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Eco-innovation *vs.* Classical Innovation Strategic Orientation: A Comparative Analysis of Their Impacts on Environmental and Operational Performance

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ABSTRACT

Objective: This study examines how a classical innovation strategic orientation (CISO) and an eco-innovation strategic orientation (EISO) are associated with environmental and operational performance (EOP) under an integrated SCP–RBV–Dynamic Capabilities lens. **Methods:** The study surveyed 844 firms across five countries and applied structural equation modelling with bias-corrected bootstrap to assess the direct effects of both strategic orientations on EOP and the mediation of eco-innovation implementation in these relationships. **Results:** We found that CISO and EISO have comparable associations with EOP. These associations appear both directly and indirectly through eco-innovation implementation in different ways, reinforcing that firms can achieve EOP improvements without exclusively adopting an eco-innovation-driven strategy. **Conclusions:** While EISO is usually more tied to environmentally sustainable outcomes, CISO can also be associated with EOP. Similar EOP outcomes may emerge from different dominant explanatory mechanisms: an externally induced, eco-innovation-mediated route for EISO, and an internally driven, capability-based direct route for CISO. By bridging innovation strategy and sustainability, this research contributes to the discussion on how firms can leverage different innovation approaches to enhance EOP.

INTRODUCTION

As global environmental crises such as climate change and resource depletion intensify, organizations face increasing pressures to adopt sustainable strategies (Intergovernmental Panel on Climate Change [IPCC], 2023; National Aeronautics and Space Administration [NASA], 2021; World Economic Forum, 2024). In this context, firms are responsible for operating in an environmentally responsible manner, offering products and services that provide value without harming the environment (Burget et al., 2017). Recent reports emphasise the importance of environmental transparency and risk management (International Financial Reporting Standards Foundation [IFRS/ISSB], 2023), underscoring the need to achieve environmental performance in conjunction with economic and operational performance to ensure that firms are viable according to the triple-bottom line – TBL (Barton & Gutiérrez-Antinopai, 2020; Elkington, 1997). Although the social pillar remains central in the broader sustainability discussion, this study focuses on environmental and operational performance because the theoretical comparison developed here concerns how different innovation strategic orientations relate to firm viability through eco-innovation implementation, efficiency gains, and competitiveness-related outcomes. This operation demands the implementation of new good practices, often referred to as green manufacturing, which involves activities that reduce firms' environmental impact by incorporating reused or recycled raw materials, minimizing pollutant emissions, reducing material and energy use throughout the supply chain, and extending product life cycles (Bendig et al., 2023; Despeisse et al., 2022; Hsu et al., 2016). Therefore, firms must balance economic and environmental goals, often mobilizing eco-innovation and classical innovation orientations to optimize performance (Fortuny-Santos et al., 2025; Nidumolu et al., 2009).

Green manufacturing practices are expected to enhance firms' environmental performance. These practices will only be commercially sustainable if they improve operational and financial performance (Barth et al., 2017). Several authors suggest that this dual contribution can be achieved by enhancing resource efficiency (Bocken et al., 2014; Ritala et al., 2018), reducing manufacturing and raw material costs (Moschetti et al., 2018), and increasing market share through improved corporate image (Hall & Wagner, 2012), customer satisfaction, and willingness to buy (Plank & Teichmann, 2018). Additionally, green manufacturing can create new products and services for a growing niche of environmentally conscious customers (De Angelis, 2022; Geissdoerfer et al., 2020; Todeschini et al., 2017). This logic is reinforced by recent evidence indicating that eco-innovation and related sustainability-oriented practices can improve performance, although effects are heterogeneous across contexts and firms (Zheng & Iatridis, 2022).

Adopting more environmentally responsible manufacturing practices demands the development of eco-innovations, which involve innovative changes in products, processes, organizational practices, and business methods to achieve environmental sustainability (De Marchi & Grandinetti, 2013). It also requires an eco-innovation strategic orientation (EISO), defined as a consistent commitment to adopting environmentally friendly practices to achieve long-term positive environmental performance (Jabbour et al., 2014; Nguyen & Adomako, 2021; Testa & Iraldo, 2010).

However, firms without explicit environmental goals can also achieve improved environmental and operational performance (EOP). Many of the most innovative business models align with environmental sustainability concepts, such as product-service systems (e.g., Adam, 2018; Bocken et al., 2018) and circular business models (e.g., De Angelis, 2022; Geissdoerfer et al., 2018; Geissdoerfer et al., 2020). Therefore, we suggest that a classical innovation strategic orientation (CISO) can also be associated with environmental and operational improvements by reducing inputs, energy, and defects achieved through process efficiency and learning spillovers (Sun & Chu, 2022; Wu et al., 2024). In addition, recent meta-analytic evidence supports that efficiency-oriented operational practices are systematically associated with environmental performance gains, reinforcing that 'non-green-labelled' innovation and operational excellence can still translate into environmental improvements (Fortuny-Santos et al., 2025). Consequently, firms prioritizing innovation as a core strategy for competitive success (Barney, 2010) could also achieve noteworthy environmental and financial results (Ezzi & Jarboui, 2016).

Therefore, we argue that EISO and CISO are associated with EOP through different dominant explanatory mechanisms. Eco-innovation aligns with the structure-conduct-performance (SCP) theory by positioning firms competitively through environmental responsiveness, as we consider well-designed environmental regulation as a stimulus to innovation and competitiveness (Porter & Van der Linde, 1995; Zhang et al., 2024). Under this SCP logic, environmental regulation, stakeholder expectations, and competitive dynamics shape the 'structure' and the payoffs of alternative strategic 'conduct'; EISO reflects a deliberate conduct in which firms prioritize eco-innovation to respond to these external pressures. So, its association with EOP is expected to arise mainly through the effective implementation of eco-innovations. (Zhang et al., 2024; Zheng & Iatridis, 2022). On the other hand, CISO leverages internal capabilities (RBV: Barney, 1991; dynamic capabilities - DC: Teece, 2007) to drive innovation irrespective of explicit environmental aims. In this capability-based route, performance improvements are theoretically comparatively more direct because internally accumulated innovation capabilities may translate into operational outcomes and, by extension, environmental improvements through process and business model innovation spillovers (Oliveira-Dias et al., 2022; Teece, 2018). So, the theoretical difference is not only that one route is explicitly 'green' and the other not, but also that the EISO route is primarily externally induced and eco-innovation-mediated, while the CISO route is primarily internally driven and capability-based and is more likely to be directly associated with EOP. In this sense, EISO and CISO should not be seen as closely related manifestations of a broader innovation posture, but as theoretically different strategic orientations that differ in their predominant trigger, strategic emphasis, and expected route to performance. This is why similar EOP outcomes may emerge through different dominant mechanisms across industries and markets (Bocken et al., 2018).

Numerous studies have explored the relationship between innovation strategies and eco-innovation (e.g., Brook & Pagnanelli, 2014; Ghisetti et al., 2015; Hsu et al., 2016), as well as the impact of these innovations on EOP (e.g., Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Ezzi & Jarboui, 2016). However, most studies examine one strategic orientation at a time (e.g., De Marchi & Grandinetti, 2013; Testa & Iraldo, 2010; Jabbour et al., 2014), without simultaneously analysing the interaction of eco-innovation and classical innovation, therefore, not disentangling whether roles are complementary or substitutive. Building on the integrative view of SCP and RBV theories (Hoskisson et al., 1999), this article argues that a firm may achieve similar EOP outcomes through different dominant strategic mechanisms: an externally induced, eco-innovation-mediated route and an internally driven, capability-based route. To the best of our knowledge, previous research does not test the effects of EISO and CISO and their interaction within a single model that estimates EOP (a necessary condition to make firms viable according to the TBL, as stated by Barton & Gutiérrez-Antinopai, 2020). Covering this gap is relevant as the current literature does not clarify whether both strategies compete for the firm's resources (Liu et al., 2023; Song et al., 2025)—implying a substitutive effect—or are complementary (Milgrom & Roberts, 1995). Besides, previous studies present heterogeneous effects of eco-innovation on performance (Oduro, 2024; Zheng & Iatridis, 2022) and divergent findings concerning the influence of classical innovation on environmental performance (Chen & Jiang, 2024; Wu et al., 2024). We expect this heterogeneity to reflect not only the difference in effect size but also the mechanism that is more salient in different circumstances. The EISO route is expected to be more important when regulatory and stakeholder pressure are stronger, while the CISO route is expected to be more salient when companies have more innovation capabilities, more resources, and better incentives to be efficient. Accordingly, our research question is: 'Are classical innovation and eco-innovation strategic orientations similarly effective in promoting improvements in firms' environmental and operational performance through different dominant mechanisms, and does a joint adoption add incremental value when both are estimated together?'

This study's contribution is twofold. First, it advances our integrative SCP-RBV/DC perspective by showing that similar EOP outcomes may have different dominant explanatory mechanisms rather than being based on the same innovation path. It makes explicit the theoretical contribution concerning how distinct strategic logics are associated with performance through different dominant mechanisms. Specifically, it reframes the understanding of the dominant mechanism connecting strategic orientation to EOP. It proposes that EISO is most likely to be associated with EOP via eco-innovation implementation. In contrast, CISO is more likely to be associated with EOP through internally accumulated innovation capabilities and efficiency-related spillovers. This also implies that the difference between EISO and CISO is not only statistical but also conceptual, as each orientation has a different strategic logic for linking innovation to environmental and operational outcomes. In this sense, the paper is more than just comparing SCP and RBV/DC as it specifies what each lens explains better and under which institutional and resource conditions each route is expected to become more salient. Second, it evaluates whether the total effects of both strategies on EOP are similar or different and how they interact, providing managers with insights to enhance strategic planning and execution. By using data from five important developed and emerging countries, this research brings insights that allow us to understand the firms' strategic responses to environmental and competitive challenges, contributing to both theory and practice in innovation management and sustainability (Ghisetti et al., 2015).

LITERATURE REVIEW

Sustainable Business Models

The incorporation of sustainability into business models has garnered increasing attention due to the evolving preferences of consumers who prioritize environmental and social accountability in their purchasing decisions. This shift in consumer behaviour has catalyzed companies to adopt practices that are both environmentally friendly and socially responsible, leading to a proliferation of studies focused on sustainable business models and innovations (Goyal et al., 2017; Plank & Teichmann, 2018; Roscoe et al., 2016; Sabatier et al., 2017; Todeschini et al., 2017). More recently, this stream has expanded by explicitly linking sustainable business model innovation and related sustainability-oriented practices to firm-level performance outcomes under increasing environmental, institutional, and market pressures (Díaz Duarte et al., 2025; Girma et al., 2025).

Contemporary scholarship has documented a significant trend among firms to integrate sustainability at the core of their business models rather than treating it as a peripheral activity. This integration is increasingly framed as a strategic response to competitive dynamics and institutional pressures, aiming at achieving competitive advantage (Lichy et al., 2023) and, in consequence, superior performance across the economic, social, and environmental aspects of the triple bottom line (Birkin et al., 2009; Carayannis et al., 2015; Geissdoerfer et al., 2018; Schaltegger et al., 2012). Recent empirical evidence suggests that sustainability-oriented business models may support environmental and operational performance when firms successfully align their value architecture with external stakeholder expectations and regulatory demands (Gazzola et al., 2024; Rathobei et al., 2024). Furthermore, the market for environmentally and socially responsible products and services continues to expand, with firms leveraging these offerings as strategic positioning mechanisms to attract and retain customers (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Hall & Wagner, 2012; Roscoe et al., 2016).

The necessity to move away from traditional business models toward innovative ones that naturally incorporate environmental and social dimensions has become evident. This paradigm shift involves not only redefining the products and services offered but also transforming the mechanisms through which value is created, delivered, and captured to meet broader stakeholder interests (Biloslavo et al., 2018; Markides, 2006; Tolkamp et al., 2018). Business models are typically characterized by three foundational elements: the value proposition, value creation and delivery, and value capture. These elements jointly determine how firms generate economic returns while addressing environmental and societal challenges (Osterwalder et al., 2005; Richardson, 2008). Recent conceptualizations emphasize that sustainable business models reconfigure these elements to internalize environmental constraints and exploit sustainability-driven opportunities, particularly under conditions of heightened competitive and regulatory pressure (Palmié et al., 2025). To guarantee consistency with the paper's scope, we focus on environmental and operational performance (EOP) as key outcomes of sustainable business models, while recognizing the relevance of the social dimension.

Implementing a business model with strong EOP typically requires systemic innovation spanning product, process, marketing, and organizational domains. Such innovations are essential for adjusting the value proposition through sustainable offerings, improving manufacturing and logistics efficiency, and redesigning organizational processes to reduce environmental impacts and operational costs. Recent studies show that environmentally sustainable manufacturing practices—such as energy and material efficiency and waste minimization—are increasingly enabled by digital transformation and Industry 4.0 technologies, which enhance process excellence and operational efficiency, thereby improving EOP (Bendig et al., 2023; Despeisse et al., 2022; Sun & Chu, 2022). In parallel, business model innovations grounded in circular economy and product–service system (PSS) logics can help firms to decouple value creation from resource consumption, simultaneously improving environmental indicators and operational performance (Izquierdo-Montfort & De Rongé, 2025; Sarasini et al., 2024).

EISO and EOP

The academy has extensively explored eco-innovation and its implications for firm performance, given organizations' increasing commitment to sustainable development (Pujari, 2006). Based on the Brundtland Commission's definition of sustainable development (World Commission on Environment and Development [WCED], 1987), Elkington (1997) introduced the triple bottom line framework, which assesses firm performance across economic, social, and environmental dimensions. From these three dimensions, environmental performance in conjunction with economic and operational performance makes firms viable (Barton & Gutiérrez-Antinopai, 2020). Roscoe et al. (2016) further defined sustainability performance in terms of ecological, economic, and social criteria. Given the well-established positive relationship between innovation and performance (e.g., Du et al., 2014; Faems et al., 2010; Tomlinson, 2010), scholars have studied environmental sustainability innovations using various terms, including green innovation (e.g., Calza et al., 2017; Schiederig et al., 2012), eco-innovation (e.g., Cai & Zhou, 2014; Kiefer et al., 2017), and sustainability-oriented innovation (Adams et al., 2016).

For firms to implement eco-innovation effectively, they must adopt an EISO (Jabbour et al., 2014; Pacheco et al., 2018; Testa & Iraldo, 2010), which entails a long-term commitment (Lee & Min, 2015; Nguyen & Adomako, 2021) to developing environmentally responsible products and services, creating markets for them, and promoting their adoption, thereby enhancing the firm's reputation (Chu et al., 2018; Hojnik & Ruzzier, 2016). SO aligns strategic planning and execution (Barney, 2010) with external opportunities and threats (Porter, 1989) and internal resources and capabilities (Barney, 1991), creating competitive advantages that improve performance (Barney, 2010). Conceptually, however, EISO should not be viewed as a generic innovation posture with environmental content, but as a strategic orientation in which environmental responsiveness is explicit and central. Its main trigger is external; in the corporate culture, the firm's behaviour toward eco-innovation and its implementation is governed by regulatory requirements, stakeholder expectations, and competitive priorities (Testa & Iraldo, 2010; Zhang et al., 2024; Zheng & Iatridis, 2022). Therefore, there is a notable link between SCP logic and EISO. Specifically, under an SCP lens, environmental regulation, stakeholder expectations, and competitive dynamics shape the 'structure' and the payoffs of alternative strategic 'conduct'; EISO captures a deliberate conduct in which firms prioritize eco-innovation to respond to these external pressures and reposition competitively (Porter & Van der Linde, 1995; Zhang et al., 2024; Zheng & Iatridis, 2022). External conditions (e.g., environmental regulation and market expectations) influence firms' conduct to focus on eco-innovation adoption, which is, on average, associated with a positive environmental performance (Oduro, 2024; Zheng & Iatridis, 2022). Consequently, process redesign and cleaner technologies also improve operational performance through efficiency gains (Bendig et al., 2023; Sun & Chu, 2022; Wu et al., 2024). Recent evidence reinforces that eco-innovation is simultaneously driven by institutional/regulatory forces, market pressures, and firm-level conditions, which helps explain why effects differ across settings (Arranz et al., 2021; Kesidou et al., 2024; Larbi-Siaw et al., 2023). Importantly, this SCP-driven route does not exclude internal capabilities: rather, capabilities condition how effectively firms translate external pressures into implemented eco-innovations and performance gains (Kesidou et al., 2024).

Among performance dimensions, the link between EISO and environmental performance is the most intuitive. Firms prioritizing eco-innovation effectively develop and implement such initiatives, reducing environmental impact, which varies by policy instrument and context (Zhang et al., 2024). Eco-innovations foster responsible business models that reduce raw material consumption, shift toward renewable resources, and minimize waste (Geissdoerfer et al., 2018). Other positive effects include lowering greenhouse gas emissions (*ibid*), pollution (Pal & Gander, 2018), and energy and water consumption (Horbach et al., 2012; Hsu et al., 2016). To achieve these benefits, eco-innovations target product, service, or business model design (Kiefer et al., 2017). For instance, process innovations modify products and services to reduce raw material, water, and energy use throughout the product lifecycle (Bocken & Allwood, 2012; Horbach et al., 2012; Hsu et al., 2016). Other innovations introduce eco-friendly materials that minimize product toxicity (Braungart et al., 2007; Horbach et al., 2012) or enable circular economy practices like reusing, reselling, refurbishing, and recycling (Høgevold et al., 2014).

Further eco-innovations reshape business models by promoting servitization, replacing ownership with pay-per-use or pay-per-result models (Tukker, 2004). This approach increases product utilization across multiple customers, reducing environmental impact and extending the product lifecycle (Gaiardelli et al., 2014). Similarly, PSS, collaborative consumption and sharing economy models may generate comparable effects in some contexts, as product sharing reduces individual ownership needs (Bellos et al., 2017; Guttentag et al., 2018; Hamari et al., 2016; Sarasini et al., 2024; Todeschini et al., 2017).

Additionally, many studies conclude that eco-innovation yields both environmental and operational performance benefits in many cases (Barth et al., 2017; Geissdoerfer et al., 2018; Hirscher et al., 2018). Operational performance broadly encompasses financial, customer, and business process indicators (Kaplan & Norton, 1992; Venkatraman & Ramanujam, 1986). Environmental pressures from governments and markets create conditions in which new opportunities and threats arise. Within this new context, eco-innovation is key to differentiate firms (Cheng et al., 2014; Lee & Min, 2015), enhancing reputation (Nguyen & Adomako, 2021), and expanding product and service offerings (Dong et al., 2014). This advantage strengthens customer loyalty among environmentally conscious consumers (Dabija et al., 2018; Kuchinka et al., 2018; Nguyen & Adomako, 2021), providing a competitive edge.

Building on these arguments, research indicates that firms introduce eco-friendly products and services as a strategy to attract an expanding market of environmentally concerned consumers (e.g., Aguilera-Caracuel & Ortiz-de-Mandojana, 2013; Hall & Wagner, 2012; Roscoe et al., 2016), increasing market share and sales. Additionally, eco-innovation helps firms comply with environmental regulations (Horbach, 2008; Horbach et al., 2012), reducing fines that could impact profit margins (Tsai & Liao, 2017). It also lowers operational costs by reducing raw material requirements or switching to recycled inputs (Geissdoerfer et al., 2018) and decreasing energy and water consumption (Horbach et al., 2012; Hsu et al., 2016). However, recent studies report that the effect of EISO on performance can be heterogeneous (Oduro, 2024; Zheng & Iatridis, 2022), motivating the test of the following hypothesis:

> Hypothesis 1: The indirect association between an eco-innovation strategic orientation and a firm's environmental and operational performance, mediated by the implementation of eco-innovations, is expected to be positive and stronger than the direct association between them, although the direct association is also expected to be positive and significant.

CISO and EOP

We advocate that a strategy oriented toward classical innovation enhances environmental and operational performance. We therefore base the mechanisms linking CISOs to performance on RBV and DC theories. In this route, performance improvements are expected to be primarily direct, because CISO reflects internally accumulated innovative resources and dynamic capabilities that translate into superior operational outcomes and, in consequence, environmental results—even without an explicit environmental intent (Barney, 1991; Teece, 2007). CISO, unlike EISO, should be viewed as a capability-based innovation orientation on the basis of competitiveness, experimentation, and renewal. Its main trigger is internal, as its strategic rationale is, in fact, the accumulation and deployment of innovative resources and dynamic capabilities and not an environmental commitment, even if it might support the adoption of environmental and circular-economy-oriented practices (Barney, 1991; Marrucci et al., 2022; Teece, 2007). To support this claim, we examine three key relationships: the positive influence of classical innovation on operational performance, its effect on environmental performance, and the correlation between both performances. The previous section addressed the third relationship; we now focus on the first two. Additionally, we acknowledge that the CISO may indirectly influence EOP through eco-innovation implementation, as internally developed innovation capabilities can facilitate the adoption of environmental innovations and process improvements (Marrucci et al., 2022).

A CISO occurs when firms continuously encourage new ideas, creativity, and innovation, aiming for market leadership (Kim et al., 2013; Naranjo-Valencia et al., 2011). Achieving this requires firms to balance internal R&D investment with partnerships that provide complementary knowledge, resources, and capabilities (Frenz & Ietto-Gillies, 2009; Paula & Silva, 2018), increasing their potential to create new combinations that drive innovation (Hagedoorn et al., 2018; Quintana-García & Benavides-Velasco, 2011). This approach aligns with open innovation (Chesbrough, 2003), which fosters technological capabilities and enhances innovativeness as part of strategic decision-making for a superior competitive advantage (Porter, 2008). Additionally, firms must develop core dynamic capabilities, such as absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002) and alliance network orchestration (Hurmelinna-Laukkanen et al., 2012), to effectively integrate knowledge. Empirical studies reinforce the link between open innovation strategy and innovation performance (e.g., Cassiman & Veugelers, 2006; Parida et al., 2012; Paula & Silva, 2018), with innovation performance measured by the number of innovations introduced to the market (Tomlinson, 2010) or their impact on operational performance (Ritala et al., 2015). Recent meta-analytic evidence also supports a robust positive association between innovation and organizational performance across contexts and innovation types (Katebi et al., 2024).

Higher innovation performance is a key driver of operational performance, as supported by several authors (e.g., Belussi et al., 2010; Faems et al., 2010; Ritala et al., 2015). All innovation types listed in the Oslo Manual (Organisation for Economic Co-operation and Development/Eurostat [OECD], 2018) can enhance firm performance (Aldieri et al., 2021). Product innovation boosts revenue and market share (Du et al., 2014) by filling demand gaps (Galindo & Méndez, 2014) and creating cost-effective or higher-quality offerings that strengthen customer loyalty (Li et al., 2016). Process innovation optimizes production efficiency and the value chain (Moutinho et al., 2015), increasing productivity (Dabla-Norris et al., 2012; Terjesen & Patel, 2017) and reducing costs. It also enhances quality and reliability (Findik & Beyhan, 2017). Organizational innovation generates sustainable competitive advantage (Birkinshaw et al., 2008) by enabling firms to adapt business practices, workplace organization, and external relationships (OECD/Eurostat, 2018), maximizing technological innovations' benefits (Camisón & Villar-López, 2014). Marketing innovation further strengthens brand competitiveness (Gupta et al., 2016). These arguments support that CISO influences operational performance.

The relationship between CISO and environmental performance is more complex. The modern business environment is increasingly competitive and dynamic (Teece, 2007), with more demanding customers (Nanda et al., 2019) and powerful incumbents (Hill & Rothaermel, 2003), requiring disruptive innovations that leverage diverse knowledge sources to achieve competitive advantage (Martín-de-Castro, 2015). Consequently, business model innovation is closely tied to firms' competitive strategies (Markides, 2006), often having a more disruptive impact than pure technological innovations.

The digital transformation technologies underpinning Industry 4.0 (Schwab, 2017) are key drivers of new business model creation (Ibarra et al., 2018; Khan et al., 2021), enabling integrated management improvements and new product, service, and process introductions (OECD/Eurostat, 2018). Industry 4.0 integrates multiple technologies, including artificial intelligence, nanotechnology, renewable energy, and quantum computing (Schwab, 2017). Business models enabled by digital transformation usually increase leaness and tie operational excellence to environmental gains (Sun & Chu, 2022; Wu et al., 2024), being inherently sustainable. Examples are product-service systems (PSS) (Adam, 2018; Bocken et al., 2018; Geissdoerfer et al., 2018; Sarasini et al., 2024; Tukker, 2004; Vezzoli et al., 2015) and sharing economy-based businesses (Bellos et al., 2017; Todeschini et al., 2017). Recent evidence further suggests that strategic orientations related to digitalization can improve environmental performance, particularly under high technological turbulence—supporting the view that boundary conditions shape when capability-driven orientations translate into environmental outcomes (Bendig et al., 2023).

PSS replaces ownership with functionality (Bocken et al., 2014), combining products and services (Tukker, 2004; Vezzoli et al., 2015), minimizing resource consumption and delivering environmental benefits (Tukker, 2004). An example is cloud computing, where firms do not need to purchase servers for data storage and processing (Lee & Lee, 2015). Instead, suppliers provide online storage and processing services, making server operations transparent to users. Similar environmental benefits arise from sharing economy models, which optimize resource use by reducing individual ownership (Guttentag et al., 2018; Hamari et al., 2016). For example, Ego, an Italian fashion firm, designs women's dresses for borrowing rather than for purchase. Subscribers can access the portfolio online while the company manages washing and maintenance (Ego, 2022). However, certain peer-to-peer ridesharing platforms (e.g., Uber, Lyft, Didi, BlaBlaCar, Grab, Ola) have contested environmental benefits, as some argue they discourage public transport use and increase emissions (Frenken & Schor, 2019; Vivanco et al., 2015).

Modern innovation is closely linked to business models based on Industry 4.0 technologies. Although some of these models' sustainability remains debatable, most contribute positively to business sustainability. Recent studies differ in their findings on the influence of classical innovation on environmental performance (Chen & Jiang, 2024; Wu et al., 2024). Taken together, this stream suggests that CISO can improve environmental performance through (1) direct efficiency and process innovations, and (2) indirect capability-based support for eco-innovation implementation—yet the magnitude of these effects is likely contingent on competitive and technological conditions (Bendig et al., 2023; Marrucci et al., 2022). Therefore, we propose to test the following hypothesis:

> Hypothesis 2: The direct association between a classical strategic orientation and a firm's environmental and operational performance is expected to be positive and stronger than the indirect association between them, mediated by the implementation of eco-innovations, although the indirect association is also expected to be positive and significant.

The two preceding hypotheses focus on the positive influence of each strategic orientation (EISO and CISO) on EOP. These arguments build on two key premises. First, operational and environmental performance are correlated and jointly instrumental to overall firm success. Second, an innovation-oriented strategy tends to improve firm performance regardless of whether sustainability is an explicit goal (as in an EISO) or not (as in a CISO). Moreover, EISO and CISO are not only empirically distinct but also conceptually different strategic orientations: the former is more environmentally focused and mainly externally driven, whereas the latter is more capability-based and mostly internally driven. Therefore, the causal mechanisms linking EISO and CISO to EOP are fundamentally different. An eco-innovation strategic orientation is predominantly driven by external pressures, in line with a structure–conduct–performance (SCP) logic: environmental regulations, market expectations, and other institutional forces shape the firm's conduct toward eco-innovation, which, in turn, promotes performance improvements through the successful implementation of green innovations. In contrast, a classical innovation strategic orientation relies on internal resource accumulation and dynamic capabilities, consistent with the resource-based view (RBV) and dynamic capabilities (DC) perspective – here, the firm's development of innovative resources, competencies, and processes directly translates into enhanced operational and even environmental outcomes. This asymmetry means that EISO's impact on performance is realized more indirectly (through eco-innovations as a mediating conduit), whereas CISO can spur performance more directly by strengthening internal capabilities. Notably, external drivers and internal capabilities are not mutually exclusive; recent evidence shows that while external forces stimulate eco-innovation, a firm's capabilities determine how effectively those pressures are converted into implemented innovations and performance gains.

Furthermore, pursuing both orientations simultaneously may entail trade-offs, as the two strategies can compete for finite resources and potentially crowd each other out, as evidenced by articles about resource-allocation tensions in innovation- and sustainability-oriented investments (Liu et al., 2023; Song et al., 2025). In other words, dedicating attention and resources to one orientation might diminish the marginal benefits of the other, especially if managers face conflicting priorities. This aligns with emerging findings that the performance effects of EISO and CISO can vary across contexts and are not always uniformly positive (Chen & Jiang, 2024; Oduro, 2024; Wu et al., 2024; Zheng & Iatridis, 2022). Given these arguments, we posit that the two orientations function as substitutes rather than complements in driving EOP. Their concurrent adoption may thus yield diminishing returns, an idea formalized in our subsequent hypotheses (H3 and H4).

> Hypothesis 3: Both a classical innovation strategic orientation and an eco-innovation strategic orientation are positively associated with a firm's environmental and operational performance to a similar extent.

> Hypothesis 4: The interaction of a classical innovation strategic orientation and an eco-innovation strategic orientation is negatively associated with a firm's environmental and operational performance.

Importantly, H1 and H2 explicitly incorporate these distinct dominant explanatory mechanisms. Hypothesis 1 highlights the indirect, eco-innovation-mediated route by which EISO influences performance (through eco-innovation implementation). In contrast, Hypothesis 2 emphasizes the direct route by which CISO is associated with internal innovation capabilities and performance. By specifying the mediated vs. direct nature of these effects, the hypotheses align closely with the theoretical mechanisms discussed above. This clarity reinforces the theoretical logic: H1 reflects an SCP-driven mediated effect, and H2 reflects an RBV/DC-driven direct effect, suggesting that similar EOP outcomes may emerge from different dominant mechanisms whose salience may vary across institutional and resource conditions.

METHOD

Sampling, data collection, and description of variables

Each firm's data was gathered by a survey answered by its representative (owner, president, vice president, CEO, director, or manager) according to their perceptions. We adopted a cross-sectional survey design and relied on informed managerial perceptions because proxies of constructs such as strategic orientation and performance are not easily directly observable in secondary datasets, especially for privately held firms, which are included in our sample. The choice is widely accepted in the management research, and its adequacy is supported by prior research that shows acceptable convergence between subjective and objective performance (e.g., Dess & Robinson, 1984; Richard et al., 2009; Venkatraman & Ramanujam, 1986; Wall et al., 2004). Accordingly, the relationships estimated in this study should be interpreted as explanatory associations rather than as strict causal effects. The questionnaire's reliability and validity (operational and face validity) were tested with five executives of Brazilian firms and five academic specialists and adapted accordingly, following Taherdoost (2016). Data were collected from 844 firms across Brazil (221 firms), China (150 firms), Germany (165 firms), India (157 firms), and the USA (151 firms), representing both developed and emerging economies with diverse innovation landscapes. We selected countries based on their varying regulatory pressures, economic development, and environmental standards, which allows a nuanced exploration of eco-innovation and classical innovation impacts across contexts. To ensure cross-national comparability, we used back-translation for all languages (Brislin, 1980). To collect the data, we hired Toluna, a leading global market research and insights company, and the questionnaires for all languages were built in Qualtrics. The sampling approach used by Toluna was to send the questionnaire by email to professionals at managerial and higher-level positions in firms from varied sectors in the five countries. Participation was voluntary and confidential, and it was made clear to the respondent that there were no right or wrong answers to reduce social desirability bias. Only thoroughly answered questionnaires were considered valid. The 844 valid questionnaires exceed Hair et al.'s (2013) recommendation of at least 200 cases for SEM, and a minimum of 15 cases per parameter. As the model has 36 parameters, the minimum would be 540 respondents.

This study tests the relationships among four constructs: CISO, EISO, Eco-innovation, and EOP, the latter a second-order construct reflected by the first-order constructs Operational Performance (OP) and Environmental Performance (EP). They were measured by seven-point Likert scales, with 1 (one) indicating 'strongly disagree' and 7 (seven) indicating 'strongly agree', previously validated in the literature (see the scales in Appendix). Control variables were included to address the potential confounding effects of economic context and organizational scale on performance outcomes. 'Emerging Country' was coded as a binary variable (1 = emerging - China, India or Brazil, 0 = developed - USA or Germany) to capture economic context differences. At the same time, 'Firm Size' (0 = up to 500 employees, 1 = more than 500 employees) was included to control for scale-related performance variations.

Statistical method

First, we performed an analysis of variance to examine differences between early and late respondents (Armstrong & Overton, 1977), and we found no significant differences, suggesting that non-response bias is unlikely to be a critical concern. Because the survey was administered through Toluna's professional panel, a conventional response rate based on the total number of invitations sent was not directly available to the authors. The final valid sample comprised 844 fully completed questionnaires. To address common-method bias (CMB), we implemented both ex-ante and ex-post strategies. For the ex-ante approach, we followed Crespo et al. (2022) by ensuring that respondents were unaware of the conceptual framework, organizing the questions into sections, and including unrelated variables in the questionnaires.

For the ex-post diagnostics, we used two approaches. The first approach was the unmeasured latent method factor (i.e., trait/method CFA - CTCM), a CFA that allows all items to load a common method factor, in addition to their theoretical constructs (Podsakoff et al., 2003; Williams et al., 2010), which made only marginal improvements to the model fit while the magnitude, direction, and statistical significance remained stable. Additionally, we run a regression with and without a correlated marker variable (CMV), which was modularisation, measured by 'Most of our products/services have parts/components in common', 7-point scale). This variable was chosen because it was theoretically unrelated to the model (Lindell & Whitney, 2001). EOP in the regression is an average of EP and OP. There were no significant changes in the coefficients between the two regressions. Both tests converged, indicating that CMB is unlikely to be a relevant issue.

Afterwards, we validated the measurement model by evaluating the adequacy of representing each construct using a factor derived from summated scales, using confirmatory factor analysis (CFA) across all constructs to assess validity and reliability. All standardized factor loadings should exceed 0.70 (Nunnally, 1978), composite reliabilities (CR) should be above 0.70, and the average variances extracted (AVE) should be greater than 0.50 (Fornell & Larcker, 1981) to support reliability and convergent validity. We assessed discriminant validity using the heterotrait–monotrait ratio of correlations (HTMT). HTMT should be lower than 0.85 or 0.90 if the constructs are theoretically related (Henseler et al., 2015).

Finally, we tested the hypotheses using structural equation modeling (SEM) and bootstrap with the bias-corrected percentile method (Diciccio & Romano, 1988) to test the direct, indirect, and total effects. These methods were selected for their ability to test complex relationships and mediation effects, aligning with our research goals of examining both direct and indirect associations (Hair et al., 2013). SEM's suitability for latent constructs and multi-path analysis makes it ideal for this study's objectives (Kline, 2023). We ran CFA and SEM using maximum likelihood estimation. The minimum acceptable fit measures for the CFA and the SEM were a CFI and a TLI higher than 0.95 and an RMSEA lower than 0.07 (*ibid*). To address the estimation of moderation effects, we used a two-step approach based on the factor scores validated in the measurement model to avoid model inflation and identification problems (Anderson & Gerbing, 1988; Little et al., 2006). The interaction term EISO × CISO was calculated by multiplying the two indicators from the first step, mean-centered (Little et al., 2006), and was specified as a predictor of eco-innovation and EOP.

RESULTS

We validated the measurement model through a CFA (see Table 1). The model presented a good overall fit (CFI = 0.95; TLI = 0.95; RMSEA = 0.059). All standardized factor loadings exceeded 0.70, CR were above 0.70, and AVE were greater than 0.50, supporting reliability and convergent validity. The HTMT correlations initially indicated an overlap between CISO and EISO. Item diagnosis indicated that the EISO proxy ESO5 should be removed. After these adjustments, discriminant validity was supported (see Table 2; HTMT < 0.85 for all but EISO-CISO, which has HTMT = 0.88 and is acceptable because the constructs are theoretically related, although conceptually distinct). Importantly, although EISO and CISO are empirically correlated, they represent conceptually distinct strategic orientations: EISO means an externally oriented, environmentally driven strategic logic, influenced by regulatory and stakeholder pressures, and CISO illustrates an internally driven capability-based innovation orientation, driven by competitiveness and efficiency. Therefore, this relationship is theoretically expected and does not indicate construct redundancy. Based on the evidence of unidimensionality, reliability, and convergent and discriminant validity, we operationalized the constructs as summated scales for use in the structural analyses.

Table 1. Measurement model results.

Construct	Item	S.R.W.	CR	AVE
EISO	ESO1	0.78	0.91	0.60
	ESO2	0.81		
	ESO3	0.79		
	ESO4	0.76		
	ESO6	0.74		
CISO	ISO1	0.80	0.90	0.58
	ISO2	0.77		
	ISO3	0.79		
	ISO4	0.75		
	ISO5	0.82		
Eco-innovation	EI1	0.73	0.93	0.61
	EI2	0.78		
	EI3	0.80		
	EI4	0.82		
	EI5	0.76		
	EI6	0.74		
	EI7	0.79		
OP	OP1	0.72	0.89	0.54
	OP2	0.75		
	OP3	0.78		
	OP4	0.81		
	OP5	0.74		
	OP6	0.76		
	OP7	0.70		
	OP8	0.73		
EP	EP1	0.77	0.92	0.62
	EP2	0.80		
	EP3	0.82		
	EP4	0.79		
	EP5	0.81		
	EP6	0.78		
	EP7	0.76		

Note. S.RW. = standardized regression weights; S.E. = standard error.

Table 2. Discriminant validity (HTMT).

Construct	1	2	3	4	5
1. EISO	—				
2. CISO	0.88	—			
3. Eco-innovation	0.76	0.71	—		
4. Operational performance	0.62	0.68	0.65	—	
5. Environmental performance	0.70	0.66	0.74	0.61	—

Note. Values represent HTMT ratios.

Table 3 contains the descriptive statistics of the whole sample, each country group, and each country. It reveals the perception that the firms in the entire sample have high EISO and CISO (5.45 and 5.61), a high level of eco-innovation implementation (5.43), and high performance (5.21 in environmental performance and 5.56 in operational performance). Surprisingly, all indicators are slightly higher in firms from emerging countries. Brazil had the highest averages across all variables in the emerging country group (except for EISO, which is higher in India). In contrast, the USA had the highest averages among developed countries. 54% of the firms in the sample are big, with 500 or more employees. The numbers are 57% in emerging countries and 49% in developed countries. Table 2 presents Pearson's correlations between the variables and their respective VIFs. We can observe that all the correlations are significant at $p < 0.05$. However, all VIFs are below 10, indicating no multicollinearity (Hair et al., 2013).

Table 3. Descriptive statistics.

	All (n = 844)		Emerging countries (n = 528)		China (n = 150)		India (n = 157)		Brazil (n = 221)		Developed countries (n = 316)		USA (n = 151)		Germany (n = 165)	
Variable	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
EISO	5.44	1.38	5.66	1.25	5.06	1.36	5.81	1.08	5.95	1.13	5.08	1.51	5.56	1.48	4.64	1.40
CISO	5.61	1.21	5.79	1.11	5.16	1.31	5.96	0.90	6.09	0.91	5.32	1.31	5.84	1.02	4.85	1.37
Eco-innovation	5.43	1.31	5.59	1.24	5.04	1.35	5.78	1.02	5.82	1.18	5.17	1.38	5.72	1.29	4.67	1.28
Environmental performance	5.21	1.30	5.36	1.21	5.06	1.26	5.45	1.05	5.49	1.25	4.95	1.40	5.38	1.39	4.56	1.30
Operational performance	5.56	1.22	5.76	1.10	5.11	1.32	5.96	0.84	6.07	0.89	5.21	1.34	5.80	1.15	4.68	1.27
Firm Size (500 emp. or more)	54%	50%	57%	50%	61%	49%	63%	48%	50%	50%	49%	50%	52%	50%	46%	50%

Note. Elaborated by the authors.

Table 4. Pearson's correlations and structural collinearity diagnostics.

Variable	VIF	1	2	3	4	5	6	7
1 – EISO	5.34	1	0.801**	0.884**	0.698**	0.828**	0.204**	0.204**
2 – CISO	4.13		1	0.797**	0.708**	0.844**	0.202**	0.186**
3 - Eco-innovation	6.06			1	0.702**	0.857**	0.225**	0.153**
4 - Environmental performance	2.33				1	0.709**	0.221**	0.149**
5 - Operational performance	5.43					1	0.185**	0.219**
6 – Firm Size (% bigger than)	1.07						1	0.082*
7 - Emerging country	1.07							1

Note. * $p < 0.05$; ** $p < 0.01$. Note: VIF values are reported for the variables included in the structural model. All VIFs are below the conventional threshold of 10, indicating that structural-level multicollinearity is not a critical concern.

Before running the SEM to test the hypotheses, another CFA with the construct EOP, reflected by Operational Performance and Environmental Performance, validated the measurement model (see Table 5). All loadings are above 0.70, and AVE is 0.71, far above the minimum of 0.5. CR is 0.83, also higher than the minimum of 0.70.

Table 5. CFA results.

	S.R.W.	S.E	t-test	CR	AVE
EOP				0.83	0.71
Environmental performance	0.819	0.067	***		
Operational performance	0.866	-	***		

Note. S.RW. = standardized regression weights; S.E. = standard error; *** $p < 0.001$.

Following, we ran SEM analysis using maximum likelihood estimation to test the hypotheses. The results are shown in Table 6 and Figure 1. Fit measures were satisfactory (χ^2 = 17.97, df = 5, χ^2/df = 3.59; CFI = 0.997; TLI = 0.985; RMSEA = 0.055). Eco-innovation and EOP R2 were considerably high (respectively 0.803 and 0.950), indicating that the model has high explanatory power. Consistent with the dual-route framework, both strategic orientations show direct and indirect associations with EOP. The direct coefficients were 0.411 for CISO ($p < 0.001$) and 0.160 for EISO ($p < 0.001$). As shown in Table 7, bootstrap analysis indicated that the intervals of both direct effects do not overlap: [0.173, 0.243] for EISO and [0.269, 0.408] for CISO, indicating that the direct association of a classical innovation strategic orientation on EOP is significantly higher.

On the other hand, eco-innovation played a more central mediating role in the case of EISO than CISO. EISO had a stronger positive effect on eco-innovation (β = 0.681, $p < 0.001$) than CISO (β = 0.254, $p < 0.001$). In turn, eco-innovation was positively associated with performance (β = 0.423, $p < 0.001$), supporting the proposed mediation mechanism. Bootstrap analysis also supported this interpretation (see Table 7). Both indirect effect intervals do not cross zero: [0.159, 0.272] for EISO and [0.054, 0.129] for CISO. As they do not overlap, this suggests that the mediation effect of eco-innovation is stronger for EISO. The analysis supports both H1 and H2. The variance accounted for (VAF) also suggests that eco-innovation implementation mediates 64.4% of the total association between EISO and EOP, while 20.6% is observed between CISO and EOP, reaffirming that mediation is much more central in the EISO route. Concerning total effects, accounting for direct and indirect, the evidence supports H3, which predicted a similar effect of EISO and CISO on EOP. Both bootstrap intervals overlap: EISO [0.226, 0.396], CISO[0.344, 0.508].

To address the estimation of moderation effects, we used a two-step approach based on the factor scores validated in the measurement model to avoid model inflation and identification problems, as indicated in the method section. Results indicate that the interaction effect was not statistically significant for eco-innovation (β = 0.006, p = 0.754) and was significant for EOP (β = -0.048, p = 0.007). However, the standardized coefficient is minimal compared to the others, which indicates a practical non-significance. Besides, bootstrap results showed that the direct, indirect, and total effects of EISO x CISO on EOP are statistically non-significant (see Table 7). Therefore, H4 was rejected. Regarding control variables, firm size exhibited a positive association with eco-innovation (β = 0.039, p = 0.041), whereas emerging country showed a small negative effect (β = –0.035, p = 0.042). For EOP, group affiliation was positively related (β = 0.049, p = 0.031), while firm size did not present a significant direct effect (β = -0.004).

Table 6. SEM results.

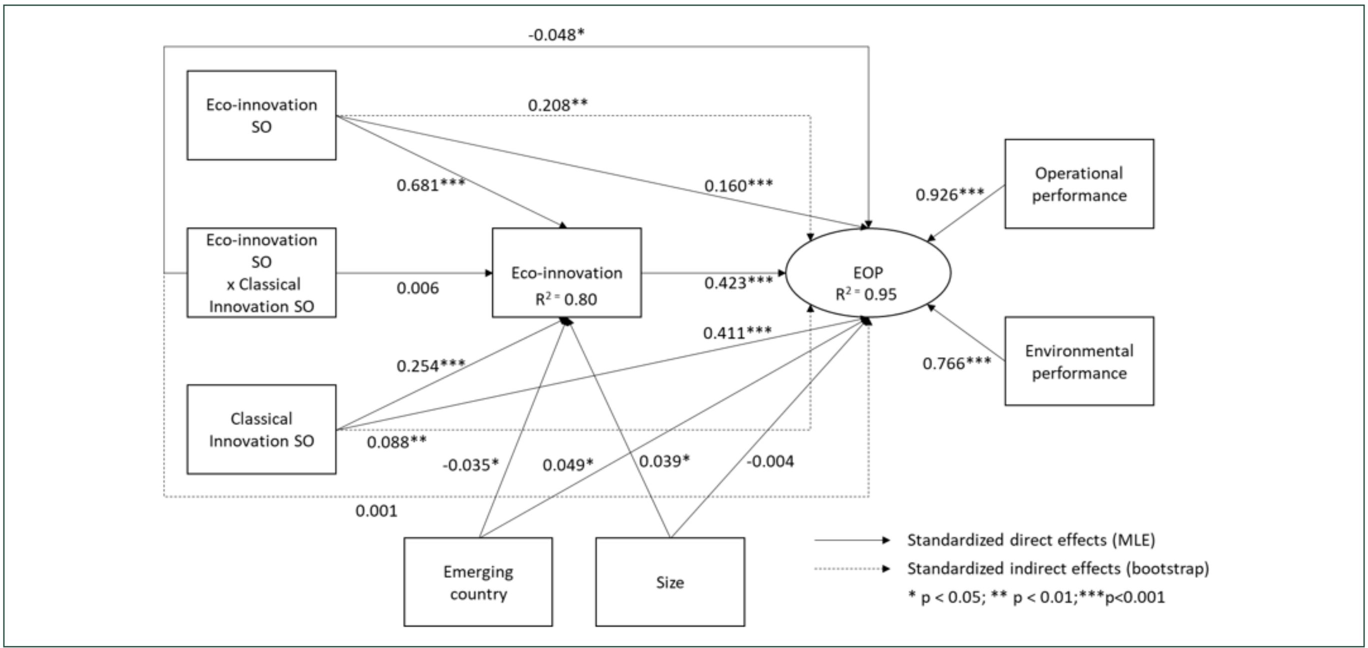
Path	S.R.W.	S.E.	Hypothesis Test
EISO → Eco-innovation	0.681***	0.025	
CISO → Eco-innovation	0.254***	0.029	
EISO x CISO → Eco-innovation	0.006	0.010	
Firm size → Eco-innovation	0.039*	0.041	
Emerging country → Eco-innovation	–0.035*	0.042	
EISO → EOP	0.160***	0.025	H1: Supported
CISO → EOP	0.411***	0.024	H2: Supported
EISO x CISO → EOP	-0.048*	0.007	
Eco-innovation → EOP	0.423***	0.027	
Group affiliation → EOP	0.049**	0.031	
Emerging country → EOP	-0.004	0.030	

Note. S.RW. = standardized regression weights; S.E. = standard error; * p < 0.05; ** p < 0.01;***p<0.001.

Table 7. Direct, indirect, and total effects with bootstrap (bias-corrected percentile method) confidence intervals.

Construct	Effect on EOP	Std. Estimate	Low	High	p-value	Hypothesis Test
EISO	Direct	0.115***	0.063	0.192	0.008	
CISO	Direct	0.338**	0.269	0.408	0.012	
EISO x CISO	Direct	-0.018	-0.036	0.004	0.102	
EISO	Indirect	0.208***	0.159	0.272	0.005	H1: Supported
CISO	Indirect	0.088***	0.054	0.129	0.008	H2: Supported
EISO x CISO	Indirect	0.001	-0.004	0.008	0.667	
EISO	Total	0.323***	0.226	0.396	0.006	H3: Supported
CISO	Total	0.427***	0.344	0.508	0.007	H3: Supported
EISO x CISO	Total	-0.017	-0.340	0.005	0.157	H4: Rejected

Note. *** p < 0.001; ** p < 0.01; * p < 0.05. Notes: Standardized coefficients are reported. Confidence intervals based on 5,000 bootstrap resamples (BCa).



Source: Elaborated by the authors.

Figure 1. Structural model.

Robustness tests

We conducted additional analysis to assess the robustness of the baseline model. First, we tested potential curvilinear effects of EISO and CISO by including their quadratic terms as predictors. This inclusion did not alter the direction and significance of the linear effects. Although the quadratic terms reached statistical significance in some specifications, the substantive conclusions regarding the direct effects and the lack of robust complementarity remained unchanged.

Second, we restimated the main relationships using the regression approach with validated factor scores and EOP as the average of EP and OP, as described in the method section on the evaluation of CMB. The results are very close to those of the SEM analysis, with no relevant changes in the magnitude, direction, or significance of the coefficients (see the comparison of the original model, the quadratic model, and the regression in Table 8).

Third, we conducted a multigroup analysis of the baseline model, distinguishing firms from emerging and developed countries. The fit measures shown in Table 9 presented a good fit for the unconstrained model (χ^2 = 90.521; df = 28; CFI = 0.987; RMSEA = 0.051), the structural-weights constrained model (χ^2 = 95.134; df = 29; CFI = 0.986; RMSEA = 0.052, with $\Delta\chi^2$ = 4.613, Δdf = 1, ΔCFI = 0.001), and the structural-covariances constrained model (χ^2 = 100.965; df = 32; CFI = 0.985; RMSEA = 0.051, with $\Delta\chi^2$ = 10.444, Δdf = 4, and ΔCFI = 0.002). Although the χ^2 difference tests were significant, the CFI changes were below the recommended 0.01 threshold (Cheung & Rensvold, 2002) and RMSEA was stable, supporting the conclusion that there was no significant structural variance between the two groups.

Finally, we estimated an additional latent moderated structural equations (LMS) model as a robustness test. This approach explicitly models the latent interaction between EISO and CISO while accounting for measurement error. The LMS converged with an acceptable fit (χ^2 = 1924.27; df = 512; RMSEA = 0.057), and the likelihood-ratio comparison between the interaction model and the baseline model was statistically significant (D = 10.31; df = 2; p = 0.006). Its results were broadly consistent with the main interpretation of the study. Specifically, the interaction remained non-significant for eco-innovation implementation (Std. B = 0.002, p = 0.823), while a small negative interaction effect emerged for EOP (Std. B = -0.024, p = 0.004). Importantly, this interaction did not meaningfully improve explanatory power, as the change in R^2 was negligible (Eco-innovation: -0.005, EOP: -0.002). Taken together, these findings do not support a synergistic interpretation of the joint adoption of EISO and CISO and reinforce the conclusion that complementarity is not a robust average pattern in the data.

Table 8. Robustness analyses (standardized coefficients comparison).

Relationship	Baseline SEM	Quadratic SEM	CMV
EISO → Eco-innovation	+***	+***	+***
CISO → Eco-innovation	+***	+***	+***
EISOxCISO → Eco-innovation	n.s.	−***	n.s.
Eco-innovation → EOP	+***	+***	+***
EISO → EOP	+***	+***	+***
CISO → EOP	+***	+***	+***
EISOxCISO → EOP	−*	−***	−**

Note. Elaborated by the authors.

Table 9. Direct, indirect, and total effects with bootstrap bootstrap (bias-corrected percentile method) confidence intervals.

Model	χ^2	Df	CFI	RMSEA	ΔCFI	$\Delta\chi^2$	Δdf
Unconstrained	90.52	28	0.987	0.051	—	—	—
Structural weights constrained	95.13	29	0.986	0.052	0.001	4.613*	1
Structural covariances constrained	100.97	32	0.975	0.051	0.002	10.444*	4

Note. Elaborated by the authors.

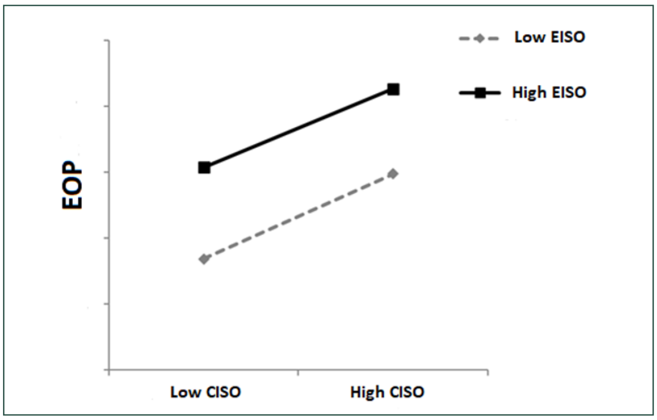
DISCUSSION

The results support the proposed affirmation that both classical innovation and eco-innovation strategic orientations have similar impacts on environmental and operational performance. The bootstrap analysis reinforced this interpretation by showing that the confidence intervals of the total effects of both SOs on EOP intersect (CISO: 0.344–0.508; EISO: 0.226–0.396), indicating that they are statistically similar. Figure 2, which shows the total effects of CISO on EOP for low and high levels of EISO, suggests that EOP for low CISO with high EISO (extreme left of the black line) is similar to that for high CISO with low EISO (extreme right of the grey dotted line). However, considering the weak and unstable evidence on interaction effects, conjoint investment should not be presented as a general prescription. Rather, managers may consider prioritizing EISO or CISO according to context (e.g., regulatory and market pressures versus cost and time-to-market constraints) and combine both orientations only if slack in the organization and strategic coherence allow it, without expecting any synergistic consequences. This pattern facilitates reconciling recent mixed evidence showing heterogeneous performance effects of eco-innovation and classical innovation orientations (e.g., Chen & Jiang, 2024; Oduro, 2024; Wu et al., 2024; Zheng & Iatridis, 2022): similar EOP outcomes may arise from distinct causal routes (i.e., equifinality), depending on whether performance improvements are primarily mediated by eco-innovation (EISO) or mainly direct via internal capability deployment (CISO).

These findings corroborate the theory-based prediction that there is a dual-pathway between both strategic orientations and EOP. Adopting an EISO, on one side, is consistent with the SCP theory (Porter, 1989, 2008, 2010), as its adoption is a response to environmental regulation and market expectations (Porter & Van der Linde, 1995; Zhang et al., 2024), and is associated with higher EOP by proactively and intentionally implementing eco-innovation practices, contributing, in consequence, to a more environmentally and economically sustainable product/service supply chain (Geissdoerfer et al., 2018) and product life-cycle (Bocken & Allwood, 2012). As we defined, the construct EISO represents the commitment of a firm to develop new environmentally responsible products and services and their markets (Jabbour et al., 2014; Nguyen & Adomako, 2021; Testa & Iraldo, 2010), besides promoting their dissemination (Hojnik & Ruzzier, 2016). Therefore, the way to measure the success of such a strategy is to verify the effective implementation of these eco-innovation practices, which the eco-innovation construct does. Besides, there is a positive influence of eco-innovation on operational performance, which is supported here and in several previous studies (e.g., Barth et al., 2017; Cheng et al., 2014; Cheng & Shiu, 2020; Geissdoerfer et al., 2018; Hirscher et al., 2018; Oduro, 2024), which demonstrate the relevance of an EISO to generate competitive advantage. As previously discussed, firms dedicated to implementing eco-innovations can improve their brand image (Hall & Wagner, 2012) and conquer the loyalty of an increasing segment of clients that value an environmental sustainability positioning (Dabija et al., 2018; Kuchinka et al., 2018; Nguyen & Adomako, 2021). In the meantime, eco-innovations can reduce the costs of raw materials and other inputs such as water and energy (Bendig et al., 2023; Despeisse et al., 2022; Horbach et al., 2012; Hsu et al., 2016). Therefore, when effectively implemented, this SO may allow a firm to improve its profits by increasing revenues and reducing costs. Importantly, this SCP-based route implies boundary conditions: the marginal payoffs of EISO are expected to be stronger when regulatory stringency/enforcement and stakeholder pressures are higher, and when competitive environments reward environmental differentiation (Zhang et al., 2024; Zheng & Iatridis, 2022).

On the other side, the mechanism to achieve EOP for firms prioritizing a CISO is more consistent with RBV (Barney, 1991) and DC (Teece, 2007) theories. The influence of the construct eco-innovation as a mediator in such a case is lower, while the direct effect is higher. We argue that the learning effects and the development of internal resources and capabilities to implement innovative business models increase process efficiency, and quality that are associated with higher operational performance and, conjointly, environmental performance even without an eco-intent (Fortuny-Santos et al., 2025; Sun & Chu, 2022; Wu et al., 2024), Many of the new business models implemented nowadays are based on concepts and technologies that are spontaneously more sustainable, such as PSS (Adam, 2018;

Bocken et al., 2018; Geissdoerfer et al., 2018; Sarasini et al., 2024) and circular business models (De Angelis, 2022; Geissdoerfer et al., 2018; Geissdoerfer et al., 2020). These firms may benefit from the cost reduction promoted by these eco-innovative business models because of the classic motives that make innovation so crucial for competitive advantage, such as increasing revenues and market share (Du et al., 2014; Nguyen & Adomako, 2021) by new products and services that fill demand gaps (Galindo & Méndez, 2014), developing lower cost or better quality products (Ateljević & Trivić, 2016), or increasing productivity (Dabla-Norris et al., 2012; Fortuny-Santos et al., 2025; Sun & Chu, 2022; Terjesen & Patel, 2017). This RBV/DC-based path also implies boundary conditions: with higher resources and capabilities, the efficiency and productivity payoffs of CISO become straightforward.



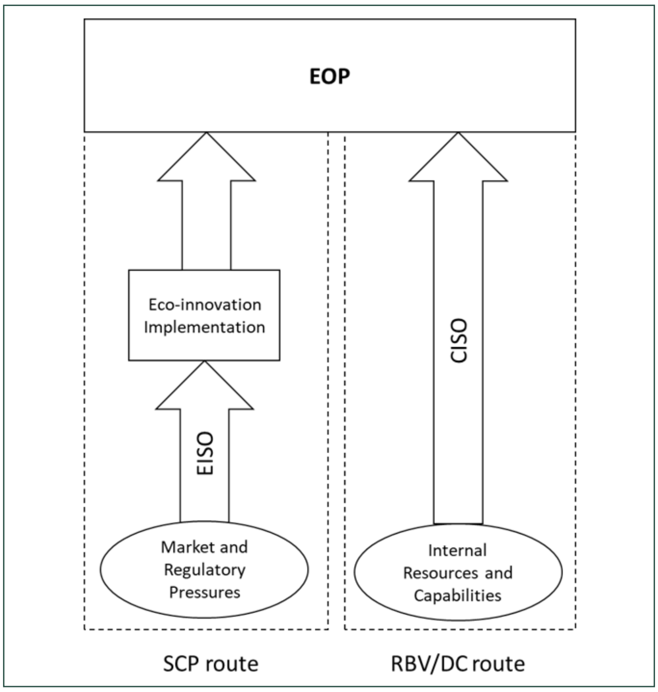
Source: Elaborated by the authors.

Figure 2. Total effects of CISO on EOP for firms with high and low EISO.

An important finding was that the interaction of both SO on eco-innovation and EOP did not provide evidence of robust complementarity between the two orientations. More precisely, the interaction effect is weak and not robust as a general pattern, and hence there is, on average, no systematic complementarity (nor systematic substitution) between the two orientations. So, no evidence exists that an EISO potentiates a CISO or vice-versa. These results are tricky as they could be interpreted adversely and jeopardise the sustainable performance of the firm in the long term. We interpret these results as a demonstration of the absence of robust complementarity of both strategies, not incompatibility. This factor can be explained by the resources crowding out and trade-offs between EISO and CISO previously reported (e.g., Liu et al., 2023; Song et al., 2025). The managerial implication is therefore contingent, as firms may prioritize EISO or CISO depending on the boundary conditions, e.g., regulatory stringency, competitive intensity and munificence of resources. The theoretical implication is also contingent, since the relative importance of each route depends on whether externally induced eco-innovation pressures or internally driven capability conditions are more dominant in a given context. If slack resources and organizational capabilities can allow for simultaneous pursuit of both paths with the least displacement on either path, integration can be possible; otherwise, trade-offs are likely. Figure 2 provides evidence that firms with a high level of both SO conjointly (extreme right of the black line) present a higher level of EOP than those adopting only one. This means that although both strategies are not robustly complementary due to the absence of interaction (Milgrom & Roberts, 1995), they are not substitutes either. It means that firms can possibly achieve high EOP through either path, and integration should not be an idealization but an option, at least when favourable conditions are present. The additional LMS robustness test is consistent with this interpretation, as the interaction remained non-significant for eco-innovation implementation and was negative, although substantively small, for EOP. If a firm focuses solely on EISO, it may have a more limited ability to cope with technological disruptions. It may be stuck in a past business model, as this SO narrows the perspective to new technological trends. On the other hand, if the focus is solely on the CISO, despite new models and technological convergence leading to sustainability, it may face long-term implementation problems due to eco-innovation practices that lack market competitiveness. Put differently, the relative attractiveness of each path comes down to the extent to which firms balance resource allocation and focus between environmental responsiveness and capability-based innovation over time.

To synthesize our findings, we propose a general theoretical framework depicting the two dominant explanatory mechanisms: the first, the SCP-based route, shows that external regulatory and market pressures can be addressed by an eco-innovation strategic orientation that fosters eco-innovation implementation, thereby improving environmental and operational performance. The second, the RBV/DC-based route, involves the CISO developing internal resources and capabilities to implement innovative business models that enhance operational and environmental performance. The framework, in combination, suggests a more specific theoretical implication: similar EOP outcomes can emerge from different dominant mechanisms (mostly mediated vs. mainly direct), which can elucidate heterogeneity and apparent contradictions regarding eco-innovation and performance research in recent years (Zheng & Iatridis, 2022; Oduro, 2024;

Wu et al., 2024). In fact, the contribution goes beyond SCP versus RBV/DC as it clarifies what each lens explains better and under what institutional and resource conditions each route is expected to become comparatively more salient—namely, stronger regulatory and stakeholder pressure in the case of the SCP-based route, and stronger innovation capabilities and resource availability in the case of the RBV/DC-based route. Finally, the robustness checks presented in the Results section corroborate these interpretations, as substantive findings are consistent across alternative specifications and estimation approaches.



Source: Elaborated by the authors.
Figure 3. Dominant explanatory mechanisms linking strategic orientations to EOP.

CONCLUSION

The present study suggests that both an eco-innovation strategic orientation and a classical innovation strategic orientation can be associated with improvements in firm environmental and operational performance similarly. These findings contribute by illustrating that both strategic orientations are associated with comparable results across different contexts—specifically in the USA, China, Germany, India, and Brazil—albeit through distinct mechanisms. A CISO is associated with performance directly, while the implementation of eco-innovation practices mediates an EISO's association with performance. More specifically, the theoretical contribution is not only to compare two parallel routes but to suggest that similar EOP outcomes may emerge from different dominant explanatory mechanisms: an externally induced and eco-innovation-mediated route in the case of EISO, and a more internally driven and capability-based route in the case of CISO. This study explains heterogeneous findings reported in recent works on eco-innovation and performance (e.g., Oduro, 2024; Zheng & Iatridis, 2022). This integrative perspective also shows that the relative relevance of the various routes may vary with institutional and resource conditions, such as regulatory and stakeholder pressure on the one hand and innovation capabilities and resource availability on the other.

This study has some limitations. One methodological limitation is that the data are cross-sectional. Another is the non-probabilistic sample, which restricts the generalizability of the conclusions. Additionally, the survey relied on respondents' perceptions, which can be influenced by various factors, potentially introducing bias. While we utilized multiple complementary diagnostics to minimize common method bias (e.g., trait/method CFA and a correlated marker variable), causal inferences should nevertheless be exercised with caution, as in a cross-sectional survey analysis. We also did not include social performance. This was not just a matter of scope delimitation: the theoretical mechanisms discussed in this article—eco-innovation implementation, efficiency spillovers, and competitiveness-related outcomes—are more closely aligned to the environmental and operational performance domains. Including the social pillar would require a more general model and some partially different explanatory mechanisms. Furthermore, the model did not include critical constructs such as institutional pressures or innovative business models. Besides, while the sample comprised firms from diverse sectors, detailed sector-distribution information was not provided, which restricts sector-specific generalizations.

To address these limitations, we suggest conducting future longitudinal studies, which are essential for capturing how the impacts of EISO and CISO on EOP evolve. As market and regulatory dynamics shift, longitudinal data would provide deeper insights into how strategic orientations adapt and contribute to firm resilience (Geissdoerfer et al., 2018). Another suggestion is to incorporate additional constructs, such as industry, institutional pressures, and innovative business models, which are significant factors in innovation research and would allow us to test more directly under which conditions each dominant mechanism becomes comparatively more salient. Drawing on the framework in Figure 3, future research may define all of these variables as boundary conditions and explicitly test when each pathway dominates. In other words, studies can (1) model institutional and regulatory pressure as moderators boosting the EISO → eco-innovation → EOP route; (2) test competitive intensity and resource munificence/slack as moderators shaping the predominance of the CISO → EOP direct route; and (3) investigate whether certain innovation-enabled business models (e.g., circular/PSS) amplify or attenuate the mediated versus direct mechanisms. Longitudinal designs can also examine if the relative strengths of the two routes vary over time as regulation, technologies, and market expectations change. This will help to determine if the results differ under these conditions. Lastly, we recommend studies including social performance to test the phenomenon on all three constructs of sustainable performance of an organization.

Despite these limitations, the contributions of this paper are significant. Theoretically, it supports the argument that there is a dual strategic pathway to achieve EOP through strategic orientations towards innovation that integrate SCP, RBV, and DC theories: EISO responds to regulatory/market pressures and raises EOP mainly by eco-innovation implementation. At the same time, CISO leverages internal resources and capabilities to be associated with EOP more directly, as they support the implementation of new and more sustainable business models. The evidence regarding the EISO×CISO interaction should be interpreted cautiously. The data used by the SEM shows statistically significant interaction, although the standardized magnitude is small and the effect is not consistently supported in the bootstrap analysis. That is, we do not consider the interaction to be substantively meaningful on average, but rather the main contribution lies in the two distinct routes (direct capability-based versus eco-innovation-mediated) that lead to EOP. The additional LMS robustness test is consistent with the above interpretation, in that it does not support robust complementarity between the two orientations. We summarize these contributions in Figure 3 and can cross-test in different contexts. More cautiously, the study is also in line with the idea that several current innovation trajectories (e.g., efficiency-driven process innovations and certain types of business model innovations) have the potential to generate environmental improvements, although the magnitude of such gains may differ by context and technology (Chen & Jiang, 2024; Oduro, 2024; Wu et al., 2024; Zheng & Iatridis, 2022).

The study also provides valuable insights for managers to improve their firms' strategic planning and execution processes. Both strategic orientations discussed here may be effective in achieving a strong EOP. When resources are limited, EISO can be more appropriate under stronger green-market and regulatory pressures, while CISO may be more appropriate when competition is intense, and cost and time-to-market pressures are more salient. Yet, considering that there is evidence of trade-offs, conjoint investment should be treated as contingent rather than universally recommended—some slack resources and managerial attention might enable firms to pursue both orientations without crowding out, especially when the regulatory and market incentives are strong enough to promote such integration. Lastly, in emerging markets, more gradual eco-innovation may be more indicated due to resource constraints, aligning with incremental innovation (Nidumolu et al., 2009). In developed markets, where regulatory support and customer demand are higher (Goyal et al., 2017), more ambitious eco-innovation trajectories may be more feasible. These implications should be interpreted as context-sensitive tendencies rather than universal prescriptions. Future studies might provide further clarification of these implications by focusing explicitly on the shaping role of institutional and competitive moderators of such a strategic decision process over time (Zhang et al., 2024; Zheng & Iatridis, 2022).

REFERENCES

Adam, M. (2018). The role of human resource management (HRM) for the implementation of sustainable product-service systems (PSS): An analysis of fashion retailers. *Sustainability, 10*(7), 2518. https://doi.org/10.3390/su10072518

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., & Overy, P. (2016). Sustainability-oriented innovation: A systematic review. *International Journal of Management Reviews, 18*(2), 180-205. https://doi.org/10.1111/ijmr.12068

Aguilera-Caracuel, J., & Ortiz-de-Mandojana, N. (2013). Green innovation and financial performance: An institutional approach. *Organization & Environment, 26*(4), 365-385. https://doi.org/10.1177/1086026613507931

Aldieri, L., Barra, C., Vinci, C. P., & Zotti, R. (2021). The joint impact of different types of innovation on firm's productivity: Evidence from Italy. *Economics of Innovation and New Technology, 30*(2), 151-182. https://doi.org/10.1080/10438599.2019.1685211

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin, 103*(3), 411–423. https://psycnet.apa.org/doi/10.1037/0033-2909.103.3.411

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research, 14*(3), 396-402. https://doi.org/10.1177/002224377701400320

Arranz, N., Lopez Arguello, N., & Fernández de Arroyabe, J. C. (2021). How do internal, market and institutional factors affect the development of eco-innovation in firms? *Journal of Cleaner Production, 297*, 126692. https://doi.org/10.1016/j.jclepro.2021.126692

Ateljević, J., & Trivić, J. (2016). *Economic development and entrepreneurship in transition economies: Issues, obstacles and perspectives*. Springer.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120. https://doi.org/10.1177/014920639101700108

Barney, J. B. (2010). *Gaining and sustaining competitive advantage (4th ed.)*. Prentice Hall.

Barth, H., Ulvenblad, P. O., & Ulvenblad, P. (2017). Towards a conceptual framework of sustainable business model innovation in the agri-food sector: A systematic literature review. *Sustainability, 9*(9), 1620. https://doi.org/10.3390/su9091620

Barton, J. R., & Gutiérrez-Antinopai, F. (2020). Towards a visual typology of sustainability and sustainable development. *Sustainability, 12*(19), 7935. https://doi.org/10.3390/su12197935

Bellos, I., Ferguson, M., & Toktay, L. B. (2017). The car sharing economy: Interaction of business model choice and product line design. *Manufacturing & Service Operations Management, 19*(2), 185-201. https://doi.org/10.1287/msom.2016.0605

Belussi, F., Sammarra, A., & Sedita, S. R. (2010). Learning at the boundaries in an 'Open Regional Innovation System': A focus on firms' innovation strategies in the Emilia Romagna life science industry. *Research Policy, 39*(6), 710-721. https://doi.org/10.1016/j.respol.2010.01.014

Bendig, D., Schulz, C., Theis, L., & Raff, S. (2023). Digital orientation and environmental performance in times of technological change. *Technological Forecasting and Social Change, 188*, 122272. https://www.sciencedirect.com/science/article/pii/S0040162522007934

Biloslavo, R., Bagnoli, C., & Edgar, D. (2018). An eco-critical perspective on business models: The value triangle as an approach to closing the sustainability gap. *Journal of Cleaner Production, 174*, 746-762. https://doi.org/10.1016/j.jclepro.2017.10.281

Birkin, F., Cashman, A., Koh, S. C. L., & Liu, Z. (2009). New sustainable business models in China. *Business Strategy and the Environment, 18*(1), 64-77. https://doi.org/10.1002/bse.568

Birkinshaw, J., Hamel, G., & Mol, M. J. (2008). Management Innovation. *Academy of Management Review, 33*(4). https://doi.org/10.5465/amr.2008.34421969

Bocken, N. M., & Allwood, J. M. (2012). Strategies to reduce the carbon footprint of consumer goods by influencing stakeholders. *Journal of Cleaner Production, 35*, 118-129. https://doi.org/10.1016/j.jclepro.2012.05.031

Bocken, N. M., Mugge, R., Bom, C. A., & Lemstra, H. J. (2018). Pay-per-use business models as a driver for sustainable consumption: Evidence from the case of HOMIE. *Journal of Cleaner Production, 198*, 498-510. https://doi.org/10.1016/j.jclepro.2018.07.043

Bocken, N. M., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production, 65*, 42-56. https://doi.org/10.1016/j.jclepro.2013.11.039

Braungart, M., McDonough, W., & Bollinger, A. (2007). Cradle-to-cradle design: Creating healthy emissions, a strategy for eco-effective product and system design. *Journal of Cleaner Production, 15*(13/14), 1337-1348. https://doi.org/10.1016/j.jclepro.2006.08.003

Brislin, R. W. (1980). *Cross-cultural research methods: Strategies, problems, applications. In Environment and Culture* (pp. 47-82). Springer US.

Brook, J. W., & Pagnanelli, F. (2014). Integrating sustainability into innovation project portfolio management–A strategic perspective. *Journal of Engineering and Technology Management, 34*, 46-62. https://doi.org/10.1016/j.jengtecman.2013.11.004

Burget, M., Bardone, E., & Pedaste, M. (2017). Definitions and conceptual dimensions of responsible research and innovation: A literature review. *Science and Engineering Ethics, 23*(1), 1-19. https://doi.org/10.1007/s11948-016-9782-1

Cai, W. G., & Zhou, X. L. (2014). On the drivers of eco-innovation: Empirical evidence from China. *Journal of Cleaner Production, 79*, 239-248. https://doi.org/10.1016/j.jclepro.2014.05.035

Calantone, R. J., Cavusgil, S. T., & Zhao, Y. (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management, 31*(6), 515-524. https://doi.org/10.1016/S0019-8501(01)00203-6

Calza, F., Parmentola, A., & Tutore, I. (2017). Types of green innovations: Ways of implementation in a non-green industry. *Sustainability, 9*(8), 1301-1316. https://doi.org/10.3390/su9081301

Camisón, C., & Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of Business Research, 67*(1), 2891-2902. https://doi.org/10.1016/j.jbusres.2012.06.004

Carayannis, E. G., Sindakis, S., & Walter, C. (2015). Business model innovation as lever of organizational sustainability. *The Journal of Technology Transfer, 40*(1), 85–104. https://doi.org/10.1007/s10961-013-9330-y

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science, 52*(1), 68-82. https://doi.org/10.1287/mnsc.1050.0470

Chen, Y., & Jiang, Z. (2024). The Impact of Enterprise Technological Innovation on Environmental Performance—An Industry Perspective. *Sustainability, 16*(15). https://doi.org/10.3390/su16156457

Cheng, C. C., & Shiu, E. C. (2020). Leveraging open innovation strategies for fueling eco-innovation performance in dynamic environments. *Sustainability Accounting, Management and Policy Journal, 11*(7), 1245-1270. https://doi.org/10.1108/SAMPJ-04-2018-0103

Cheng, C. C., Yang, C. L., & Sheu, C. (2014). The link between eco-innovation and business performance: A Taiwanese industry context. *Journal of Cleaner Production, 64*, 81-90. https://doi.org/10.1016/j.jclepro.2013.09.050

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology.* Harvard Business Press.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling, 9*(2), 233–255. https://doi.org/10.1207/S15328007SEM0902_5

Chu, Z., Xu, J., Lai, F., & Collins, B. J. (2018). Institutional theory and environmental pressures: The moderating effect of market uncertainty on innovation and firm performance. *IEEE Transactions on Engineering Management, 65*(3), 392-403. https://doi.org/10.1109/TEM.2018.2794453

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152. https://doi.org/10.2307/2393553

Crespo, C. F., Crespo, N. F., & Curado, C. (2022). The effects of subsidiary's leadership and entrepreneurship on international marketing knowledge transfer and new product development. *International Business Review, 31*(2), 101928. https://doi.org/10.1016/j.ibusrev.2021.101928

Dabija, D. C., Bejan, B. M., & Grant, D. B. (2018). The impact of consumer green behaviour on green loyalty among retail formats. *Moravian Geographical Reports, 26*(3), 173-175. https://doi.org/10.2478/mgr-2018-0014

Dabla-Norris, E., Kersting, E. K., & Verdier, G. (2012). Firm productivity, innovation, and financial development. *Southern Economic Journal, 79*(2), 422-449. https://doi.org/10.4284/0038-4038-2011.201

De Angelis, R. (2022). Circular economy business models: A repertoire of theoretical relationships and a research agenda. *Circular Economy and Sustainability, 2*(2), 433-446. https://doi.org/10.1007/s43615-021-00133-x

De Marchi, V., & Grandinetti, R. (2013). Knowledge strategies for environmental innovations: The case of Italian manufacturing firms. *Journal of Knowledge Management, 17*(4), 569-582. https://doi.org/10.1108/JKM-03-2013-0121

Despeisse, M., Chari, A., González Chávez, C. A., Chen, X., Kurdve, M., & Johansson, B. (2022). A systematic review of empirical studies on green manufacturing: Eight propositions and a research framework for digitalized sustainable manufacturing. *Production & Manufacturing Research, 10*(1), 727–759. https://doi.org/10.1080/21693277.2022.2127428

Dess, G. G., & Robinson, R. B. Jr (1984). Measuring organizational performance in the absence of objective measures: the case of the privately-held firm and conglomerate business unit. *Strategic Management Journal, 5*(3), 265-273. https://doi.org/10.1002/smj.4250050306

Díaz Duarte, A. A., Puron-Cid, G., & Rivera Martínez, M. E. (2025). Business Performance and Sustainability Outcomes Driven by Circular Economy, Eco-Innovation, and Sustainable Marketing. *Sustainability, 17*(21), 9858. https://doi.org/10.3390/su17219858

Diciccio, T. J., & Romano, J. P. (1988). A review of bootstrap confidence intervals. *Journal of the Royal Statistical Society: Series B (Methodological), 50*(3), 338-354. https://www.jstor.org/stable/2345699

Dong, Y., Wang, X., Jin, J., Qiao, Y., & Shi, L. (2014). Effects of eco-innovation typology on its performance: Empirical evidence from Chinese enterprises. *Journal of Engineering and Technology Management, 34*, 78-98. https://doi.org/10.1016/j.jengtecman.2013.11.001

Du, J., Leten, B., & Vanhaverbeke, W. (2014). Managing open innovation projects with science-based and market-based partners. *Research Policy, 43*(5), 828-840. https://doi.org/10.1016/j.respol.2013.12.008

Ego. (2022). *Home – Ego*. https://www.egoforme.com

Elkington, J. (1997). *Cannibals with forks: The triple bottom line of twenty-first century business.* Capstone.

Ezzi, F., & Jarboui, A. (2016). Does innovation strategy affect financial, social and environmental performance? *Journal of Economics, Finance and Administrative Science, 21*(40), 14-24. https://doi.org/10.1016/j.jefas.2016.03.001

Faems, D., De Visser, M., Andries, P., & Van Looy, B. (2010). Technology alliance portfolios and financial performance: Value-enhancing and cost-increasing effects of open innovation. *Journal of Product Innovation Management, 27*(6), 785-796. https://doi.org/10.1111/j.1540-5885.2010.00752.x

Findik, D., & Beyhan, B. (2017). A perceptual measure of innovation performance: Firm-level evidence from Turkey. *International Journal of Innovation and Technology Management, 14*(6), 1750038. https://doi.org/10.1142/S0219877017500389

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research, 18*(3), 382–388. https://doi.org/10.2307/3150980

Fortuny-Santos, J., Ruiz-de-Arbulo-López, P., Zubeltzu-Jaka, E., & Lujan-Blanco, I. (2025). Lean manufacturing and environmental performance: A meta-analytic approach. *International Journal of Lean Six Sigma, 16*(4), 848-889. https://doi.org/10.1108/IJLSS-11-2023-0190

Frenken, K., & Schor, J. (2019). Putting the sharing economy into perspective. *Environmental Innovations and Societal Transitions, 23*, 3-10. https://doi.org/10.1016/j.eist.2017.01.003

Frenz, M., & Ietto-Gillies, G. (2009). The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey. *Research Policy, 38*(7), 1125-1135. https://doi.org/10.1016/j.respol.2009.05.002

Gaiardelli, P., Resta, B., Martinez, V., Pinto, R., & Albores, P. (2014). A classification model for product-service offerings. *Journal of Cleaner Production, 66*, 507-519. https://doi.org/10.1016/j.jclepro.2013.11.032

Galindo, M. Á., & Méndez, M. T. (2014). Entrepreneurship, economic growth, and innovation: Are feedback effects at work? *Journal of Business Research, 67*(5), 825-829. https://doi.org/10.1016/j.jbusres.2013.11.052

Gazzola, P., Drago, C., Pavione, E., & Pignoni, N. (2024). Sustainable business models: An Empirical analysis of environmental sustainability in leading manufacturing companies. *Sustainability*, *16*(19), 8282. https://doi.org/10.3390/su16198282

Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., & Evans, S. (2018). Business models and supply chains for the circular economy. *Journal of Cleaner Production, 190*, 712–721. https://doi.org/10.1016/j.jclepro.2018.04.159

Geissdoerfer, M., Pieroni, M. P., Pigosso, D. C., & Soufani, K. (2020). Circular business models: A review. *Journal of Cleaner Production, 277*, 123741. https://doi.org/10.1016/j.jclepro.2020.123741

Ghisetti, C., Marzucchi, A., & Montresor, S. (2015). The open eco-innovation mode. An empirical investigation of eleven European countries. *Research Policy, 44*(5), 1080-1093. https://doi.org/10.1016/j.respol.2014.12.001

Girma, L., Oduro, S., Cucari, N., & Cristofaro, M. (2025). Venturing green: The impact of sustainable business model innovation on corporate environmental performance in social enterprises. *Management Research Review, 48*(13), 20–44. https://doi.org/10.1108/MRR-07-2024-0534

Golini, R., De Marchi, V., Boffelli, A., & Kalchschmidt, M. (2018). Which governance structures drive economic, environmental, and social upgrading? A quantitative analysis in the assembly industries. *International Journal of Production Economics, 203*, 13-23. https://doi.org/10.1016/j.ijpe.2018.05.021

Goyal, S., Sergi, B. S., & Kapoor, A. (2017). Emerging role of for-profit social enterprises at the base of the pyramid: The case of Selco. *Journal of Management Development, 36*(1), 97-108. https://doi.org/10.1108/JMD-05-2015-0070

Gupta, S., Malhotra, N. K., Czinkota, M., & Foroudi, P. (2016). Marketing innovation: A consequence of competitiveness. *Journal of Business Research, 69*(12), 5671-5681. https://doi.org/10.1016/j.jbusres.2016.02.042

Guttentag, D., Smith, S., Potwarka, L., & Havitz, M. (2018). Why tourists choose Airbnb: A motivation-based segmentation study. *Journal of Travel Research, 57*(3), 342-359. https://doi.org/10.1177/0047287517696980

Hagedoorn, J., Lokshin, B., & Zobel, A. K. (2018). Partner type diversity in alliance portfolios: Multiple dimensions, boundary conditions and firm innovation performance. *Journal of Management Studies, 55*(5), 809-836. https://doi.org/10.1111/joms.12326

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2013). *Multivariate data analysis*. Pearson Education Limited.

Hall, J., & Wagner, M. (2012). Integrating sustainability into firms' processes: Performance effects and the moderating role of business models and innovation. *Business Strategy and the Environment, 21*(3), 183-196. https://doi.org/10.1002/bse.728

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The sharing economy: Why people participate in collaborative consumption. *Journal of the Association for Information Science and Technology, 67*(9), 2047-2059. https://doi.org/10.1002/asi.23552

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115-135. https://doi.org/10.1007/s11747-014-0403-8

Hill, C. W., & Rothaermel, F. T. (2003). The performance of incumbent firms in the face of radical technological innovation. *Academy of Management Review, 28*(2), 257-274. https://doi.org/10.2307/30040712

Hirscher, A. L., Niinimäki, K., & Armstrong, C. M. J. (2018). Social manufacturing in the fashion sector: New value creation through alternative design strategies? *Journal of Cleaner Production, 172*, 4544-4554. https://doi.org/10.1016/j.jclepro.2017.11.020

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

Horbach, J. (2008). Determinants of environmental innovation—New evidence from German panel data sources. *Research Policy, 37*(1), 163-173. https://doi.org/10.1016/j.respol.2007.08.006

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

Hoskisson, R., Wan, W., Yiu, D., & Hitt, M. (1999). Theory and research in strategic management: Swings of a pendulum. *Journal of Management, 25*(3), 417-456. https://doi.org/10.1016/S0149-2063(99)00008-2

Hsu, C. C., Tan, K. C., & Zailani, S. H. M. (2016). Strategic orientations, sustainable supply chain initiatives, and reverse logistics: Empirical evidence from an emerging market. *International Journal of Operations and Production Management, 36*(1), 86-110. https://doi.org/10.1108/IJOPM-06-2014-0252

Hurmelinna-Laukkanen, P., Olander, H., Blomqvist, K., & Panfilii, V. (2012). Orchestrating R&D networks: Absorptive capacity, network stability, and innovation appropriability. *European Management Journal, 30*(6), 552-563. https://doi.org/10.1016/j.emj.2012.03.002

Høgevold, N. M., Svensson, G., Wagner, B., Petzer, D. J., Klopper, H. B., Varela, J. C., Padin, C., & Ferro, C. (2014). Sustainable business models: Corporate reasons, economic effects, social boundaries, environmental actions and organizational challenges in sustainable business practices. *Baltic Journal of Management, 9*(3), 357-380. https://doi.org/10.1108/BJM-09-2013-0147

Ibarra, D., Ganzarain, J., & Igartua, J. I. (2018). Business model innovation through Industry 4.0: A review. *Procedia Manufacturing, 22*, 4-10. https://doi.org/10.1016/j.promfg.2018.03.002

International Financial Reporting Standards Foundation/ISSB. (2023). *IFRS S2 Climate-related Disclosures*. IFRS Foundation.

Intergovernmental Panel on Climate Change. (2023). *Climate Change 2023: Synthesis Report. Intergovernmental Panel on Climate Change*. Retrieved from: https://www.ipcc.ch/report/ar6/syr/

Izquierdo-Montfort, J. O., & De Rongé, Y. (2025). Circular business model innovation: Uncovering practices and patterns to retain the value of resources. *Sustainable Production and Consumption, 58*, 188-202. https://doi.org/10.1016/j.spc.2025.06.009

Jabbour, A. B., Jabbour, C., Govindan, K., Kannan, D., & Arantes, A. F. (2014). Mixed methodology to analyze the relationship between maturity of environmental management and the adoption of green supply chain management in Brazil. *Resources, Conservation and Recycling, 92*, 255-267. https://doi.org/10.1016/j.resconrec.2014.02.004

Kaplan, R. S., & Norton, D. P. (1992). The balanced scorecard—Measures that drive performance. *Harvard Business Review, 70*(1), 71-79. https://www.hbs.edu/faculty/Pages/item.aspx?num=9161

Katebi, A., Eghdam, H. H., Baseri, H., & Salehi, A. M. (2024). The relationship between innovation and organizational performance: A meta-analysis. *Journal of Management & Organization, 30*(6), 2474-2494. https://www.hbs.edu/faculty/Pages/item.aspx?num=9161

Kesidou, E., Krammer, S. M. S., & Wu, L. (2024). Subnational institutions, firm capabilities and eco-innovation. *Industrial and Corporate Change, 33*(6), 1460–1486. https://doi.org/10.1093/icc/dtae016

Khan, I. S., Ahmad, M. O., & Majava, J. (2021). Industry 4.0 and sustainable development: A systematic mapping of triple bottom line, Circular Economy and Sustainable Business Models perspectives. *Journal of Cleaner Production, 297*. https://doi.org/10.1016/j.jclepro.2021.126655

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

Kim, N., Im, S., & Slater, S. F. (2013). Impact of knowledge type and strategic orientation on new product creativity and advantage in high-technology firms. *Journal of Product Innovation Management, 30*(1), 136-153. https://doi.org/10.1111/j.1540-5885.2012.00992.x

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford Publications.

Kuchinka, D. G., Balazs, S., Gavriletea, M. D., & Djokic, B. B. (2018). Consumer attitudes toward sustainable development and risk to brand loyalty. *Sustainability, 10*(4), 997. https://doi.org/10.3390/su10040997

Larbi-Siaw, O., Xuhua, H., & Donkor, D. O. (2023). Attaining sustainable business performance via eco-innovation under ecological regulatory stringency and market turbulence. *Journal of Cleaner Production, 394*, 136404. https://doi.org/10.1016/j.jclepro.2023.136404

Lee, I., & Lee, K. (2015). The Internet of Things (IoT): Applications, investments, and challenges for enterprises. *Business Horizons, 58*(4), 431-440. https://doi.org/10.1016/j.bushor.2015.03.008

Lee, K. H., & Min, B. (2015). Green R&D for eco-innovation and its impact on carbon emissions and firm performance. *Journal of Cleaner Production, 108*, 534-542. https://doi.org/10.1016/j.jclepro.2015.05.114

Li, C. R., Liu, Y. Y., Lin, C. J., & Ma, H. J. (2016). Top management team diversity, ambidextrous innovation and the mediating effect of top team decision-making processes. *Industry and Innovation, 23*(3), 260-275. https://doi.org/10.1080/13662716.2016.1144503

Lichy, J., Kachour, M., & Stokes, P. (2023). Questioning the business model of sustainable wine production: The case of French 'Vallée du Rhône' wine growers. *Journal of Cleaner Production, 417*. https://doi.org/10.1016/j.jclepro.2023.137891

Lindell, M. K., & Whitney, D. J. (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology, 86*(1), 114–121. https://psycnet.apa.org/doi/10.1037/0021-9010.86.1.114

Little, T. D., Bovaird, J. A., & Widaman, K. F. (2006). On the merits of orthogonalizing powered and product terms: Implications for modeling interactions among latent variables. *Structural Equation Modeling, 13*(4), 497–519. https://doi.org/10.1207/s15328007sem1304_1

Liu, H., Zhang, J., & Lei, H. (2023). Crowding in or crowding out? The effect of imported environmentally sound technologies on indigenous green innovation. *Journal of Environmental Management, 345*, 118579. https://doi.org/10.1016/j.jenvman.2023.118579

Markides, C. (2006). Disruptive innovation: In need of better theory. *Journal of Product Innovation Management, 23*(1), 19-25. https://doi.org/10.1111/j.1540-5885.2005.00177.x

Marrucci, L., Daddi, T., & Iraldo, F. (2022). Do dynamic capabilities matter? A study on environmental performance and the circular economy in European certified organisations. *Business Strategy and the Environment, 31*(6), 2641–2657. https://doi.org/10.1002/bse.2997

Martín-de-Castro, G. (2015). Knowledge management and innovation in knowledge-based and high-tech industrial markets: The role of openness and absorptive capacity. *Industrial Marketing Management, 47*, 143-146. https://doi.org/10.1016/j.indmarman.2015.02.032

Milgrom, P., & Roberts, J. (1995). Complementarities and fit strategy, structure, and organizational change in manufacturing. *Journal of Accounting and Economics, 19*(2-3), 179-208. https://doi.org/10.1016/0165-4101(94)00382-F

Moschetti, R., Brattebø, H., Skeie, K. S., & Lien, A. G. (2018). Performing quantitative analyses towards sustainable business models in building energy renovation projects: Analytic process and case study. *Journal of Cleaner Production, 199*, 1092-1106. https://doi.org/10.1016/j.jclepro.2018.06.091

Moutinho, R., Au-Yong-Oliveira, M., Coelho, A., & Manso, J. P. (2015). The role of regional innovation systems (RIS) in translating R&D investments into economic and employment growth. *Journal of Technology Management and Innovation, 10*(2), 9-23. https://doi.org/10.4067/S0718-27242015000200002

Nanda, T., Gupta, H., Singh, T. P., Kusi-Sarpong, S., Jabbour, C. J. C., & Cherri, A. (2019). An original framework for strategic technology development of small manufacturing enterprises in emerging economies. *Benchmarking: An International Journal, 27*(2), 781-816. https://doi.org/10.1108/BIJ-02-2019-0074

Naranjo-Valencia, J. C., Jiménez-Jiménez, D., & Sanz-Valle, R. (2011). Innovation or imitation? The role of organizational culture. *Management Decision, 49*(1), 55-72. https://doi.org/10.1108/00251741111094437

National Aeronautics and Space Administration (2021). *Scientific consensus: Earth's climate is warming.* https://climate.nasa.gov/scientific-consensus/

Navas-Alemán, L. (2011). The impact of operating in multiple value chains for upgrading: The case of the Brazilian furniture and footwear industries. *World Development, 39*(8), 1386-1397. https://doi.org/10.1016/j.worlddev.2010.12.016

Nguyen, N. P., & Adomako, S. (2021). Environmental proactivity, competitive strategy, and market performance: The mediating role of environmental reputation. *Business Strategy and the Environment, 30*(4), 2008-2020. https://doi.org/10.1002/bse.2729

Nidumolu, R., Prahalad, C. K., & Rangaswami, M. R. (2009). Why sustainability is now the key driver of innovation. *Harvard Business Review, 87*(9), 56-64. https://www.hbs.edu/faculty/Shared%20Documents/conferences/2015-strategy-research/Why%20Sustainability%20is%20Now%20the%20Key%20Driver%20of%20Innovation.pdf

Ninlawan, C., Seksan, P., Tossapol, K., & Pilada, W. (2010). The implementation of green supply chain management practices in the electronics industry. In World Congress on Engineering 2012 (Vol. 2182, pp. 1563-1568). *International Association of Engineers*.

Nunnally, J. C. (1978). An overview of psychological measurement. In *Clinical Diagnosis of Mental Disorders* (pp. 97-146). Springer Nature.

Oduro, S. (2024). Eco-innovation and SMEs' sustainable performance: A meta-analysis. *European Journal of Innovation Management, 27*(9), 248–279. https://doi.org/10.1108/EJIM-11-2023-0961

Oliveira-Dias, D., Kneipp, J. M., Bichueti, R. S., & Gomes, C. M. (2022). Fostering business model innovation for sustainability: A dynamic capabilities perspective. *Management Decision, 60*(13), 105-129. https://doi.org/10.1108/MD-05-2021-0590

Organisation for Economic Co-operation and Development/Eurostat. (2018). *Oslo Manual 2018: Guidelines for collecting, reporting and using data on innovation (4th ed.).* OECD Publishing. https://www.oecd.org/en/publications/2018/10/oslo-manual-2018_g1g9373b.html

Osterwalder, A., Pigneur, Y., & Tucci, C. L. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems, 16*(1), 1-25. https://doi.org/10.17705/1CAIS.01601

Pacheco, D. A. J., Caten, C. S., Jung, C. F., Navas, H. V. G., & Cruz-Machado, V. A. (2018). Eco-innovation determinants in manufacturing SMEs from emerging markets: Systematic literature review and challenges. *Journal of Engineering and Technology Management, 48*, 44-63. https://doi.org/10.1016/j.jengtecman.2018.04.002

Pal, R., & Gander, J. (2018). Modelling environmental value: An examination of sustainable business models within the fashion industry. *Journal of Cleaner Production, 184*, 251-263. https://doi.org/10.1016/j.jclepro.2018.02.001

Palmié, M., Aebersold, A., Oghazi, P., Pashkevich, N., & Gassmann, O. (2025). Digital-sustainable business models: Definition, systematic literature review, integrative framework and research agenda from a strategic management perspective. *International Journal of Management Reviews, 27*(3), 346-374. https://doi.org/10.1111/ijmr.12380

Parida, V., Westerberg, M., & Frishammar, J. (2012). Inbound open innovation activities in high-tech SMEs: The impact on innovation performance. *Journal of Small Business Management, 50*(2), 283-309. https://doi.org/10.1111/j.1540-627X.2012.00354.x

Paula, F. D. O., & Silva, J. F. D. (2018). Balancing internal and external R&D strategies to improve innovation and financial performance. *BAR-Brazilian Administration Review, 15*(2), 1-26. https://doi.org/10.1590/1807-7692bar2018170129

Plank, A., & Teichmann, K. (2018). A facts panel on corporate social and environmental behavior: Decreasing information asymmetries between producers and consumers through product labeling. *Journal of Cleaner Production, 177*, 868-877. https://doi.org/10.1016/j.jclepro.2017.12.195

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879-903. https://doi.org/10.1037/0021-9010.88.5.879

Porter, M. E. (1989). How competitive forces shape strategy. In *Readings in Strategic Management* (pp. 133-143). Palgrave.

Porter, M. E. (2008). *Competitive advantage: Creating and sustaining superior performance.* Simon and Schuster.

Porter, M. E. (2010). *Competitive strategy: Techniques for analyzing industries and competitors*. Free Press.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives, 9*(4), 97-118. https://doi.org/10.1257/jep.9.4.97

Prajogo, D., Chowdhury, M., Yeung, A. C., & Cheng, T. C. (2012). The relationship between supplier management and firm's operational performance: A multi-dimensional perspective. *International Journal of Production Economics, 136*(1), 123-130. https://doi.org/10.1016/j.ijpe.2011.09.022

Pujari, D. (2006). Eco-innovation and new product development: Understanding the influences on market performance. *Technovation, 26*(1), 76-85. https://doi.org/10.1016/j.technovation.2004.07.006

Quintana-García, C., & Benavides-Velasco, C. A. (2011). Knowledge organisation in R&D alliances: Its impact on product innovation. *Technology Analysis and Strategic Management, 23*(10), 1047-1061. https://doi.org/10.1080/09537325.2011.621300

Rathobei, K. E., Ranängen, H., & Lindman, Å. (2024). Stakeholder integration in sustainable business models to enhance value delivery for a broader range of stakeholders. *Business Strategy and the Environment, 33*(4), 3687-3706. https://doi.org/10.1002/bse.3651

Richard, P. J., Devinney, T. M., Yip, G. S., & Johnson, G. (2009). Measuring organizational performance: Towards methodological best practice. *Journal of Management, 35*(3), 718-804. https://doi.org/10.1177/0149206308330560

Richardson, J. (2008). The business model: An integrative framework for strategy execution. *Strategic Change, 17*, 133-144. https://doi.org/10.1002/jsc.821

Ritala, P., Huotari, P., Bocken, N., Albareda, L., & Puumalainen, K. (2018). Sustainable business model adoption among S&P 500 firms: A longitudinal content analysis study. *Journal of Cleaner Production, 170*, 216-226. https://doi.org/10.1016/j.jclepro.2017.09.159

Ritala, P., Olander, H., Michailova, S., & Husted, K. (2015). Knowledge sharing, knowledge leaking and relative innovation performance: An empirical study. *Technovation, 35*(1), 22-31. https://doi.org/10.1016/j.technovation.2014.07.011

Roscoe, S., Cousins, P. D., & Lamming, R. C. (2016). Developing eco-innovations: A three-stage typology of supply networks. *Journal of Cleaner Production, 112*, 1948-1959. https://doi.org/10.1016/j.jclepro.2015.06.125

Sabatier, V., Medah, I., Augsdorfer, P., & Maduekwe, A. (2017). Social business model design and implementation in developing countries: Learning from an affordable medicine developed in Burkina Faso. *Journal of Management Development, 36*(1), 48-57. https://doi.org/10.1108/JMD-03-2015-0041

Sarasini, S., Bocken, N., Diener, D., Velter, M., & Whalen, K. (2024). Reviewing the climatic impacts of product service systems: Implications for research and practice. *Journal of Cleaner Production, 452*, 142119. https://doi.org/10.1016/j.jclepro.2024.142119

Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business cases for sustainability: The role of business model innovation for corporate sustainability. *International Journal of Innovation and Sustainable Development, 6*(2), 95-119. https://doi.org/10.1504/IJISD.2012.046944

Schiederig, T., Tietze, F., & Herstatt, C. (2012). Green innovation in technology and innovation management–An exploratory literature review. *R&D Management, 42*(2), 180-192. https://doi.org/10.1111/j.1467-9310.2011.00672.x

Schwab, K. (2017). *The fourth industrial revolution.* Crown Business.

Song, L., Yu, Y., Li, T., & Zhang, J. (2025). Crowding out Sustainability? The trade-off between digital technology innovation and CO2 Emissions: Firm-level evidence. *Journal of Cleaner Production, 523*, 146441. https://doi.org/10.1016/j.jclepro.2025.146441

Sun, H., & Chu, X. (2022). Industry 4.0 powered process technology innovation, firm's leanness, and eco-environmental performance during the COVID-19 phase. *Frontiers in Environmental Science, 10*, 902182. https://doi.org/10.3389/fenvs.2022.902182

Taherdoost, H. (2016). Validity and reliability of the research instrument; How to test the validation of a questionnaire/survey in a research. *International Journal of the Academic Research Management, 5*(3), 28-36. https://doi.org/10.2139/ssrn.3205040

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319-1350. https://doi.org/10.1002/smj.640

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40-49. https://doi.org/10.1016/j.lrp.2017.06.007

Terjesen, S., & Patel, P. C. (2017). In search of process innovations: The role of search depth, search breadth, and the industry environment. *Journal of Management*, *43*(5), 1421-1446. https://doi.org/10.1177/0149206315575710

Testa, F., & Iraldo, F. (2010). Shadows and lights of GSCM (Green Supply Chain Management): Determinants and effects of these practices based on a multi-national study. *Journal of Cleaner Production, 18*(10-11), 953-962. https://doi.org/10.1016/j.jclepro.2010.03.005

Todeschini, B. V., Cortimiglia, M. N., Callegaro-de-Menezes, D., & Ghezzi, A. (2017). Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges. *Business Horizons, 60*(6), 759-770. https://doi.org/10.1016/j.bushor.2017.07.003

Tolkamp, J., Huijben, J. C. C. M., Mourik, R. M., Verbong, G. P. J., & Bouwknegt, R. (2018). User-centred sustainable business model design: The case of energy efficiency services in the Netherlands. *Journal of Cleaner Production, 182*, 755-764. https://doi.org/10.1016/j.jclepro.2018.02.032

Tomlinson, P. R. (2010). Co-operative ties and innovation: Some new evidence for UK manufacturing. *Research Policy, 39*(6), 762-775. https://doi.org/10.1016/j.respol.2010.02.010

Tsai, K. H., & Liao, Y. C. (2017). Innovation capacity and the implementation of eco-innovation: Toward a contingency perspective. Business *Strategy and the Environment, 26*(7), 1000-1013. https://doi.org/10.1002/bse.1963

Tukker, A. (2004). Eight types of product–service system: Eight ways to sustainability? Experiences from SusProNet. *Business Strategy and the Environment, 13*(4), 246-260. https://doi.org/10.1002/bse.414

Venkatraman, N., & Ramanujam, V. (1986). Measurement of business performance in strategy research: A comparison of approaches. *Academy of Management Review, 11*(4), 801-814. https://doi.org/10.5465/amr.1986.4283976

Vezzoli, C., Ceschin, F., Diehl, J. C., & Kohtala, C. (2015). New design challenges to widely implement 'Sustainable Product–Service Systems'. *Journal of Cleaner Production, 97*, 1-12. https://doi.org/10.1016/j.jclepro.2015.02.061

Vivanco, D. F., Kemp, R., & van der Voet, E. (2015). The relativity of eco-innovation: Environmental rebound effects from past transport innovations in Europe. *Journal of Cleaner Production, 101*, 71-85. https://doi.org/10.1016/j.jclepro.2015.04.019

Wall, T. D., Michie, J., Patterson, M., Wood, S. J., Sheehan, M., Clegg, C. W., & West, M. (2004). On the validity of subjective measures of company performance. *Personnel Psychology, 57*(1), 95-118. https://doi.org/10.1111/j.1744-6570.2004.tb02485.x

World Commission on Environment and Development. (1987). *Our common future: World Commission on Environment and Development*. Oxford University Press. https://global.oup.com/academic/product/our-common-future-9780192820808

Williams, L. J., Hartman, N., & Cavazotte, F. (2010). Method variance and marker variables: A review and comprehensive CFA marker technique. *Organizational Research Methods, 13*(3), 477–514. https://doi.org/10.1177/1094428110366036

World Economic Forum. (2024). *Global risks report 2024. Geneva: World Economic Forum*. https://www.weforum.org/reports/global-risks-report-2024/

Wu, Y., Zhang, M., & Wang, Z. (2024). Technological innovation and environmental performance: evidence from China. *Industrial Management & Data Systems, 124*(5), 1746-1768. https://doi.org/10.1108/IMDS-11-2023-0804

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, *27*(2), 185-203. https://doi.org/10.2307/4134351

Zhang, W., Zhu, B., Li, Y., & Yan, D. (2024). Revisiting the Porter hypothesis: a multi-country meta-analysis of the relationship between environmental regulation and green innovation. *Humanities and Social Sciences Communications, 11*, 1-15. https://doi.org/10.1057/s41599-024-02671-9

Zheng, L., & Iatridis, K. (2022). Friends or foes? A systematic literature review and meta-analysis of the relationship between eco-innovation and firm performance. *Business Strategy and the Environment, 31*(4), 1838-1855. https://doi.org/10.1002/bse.2986

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APPENDIX I

Tabela 1. Constructs and variables.

Construct	Variable	Code	Theoretical sources
Eco-innovation strategic orientation	Regard the firm where you work... our company allocates adequate resources for new green innovation initiatives/activities...	ESO1	Hsu et al. (2016); Testa and Iraldo (2010)
	there are emphasizes on process innovation that promotes green initiatives	ESO2	
	our top management emphasizes product innovation that promotes green initiatives	ESO3	
	green life-cycle assessment is an important criterion while developing new products	ESO4	
	our company competes on innovative driven goals and green initiatives.	ESO5	
	our company aggressively conducts training and education in innovation-based green initiatives.	ESO6	
Classical innovation strategic orientation	Considering to your company's innovation capability...		Calantone et al. (2002)
	our company frequently tries out new ideas.	ISO1	
	our company seeks out new ways to do things.	ISO2	
	our company is creative in its methods of operation.	ISO3	
	our company is often the first to market with new products and services.	ISO4	
	innovation in our company is very stimulated.	ISO5	
Eco-innovation	My company...		Hsu et al. (2016); Kiefer et al. (2017); Ninlawan et al. (2010)
	produces products with reused or recycled contents such as recycled plastics and glass.	EI1	
	uses life-cycle assessment to evaluate the environmental load of products.	EI2	
	produces products that are free of hazardous substances, such as lead, mercury, etc.	EI3	
	designs products to ensure they have recyclable or reusable contents.	EI4	
	produces products that reduce the consumption of materials and energy during use.	EI5	
	reduces power consumption in products during manufacturing and transportation.	EI6	
	increases product life-span resulting in higher efficiency and productivity.	EI7	
Operational performance	Compared to our competitors ...		Calantone et al. (2002); Prajogo et al. (2012)
	our operating costs are lower.	OP1	
	our prices of products / services are more competitive.	OP2	
	we have better compliance with product / service specifications	OP3	
	we have better product quality / service performance	OP4	
	we have better delivery time	OP5	
	we have better speed of delivery	OP6	
	we have better flexibility of production capacity	OP7	
	we have the best range of products / service	OP8	
Environmental performance	About your company in the last three years, please answer:		Golini et al. (2018); Navas-Alemán (2011)
	water consumption has decreased substantially.	EP1	
	water pollution has decreased substantially.	EP2	
	energy consumption has decreased substantially.	EP3	
	raw material consumption has decreased substantially.	EP4	
	waste production has decreased substantially.	EP5	
	atmospheric pollutants emission has decreased substantially.	EP6	
	soil degradation has decreased substantially.	EP7	