is a dynamic capability that allows firms to anticipate and prepare for future trends, uncertainties, and shifts in the market (Paliokaitė et al., 2014; Teece et al., 1997). It involves the systematic exploration and analysis of potential future scenarios to inform strategic decision-making and innovation efforts (Rohrbeck & Kum, 2018). The current study refers to the three dimensions of strategic foresight, as reported by Awais et al. (2023), that include planning, resources, and coordination flexibility. These foresight capabilities are critical for firms that aim to align their new product development processes with future market demands and technological advancements, thereby improving innovation outcomes. Recent studies have provided deeper insights into the role of foresight in new product development. For example, Li et al. (2020) examined how collaborative strategic foresight in Chinese pharmaceutical firms improved new product development performance by integrating future-oriented strategies with ongoing product development efforts. Their findings suggest that firms that excel in foresight are better able to identify emerging market opportunities and align their new product development efforts accordingly. Moreover, Nascimento et al. (2021) highlighted how strategic foresight interacts with knowledge management to drive innovation, especially in dynamic environments where firms must respond to emerging technologies. Sakellariou and Vecchiato (2022) expanded on this perspective by highlighting the role of foresight in sensemaking, which enables firms to interpret future trends and align their new product development activities accordingly. By adopting foresight-driven new product development, firms can more effectively anticipate customer needs, emerging technologies, and potential disruptions in the market, allowing them to innovate proactively and sustain their competitive advantage (Amniattalab & Ansari, 2016; Dabic et al., 2023; Ghobakhloo et al., 2022).

Open innovation and new product development

Open innovation represents a paradigm shift from traditional closed innovation models, where firms rely solely on internal resources, to a more collaborative approach that integrates external knowledge, ideas, and technologies into firms' innovation processes (Chesbrough, 2003; Mubarak et al., 2024a). Open innovation enables firms to access a broader pool of resources and knowledge, thereby improving their new product development performance. The current study focuses on inbound and outbound open innovation. Griffith et al. (2021) emphasized that open innovation can significantly improve a firm's capacity for both knowledge exploration and exploitation, thus improving new product development performance. By integrating external knowledge, firms can accelerate their product development lifecycle, reduce associated costs, and enhance innovation quality. In addition, Ferreira et al. (2021) argue that knowledge-sharing alliances and open innovation practices enhance firms' abilities to manage both exploratory and exploitative knowledge, leading to more successful new product development outcomes. Open innovation plays an important role in the relationship between strategic foresight, knowledge management, and new product development. Botega and da Silva (2020) highlighted that open innovation, supported by AI-driven knowledge management systems, enables firms to integrate external knowledge more effectively into their innovation processes. This integration provides both exploration and exploitation, allowing firms to better manage the complexities of new product development (Fernandes Rodrigues Alves et al., 2025; Sakellariou et al. 2020). Furthermore, Abhari et al. (2020) and Zhang et al. (2022) suggested that firms that engage in open innovation can enhance their knowledge-seeking efforts, thereby facilitating improved new product development outcomes. By collaborating with external partners, firms are better positioned to leverage both internal and external knowledge sources, ultimately driving new product development performance.

Hypotheses development

Strategic foresight and open innovation

Strategic foresight plays an important role in improving a firm's innovation capability. It enables firms to anticipate changes in the external environment and adjust their strategies proactively, making it an essential element of effective innovation management (Rohrbeck & Kum, 2018). Strategic foresight allows firms to identify emerging opportunities and threats in the market early, thereby positioning themselves to leverage new technologies, market shifts, and evolving customer needs. When applied in the context of open innovation, strategic foresight can significantly improve a firm's capacity to engage with external sources of knowledge, enabling more robust and diverse innovation outcomes.

Since its inception, open innovation has become increasingly important in today's dynamic and interconnected business world. Firms that adopt open innovation are better positioned to adapt to rapidly changing market conditions by leveraging a broader pool of external expertise and resources to complement their internal capabilities (Chesbrough & Bogers, 2014; Mubarak et al., 2024). The link between strategic foresight and open innovation is crucial because foresight enables firms to identify and engage with external partners who possess the required knowledge and skills to address future challenges and opportunities. Previous research suggests that firms possessing strong strategic foresight capabilities are more likely to engage in open innovation. This greater likelihood is because foresight activities provide the insights needed to recognize the value of external knowledge and the potential benefits of collaboration with external partners (Paliokaitė et al., 2014; Rohrbeck et al., 2015). By identifying emerging trends and technologies in the market, strategic foresight helps firms to proactively seek out external collaborations that align with their strategic goals (Sakellariou et al., 2020). This proactive approach to innovation not only enhances firms' ability to innovate, but also reduces the risks associated with research and development by leveraging existing external solutions and expertise (Vanhaverbeke et al., 2018).

Moreover, strategic foresight enables a culture of openness and collaboration to be established within firms, which is crucial for effectively implementing open innovation. Firms that prioritize foresight are more inclined to adopt a long-term perspective on innovation, encouraging cross-functional teams to explore and integrate external ideas into their innovation processes (Mubarak et al., 2024c; Vecchiato, 2015; Shabbir et al., 2024). Such a culture of openness is considered critical for overcoming the *"not-invented-here syndrome"*, a common barrier to open innovation where firms resist external ideas in favour of internally developed solutions (Hannen et al., 2019). Empirical evidence (Rohrbeck & Kum, 2018) suggests that firms with advanced foresight capabilities are more likely to engage in open innovation, leading to improved innovation outcomes. In addition, Jarrahi (2018) highlighted the role of foresight in enabling firms to navigate complex and uncertain environments, which in turn facilitates more effective collaboration with external partners. Moreover, Awais et al. (2023) report the impact of planning, resource, and coordination flexibility on firms' product and service innovation performance with their findings demonstrating that strategic foresight not only improves a firm's ability to identify and capitalize on external knowledge, but also enhances the overall effectiveness of open innovation initiatives. Therefore, this study proposes the following hypothesis:

Hypothesis 1. *Strategic foresight positively improves open innovation.*

Knowledge management and open innovation

Knowledge management has long been recognized as a critical component for innovation within firms. It encompasses the systematic processes of acquiring, creating, sharing, and applying knowledge to enhance organizational performance and innovation outcomes (Nonaka & Takeuchi, 1995). Within the context of knowledge management, two key dimensions exist (i.e., knowledge exploration and knowledge exploitation), which play distinct but complementary roles in driving firms' innovation performance. Together, these dimensions are crucial for enabling firms to innovate, particularly in the context of open innovation. The success of open innovation relies heavily on firms' ability to manage and integrate both internal and external sources of knowledge (Laursen & Salter, 2006; Shabbir et al., 2024). In this regard, knowledge exploration and exploitation serve as fundamental mechanisms that facilitate the effective integration and utilization of external knowledge within firms' innovation processes.

Knowledge exploration enhances open innovation by broadening the scope of knowledge that a firm can access and utilize. Through exploration activities, firms can identify and acquire new knowledge from external sources, such as research institutions, technology partners, and even competitors (Dahlander & Gann, 2010). This influx of ideas and technologies enrich firms' internal knowledge bases, providing a wider array of options for innovation activities. In addition, knowledge exploration enables firms to tap into emerging trends and technological advancements, which are critical for staying ahead of competitors in dynamic markets (Posen & Levinthal, 2017). The continuous search for and integration of external knowledge through exploration activities is, thus, considered a critical driver of open innovation. On the other hand, knowledge exploitation is essential for ensuring that the knowledge acquired through exploration is effectively used to generate tangible innovation outcomes. Exploitation involves the refinement and application of both internal and external knowledge to develop new products, services, and processes (March, 1991; Posen & Levinthal, 2017). In the context of open innovation, effective exploitation ensures that the knowledge captured from external sources is integrated into the firm's existing capabilities and resources, leading to the development of

innovative solutions that meet market demands (Zahra & George, 2002). Moreover, exploitation activities help firms to maximize the value of their knowledge assets by applying them in ways that enhance efficiency, reduce costs, and improve the overall effectiveness of the innovation process (Chesbrough, 2006).

Empirical research supports the positive relationship between these two knowledge management dimensions and open innovation. Laursen and Salter (2006) demonstrated that firms with higher levels of knowledge exploration and exploitation capabilities are more likely to engage in open innovation which, in turn, leads to improved innovation performance. Similarly, Lichtenthaler and Lichtenthaler (2009) found that firms with strong knowledge management capabilities are better equipped to manage the complexities of open innovation as they can more effectively integrate external knowledge into their internal research and development. These findings suggest that the successful implementation of open innovation is contingent upon a firm's ability to balance knowledge exploration and exploitation, ensuring that new knowledge is not only acquired but also effectively applied to generate innovative outcomes. As a result, this study proposes the following hypotheses:

Hypothesis 2. *Knowledge management dimensions (*i.e.*, knowledge exploration and exploitation) improve open innovation. Specifically,*

Hypothesis 2a. *Knowledge exploration improves the open innovation practices of firms.*

Hypothesis 2b. *Knowledge exploitation improves the open innovation practices of firms.*

Open innovation and new product development

Open innovation has redefined how firms approach innovation, moving away from a closed, insular model to one that embraces external knowledge, ideas, and collaboration (Chesbrough, 2003). This shift is particularly relevant in the context of new product development, where the integration of external resources and capabilities can significantly improve the innovation process and lead to more successful outcomes. Open innovation posits that firms should leverage external as well as internal ideas and pathways to market, creating a more dynamic and flexible approach to innovation that is critical for competitive advantage in fast-paced markets (Chesbrough & Bogers, 2014). New product development is a crucial process for firms seeking to maintain competitiveness, respond to market changes, and meet evolving customer needs. It involves the transformation of market opportunities and technological possibilities into tangible products (Ulwick, 2002). However, traditional new product development processes are fraught with challenges, including high costs, long development times, and significant risks of market failure. Traditionally, firms have relied on internal research and development capabilities to drive new product development performance, but this approach often limited in scope and can lead to missed opportunities in rapidly changing markets (Dabic et al., 2023). By incorporating open innovation into new product development, firms can overcome these limitations and improve their ability to develop successful new products.

Open innovation improves new product development by expanding the knowledge base available to firms. By engaging with external sources of knowledge, such as universities, research institutions, suppliers, and even customers, firms can access a broader range of ideas, technologies, and market insights (Bogers, 2011). Such external knowledge complements internal research and development, filling gaps in firms' capabilities and accelerating the innovation process. For example, Laursen and Salter (2006) argue that firms engaged in open innovation are better able to combine external and internal knowledge, leading to more creative and effective product solutions (Obradovic et al., 2021). This collaboration allows firms to leverage the expertise of external partners, reducing the time and costs associated with new product development while increasing the likelihood of success.

Moreover, open innovation provides greater flexibility and adaptability in new product development. By integrating external knowledge, firms can quickly respond to changes in the market and technological advancements, ensuring that their products remain relevant. This adaptability is important in industries that are characterized by rapid technological change, where the ability to innovate quickly creates significant competitive advantage (Chesbrough, 2006). In addition, open innovation allows firms to engage in iterative product development, where external feedback is continuously integrated into the product development lifecycle, leading to products that are better aligned with customer needs and desires (Von Hippel, 2005). Furthermore, open innovation reduces the risks associated with new product development. By distributing the innovation burden across multiple stakeholders, firms share the costs and risks associated with developing new products. This collaborative approach not only reduces the financial strain on individual firms but also increases the overall resilience of the innovation process. For example, Enkel et al. (2009) suggested that open innovation allows firms to pool resources and share the risks of research and development, leading to more sustainable innovation practices. In addition, the involvement of external partners provides firms with the ability to validate early product concepts, reducing the likelihood of costly failures in later stages of product development.

Research supports the positive impact of open innovation on new product development. For example, West and Bogers (2014) identified that firms engaged in open innovation practices tend to achieve higher rates of successful product introductions than those relying solely on internal research and development. Similarly, Dabic et al. (2023) demonstrate that firms that adopt open innovation are more likely to bring innovative products to market faster and with greater commercial success. These findings demonstrate the strategic importance of open innovation in enhancing the effectiveness and efficiency of the new product development process. In addition to improving the new product development process its associated outcomes, open innovation can lead to the creation of entirely new business models and market opportunities. For example, open innovation can enable firms to enter new markets, develop new product categories, or create value-added services that complement their existing product portfolios (Gassmann et al., 2010; Ozer, 2009). Such an ability to innovate across different dimensions is a key factor in sustaining long-term competitiveness in an increasingly interconnected and competitive global marketplace. Therefore, this study proposes the following hypothesis:

Hypothesis 3. *Open innovation improves new product development outcomes.*

The study's research model, shown in Fig. 1, illustrates the relationship between strategic foresight, knowledge management, open innovation, and new product development. It posits that Strategic Foresight and Knowledge Management positively influence Open Innovation, which in turn improves new product development outcomes. Specifically, the study proposes that firms that possess strong foresight and effective knowledge management practices are better equipped to engage in open innovation, leveraging external ideas and resources to drive successful product development.

Methodology

This study employed a quantitative approach to investigate the relationships between strategic foresight, the two dimensions of knowledge management (exploration and exploitation), open innovation, and new product development. Data were collected using a questionnaire designed with validated scales from the existing literature to ensure the reliability and validity of the measures. Strategic foresight was measured using nine indicators of Planning Flexibility (Pflex), Resource Flexibility (Rflex), and Coordination Flexibility (Cflex), as established by

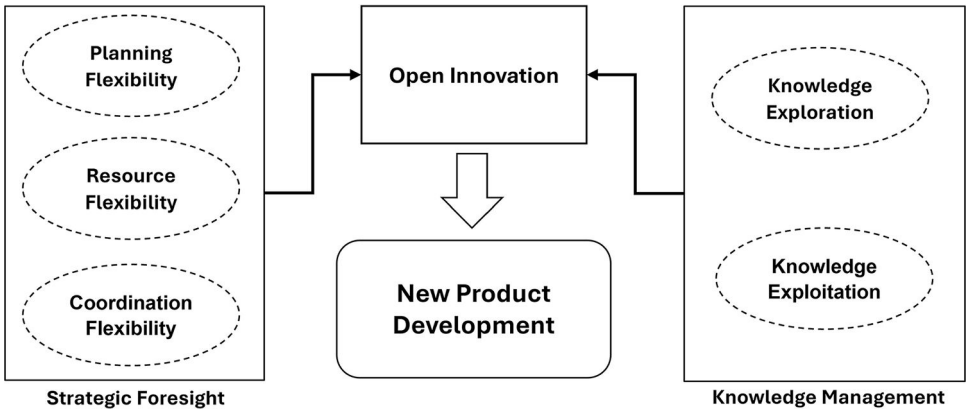

Fig. 1. Research model.

Han and Zhang (2021) and Dibrell et al. (2014), and subsequently applied by Awais et al. (2023). Knowledge management was assessed using three indicators for each dimension (i.e., exploration and exploitation), based on the work of Gonzalez and de Melo (2018). Moreover, open innovation was measured using six indicators adapted from Hung and Chou (2013); Sisodiya et al. (2013), and Inauen and Schenker-Wicki (2011). The effectiveness of new product development was measured using three indicators taken from Camison and Villar Lopez (2010) and Acur et al. (2010), which evaluate the success of firms in developing and commercializing new products. To facilitate the data collection process, purposive sampling was used with a focus on technology-based firms from Lithuania and Slovakia in Central eastern Europe. In total, data were collected from 298 technology-based firms, including 142 from Lithuania and 156 from Slovakia, which were subjected to rigorous analysis using SEM where firm is the unit of analysis. SEM was considered appropriate for analysis due to its ability to assess complex relationships among multiple constructs simultaneously, making it well-suited for testing the proposed hypotheses in this study.

Findings

Reliability and validity of the measurement models

The data analysis involved an assessment of the measurement model to ensure the constructs used were both valid and reliable. In doing so, factor loadings, Cronbach's alpha, convergent validity, and Composite Reliability (CR) were the primary indicators used to evaluate the constructs. First, the factor loadings of the indicators for each construct were examined. The loadings of all constructs were found to be more than 0.70 which falls within acceptable limits, indicating strong alignment between the indicators and their respective constructs (Hair et al., 2017). Next, Cronbach's alpha was analyzed to determine the internal consistency of the constructs, with all values exceeding the acceptable threshold of 0.70, as suggested by Hair et al. (2017). Then, the CR values for all constructs were examined with results well above the recommended cutoff of 0.70, as per the guidelines of Hair et al. (2017). Lastly, convergent validity was assessed using the Average Variance Extracted (AVE), with all constructs showing values above the acceptable threshold of 0.50. The results of our analysis are presented in Table 1.

Discriminant validity

Discriminant validity is important for ensuring that each construct measures a unique concept, separate from the other constructs, which is critical for the validity of the structural model. Discriminant validity was assessed using the Fornell-Larcker criterion and Heterotrait-Monotrait ratio (HTMT) values. The square root of the AVE for strategic foresight was 0.90, which surpassed its correlations with other constructs, highlighting its unique role as a forward-looking capability essential for strategic alignment (Rohrbeck & Kum, 2018). Similarly, the square root of the AVE for knowledge exploration (0.785) and knowledge exploitation (0.874) confirmed their separate dimensions within knowledge management, emphasizing exploration's role in exploring innovation-related knowledge and exploitation's focus on applying existing knowledge effectively (Griffith et al., 2021). Open Innovation, with an AVE square root of 0.84, was found to be distinct from new product development (0.633 correlation), supporting its function as an interface for external knowledge integration (Chesbrough & Bogers, 2014). The AVE of new product development at 0.919 further strengthens its position as an independently defined construct, crucial for capturing product development outcomes without overlap with other constructs (Laursen & Salter, 2006). This strong discriminant validity across constructs validates the examination of the dynamic interactions among strategic foresight, knowledge management, and open innovation in driving new product development outcomes. The results of the Fornell-Larcker criterion are presented in Table 2.

In addition, the HTMT values presented in Table 3 indicate the discriminant validity of the constructs in the study's model. According to Henseler et al. (2015), HTMT values below 0.85 suggest adequate discriminant validity, meaning that the constructs are sufficiently distinct from one another. In the current study, all HTMT values fell below the conservative threshold of 0.85, confirming discriminant validity between the constructs. According to Kock (2015), Variance Inflation Factor (VIF) values below 3.3 are considered acceptable, indicating that Common Method Bias (CMB) is unlikely to be a significant issue. In this study, all variables exhibit VIF values below this

Table 1
Evaluation results of the measurement model.

Construct	Validity and reliability			*Min. loadings*
	CB Alpha	*CR*	*AVE*	
Knowledge exploration (KEL)	0.71	0.72	0.61	*0.76*
Knowledge exploitation (KET)	0.83	0.84	0.76	*0.83*
New product development (NPD)	0.82	0.85	0.84	*0.87*
Open innovation (OIN)	0.80	0.82	0.72	*0.72*
Strategic foresight (SFT)	0.87	0.88	0.81	*0.80*

Table 2
Assessment of the Fornell-Larcker criterion.

Construct	KEL	KET	NPD	OIN	SFT
Knowledge exploration (KEL)	0.785				
Knowledge exploitation (KET)	0.663	0.874			
New product development (NPD)	0.653	0.450	0.919		
Open innovation (OIN)	0.696	0.565	0.633	0.84	
Strategic foresight (SFT)	0.486	0.354	0.654	0.708	0.900

Table 3
Heterotrait-Monotrait (HTMT) values.

Constructs	KEL	KET	NPD	OIN	SFT
Knowledge exploration (KEL)	–				
Knowledge exploitation (KET)	0.838	–			
New product development (NPD)	0.797	0.493	–		
Open innovation (OIN)	0.778	0.638	0.677	–	
Strategic foresight (SFT)	0.597	0.378	0.678	0.748	–

threshold, suggesting that multicollinearity is within acceptable limits and there is no substantial indication of CMB based on the VIF analysis.

Hypotheses testing

The structural model results identify relationships between strategic foresight, knowledge management, and open innovation, each playing important roles in driving new product development outcomes. These relationships not only demonstrate the importance of these elements in innovation, but also highlight the varying degrees of influence they exert. Hypothesis 1 (H1) posited a positive relationship between strategic foresight and open innovation, and this is strongly confirmed by the data, with a path coefficient of 0.477, a t value of 13.423, and a p value of 0.000. This result highlights the role of strategic foresight in enabling firms to anticipate future trends and integrate external knowledge, aligning with prior research that emphasizes foresight's importance in shaping proactive innovation trajectories (Rohrbeck & Kum, 2018; Vecchiato, 2015). Firms with advanced foresight capabilities not only respond to environmental shifts, but actively shape their innovation agendas to maintain competitive advantage. The VIF for this path was 1.313, indicating minimal multicollinearity and supporting the reliability of this relationship.

Hypothesis 2a (H2a) examined the impact of knowledge exploration (KEL) on open innovation and was also substantiated by the model with a path coefficient of 0.359, t value of 9.564, and p value of 0.000. The moderate effect size suggests that while exploration (i.e., the pursuit of new knowledge, technologies, and insights) serves as a key driver of open innovation, it operates synergistically with other elements to amplify its impact on innovation outcomes. This finding is consistent with previous studies that highlight the role of exploratory learning in enabling innovation, particularly within complex environments (Grant, 1996; Yayavaram & Chen, 2015). The VIF for this path was 2.048, which is below the recommended threshold, indicating acceptable multicollinearity and reinforcing the distinctiveness of knowledge exploration within the model. Likewise, Hypothesis 2b (H2b) suggested a positive effect of knowledge exploitation on open innovation, which is confirmed with a path coefficient of 0.158, t value of 3.869, and p value of 0.000. Although the influence of knowledge exploitation is smaller than the influence of knowledge exploration, this result highlights the role of effectively using and refining existing knowledge in the innovation process. This result highlights the need to balance exploration with exploitation to maximize innovation potential because leveraging established knowledge is crucial for sustaining competitive advantage (Lavie et al., 2010; Raisch & Birkinshaw, 2008). The VIF of 1.788 indicates low multicollinearity, suggesting the robustness of this construct's contribution to open innovation.

Hypothesis 3 (H3) posited that open innovation drives new product development and this is robustly supported by the data, with a high path coefficient of 0.633, a t value of 14.322, and a p value of 0.000. This strong relationship demonstrates the transformative role of open innovation in improving new product development outcomes. Firms that leverage open innovation access a broader range of external ideas and resources, enabling accelerated product development lifecycles and improved adaptability to changes in market demands. These findings align with previous studies which assert that open innovation not only enriches the innovation process but also amplifies competitiveness in fast-evolving industries (Laursen & Salter, 2006; Chesbrough & Bogers, 2014). The VIF for this path is 1.001, indicating minimal multicollinearity and validating the substantial influence of open innovation on new product development. The results of the structural model are shown in Table 4.

The model demonstrates high explanatory power, with an adjusted R-square value of 0.674 for open innovation, indicating that 67.4 % of the variance in open innovation is accounted for by strategic foresight, knowledge exploration, and knowledge exploitation. Similarly, the adjusted R-square for new product development is 0.499, suggesting that open innovation explains 49.9 % of the variance in new product development outcomes. These values demonstrate the centrality of these constructs in the innovation process, confirming that the interplay between strategic foresight, knowledge management, and open innovation is essential for firms aiming to improve their new product development performance. Consequently, this study reinforces the importance of establishing foresight capabilities and leveraging both exploratory and exploitative knowledge processes as foundational elements for achieving sustained competitive advantage through effective new product development.

Multi-Group analysis

Multi-group analysis was conducted using the Welch-Satterthwaite test to evaluate whether the relationships between constructs differ significantly between Lithuania (LTU) and Slovakia (SKV). The analysis examined four specific paths: knowledge exploration to open innovation, knowledge exploitation to open innovation, open innovation to new product development, and strategic foresight to open innovation. The results for the path knowledge exploration to open innovation show a difference of 0.505 between Lithuania and Slovakia, with a t value of 0.019 and a p value of 0.985. This very high p value suggests no statistically significant difference, meaning that the influence of knowledge exploration on open innovation is similar across both countries. For the path knowledge exploitation to open innovation, the difference was −0.463, with a t value of 0.021 and a p value of 0.983. This result again shows no significant difference, indicating that the impact of knowledge exploitation on open innovation is consistent in Lithuania and Slovakia. Furthermore, the path open innovation to new product development shows a difference of 0.227, with a t value of 2.366 and a p value of 0.019, indicating a statistically significant difference between the two countries. This finding suggests that open innovation has a different level of influence on new product development outcomes in Lithuania than in Slovakia, with the effect likely being stronger in one country. Lastly, the path of strategic foresight to open innovation has a difference of −0.166, with a t value of 0.019 and a p value of 0.985, which indicates no significant difference. This result implies that the impact of strategic foresight on open innovation is similarly perceived in both Lithuania and Slovakia. In summary, the multi-group analysis results show consistency in the effects of knowledge exploration, knowledge exploitation, and strategic foresight on open innovation across the two countries. However, the relationship between open innovation and new product development differs significantly, suggesting that open innovation contributes differently to new product development outcomes in these two countries. This difference may reflect varying approaches or contexts for product development in Lithuania and Slovakia, despite their similar economic profiles. These findings indicate that the relationships among most of the studied constructs are consistent across both countries, demonstrating that the model's applicability and effectiveness are similar in both national contexts. The reason for this consistency can be explained by both countries being relatively small with emerging economies and a high integration to innovation networks across Europe and beyond. This similarity suggests that firms in these countries can leverage strategic foresight, knowledge exploration, and exploitation in a comparable manner to enhance open innovation and achieve successful new product development outcomes. The results of the multi-group analysis are presented in Table 5.

Table 4
Results of the structural model.

	Hypothesis *(Path)*	VIF (Internal model)	Path coefficient *(β)*	Sample mean *(M)*	STDEV	t value	p value
H1	Strategic foresight→ open innovation	1.313	0.477	0.476	0.036	13.423	0.000
H2a	Knowledge exploration→ open innovation	2.048	0.359	0.362	0.038	9.564	0.000
H2b	Knowledge exploitation→ open innovation	1.788	0.158	0.157	0.041	3.869	0.000
H3	Open innovation→ new product development	1.001	0.633	0.632	0.044	14.322	0.000
Adj. R-Square: OIN = 0.674, NPD = 0.499							

Discussion

The roles of knowledge exploration and exploitation in driving new product development have been extensively studied in innovation and product development literature, with studies highlighting the need to balance these processes to maximize innovation outcomes (Fernandes Rodrigues Alves, Pacheco, & Galina, 2025). The results of the current study align with this previous research, demonstrating that both knowledge exploration and exploitation significantly improve new product development outcomes. However, this study extends the literature by providing empirical evidence that knowledge management processes, combined with open innovation practices, amplify the effectiveness of both knowledge exploration and exploitation, ultimately leading to improved new product development outcomes. Whereas previous research has emphasized the importance of balancing exploration and exploitation (Griffith et al., 2021; Zhang et al., 2022), this study highlights the critical role of open innovation as a mechanism for integrating external knowledge sources into internal knowledge management processes, thereby improving the synergy between knowledge exploration and exploitation to achieve innovation success.

The study's results also highlight that both knowledge exploration and exploitation play crucial, albeit distinct, roles in fostering open innovation. Knowledge exploration has a moderate effect in influencing open innovation, whereas knowledge exploitation has a slightly lower but still significant effect, highlighting the need to use both processes to strengthen open innovation and, consequently, new product development outcomes. This nuanced finding challenges the notion that only knowledge exploitation has a substantial indirect effect, demonstrating instead that the integration of both knowledge exploration and exploitation is key to driving new product development through open innovation (Lavie et al., 2010; Raisch & Birkinshaw, 2008).

Previous research by Ferreira et al. (2021) and Griffith et al. (2021) has highlighted the important role of open innovation in supporting both knowledge exploration and exploitation, particularly in dynamic and competitive markets. The current study aligns with the findings of these studies and provides additional insights by demonstrating that strategic foresight, when integrated with open innovation, further enhances new product development outcomes. Firms with robust foresight capabilities are better equipped to anticipate future market trends, identify relevant external knowledge sources, and effectively incorporate these insights, supporting recent work on aligning innovation strategies with market demands (Pulsiri & Vatananan-Thesenvitz, 2018; Sakellariou & Vecchiato, 2022). In addition, this study confirms that open innovation functions as a catalyst between knowledge management and new product development, facilitating the seamless integration of both internal and external knowledge sources. This finding supports prior research on the importance of external knowledge for successful new product development (Lichtenthaler, 2021; Nascimento et al., 2021), while also adding empirical support to the role of open innovation in balancing exploration and exploitation. Our study further elaborates on prior findings by demonstrating that strategic foresight, combined with knowledge management practices, not only strengthens knowledge exploration and exploitation but also fosters more effective new product development. Unlike earlier findings that highlight foresight's direct impact on new product development (Li et al., 2020), this study shows that the interaction between foresight-driven knowledge management and open innovation enhances firms' ability to balance exploratory and exploitative knowledge. This interaction is most impactful when open innovation serves as a core phenomenon, integrating external knowledge into new product development processes, thus providing additional validation for the dynamic interplay between strategic foresight and knowledge management in achieving improved new product development outcomes (Nascimento et al., 2021). These findings support the work of Sakellariou and Vecchiato (2022), who emphasized that foresight enables firms to sense and shape future trends in new product development.

Table 5
Welch-Satterthwaite test.

Path	Difference *(LTU - SKV)*	*t value*	*p value*
Knowledge exploration → open innovation	0.505	0.019	0.985
Knowledge exploitation → open innovation	−0.463	0.021	0.983
Open innovation → new product development	0.227	2.366	0.019
Strategic foresight→ open innovation	−0.166	0.019	0.985
Notes: LTU – Lithuania, SKV – Slovakia			

The multi-group analysis further evaluates the consistency of these relationships across Lithuania and Slovakia with the results proving that most relationships remain consistent across the two countries, which reinforces the model's applicability. However, one key difference emerged; specifically, the influence of open innovation on new product development varies significantly between Lithuania and Slovakia, suggesting that open innovation contributes differently to new product development outcomes in these two countries. This discrepancy, absent from previous results, may reflect differences in national or sector-specific approaches to new product development. The overall consistency observed between Lithuania and Slovakia aligns with their profiles as being small emerging economies, with strong integration within regional or global innovation networks, facilitating similar knowledge management and strategic foresight practices (Rohrbeck & Kum, 2018; Petraite et al., 2022). This integration likely enables effective knowledge acquisition and responsiveness to market demands, supporting similar new product development outcomes across the two countries (Nascimento et al., 2021; Sakellariou & Vecchiato, 2022). This study suggests that firms located in countries with similar economies (e.g., Poland) could adopt comparable strategies to improve their innovation performance by leveraging the combined strengths of strategic foresight, knowledge management, and open innovation. However, it is worth noting that differences may emerge in larger and more developed economies, where firms often have access to more substantial resources and broader innovation networks. In such contexts, the dynamics of open innovation and knowledge management practices may differ significantly and, therefore, further research is needed to assess the applicability of these findings beyond smaller, emerging economies.

Conclusion

This study examined the roles of strategic foresight and knowledge management in promoting open innovation and driving new product development outcomes. Grounded in the knowledge-based view of the

firm, the research investigated how strategic foresight influences open innovation processes and how knowledge management catalyzes innovation success. Using SEM on data collected from 298 technology-based firms located in Lithuania and Slovakia, the study found that strategic foresight directly impacts open innovation and significantly improves new product development through open innovation. In addition, knowledge exploration and exploitation were found to play important roles in open innovation, with balanced effects on new product development outcomes. The study also identified open innovation as a critical mechanism that links strategic foresight and knowledge management to improve new product development, extending the knowledge-based view of the firm by highlighting the integration of external knowledge with internal processes, particularly in smaller, emerging economies.

Implications

This study makes several important contributions to the theoretical understanding of innovation management by extending the KBV of the firm. First, whereas the KBV traditionally emphasizes the role of internal knowledge and capabilities in driving innovation performance (Grant, 1996), this study broadens its scope by demonstrating how strategic foresight and knowledge management play critical roles in enhancing open innovation practices and, subsequently, new product development. The study finds that strategic foresight is a crucial enabler of open innovation, allowing firms to anticipate future market trends and uncertainties in the market. This foresight capability enhances the integration of external knowledge into internal innovation processes, aligning firms' new product development efforts with future market demands. In doing so, the research extends the KBV by incorporating the importance of external knowledge acquisition and leveraging external knowledge sources, in addition to internal knowledge creation and management. The study's findings align with and expand on the previous studies of Nascimento et al. (2021) and Sakellariou and Vecchiato (2022), emphasizing that strategic foresight and knowledge management interact dynamically to drive innovation.

Second, the study highlights the important role of open innovation as a catalyst between knowledge management and new product development, demonstrating that both knowledge exploration and exploitation contribute to open innovation which, in turn, improves new product development outcomes. Unlike prior studies that have suggested a predominant focus on knowledge exploitation, this research provides a more balanced view, demonstrating that knowledge exploration also plays a significant role. This nuanced perspective on how knowledge management practices drive new product development through open innovation expands on recent research by Griffith et al. (2021) and Ferreira et al. (2021), offering a more nuanced understanding of how firms can manage knowledge effectively across organizational boundaries through open innovation. By demonstrating how strategic foresight and knowledge management jointly enhance open innovation and new product development outcomes, this study offers a comprehensive theoretical framework for understanding how firms can achieve sustained competitive advantage. These findings highlight the dynamic capabilities required to manage the interplay between internal and external knowledge sources in rapidly changing environments, advancing the discourse on innovation management and new product development success.

For managers of technology-based firms, the strong positive relationship between strategic foresight and open innovation emphasizes the need for firms to invest in foresight activities that can identify emerging trends, technological advancements, and market shifts. Firms that actively engage in foresight can better anticipate changes in their external environment and more effectively integrate external knowledge into their innovation processes, resulting in more competitive and innovative products. This research also demonstrates the importance of effective knowledge management practices in driving open innovation. Managers should focus on building organizational capabilities that not only encourage the search for new knowledge but also supports its effective application. This may involve establishing an organizational culture that values continuous learning, supports experimentation, and encourages collaboration both within the firm and with external partners. Such practices enable firms to manage the balance between exploration and exploitation more effectively, aligning with the findings of Griffith et al. (2021) and Stock et al. (2021) on the role of knowledge management in enhancing innovation outcomes.

Furthermore, the evidence of the link between open innovation and new product development performance suggests that firms can significantly improve their product development outcomes by adopting collaborative innovation practices. Managers should consider forming strategic partnerships with external stakeholders, including suppliers, customers, and even competitors, to access wider pools of ideas and resources. Such collaborative efforts can help firms accelerate their innovation cycles, reduce risks associated with new product development, and ultimately enhance competitiveness in the marketplace. As noted by Ferreira et al. (2021), strategic alliances and knowledge-sharing partnerships play a critical role in enabling both knowledge exploration and exploitation, contributing to more successful new product development efforts. Given the consistent relationships observed in both Lithuania and Slovakia, managers in other smaller, emerging economies, with access to global or regional innovation networks may find similar strategies beneficial for improving new product development outcomes. However, the dynamics of these relationships may vary in larger economies, where more substantial resources and broader networks can influence knowledge management and open innovation practices. The insights of this study should, therefore, be considered carefully as to how these strategies apply in larger, more resource-rich contexts because the balance between exploration, exploitation, and external collaboration may drastically differ.

Limitations and future research

This study was conducted using data from technology-based SMEs located in Central Eastern Europe, which may limit the generalizability of the findings to other contexts, such as different sectors or geographic areas. Future research could address this limitation by employing longitudinal studies that track changes over time or by replicating the study in diverse industry settings and across different regions. Such approaches would help validate the findings and explore how the relationships between the key constructs might vary in different environmental contexts or over extended periods. Similarly, the study's focus on smaller economies may restrict the generalizability of the findings to countries with larger economies. Smaller economies often have unique characteristics, including higher integration within regional innovation networks, more agile decision-making processes, and differing scales of resource allocation compared to countries with larger economies.

Moreover, the study highlights the balanced roles of knowledge exploration and exploitation in fostering open innovation. Future studies could, therefore, examine how these roles might change in larger economies, where resource availability and network dynamics may influence these knowledge processes differently. Likewise, the study emphasizes strategic foresight and knowledge management dimensions (i.e., knowledge exploration and exploitation) as primary antecedents of open innovation and new product development. This focus may overlook other critical factors that could influence these relationships, such as organizational culture, leadership styles, and the external environment. Future research could expand the theoretical model reported in this study to include these additional variables, providing a more holistic understanding of the drivers of open innovation and new product development. For example, examining how organizational culture moderates the impact of strategic foresight on open innovation could yield valuable insights into how different organizational environments support or limit innovation efforts. Lastly, the study does not fully

explore the potential moderating or mediating effects of various organizational capabilities, such as digital capabilities, absorptive capacity, and organizational learning, which could further clarify the pathways through which strategic foresight and knowledge management influence open innovation and new product development. Future research should, therefore, investigate these variables to provide a more nuanced understanding of how these factors interact.

CRediT authorship contribution statement

Muhammad Faraz Mubarak: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Funding acquisition, Formal analysis, Conceptualization. **Giedrius Jucevicius:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Conceptualization. **Mubarra Shabbir:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Monika Petraite:** Writing – review & editing, Visualization, Validation, Resources, Project administration, Conceptualization. **Morteza Ghobakhloo:** Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Richard Evans:** Writing – review & editing, Visualization, Validation, Project administration.

Declaration of competing interest

The authors declare that there are no financial conflicts of interest related to this research.

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